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Trauma and Interpersonal Violence in Ancient Nubia during the Kerma Period (ca. 2500-1500 BC)

by

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ABSTRACT

Interpersonal violence is a critical social and health problem in modern society, and as a result has generated a wealth of research that facilitates the interpretation of interpersonal violence among ancient societies. The dual goals of this investigation were to develop critical methods of evaluating interpersonal violence, and to integrate these methods into the assessment of interpersonal violence among the ancient Nubians of the Kerma period (ca. 2500-1500 BC), an era of trade and conquest between Egypt and Upper Nubia.

A general trauma analysis of all bones revealed that violence-related injuries (skull trauma, the ulna parry fracture, and multiple injuries) were comparatively high among both rural (n = 55) and urban (n = 223) people of the Kerma culture in contrast to other Nile Valley skeletal samples, and may have been influenced by violence-associated activities at the state level. Skull vault injuries were common, but few facial injuries were observed in contrast to the clinical pattern, which suggested a culturally distinctive pattern of inflicting injury. Skull fractures among the urban people were more severe than those of the rural residents, which implicated inanimate objects as an alternative to the hands and feet as a weapon for inflicting injury on the urban people, and this choice may have been associated with status. Multiple injuries were evaluated using the clinical model of "injury recidivism" or repeat trauma, and the pattern observed among the ancient Nubians closely resembled that revealed in the clinical realm. This clinical model promises to increase the dimensions of our interpretation of past multiple injury

distribution at the populational level due to intentional as well as accidental injury mechanisms.

This investigation emphasised the value of critically examining all traumatic lesions when attempting to interpret behaviour in past societies, particularly interpersonal violence. State-sanctioned violence during the Kerma period was shown to be associated with a high frequency of nonlethal intentional injuries among both rural and urban people; however, the existence of interpersonal violence in ancient and modern societies represents the confluence of multiple sociocultural and environmental factors, further tempered by the individual's behaviour and past experiences.

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CHAPTER 1
Introduction

Trauma, accompanied by osteoarthritis and dental disease, forms a trinity of the most frequently observed disease processes among ancient humans; however, recording and interpretation problems continue to plague palaeotrauma analysis, and as Lovell (1997) and Jurmain (1999, 185-230) observed, critical evaluation using all available diagnostic information is sadly lacking. This investigation responded to many of their concerns in the assessment of interpersonal violence among two communities, one rural and one urban, of ancient Nubia's Kerma period (ca. 2500-1500 BC).

Ancient Nubia's earliest complex society emerged during the Kerma period amidst an era of Nubian culture history that was exceptionally volatile and aggressive at the state level, and, therefore, the Kerma period presents a viable venue from which to assess interpersonal violence. Human and animal sacrificial burials, weaponry skills (such as archery), military culture, and involvement in the Nile slave trade characterised this society, whose political and economic ambitions for control of the Nile trade were stringently monitored by Egypt. Although the causes of violence are multifactorial, a "culture of violence," such as that recorded archaeologically and historically for the Kerma society, is considered to be one factor that catalyses violence at the domestic and interpersonal levels, and eventually permeates into the surrounding rural hinterland where people of the same culture reside. It was within this theoretical realm that interpersonal violence was assessed for the ancient Kerma culture using clinical models from developing and developed countries.

Clinical literature is indispensable to bioarchaeologists in the identification and evaluation of palaeotrauma, particularly interpersonal violence, which is reaching epidemic proportions among our own society, and therefore, has become a dynamic area of inquiry among clinical researchers. Injuries of violence (cranial fractures, forearm fractures, and multiple injuries) observed by clinicians, and later identified by bioarchaeologists studying palaeotrauma, were profiled for the two Kerma communities and compared to the trauma sequence for Upper Nubia in order to ascertain whether the level of violence was higher during the Kerma period, and by inference, was associated with documented high levels of state-sanctioned violence. Minor injuries and multiple injury patterns, often neglected in palaeotrauma research, were evaluated as potential sources for the recognition of interpersonal violence within ancient societies.

Chapter 2 recounts the development of archaeological interest in Upper Nubia and traces the cultural historical sequence for this region commencing from the Palaeolithic period until the termination of the Kerma culture in 1520 BC. Chapter 3 discusses the role of clinical and nonhuman primate research in enhancing the interpretation of ancient trauma with an emphasis on interpersonal violence. Skeletal indicators of interpersonal violence are categorised and selected cases from a broad spectrum of palaeotrauma literature are presented to demonstrate the integration of the palaeoepidemiological patterns of trauma with the culture history of the society. Finally, a review of palaeotrauma research at the populational level in the Upper Nubian vicinity is compiled.

The fourth chapter considers the preservation problem among archaeological skeletal collections, first addressed by Lovejoy and Heiple (1981). Here, the long bones and fractures of one skeletal sample are systematically recorded using various recording protocols to ascertain if a meaningful difference in fracture frequency statistics really exists among the methods.

Chapter 5 is concerned with the role of interpersonal violence among the Kerma people in light of their social and ecological environments in comparison to other Nubian samples. Various social theories exist that attempt to explain why humans are violent, but these theories are reduced to two central themes—nature and nurture (e.g., Ember and Ember 1997; Leakey and Lewin 1987; Levinson 1989, 40-41). Because Kerma was known for its human and animal sacrificial burials, involvement in the slave trade, military skills, and penchant for warfare, the presence of nonlethal injuries attributed to interpersonal violence (cranial injury, direct force forearm trauma, and multiple trauma) is expected to be more prevalent among the Kerma skeletal remains than in other skeletal samples from more peaceful contemporary groups.

Sociologists and clinicians have reported that the level of interpersonal violence among rural and urban groups that belong to the same culture is comparable (e.g., Poole et al. 1993; Websdale 1998; Williams et al. 1997; Wladis et al. 1999). Chapter 6 develops the trauma profile for a small rural skeletal collection from a Kerma cultural context under the assumption that trauma due to interpersonal violence would have permeated into the rural society and, therefore, the level of interpersonal violence among the rural people would be comparable to that of the urban group from Kerma, the data of which were presented in Chapter 5. However, trauma due to accident is expected to prevail among the rural residents owing to the more hazardous nature of rural lifestyles as reported in clinical research (e.g., Boyle et al. 1997; Jones 1990; Pratt et al. 1992; Stueland et al. 1997).

Both Lovell (1997) and Jurmain (1999, 215-222) emphasised the necessity for a more rigorous analysis of fractures to facilitate interpretation and comparison, specifically for the "parry" fracture, an injury attributed to fending off a blow to the head. In Chapter 7, the forearm fractures from both of the rural and urban Kerma period samples are classified by qualitative and quantitative criteria, and the proximate cause of injury (direct or indirect force) is proposed for each injured bone. These results are integrated into the general trauma analysis of the rural and urban Nubian groups, and the subsequent analysis of multiple trauma. The usefulness of this detailed analysis is discussed in relation to the results from Chapters 5 and 6.

Multiple trauma analysis is particularly underdeveloped at the populational level in palaeotrauma research, although case studies are bountiful (e.g., Hershkovitz et al. 1996; Wakely 1996). This lacuna is possibly due to the absence of clinical models for accumulated injury. In the past decade, however, clinicians have studied individuals who had repeatedly sought medical attention for injury and based on this research, clinicians have developed a profile of the "injury recidivist" subgroup (e.g., Kaufmann et al. 1998;

Poole et al. 1993; Sims et al. 1989; Williams et al. 1997). The injury recidivist model is employed in Chapter 8 to assess the pattern of multiple injury among the rural and urban samples, and to determine if the demographic, residential, and proximate injury mechanism distributions are comparable among ancient and modern societies.

In summary, this investigation focuses on two central concerns in palaeotrauma research. First, the lack of critical evaluation in trauma recording and analysis is addressed by an evaluation of long bone fracture recording techniques, a quantified assessment of fracture and proximate mechanism identification for the forearm, and a demonstration of a method for evaluating multiple trauma. Second, many of the results of these three analyses are integrated into the general trauma analyses of two skeletal samples from Sudanese Upper Nubia to assess more critically the role of interpersonal violence among ancient Nubians of the Kerma culture.

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CHAPTER 2
Nubian culture history

2.1 Introduction

Napoleon's 1798 invasion of Egypt, and the subsequent discovery and decipherment of the Rosetta stone—the key to Egyptian hieroglyphics—precipitated a passionate curiosity in ancient Egyptian culture among Europeans. Nubia, Egypt's southern trade adversary, was frequently mentioned in the now decipherable Egyptian historical sources and attracted the truly daring adventurer beyond Egypt, just as it had lured the ancient Egyptians thousands of years earlier into its rugged, but resource-laden lands. Because of their common stake in the Nile Valley trade, the historical and archaeological relationship between Egypt and Nubia is intertwined (Table 2.1). This is most obvious with the fluctuating political and economic prosperity between the two nations—when one experienced internal difficulties inimical to trade, the other reaped benefits. Because no known translatable Nubian historic documents exist, Nubia's past unfolds through ancient Egyptian sources, which complement the Nubian version of prehistory extracted from the archaeological record.

2.2 Geopolitical context

The Nile River creates a cultivable land belt 1.5 to 3.0 km wide on both banks that marks the longitudinal boundaries of ancient Nubia, which straddles the modern Egyptian and Sudanese borders (Figure 2.1) (Adams 1977, 22). This valley landscape fluctuates between yellow-brown sandstone and igneous North African Basement Complex, of which granite is the prime component. The erosion of these two geological units has produced a sharply contrasting desert landscape. Areas of exposed granite are characterised by sharp, deep *wadis* (Arabic for "dried river beds") and a steep-walled, narrow riverbed pierced with islands. The eroded sandstone regions are visible as level terraces, shallow *wadis*, expanses of fertile alluvial soil, and a smooth, wide riverbed. The transitional zones, when traversed by the Nile River, appear as cataracts, due to the sharp descent gradient of the water-eroded granite, which creates untamed, rocky waters unsuited to travel.

In antiquity, the First Cataract, located immediately south of Aswan (24°N), severed Egypt from the African interior and functioned as a barricade to any vessel travelling up the Nile from the north. The Second Cataract near Wadi Halfa (22°N) marked the southern boundary of this 370 km stretch of land, now known as Lower Nubia. The area that separates the Second and Third Cataracts—*Batn el Hajar* (Arabic for "belly of rock")—features unnavigable waters that stretch south from the Second Cataract for 100 km towards the Third Cataract; this natural barrier successfully repelled Egyptian invasion until 1520 BC. The expanse between the Third and Fourth Cataracts (known as the Dongola Reach) was particularly hospitable for agriculture and, therefore, was more settled in the past in comparison to the *Batn el Hajar* stretch of land. This region above the Second Cataract, now known as Upper Nubia, was referred to by the ancient Egyptians as "Kush" or "Yam" and was home to the first indigenous state power of Nubia—Kerma (e.g., Adams 1977; Arkell 1955; Kendall 1997; O'Connor 1991).[1]

2.3 Archaeological interest in Nubia

Before Napoleon's invasion of Egypt in 1798 Egypt and Sudan were known to the world only from the observations of classical writers (such as Herodotus), ecclesiastical historians, Arab historians and a small number of European travellers, for example, James Bruce (1805).[2] In 1798, Napoleon entered Egypt with an army of soldiers and scholars, most notably, Dominique Vivant Denon, an accomplished artist and diplomat of the French court. Denon's engravings of ancient Egyptian monuments, combined with the French team's compilation of Egyptian natural history, geography and architecture, resulted in a 24 volume publication—"*La Description de l'Egypte,*" which ignited an interest in ancient Egypt among European scholars and the general public. European travellers and explorers flocked to Egypt and some, such as Johann Burckhardt (1819) in 1813-14 and Belzoni (1821) in 1816-17, ventured south of the First Cataract, the most southerly extent of Napoleon's scholarly campaign. The Egyptian invasion of Sudan in

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[1] During the later Meroitic Period (300 BC-350 AD) Upper Nubia reached the confluence of the Nile Rivers at Khartoum (Adams 1977, 33). The southern boundary of Upper Nubia fluctuates depending on the period investigated and the researcher; for this investigation the boundary is the Fourth Cataract, the most southerly extent of the known Kerma empire.

[2] See Adams (1977, 66-70), Budge (1907, 1-63), and Török (1997, 8-10: notes 7, 20) for a summary of early travellers and writers.

1820 and Sudan's subsequent annexation by Egypt further opened the country, as well as central Africa. Scholars and explorers, such as Cailliaud (1823-1927) and Lepsius (1849-1859) immortalised ancient Nubian ruins in drawings, while Belzoni's (1821) and Ferlini's (Budge 1907, 307-320 present extracts from Ferlini's original pamphlets) discoveries of ancient mummies and treasures are oft-cited in archaeological textbooks, for example, Brewer and Teeter (1999). The Mahdist Revolt (1881-1898), a bid for Sudanese independence and a return to fundamental Islamic beliefs, truncated the Western world's fledgling romance with Sudan, but once the British and Egyptian governments acquired control of Sudan in 1898 under Sir Herbert Kitchener, Sudanese archaeology captured global interest once again (Adams 1977, 625-34).

According to Adams (1996), a complex of factors precipitated modern interest in the archaeological exploration of Sudan. First, the Anglo-Egyptian conquest in 1898 stabilised the area under the British colonial establishment—the "patron" of archaeology. Second, previously unexplored lands beckoned a new generation of adventurers and scholars, not to mention fortune hunters. Third, media coverage of the colonial administration lured European and American interests into the depths of this resource-laden territory. Finally, the construction of the Aswan Dam to regulate water supply at the First Cataract in 1898 had decimated archaeological sites and villages in Lower Nubia. Its reinforcement in 1907 threatened further destruction, which the Egyptian government circumvented by initiating an archaeological survey to discover and record sites that fell below the 115 m contour line along the Nile's banks. George Reisner (1910), an eminent American Egyptologist, led the "Archaeological Survey of Lower Nubia" during the 1907 season; Colin Firth (1912; 1915; 1927) completed the project—151 cemeteries, 8239 graves and three years later.

During this era, Egyptologists in Nubia and Egypt sought monumental architecture, cemeteries, and luxurious artefacts suitable for museum exhibition. Reisner (1910, 11; Reisner et al. 1909, viii) enhanced this traditional approach to archaeology and introduced an era of meticulous and systematic recording methods that many contemporary colleagues, but unfortunately not all, adopted. Reisner (1910) outlined the culture history of Nubia, designated the Nubian cultures alphabetically (A-Group, B-Group, C-Group, and X-Group), and using pottery, he correlated the cultural sequence with the Egyptian chronology. This reconstruction was heavily influenced by two anthropological paradigms of the period (Adams 1977, 91; Török 1997, 13-20; Trigger 1982). "Ethnic prehistory" identified artefacts with a specific ethnic group and attributed variation to migration or diffusion, while "biological determinism," upheld by leading European physical anthropologists, identified race through skeletal material. This intellectual climate, supplemented by the perspective of Reisner's field anatomists, Grafton Elliot Smith and Douglas Derry (Smith 1911; 1923; Smith and Wood-Jones 1910, 15), who regarded all cultures as inferior to that of ancient Egypt, was reflected in Reisner's account of Nubian culture history. Reisner (1910, 348) interpreted the Nubian cultural sequence as a series of fluctuations between periods of achievement during an Egyptian presence and periods of cultural decline (for example, Reisner's B-Group) due to the influx of "primitive" indigenous Africans. The second heightening of the Aswan Dam reinitiated the "Archaeological Survey of Lower Nubia," which was directed by Walter Emery and Laurence Kirwan (1935; 1938) from 1929-1934.

An exploding population in Egypt necessitated an "industrial revolution" to support the masses in the 1950's. A cheap and efficient energy supply was essential and electricity generated through waterpower was the solution, hence the need for yet a larger dam—"El Sad Al'Aly" at Aswan. Fully aware of the potential destruction to Nubian culture and the surrounding environment between the First and Second Cataracts, the newly formed Egyptian and Sudanese governments,[3] assisted by UNESCO, initiated an international pact to save the heritage of Nubia (UNESCO 1960). In a monograph, "Temples and Tombs of Ancient Nubia," Säve-Söderbergh (1987) chronicled the events preceding this international campaign, highlighted monument preservation, and reported the outcome of the High Dam Project. The vast numbers of individuals[4] involved in this project that spanned 20 years from inception, complemented by detailed and frequent publications,

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[3] Egypt was declared a republic on June 18,1953, but remained occupied by British troops until 1956 (Annesley 1994, 436); Sudan became a republic on January 1, 1956 (Woodward 1990, 91).
[4] See Adams (1977, 83-86) for a complete list of the participating institutions.

was characteristic of the renewed interest of the scholar and public alike in ancient Nubian cultures.

2.4 Nubian culture history and archaeology

2.4.1 Palaeolithic

Adams (1977) designated Nubia as the "Corridor to Africa," but some scholars consider the Nile Valley to be a "Corridor Out-of-Africa"—the route taken by early humans to emigrate into Europe and Asia during the pluvial periods (e.g., Adams 1977, 102-3; Krings et al. 1999; Stringer 1990; VanPeer 1998).[5] Ironically, skeletal evidence for this is meagre and the earliest date for anatomically modern humans in the entire Nile Valley is 55,000 BC at Taramsa Hill near the Qena Bend in Upper Egypt (Figure 2.2) (Vermeersch et al. 1998). The earliest skeletal remains from Nubia were found 12 km north of Aswan at Wadi Kubbaniya and date to the Late Palaeolithic, about 20,000 BP. The isolated, partially exposed, rectangular pit grave contained a solitary young male adult, laid face down and extended, with his head to the east, and two bladelets in the abdominal area (Angel and Kelley 1986; Wendorf and Schild 1986).

The first evidence for the organised burial of the dead in Nubia was at Toshka, north of Wadi Halfa, which was dated to the Qadan culture[6] of the Nubian Final Palaeolithic period (ca. 12500-9000 BC) (Nordström 1972, 7; Shinnie 1996, 25). Here, 19 single, randomly oriented, flexed inhumations that had become exposed to erosive elements were recovered. Wild cattle horn cores located on the surface above two skulls implied grave offerings, but the association was ambiguous (Wendorf 1968a, 1048-1053). Sahaba, 3.0 km north of Wadi Halfa, featured a later cemetery (Site 117) where thin sandstone slabs were piled on graves that were about 40 cm deep. These shallow open pits contained one to four contracted individuals laid on their left sides, head to the east, and facing south. Over 110 stone points or barbs penetrated the vertebrae, thoraxes, arms, and skulls of 24 out of 59 adults and children, while the burial fills produced a further 73

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[5] The age of the Nile River's formation continues to be debated (Adams 1977, 103; Schild and Wendorf 1986).

[6] The Qadan culture represented the apogee of the economic shift to sedentism and evidence for the use of wild cereals (Nordström 1972, 7; Shinnie 1996, 25).

loose lithics (Anderson 1968; Wendorf 1968b). This cemetery established the precedent for cemetery and burial configuration in ancient Nubia as follows (Geus 1991, 57):

1. formal cemeteries were set aside for the dead,
2. the dead were buried in small circular pits with a stone covering,
3. the body was uniformly placed on its side in a flexed position,
4. multiple burials were common,
5. the cemetery contained adults and children.

2.4.2 Mesolithic

The archaeological record is silent in Upper Nubia during the Mesolithic period, but fortunately the Sixth Cataract region is well researched and provides continuity for later Nubian cultural development. The Khartoum Mesolithic (ca. 8000-5000 BC) culture, characterised by the appearance of microlithic technology and pottery, but absence of plant and animal domestication, emerged at the end of the Palaeolithic period. This period was identified by Adamson et al. (1974), who conducted a systematic environmental survey of the Gezira Plain, south of Khartoum. The Mesolithic sites, typically positioned along *wadis* and adapted to a riverine economy, were often disturbed by later Meroitic cemeteries (ca. 300 BC-350 AD) (Figure 2.3). Cultural remnants, such as scrapers, microliths, small grinders, hammerstones, perforated reused ceramic discs, and bone and composite tools, attested to the fishing and collecting economy; wild animals that favoured wet climates complemented the diet. The most dramatic economic modification of the Mesolithic period—pottery making—foreshadowed increased sedentism in the south. The distinctive catfish combed "wavy line" pottery in the 9th –8th millennium BC, followed by the "dotted wavy-line" pottery during the 7th millennium BC littered the Sixth Cataract region at the Khartoum Hospital (Arkell 1949), Karima (el-Tayeb 1998), Geili (Caneva 1988), and the Atbara sites (Haaland 1992).[7]

The Mesolithic burials of the south contradicted the earlier Lower Nubian model represented by the Qadan culture. The dead were buried in unmarked shallow pits that were situated under or between mudbrick structures within the settlement. Orientation

[7] Khartoum Mesolithic pottery has also been found in the western Sahara (Adams 1977, 112).

was random and variation occurred in the burial position: the hands were placed in front of the face of the tightly contracted bodies at Damer (Haaland and Magid 1991), while Clark (1989) found individuals prone with legs flexed and hands away from the face at Shabona. One grave from Damer contained a flexed body oriented with the head to the west and facing north; a northerly facing gazelle's skull was placed beside the individual's feet (Haaland and Magid 1991).

2.4.3 Neolithic

The Neolithic culture of the Sudanese Nile Valley (ca. 5700-3000 BC) is best represented in the south at Kadero (Krzyzaniak 1996; Reinold and Krzyzaniak 1997), Kadada (Geus 1980), and Geili (Caneva 1988) (Figure 2.3). These sites, located near Khartoum and dating to the beginning of the 5^{th} millennium BC, document socioeconomic changes that became intrinsic to subsequent Nubian cultures: widespread farming, domestication, social stratification, and complex burial practices. Means of survival varied throughout the Khartoum Neolithic, with fishing heavily entrenched from the Mesolithic. By about 3,300 BC, however, archaeological evidence for aquatic subsistence declined, while domestication of livestock increased. Kadero, probably the best-documented Neolithic site, featured a domestic faunal assemblage dominated by 80% cattle, followed by sheep, dog, and goat; antelope, river turtles, and big game augmented the diet (Krzyzaniak 1996). Pottery impressions of sorghum and watermelon seed, in addition to numerous grindstones, confirmed some reliance on domesticated plants (Klichowska 1978; Stemler 1990). Zakiab, a nearby Neolithic site, featured fishing equipment, butchered domestic animals, and Kadero-manufactured pottery. Based on her observations of the modern cattle-raising Nuer people, Haaland (1987; 1991) proposed that the southern settlements formed a network of small dry-season fishing/herding camps associated with diversified stationary base camps where residents manufactured pottery, processed grains with grindstones, butchered meat, and buried their dead.

Like subsistence strategies, burial practices were also heterogeneous. Formal cemeteries, established external to the main settlement, contained clusters of pit graves (1.0-2.0 m diameter) such as the cemeteries at Kadero (Krzyzaniak 1992), Geili (Caneva 1992), and

Ghaba (Lecointe 1987). Variation in distribution and quality of grave goods, particularly among children's burials, indicated that status was hereditary rather than achieved among these Neolithic groups. Each grave from the cemetery at Ghaba held one randomly oriented, centrally placed, and contracted individual. Items interred with the body comprised personal jewellery (bracelets, ivory anklets, necklaces, and lip plugs), mace heads, palettes, inverted and nested ceramic vessels, bone tools, fresh water mollusc shells, clay figurines, and malachite fragments; cattle bucrania (bovid skulls with horns intact) rested beside the skull. Colour flecked the burial: malachite residue coated the skull and teeth, red ochre pigments appeared on the bones and sediment, while a white substance, possibly palm fronds, lay under the skull and feet. At Kadada, a later cemetery, the flexed, randomly oriented body was placed on a mat in a simple round or oval pit, 0.8 to 2.0 m in diameter. Notable differences in grave good placement and inventory at Kadada included upright standing vessels; chunks of malachite and ochre were found in palettes or in the hands of the individual, but not on the skin; female ceramic figurines appeared; burials were multiple; and dogs and goats were buried beside the bucrania. Within the community, pottery vessels contained deceased children (younger than six years old) accompanied by beads, shells, pottery, and ostrich eggs (Geus 1980; Reinold 1987; 1991; Reinold and Krzyzaniak 1997). Krzyzaniak (1992) distinguished four burial artefact assemblages among the 160 graves excavated at Kadero:

1. no grave goods,
2. one functional pot only,
3. children's burials with one to three vessels and personal ornaments such as a carnelian necklace or malachite nuggets,
4. elite, deeply-dug burials (10% of the sample including men, women, and children) with incised, red polished fineware, Red Sea shell diadems, ivory jewellery, palettes with malachite, porphyry maceheads, rhyolite axe-heads, and bone harpoon heads.

A distinction between social classes had indeed emerged by the end of the Neolithic period.

Evidence for the Neolithic period is particularly sparse in Lower Nubia and sites are identified by small nonpermanent camps in close proximity to the Nile River (Figure 2.4). The people of these small riverside camps relied on fishing in addition to wild animals such as cattle, elephant, and hippo are known and each was associated with pottery. Abka, near Wadi Halfa, was linked with the Qadan culture, based on the large quantities of borers and diagnostic groovers recovered. The earliest burnished and rippled pottery in Nubia originated here, while the "wave-and-dot motif" or "Khartoum Variant" pottery denoted a southern influence (Nordström 1972, 8-12, 14; Reinold and Krzyzaniak 1997, 13; Shinnie 1996, 40).

Kadruka, situated above the Third Cataract produced the most complete picture of the Neolithic in Upper Nubia (Figure 2.4). Erosion devastated much of the settlement, but fortunately the burial shafts were deep and thus, well preserved (Reinold 1998; Reinold and Krzyzaniak 1997). The 102 flexed bodies were laid on their left side, but Reinhold (1994) discerned two distinct groups of graves that formed concentric rings around a central grave that was much deeper and richer in comparison. Pottery, meat cuts, and bucrania were found in all burials, but the interior ring group, Group A, which contained 90% male burials, possessed unique grave goods, such as bone-handled tools, ivory combs, shell belts, quartz-beaded necklaces, ivory and diorite palettes, human figurines, and mace heads. The central burial contained a middle-aged adult male, one out of five individuals that faced north. The perimeter of his burial pit was surrounded by isolated clusters of offerings, which included an anthropomorphic figurine and a piece of coloured paint; three mace heads, a small axe, and shells; a paint case, a bone handle and needle, and a small ivory axe; and finally, a group of four mace heads. The body was laid on a yellow-coloured ox-hide and wore an elephant tusk bracelet, six ivory bracelets, and an agate necklace. The body was interred with two bucrania, two maceheads, a polished stone pestle, assorted goblets, and paint palettes (Reinold 1994). The configuration of this cemetery and associated grave goods signalled a hierarchical society, likely controlled by a single chief, and foreshadowed the burial program of the Kerma Period. The presence of the A-Group people (ca. 3700 BC) signified the Neolithic demise in Lower Nubia and the commencement of the Protohistoric period in the middle Nile Valley.

2.4.4 A-Group

According to Adams (Adams 1977, 118-129) the A-Group culture is distinguished from the Neolithic by:

1. grain cultivation,
2. domestic permanent architecture,
3. distinctive burnished pottery with a red rippled exterior and black interior,
4. increased grave good frequency and social stratification in burials,
5. copper artefacts,
6. trade with Egypt.

Because no historical evidence was available that named these ancient people,[8] Reisner (1923a) labelled them as the A-Group, the first Nubian society contemporary with the Predynastic Egyptian Nagada culture, and according to Reisner, they were likely Egyptian immigrants. Later excavators, however, observed continuity among the earlier Abkan, Qadan, and Khartoum cultures with the A-Group based on pottery, lithics, and mortuary configurations to establish indigenous Nubian origins (e.g., Adams 1977; Gratien 1978; Nordström 1972; Trigger 1976; Williams 1989).

Diverse ecofacts illustrated that the residents hesitated to commit to one form of subsistence. Incipient agriculturists harvested wheat, barley, and legumes, but occasionally supplemented their diet with goat or cattle, whose dung served as a common pottery temper diagnostic of A-Group ceramics (Nordström 1972, 19, 23-24). Fishing retained popularity and copper hooks appeared. Other copper implements such as adzes, axes, needles, knives, and awls scattered Lower Nubia, although no traces of copper mining or manufacturing were discovered (Gratien 1978, 299). Gold objects were recovered at Seyala in the form of two hammered mace handles—a definitive symbol of individual achievement or status (Firth 1927, 207) (Figure 2.4). Domestic and storage structures formed the earliest permanent Nubian dwellings with small circular huts the norm. At Afyeh, isolated rectangular structures grew to six rooms with pebbled mud

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[8] The ancient name of the A-Group continues to elude us.

floors and stone slab foundations; these architectural features flagged the appearance of social differentiation in habitation or a formal business centre (Lal 1967).

Further evidence for foreign trade, social stratification, skilled artisans, and thus, sociopolitical stability, was recovered at cemeteries in the Wadi Halfa vicinity. Oval-shaped graves contained contracted bodies that rested on their right side facing west, on a north/south axis; occasionally they were sprinkled with red ochre (Gratien 1978, 302; Nordström 1972, 27). Leather or cloth shrouded the bodies, which were decadently adorned with Egyptian beads, ivory combs, and Red Sea shell jewellery. Utilitarian objects that surrounded the deceased consisted of Egyptian wheel-made pottery, utensils, basketry, wooden throwsticks, copper borers, alabaster palettes, female figurines, eye paint, and red ochre. It is noteworthy that A-Group artefacts were absent in Egypt (Gratien 1978, 301; Nordström 1972, 31; Shinnie 1996, 51); no doubt Egyptians concentrated on procuring the exotic African natural assets of gold, ebony, giraffe tails, ivory, leopard skins, and slaves.

Uniquely structured and richly endowed burials dated to the Early A-Group (ca. 3400 BC) at Qustal corroborated royalty or high status among the inhabitants (Williams 1986; 1989). The contents of these tombs incited a dramatic controversy over the origins of Egyptian kingship and thus the Nubian/Egyptian historical threshold. Early archaeologists regarded Nubia as an Egyptian colony, which was incapable of internal cultural development and at most governed by tribal chiefs, who informally controlled their villages and liased with the Egyptians for trade (e.g., Budge 1907, 509-512; Reisner 1923a, 7). The A-Group was contemporary with the Predynastic Nagada culture and was prosperous when Upper and Lower Egypt amalgamated around 3200 BC under King Narmer. This date is based on artefacts (for example, the Oxford palette, Narmer palette, and the Scorpion King macehead from Hierakonpolis) that commemorated southern Egypt's victory over the northern delta (Williams 1980). These political legacies identified the new king by the Egyptian double crown or in the guise of a bull, falcon, or lion and depicted him smiting the conquered people. Williams (1980) argued that images of royal icons (such as, *serekhs* or royal palace façades, a figure wearing the Upper

Egyptian white crown, a falcon's tail, and rosettes) incised on sandstone incense burners recovered from the Qustal tombs depicted early royal insignia and were considerably older than the Royal Cemeteries in Dynastic Egypt where the first pharaohs were entombed.[9] The origins of the incense burners are questionable and the workmanship deemed to be Egyptian, but they do represent early pharaonic images; an ununited "pharaonic cult" that was present in the Nile Valley and neighbouring cultures is currently considered to be the more accepted explanation (O'Connor 1993b; Williams 1987; 1998).

Early Nubian excavators and anatomists speculated that the decline in quality and quantity of A-Group grave goods, as well as the sudden disappearance of the A-Group, was due to the appearance of "a more primitive Negroid race," that is, Reisner's B-Group, who, according to Reisner, overthrew the A-Group and forced their flourishing culture into recession (e.g., Reisner 1910; Reisner et al. 1909; Smith and Wood-Jones 1910). A startling discovery was made when Smith (1966) reviewed Reisner's and Firth's records. He found that 25% of the excavated burials held no bones and 30% contained animals bones only; the remaining burials were classed as A- or C- Group[10] or were too badly preserved to assign a date—Reisner's B-Group, therefore, never existed. An invasion by a newly united Egypt would account for the sudden grave good poverty that Reisner identified with the B-Group, since an Egyptian subjugation of the A-Group would have them forfeit their wealth to the victor (Nordström 1972, 32). Gratien (1978, 302) proposed that after a period of impoverishment the A-Group people became desert refugees or were deported from their homeland, a popular military tactic used to weaken conquered people and prevent uprisings. The A-Group operated as a convenient broker for southern resources, but did not trade Nubian objects with the Egyptians; perhaps cereals and other consumables were exchanged (O'Connor 1993a, 15). The sudden disappearance of Egyptian grave artefacts in Lower Nubia during the First Dynasty

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[9] The recovery of any royal iconography predating Egyptian unification would further trace the pharaonic origins—to find such evidence in Nubia created agitation among Egyptologists, while African nationalists (e.g., Monges 1997, 91-97), who in the tradition of Dubois (1946) and Diop (1974) attributed complex Nile Valley civilisations to African origins, were delighted.

[10] The C-Group is discussed below.

marked the termination of the A-Group from the Egyptian trade cartel (Bonnet 1997a; Gratien 1978, 302; Nordström 1972, 31-32; Smith 1991).

2.4.5 Kerma Period: the city and state

South of the A-Group settlements, the contemporary Kerma culture developed about 2500 BC. Kerma,[11] the type-site for the culture and state nucleus, is situated on the Nile's east bank 20 km south of the Third Cataract (Figure 2.5). The site was first explored and excavated by George Reisner (1918; 1923a; 1923b) of the Harvard-Boston Expedition (Harvard University and Boston Museum of Fine Arts) from 1913 to 1916. Like his earlier excavations, Reisner's documentation of the Kerma cemeteries was meticulous for its time, but unfortunately his interpretation suffered from Victorian convictions couched in Egyptocentrism and biological determinism:

> But the local culture, which has produced none of these things and is incapable of producing or even of fully utilising them, still remains practically late neolithic in its condition. I take it that a race which cannot produce or even fully utilize the products of a higher culture must, from a historical point of view, still be counted in its former state. The evidences of the fortuitous possession of the products of a higher culture only deepen the impression of cultural incompetence (Reisner 1923a, 7).

Reisner noticed an obvious variation in tomb style and contents in the Eastern Cemetery at Kerma and divided the cemetery into three sections: Egyptian, Mixed, and Nubian, extending from south to north, respectively. Convinced of Egyptian origins, Reisner (1923b, 121) interpreted the largest, most decadent tombs as Egyptian and therefore the oldest, dated to the XIIth Dynasty (1991-1786 BC); the smaller Northern Cemetery tombs proclaimed the decline of the Kerma culture after 1580 BC. Reisner, in fact, reversed the chronology completely. Gratien (1978), who excavated the Sai necropolis with Vercoutter, determined the correct pottery sequence of the Kerma chronology and identified three phases of the Kerma period: Ancien (2500-2050 BC), Moyen (2050-1750 BC), and Classique (1750-1500 BC).[12]

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[11] The name "Kerma" derived from the modern village located near the site and the ancient name of the city remains unknown.

[12] These periods are also referred to as Early, Middle, and Classic Kerma (e.g., Kendall 1997).

Excavation at Kerma ceased for the following 60 years, but the Kerma culture was discovered as far north as Kubban (Emery and Kirwan 1935; Firth 1927) and on Sai Island, where Vercoutter (1958) excavated an extensive necropolis that rivalled Kerma in size. Adams synthesised an account of Nubian history and archaeology in 1977, in which he appealed for systematic excavations in Upper Nubia and Kerma, known only from Reisner's excavation of the Royal Cemetery and two mudbrick monuments. Coincidentally, that same year, a team from the University of Geneva, led by Dr. Charles Bonnet, commenced excavation at Kerma, with the intent to examine environmental and cultural remnants that resonated with life as well as death. Adams' plea was successful: Bonnet (1990a) exposed an earlier settlement, now referred to as of the Pre-Kerma[13] period (ca. 3000 BC), and continues to unmask the Kerma society and urban lifestyle, while the quest for the cultural dimensions lures international archaeological teams to Nubia and its hinterlands annually.

2.4.5.1 Pre-Kerma

Bonnet's (1990a; Honegger 1998) excavations at Kerma exposed a burgeoning settlement of agriculturists and ranchers who lived in small circular tents clustered around a communal storage-pit zone of some 500 pits. Bonnet's team excavated 49 houses and three rectangular community centres, the final phase atop a three-level Neolithic sequence dated to 5000 BC. The third Neolithic and Pre-Kerma levels revealed pottery with Terminal A-Group affinities, but no trace of Egyptian imports or influence (Honegger 1998). A similar storage-pit field, carbon-dated to 2900 BC, was excavated on Sai Island with one significant difference—Egyptian pottery was found *in situ* (Geus 1998). It is noteworthy that Sai Island is situated exactly midway between the Second and Third Cataracts, just south of *Batn el Hajar*—a convenient exchange point between the A-Group and Kerma. This overlap of cultures forged another link in the Egyptian trade network with the people of Upper Nubia, the purveyors of resources from the African interior, and the flourishing A-Group, trade brokers of Lower Nubia. The Egyptian desire for unchallenged access to the interior and trade dominance, fortified by an aggressive

[13] Some archaeologists working in Sudan consider this to be the Late Neolithic period (Derek Welsby, personal communication, 2000).

kingship, would have been the impetus required to disable the A-Group in order to barter directly with Upper Nubia (Smith 1991).

Upper Nubia lacked the gold mines and diorite quarries of Lower Nubia that beckoned pharaohs for centuries, but held a natural resource coveted by the Egyptians—the middle Nile River—the trade route for portable exotic goods from Central Africa. In reciprocation for incense (frankincense, myrrh), resins and ebony, as well as wild animals such as elephants, monkeys, leopards, and ostriches that provided ivory, entertainment, pelts, and ostrich feathers, the Nubians obtained Egyptian manufactured products, for example, weapons, faience, finely crafted jewellery, ointment, and cloth (Amin 1970; Bonnet 1990a; 1994; Reisner 1923a, 537). Humans were perhaps the most lucrative commodity harvested by the Nubians to trade as labourers for the pharaoh's architectural program or domestic service (Adams 1977, 167-8; Amin 1970; Budge 1907, 522). As early as the Third Dynasty, the Egyptian army drafted Nubian mercenaries, famous for their skill with the longbow (Fischer 1961); those less eager to enlist were collected during intermittent Egyptian raids (Watterson 1997, 51).

2.4.5.2 Kerma Ancien

The cataracts between Kerma and Egypt necessitated that cargo be transferred from boats to donkeys for overland conveyance around the cataracts; alternatively, mud paths reinforced by rails served as a device for slaves to pull the boat along the riverbank without unloading the cargo at the Second Cataract (Amin 1970). A continual threat of Egyptian or Bedouin attack hovered over the portage area, the caravan trails en route to Kerma, and likely the growing treasury within the community itself. Protection from raiders may have been the catalyst that forced the small farms and resident traders to centralise during the Kerma Ancien period. The town, now within a mudbrick enclosure, relocated adjacent to the Nile perhaps to facilitate escalating commerce (Bonnet 1997b).

Kerma Ancien burials clearly demonstrated continuity or strong influence from the A-Group and southern Neolithic cultures. Burial pits were circular, about 1.2 m in diameter, 1.0 to 2.0 m deep, and diverse in complexity. White quartzite and black pebbles overlaid the low, burial mounds; occasionally small white sandstone stelae that projected 10 cm above the surface encircled the feature. The deceased was placed on an ox-hide scraped clean of fur, except for a narrow pelt retained as a border; often a second hide blanketed the body for protection. This burial position maintained uniformity throughout the Kerma period—the flexed body rested on its right side, oriented with the head to the east facing north. Incised sandals were either worn by the individual or placed beside the body. A finely beaded tunic cinched with a decorated belt shrouded the deceased and a beaded cap or hairnet hugged the skull. The deceased's personal effects included rings or earrings of natural material (i.e., wood, bone, or stone), wood pins, ostrich feather fans, and clay seals; often, a small leather bag that contained a clay seal, bone pin, and quartz tools was attached to the belt. Some males were interred with weapons such as bows and arrows, with the cord of the bow held in the hand. A joint of lamb or goat was offered beside the tumulus to accompany libation vessels that were arranged upright on the east side (Bonnet 1990b; 1994; 1997b).

The evolution of Kerma from a bustling village to state centre is inferred from Egyptian texts. Tomb inscriptions that boastfully traced career achievements became fashionable among the elite during the VIth Dynasty (ca. 2200 BC), especially among traders (e.g., Watterson 1997, 93). The most successful or at least best known merchant of this era, Harkhuf (Breasted 1962a, 150-4), was no exception and he faithfully recorded his voyages to the bountiful land of "Yam," deemed by some scholars to be ancient Kerma (e.g., Adams 1977, 158-160; Shinnie 1996, 65). In addition to this cryptic geographic trail, Harkhuf's epitaph offered an insightful glimpse of Yamite politics. He described his first two journeys through various provinces that were each governed by a chieftain, but on his final visit, a solitary ruler controlled the land and granted permission for Egyptians to trade on his soil (Breasted 1962a, 154).

2.4.5.2.1 Lower Nubian interlude: the C-Group

While Harkhuf pursued the Oasis Route through the Western Desert to avoid skirmishes along the Nile, a new society congregated in Lower Nubia—the C-Group. Parallels between the A- and C-Groups were unmistakable even after 600 years: distinctive black rimmed pottery and Egyptian grave goods covered the territory from the Western Desert, Red Sea, and Omdurman, although the C-Group emphasis on cattle stressed their pastoral ancestry (Shinnie 1996, 55; Williams 1977, 116). Biological continuity among cranial nonmetric traits,[14] between the A- and C-Groups provides more convincing evidence that the C-Group were direct descendants of the A-Group (Prowse and Lovell 1995). The vestiges of A-Group culture found at C-Group sites, therefore, is attributed to evolving internal and external influences during the interval between the two cultures.

The nomadic past of the C-Group was confirmed at Aniba (Figure 2.5). A circular arrangement of postholes and leather fragments observed in Aniba's lower stratum was identified as a group of tents—the first architectural phase of the C-Group. The second architectural phase contained single or multiple-roomed subterranean houses of stone and mud, while the final phase featured Egyptian-style rectilinear mudbrick houses (Steindorff 1935). Wadi es-Sebua and Amada presented unique alterations to the Lower Nubian landscape—urbanisation and fortification. Egyptian-style perimeter walls that were embellished with gates, towers, and archer's slots enclosed dense clusters of round and rectangular houses at these sites (Adams 1977, 149-150).

C-Group burials hybridised some A-Group and Kerma elements (Adams 1977, 155-157; Geus 1991; Williams 1977, 3-8). A 1.0 m high circular stone perimeter filled with sand and gravel covered a round shaft; occasionally stone slabs capped the structure and stele carved with cattle leaned against it. The individual was flexed on their right side, head to the east, and facing north—the opposite of the A-Group, but reminiscent of Kerma Ancien. In addition to distinctive C-Group black-incised pottery, burials contained copper knives, mirrors, and Red Sea shell jewellery. Pots with food were laid outside the tumulus wall on the north or east sides. Around 1950 BC, the burial form changed to a rectangular stone-lined pit, which was capped by a brick vault that projected through a wider and lower tumulus. Vases, and occasionally cattle bucrania and stele were placed

[14] Nonmetric traits are minor variations in skeletal features, which are thought to be markers of familial inheritance (Buikstra and Ubelaker 1994, 85).

against the walls of the largest and richest structures. Later, ostrich feathers, clay female and cattle figurines, as well as sacrificial sheep, goats, gazelles, and dogs accompanied the interment. This change in burial patterning denotes increasing prosperity among the C-Group people, although they never achieved the richness of the A-Group burials (Williams 1977, 118). The size of the burial structure and quantity, rather than the quality or hierarchical distribution of unique grave goods, distinguished status in this society and implied the presence of some form of chiefdom (Parker-Pearson 1999, 72-94).

Brisk trade between Egypt and Kerma continued, but, like their A-Group ancestors, the C-Group had little to offer Egypt in return other than a comfortable rest stop en route to the Eastern desert gold mines or the southerly trade centre at Kerma. Over time, this society assimilated selected aspects of its trading partners, but eventually succumbed to Egyptian patronisation and lifestyle when the Egyptian army physically occupied Lower Nubia during Twelfth Dynasty (Adams 1977, 143-5, 175-188; Williams 1977, 119-120).

2.4.5.3 Kerma Moyen

The Upper Nubians at Kerma recognised the benefits of internal Egyptian turmoil and perhaps observed an opportunity to gain uncontested access to the Lower Nile, which led to the merchants of the Levant and Mediterranean. Kerma flourished at the beginning of the second millennium and, unopposed by the C-Group, Kerma traders steadily crept down the Nile. The Kerma Moyen period witnessed an expansion of the city limits and growth of its infrastructure, manifest by specialised buildings and areas fortified by a system of walls, ditches three to six meters deep, gates, and towers (Bonnet 1994). A religious precinct held a solid mudbrick rectangular temple, braced with wooden beams in Egyptian style, called the "western *deffufa*" (Nubian for "large unfired brick structure"). Small chapels, a priests' residence, cult storerooms, a bronze foundry, and sacred workshops surrounded this monument. A bakery, essential for the production of consecrated bread, was built along the fortification wall. Nearby, another enclosed complex contained an imposing mudbrick structure that was buttressed by doum palms, whose carbonised trunks were preserved in the ground. This structure, surrounded by storerooms and round huts up to 4.7 m in diameter, was thought to be the royal residence and trade centre due to its close proximity to the western *deffufa*, warehouses, and river (Bonnet 1994; Kendall 1997, 48-49). Bonnet (1990a) described a complex of houses located a distance from the central city along the river: each round house had one main room for reception and rest, spartan furnishings, and a central courtyard for domestic activity. Barley was the most important cereal, harvested with sickles and stored in silos in the house or garden. Household remains included ostrich shell beads, mica chips, ovens and hearths, pottery, and linen threads, as well as wooden head rests, boxes, and beds.

Perhaps the most striking evidence of Kerma's success was not found at Kerma but down river at the Second Cataract. Fearing the growing presence of the Kingdom of Kerma, which now extended from the Fourth Cataract to *Batn el Hajar*, a reunited Egypt, eager to stay on congenial terms with the Nubian ruler who permitted them to mine gold, yet wary of Nubian infiltration, constructed a series of 11 forts at the Second Cataract from 1943 to 1843 BC (Watterson 1997, 55). The names of the forts, for example, "Warding off the Bows," and "Curbing the Countries," bespeak their function. These forts also served as storehouses and a barrier to Nubian trade down the Nile, which created an Egyptian trade monopoly below the Second Cataract (Adams 1977, 179-185; Watterson 1997, 55).

Obvious class distinctions continued in the Kerma Moyen cemeteries, which were identified by intermittently placed large tumuli surrounded by a sea of smaller graves, analogous to the Neolithic cemetery at Kadruka. The central tumuli grew up to 12.0 m in diameter; each feature had a slight central depression and was covered by white quartzite pebbles surrounded by a ring of black stones. As many as 500 cattle bucrania[15] cradled the southern edge and the east side held food offerings (Bonnet 1990b, 77-78). Mudbrick structures, believed to be shrines due to their red-ochred floors, accompanied some of the larger tumuli. Bodies retained their traditional burial configuration, but were placed on mica-inlaid, wooden beds that stood on legs stylised to resemble those of a bovid

[15] During the 2000 field season a tomb with about 4000 bucrania was excavated (Louis Chaix, personal communication, January 2000).

(Reisner 1923b, 208-228). Artefacts included razors, ivory hooks and harpoons, stone tools and arrowheads, bronze knives, and bread moulds. Goat and sheep meat cuts surrounded the body, but entire animals also accompanied the dead. These creatures, occasionally painted with red ochre, were draped in ornate ostrich feather headdresses, horn protectors, and beaded pendants that hung through holes pierced through the horns (Bonnet 1994). The western and southern areas of some pits were reserved for additional humans, frequently youths or children, and the occasional dog. These auxiliary burials have been interpreted as human sacrifices (e.g., BBC 1999, Kendall's and Bonnet's comments; Bonnet 1990b, 77; Kendall 1997, 60; Reisner 1923a); however, no Egyptian texts that annotate this practice have surfaced to date. Signs of violent perimortem trauma do not exist; however, it is proposed that the people sacrificed themselves willingly or perhaps were drugged (BBC 1999, Kendall's comments).

Egypt's unification was again short-lived and for a period of about 200 years 60 unrelated rulers governed segments of the country, creating political decentralisation and anarchy. Egyptian troops were subsequently recalled from the borders to restore order to the cities, a decision that permitted an unanticipated invasion and capture of the northern Egyptian throne by the Hyksos from the eastern borders, while the Nubians easily appropriated the abandoned forts at the Second Cataract. Thebes, in a precarious position between the Hyksos and Nubians indeed felt threatened, but, more significant for Egypt, humiliated (Adams 1977, 189-191; Watterson 1997, 56-58).

2.4.5.4 Kerma Classique

Under these conditions, Kerma and the Nubian culture of the Kerma Classique period matured magnificently. The central city covered six hectares, but blossomed to 25 hectares when houses outside the fortification were included. Old fortification ditches that had filled with debris over time were overlaid with sun-hardened mud to expand the metropolitan limits during this peak phase. Small buildings appeared on this new surface and engineers constructed a massive casemate system (Bonnet 1994). A new Egyptian-style royal palace was erected near the older palace. The structure was subdivided into rooms each with a specific purpose: reception, business, kitchen, throne room, and living quarters; as previously, warehouses were within easy access to the river road. Kerma also had to protect its interests and constructed an oval-shaped surveillance fort 18 miles inland to monitor trade and military activity in the Eastern desert (Bonnet et al. 1993; Kendall 1997, 51).

Kerma Classique royal burials were distinguished by boldly contrasting black and white geometric designs of stone (Bonnet 1990b; Reisner 1923a). The central area of the dome-shaped tumulus was overlaid in white quartzite pebbles and concentric rings or triangles of small black pebbles delineated the circumference. Bucrania hugged the south side and a marble cone flagged the tumulus' centre. These tumuli, braced with mud retaining walls, measured 80-90 m in diameter and covered one vaulted, centrally located burial chamber that was flanked by chambers of smaller multiple interments (Figure 2.6). Three tumuli contained "sacrificial corridors" with as many as 322 additional human skeletons scattered about, each with its own assemblage of grave goods (Reisner 1923a) (Figure 2.7). The smaller tumuli and discrete graves emulated the burial style of the larger tumuli aside from the sacrificial corridors. The prominent burial, clothed in linen, rested on an ivory or mica inlaid wooden bed situated on the south side of the tomb. Personal jewellery, weapons, ostrich feather fans, and sandals were placed on the bed; bronze toiletries stood at the bed's foot. The bed was surrounded by pottery vessels scattered amongst an array of haphazardly positioned human skeletons. Highly refined items accompanied burials, such as, alabaster goblets, bronze daggers in leather cases, makeup pots, mirrors, combs, ivory carvings, gold, precious stones, and mother of pearl (Bonnet 1990b; 1923a; Reisner 1923b). Two massive vaulted ritual buildings associated with the largest of the Kerma Classique tumuli contained murals that depicted boats, animals, and scenes from everyday life as well as gold-leaf and faience wall tiles. The function of these buildings is unknown, although the positioning of floor holes corresponded to those of the funerary beds and suggested that they served as a repository for accumulated burial goods and the king's body before interment (Reisner 1923a, 262-3).

2.4.5.5 Denouement

After suffering humiliation at the hands of the Hyksos, who conspired with Kerma during the XVth and XVIth Dynasties, Egypt reinforced its power in Thebes and, under King Kamose of the XVIIth Dynasty, embarked on a campaign to reclaim Egypt. Kamose's grandson, Thutmose I, bolstered by Hyksos-inspired chariotry, successfully penetrated the Kerma stronghold, and annihilated and looted the city, about 1520 BC. In the tradition of his predecessors, Thutmose erected a commemorative stele at Tombos that glorified his triumph (Breasted 1962b, 30).

Egypt occupied Nubia as far as the Fourth Cataract until around 1070 BC, the end of the XXth Dynasty, when the power balance in the Nile Valley shifted yet again. The motivation for the Egyptian retreat eludes us and a Nubian "Dark Age" or archaeological void ensued for 250 years (Morkot 1994; 1995). The record of recovery from this interlude is equally obscure and aside from the Egyptian account, virtually no archaeological evidence archives the ascent of the next empire indigenous to Nubia—Napata. So successful was this revitalised Nubian nation that it conquered Egypt in 725 BC and reigned over both lands as the XXVth Dynasty.

2.5 Summary

This chapter placed ancient Nubia and Kerma in a geographical, cultural, and archaeological context. The Kerma culture developed from indigenous Neolithic origins, only to come under Egyptian influence once it was established as a thriving polity. Kerma's relationship with Egypt was contentious, with control of Nile trade and African natural resources, particularly minerals, the source of discord. Commemorative plaques of conquest, burial inscriptions, Egyptian documents, weapons, and fortifications depicted this turbulent relationship, liberally kindled with aggression and atrocities. Corresponding unrest within the society is well documented for Egypt, but our knowledge of social behaviour within the Kerma state is in essence non-existent even from Egyptian historical records.

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Table 2.1: Timeline for Nubia

(data obtained from O'Connor, 1993; Kendall, 1997; Watterson, 1997)

Time (BC)	Upper Nubia (above 4th Cataract)	Upper Nubia	Lower Nubia	Upper Egypt	Lower Egypt
Final Palaeolithic 13000-8000			Halfan, Qadan, Arkinian, Bahallan, Shamarkian		
Mesolithic 8000-5000	Khartoum Mesolithic	Khartoum Variant	Abkan		
Neolithic 5700-3000	Khartoum Neolithic			Badarian	Fayum A Merimda
3700-3250			A-Group-Early		Ma'adi
3250-3150			A-Group-Classic	Nagada	
3150-2800		Pre-Kerma (3000)	A-Group Terminal	Archaic: I –II Dynasty (3168-2705)	
2500				Old Kingdom: III-VI Dynasty (2705-2250)	
2200		Kerma Ancien (2500-2050)	C-Group I (2200-1950)	First Intermediate Period: VII-X Dynasty (2250-2035)	
2050		Kerma Moyen (2050-1750)	C-Group II (1950-1600)	Middle Kingdom: XI-XIII Dynasty (2035-1720)	
1750		Kerma Classique (1750-1520)	C-Group III (1600-1500)	Second Intermediate Period: XIV-XVII Dynasty (1720-1550)	
1520		Egyptian		New Kingdom: XVIII-XX Dynasty (1550-1070)	

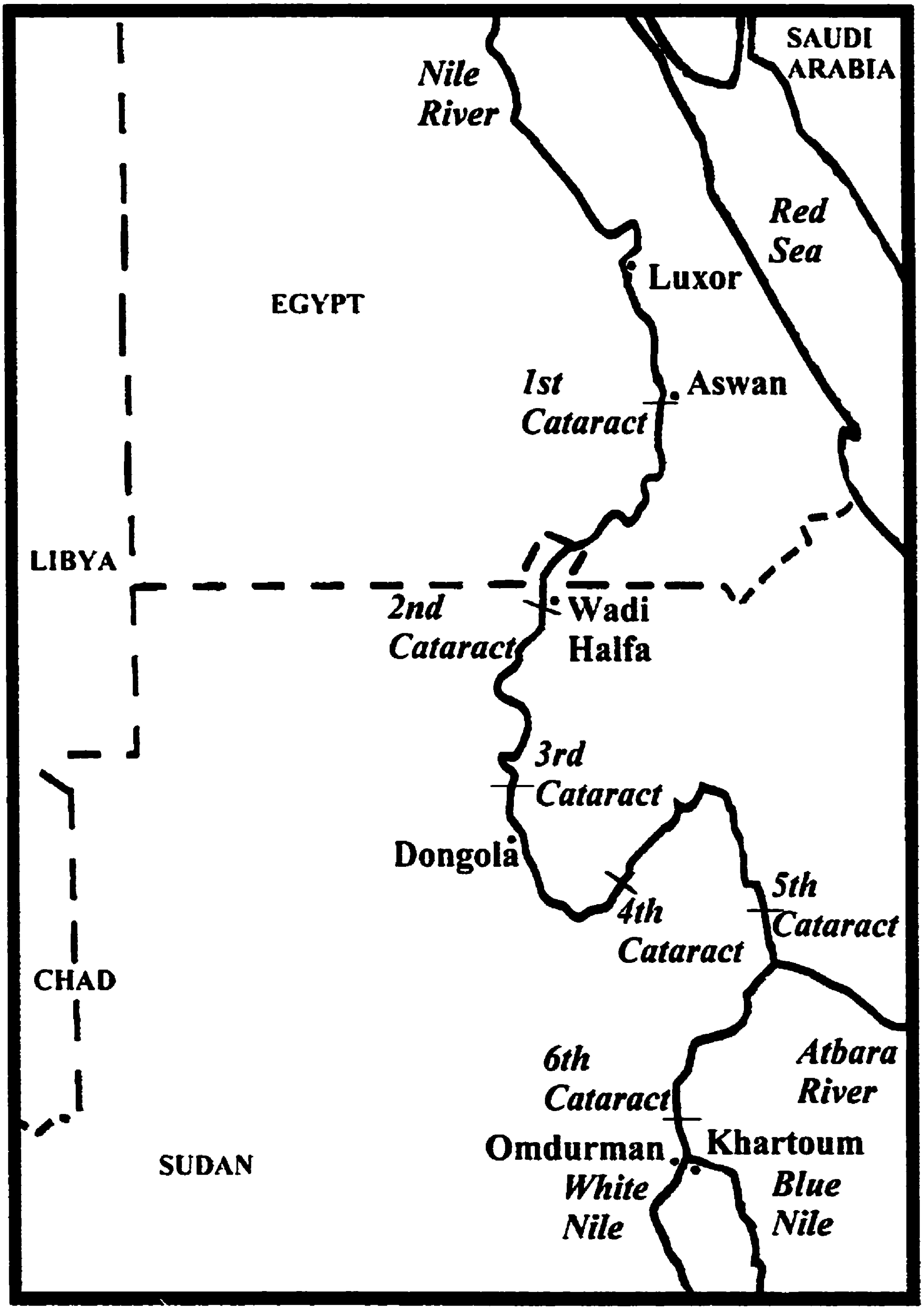

Figure 2.1: Geopolitical map of the Nile Valley

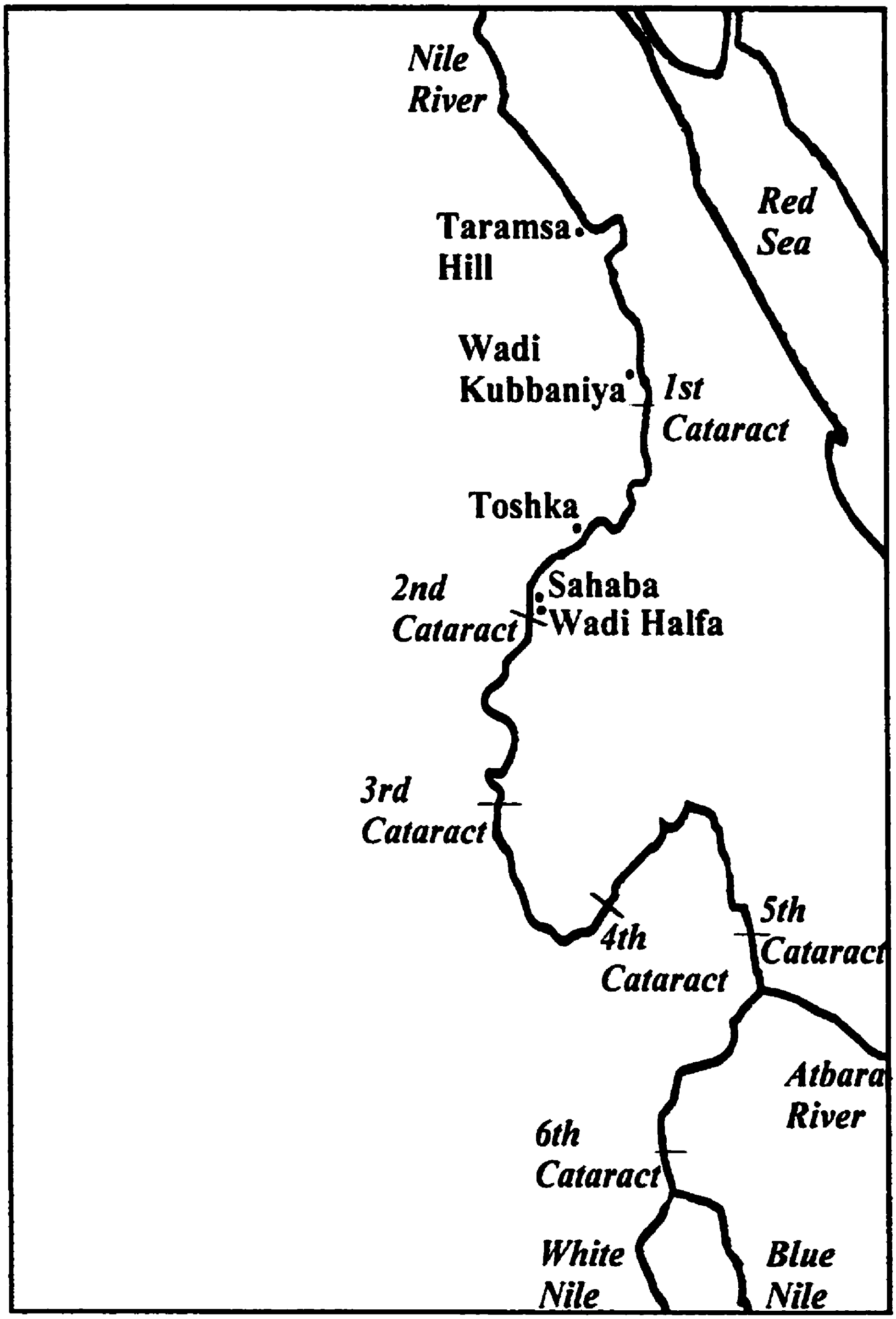

Figure 2.2: Location of Palaeolithic sites in Nubia and vicinity

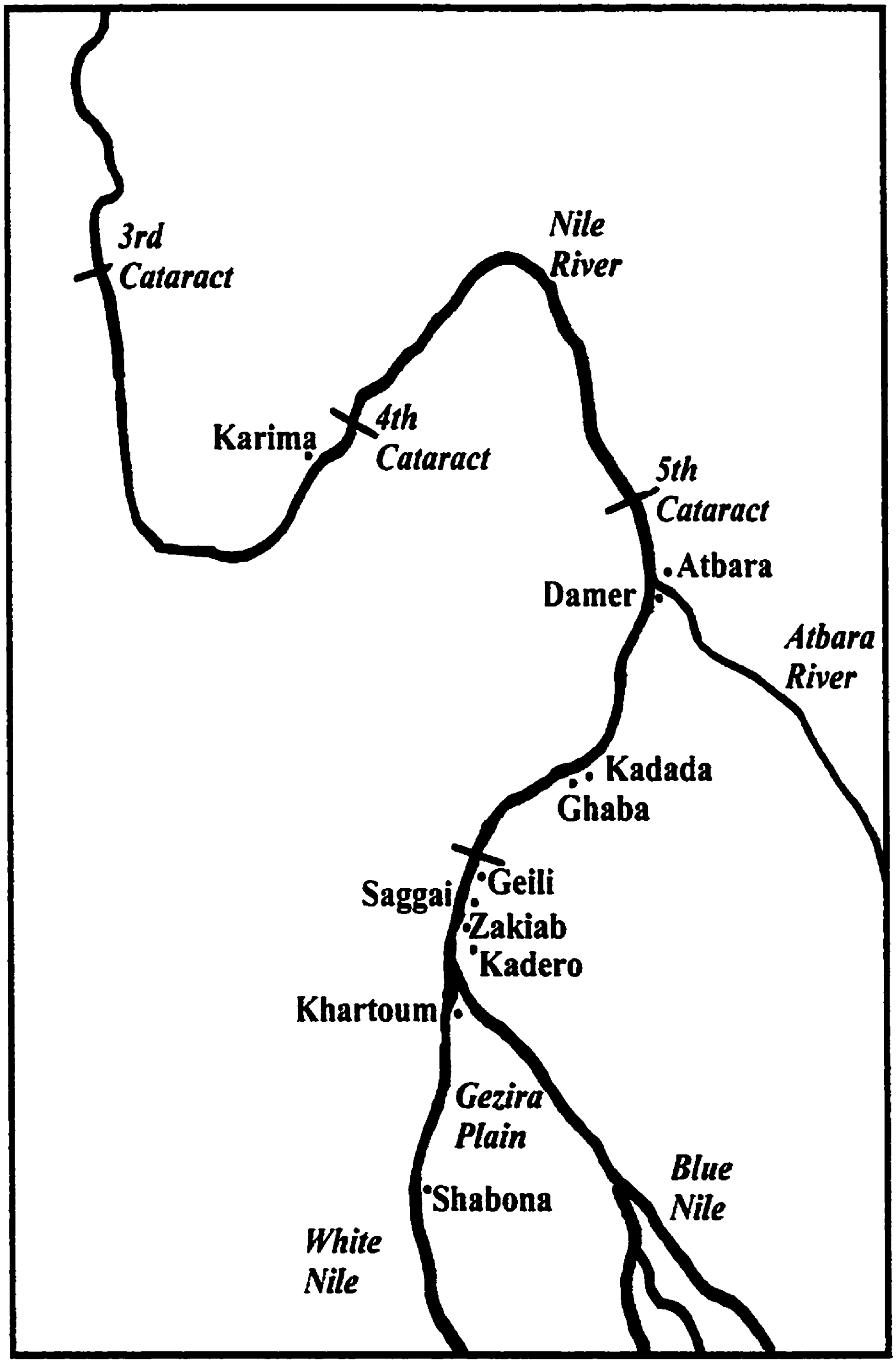

Figure 2.3: Location of Mesolithic and Neolithic sites in Central Sudan

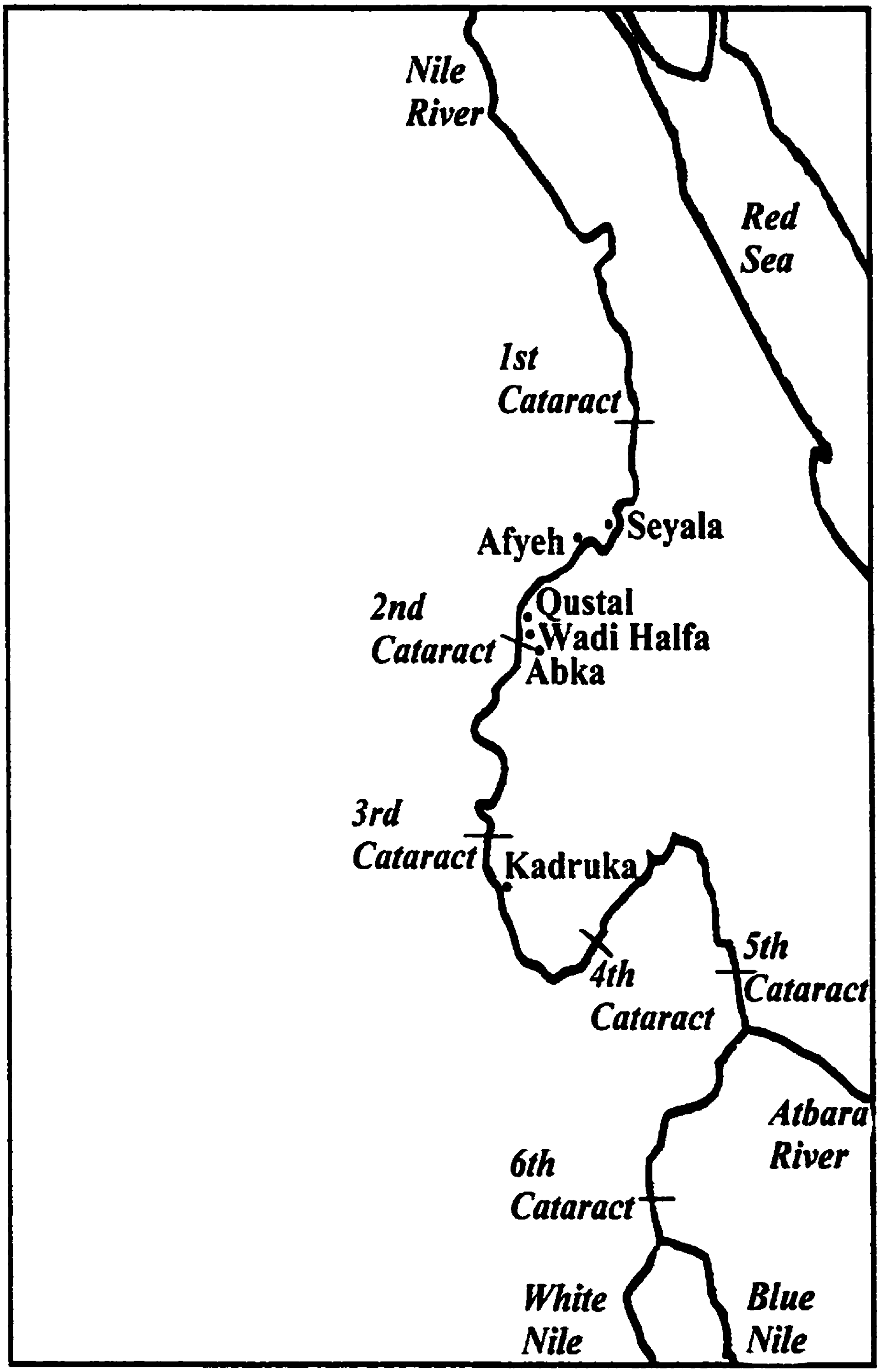

Figure 2.4: Location of Neolithic and A-Group sites in Upper and Lower Nubia

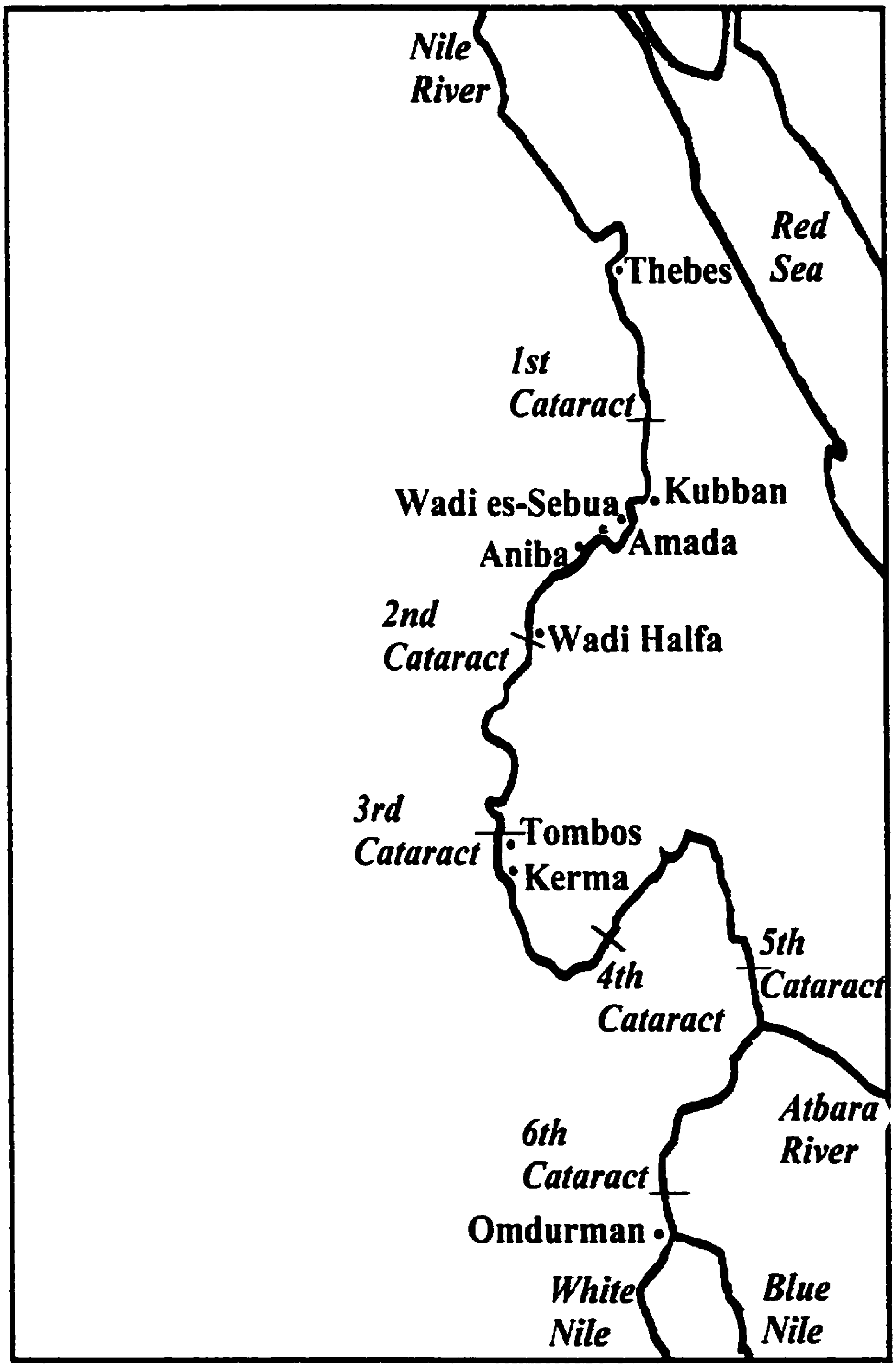

Figure 2.5: Location of Kerma Period and C-Group sites in Upper and Lower Nubia

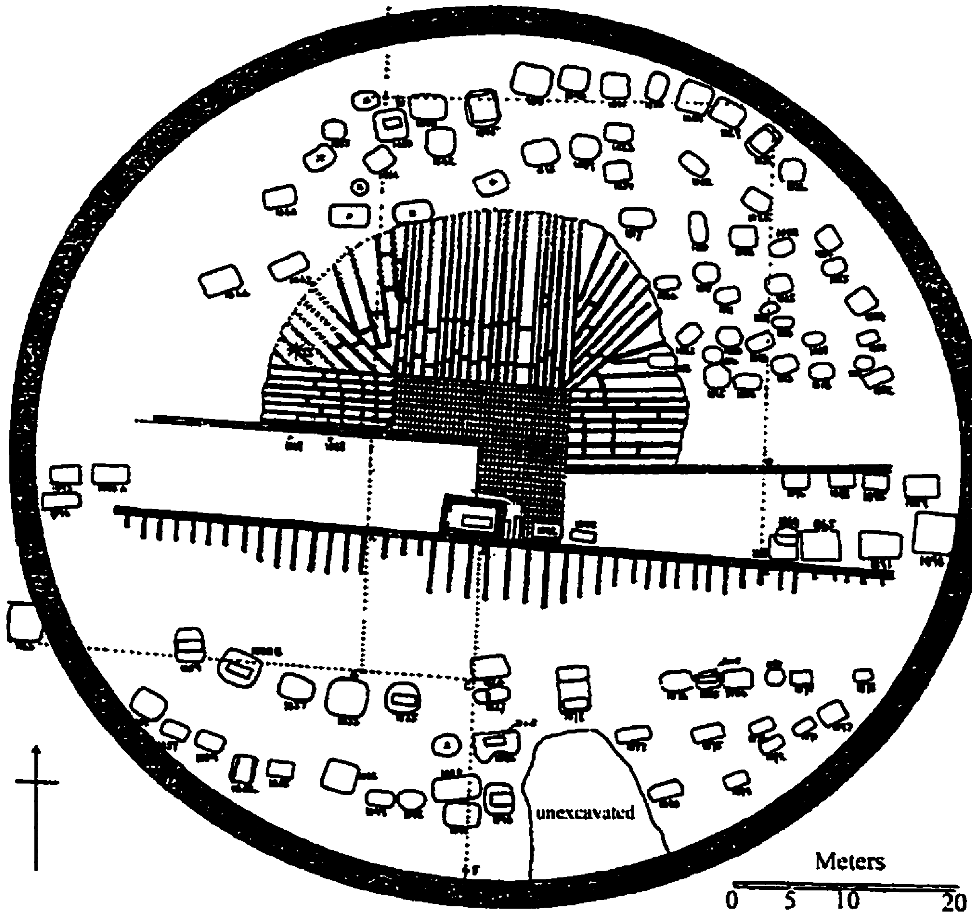

Figure 2.6: Top plan of Kerma Classique Tumulus X
(modified from Reisner 1923a, Plan XXI)

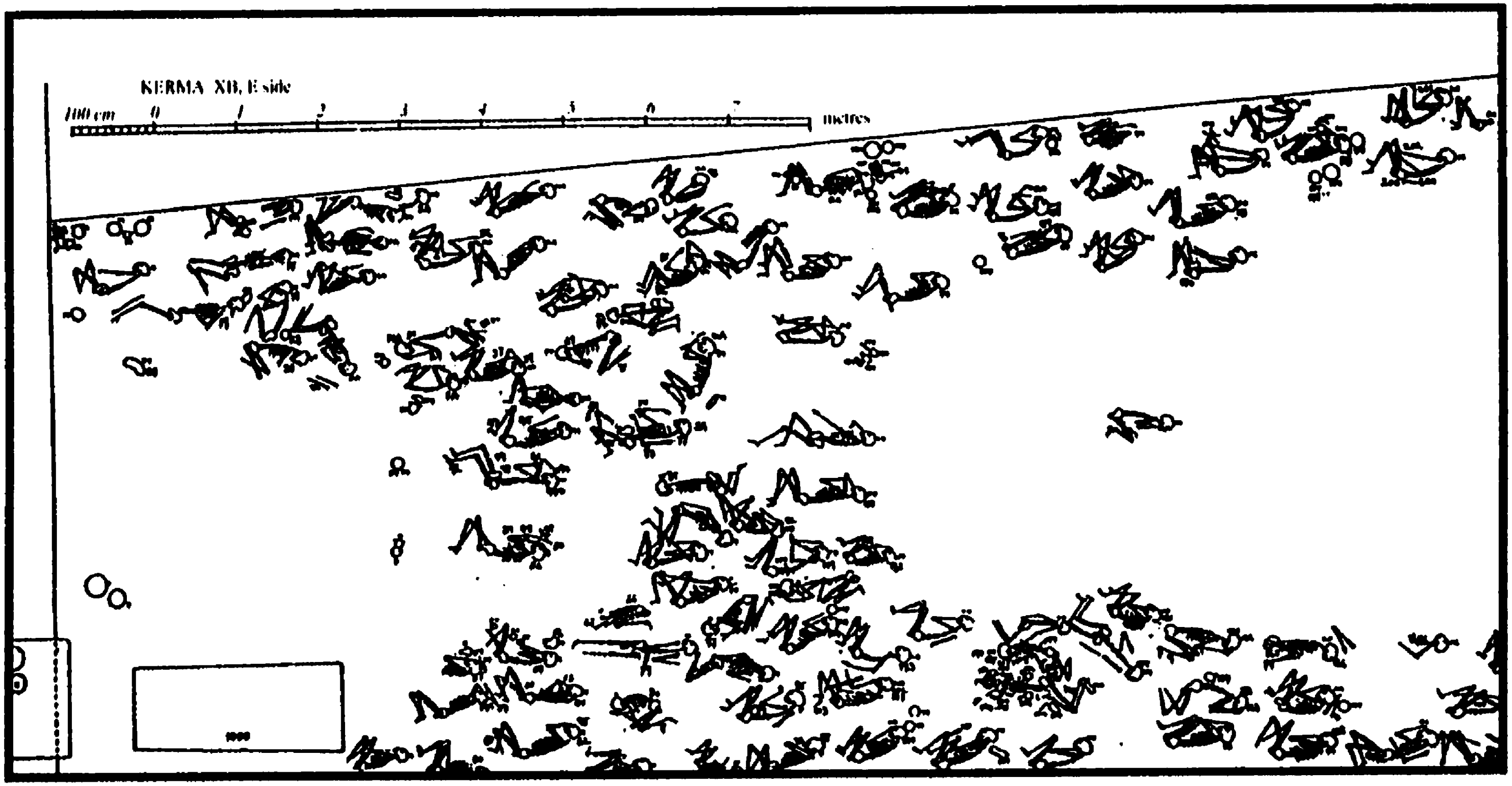

Figure 2.7: Sacrificial corridor on east side of Tumulus X, Kerma (modified from Reisner 1923a, XXIII)

CHAPTER 3

Interpersonal violence: clinical, nonhuman primate, and bioarchaeological interpretations

3.1 Introduction

A sampling of introductions taken from clinical literature exemplifies the mounting trauma crisis in our society: "Injuries are the leading cause of death for more than four decades of life" (Kaufmann et al. 1998), "Intentional and unintentional trauma in industrialised countries is assuming epidemic proportions" (Sayfan and Berlin 1997), "Trauma is acknowledged to be the primary health and social problem of our society" (Sims et al. 1989), and "Injuries constitute one of the most costly health problems in the United States" (Reiner et al. 1990). However, trauma, specifically nonlethal interpersonal violence, is not limited to our modern world, but is deeply anchored in antiquity.

Many theories exist that attempt to explain some aspect of human aggression, but generally are reduced to "nature versus nurture" (e.g., Leakey and Lewin 1987; Sipes 1973). The "Drive Discharge Model" argued that aggression is innate and is periodically expelled in all societies although the mode of expression may vary (e.g., Lorenz 1966). The "Culture Pattern Model" regarded some societies as more aggressive than others through "social learning" by enculturation or nurture for violence and aggression in various aspects of their society, such as, initiation rites, criminal punishment, infanticide, ritual, child rearing practices, treatment of animals, torture of captives, military or religious subcultures, and methods of conflict resolution (e.g., Levinson 1989). It is the cultural factors that stimulated violence within an ancient society that may be visible in the archaeological and skeletal records, while innate or biological factors remain more elusive. Violence due to war or homicide is easily inferred in the archaeological record by artifacts and features, such as weapons, monumental defensive systems, and documents. Nonlethal physical violence, however, is much subtler, even in modern societies—it demands no special equipment and may or may not affect the skeleton. What is most confounding is the cultural perception of interpersonal violence in ancient society. Bioarchaeologists observe and interpret injuries manifest by the skeletal remains, but it is unknown whether the behaviour that produced the lesion was acceptable and legitimate in that culture, and therefore, not considered to be deviant.

Before promoting any cultural explanation for ancient behaviour, it is essential first, to describe the injury; second, to identify whether the injury was indeed a result of physical violence; and third, to determine if a pattern of injury can be detected within the society under investigation. In order for bioarchaeologists to decipher the injury mechanism and identify an injury pattern, it is necessary to examine other fields as explanatory sources: clinical and nonhuman primate literature. This review examines injury patterns, principally those of interpersonal violence, observed in clinical and nonhuman primate literature; presents geotemporally diverse lifestyle interpretations of palaeotrauma derived from the presence of accidental or intentional nonfatal injuries; and finally, summarises a selection of the published trauma analyses of ancient Upper Nubia.

3.2 Tools to interpret palaeotrauma

Before delving into questions of cultural behaviour, ancient healed injuries must be evaluated to determine whether the lesion was due to intentional or nonintentional actions. To interpret the past, it is necessary to investigate the present as a model and review the spectrum of healed lesions that occur in known situations that may be anticipated to appear in ancient material. Clinical and nonhuman primate literature provides a wealth of quantified information that assists bioarchaeologists in the assessment of ancient human trauma, especially interpersonal violence.

3.2.1 Review of the clinical literature

Smith and Wood-Jones (1910) advocated the use of clinical analogy in palaeopathology when they compared ancient Nubian trauma to clinical samples from modern British and American hospitals. However, differences in technological, environmental, and sociocultural realms that influence trauma aetiology in the clinical arena (Sahlin 1990) must also be considered by bioarchaeologists, and therefore, it is prudent to select comparative clinical studies that are most closely associated with the archaeological sample under study, if at all possible. Judd and Roberts (1999), for example, assessed injury patterns among North American and European clinical samples from agricultural contexts rather than the inner city to aid their assessment of trauma in medieval British farming communities.

Some limitations to clinical trauma studies exist, specifically in developing countries or traditional communities (Matthew et al. 1996; Mock et al. 1995; Nordberg 1994; Odero and Kibosia 1995). First, little data is available and it is only recently that this void in trauma epidemiology has been recognised by clinicians, mainly because of past concerns for debilitating infectious and childhood diseases in the developing countries. Second, the true incidence of trauma in these regions is complicated by poor documentation of the patient's profile. Third, the individual's hesitation or logistical inability to seek medical consultation may underrepresent domestic injuries, including assault. Finally, motor vehicle accident injuries are nearly always reported and medical attention sought, which may overstate trauma in this category in comparison to unreported less severe injuries.

3.2.1.1 Trauma research in developing countries

Distributions of injury mechanisms for seven studies from developing countries are tabulated in Table 3.1. In all studies, motor vehicle accidents, assault, and falls formed the majority of traumatic incidents, but varied in frequency. Economically active individuals, 20 to 40 years of age, were most often involved and males bore 67% or more of all injuries. Males experienced the most injury from all categories (i.e., bites, burns, assault, falls, and motor vehicle accidents) with the exception of domestic violence. The majority of children's injuries were due to falls or burns, while adults over 60 years of age suffered injury mostly from falls. Both children and older adults were minor contributors to the injury spectrum, with the exception of Nigerian males under 10 years of age who accounted for 46% of the male injuries (Ebong 1978). When motor vehicle injuries were removed from the trauma counts, injuries specifically due to falls ranged from 17% to 87% of all trauma, while frequency of assault (not including the intertribal warfare among villagers from Papua New Guinea) ranged from 1.5% to 65% for the seven trauma studies.

Unlikely accidents such as house collapse, blown-off roofs, a finger caught in door, and falling trees accounted for 6.3% of injuries in Nigeria (Ebong 1978), and also contributed to injury in Ghana (Mock et al. 1995) and Uganda (DeSouza 1968). Injuries from being trapped under a collapsed house involved the spine, ribs, and pelvis, although falls from trees were most serious and contributed to 53% of the cranial injuries in Ghana (Mock et al. 1995); death often was the outcome. Among individuals that fell in Uganda, 29% landed on their outstretched hand, 26% fractured their leg (one third while playing football), 11% fell from heights and suffered vertebral and calcaneal fractures, and lastly, 9% stumbled in holes after dark and injured the lower leg (DeSouza 1968). Ankle and lower leg fractures were also a frequent outcome from falls among females in rural Lesotho (Geldermalsen 1993).

The modal distributions of injuries from Ibadan, Nigeria (Ebong 1978) represented the injury distribution of a group where the majority of injuries were due to falls and miscellaneous accidents. The humerus was most frequently fractured (18%), followed by the femur (13%), paired forearm (12%), tibia and fibula (combined 9%, isolated 3% each), radius (7%, plus 3% Colles' injuries and less than 1% Smith's injuries), hand (5%), foot (4%), vertebral column (2%), pelvis (2%), ulna (2%), ribs (2%), the scapula and patella each had less than 1%, and there were no sternal fractures.[1] The skull accounted for 5% of the injuries, which were equally divided between the face and vault. Dislocations mainly affected the upper limb (57%) and were caused by falls in 40% of all cases; the ratio of dislocations to fractures was .074 (189/2571). Twenty percent of those injured experienced two or more injuries.

3.2.1.2 General trauma analyses of assault patterns

Generally, fractures and dislocations contributed the least to the suite of injuries sustained in assaults, typically less than 40% of all injuries (Butchart and Brown 1991; Chalmers et al. 1995; Geldermalsen 1993; Geldermalsen and Stuyft 1993; Matthew et al. 1996; Shepherd et al. 1988; Shepherd et al. 1990). British assault patients, for example,

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[1] Ebong (1978) subdivided this distribution further and presents some locational breakdown (i.e., distal, proximal).

contracted 846 lesions, and of these 16% were fractures. Four percent were to the arms, 1% to the tibia, 10% to the extremities, 2% to the ribs, and the remainder to the skull (Shepherd et al. 1990). In this case, fractures were more likely to occur if at least three other blows were struck. No fractures were observed among Libyans who were involved in assaults (Khalil and Shaladi 1981).

Injuries to the skull and neck region were most frequent reaching up to 90% of all injuries (Shepherd et al. 1988) and involved fractures, haematomas, contusions, lacerations, and infracranial damage (Brismar and Tunér 1982; Butchart and Brown 1991; Chalmers et al. 1995; Crandon et al. 1994; Greene et al. 1997; Khalil and Shaladi 1981; Matthew et al. 1996; Mwaniki et al. 1988; Shepherd et al. 1987; Shepherd et al. 1990). The exception was the Ghana sample (Mock et al. 1995), where assault accounted for only 5% of all injuries, and injuries to the extremities were most frequent (47%), followed by the head (23%), which was a marked contrast to the injury distribution at Ibaden, where people also experienced a low frequency of assault.

Fractures usually accounted for less than 30% of the injuries to the head and neck (Brismar and Tunér 1982; Chalmers et al. 1995; Matthew et al. 1996), with the exception of Greene's (1997) study of blunt trauma facial injuries in San Francisco where 85% of the lesions were fractures. In all studies, injuries to the face formed the majority of lesions in comparison to those of the skull vault, and although distribution varied, the mandible was most often fractured, followed by the zygomatic and nasal area (Greene et al. 1997; Mwaniki et al. 1988; Shepherd et al. 1988; Shepherd et al. 1990). Injuries were most frequent on the left side, which reflected the right handedness of 90% of the population (Mwaniki et al. 1988; Shepherd et al. 1987).

Muelleman et al. (1996) attempted to characterise injuries specific to battered[2] women in the American Midwest in order to develop a universal screening test for domestic violence. Injuries contracted by 237 battered women were compared to 2211 females in

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[2] Battery was specifically defined as injuries caused by an intimate partner, in this case a male partner (Muelleman et al. 1996).

the control group, where it was found that battered women were most likely to sustain injuries to the face (51%) and head (23%). Control patients suffered more lower extremity (32%) and spinal (23%) injuries, while the face and head contributed 16% of the lesions. Twelve specific injuries (mainly to the face, trunk, and upper limb) were observed more often in battered women than in the control group with lacerations and contusions most common; facial abrasions or contusions were the most sensitive predictors of battering (41%). The only fracture that was significantly associated with battered women was any fracture to the orbit, zygomatic or nasal bones. It is noteworthy that 20% of the battered women did not have any of these injuries and 45 additional injury types were common to both groups. The victim was beaten with the fists (68%), pushed (51%), kicked (35%), slapped (34%), or struck with a blunt object (30%), although a combination of mechanisms was used in 64% of cases. The women were typically younger than the uninjured women with most between 24-35 years of age.

Shepherd et al. (1988) also found that the nose (42%) was the preferred target for fractures, but mandibular injuries (37%) were favoured over zygomatic injuries (21%) in a British sample; haematomas and lacerations accounted for at least half of the midfacial lesions. The limbs were more frequently involved rather than the chest and abdomen; however, only two fractures were noted. In contrast, Brismar and Tuner (1982) observed that fractures accounted for 26% of facial injuries, particularly the nose and jaw, among 115 battered women from urban Stockholm. Eleven (10%) women were admitted to the trauma clinic more than one time during a two year period and had severely disfigured faces. The fists (29%) were most popular as weapons among this group and the other mechanisms were distributed similarly to those noted by Muelleman (1996). The pattern of injury due to male assault among 51 Greek women likewise indicated a preference for fractured jaws (Zachariades et al. 1990). Injuries were caused by the hands in 71% of the cases and were as follows: fractured mandible (39%), haematoma (22%), fractured zygomaticomaxillary complex (10%), and 2% for each of the nasal fracture, alveolar fracture and Le Fort III fracture.[3]

[3] This fracture traverses the upper orbital bone and nasal bone (Galloway 1999, 74).

The majority of adult assault participants from North American and European samples claimed to suffer lesions from a punch, hit, push or kick (Brismar and Tunér 1982; Chalmers et al. 1995; Goldberg and Tomlanovich 1984; Greene et al. 1997; Muelleman et al. 1996; Shepherd et al. 1990; Zachariades et al. 1990), and in some cases, the use of the hands and feet produced the most severe lesions (Greene et al. 1997; Shepherd et al. 1990). It is of interest that Shepherd et al. (1990) noticed that 81% of blunt weapon injuries resulted in soft tissue trauma only. Choice of weapon varied with the sex of the attacker and the victim from Lesotho, South Africa (Geldermalsen 1993; Geldermalsen and Stuyft 1993). The male fighting stick, used for sport and aggression was the favoured weapon among males and used against either sex. This was followed by the knife, which was wielded against other males, but the extremities were used to attack females. In the eight cases of female assault against males, Women chose knives in 50% of the cases, followed by their extremities (25%). They used their teeth in 24% of 33 incidents of assault against other females to bite the ears, nose or lips, and on occasion opted for knives (18%), stones (15%), or anything handy. Sticks were selected in 58% of the incidences in Uganda and were used to strike the head or limbs, with the Monteggia fracture[4] being a common defensive injury (DeSouza 1968). The fist (15%), knife (12%), or falls from a push (12%), which emulated injuries from accidental falls, formed the majority of other mechanisms. Sharp weapons were popular in urban Johannesberg (Butchart and Brown 1991) and Jamaica (Crandon et al. 1994), as well as blunt instruments, the hands and feet, and stones. The rural Kandy villages settled disputes over water and land with anything convenient. From an eclectic arsenal of weapons they preferred blunt weapons over sharp objects (umbrellas, crowbars, shovels, coconuts, chains, knives, blades, sickles, etc.), but used guns as a last resort (Babapulle et al. 1994).

The two studies from Papua New Guinea offered an opportunity to contrast urban trauma to village trauma among neighbouring locales. The Southern Highland villages yielded high frequencies of injuries due to violence, both domestic (31%, n = 141) and intertribal warfare (25%, n = 108) among 474 cases (Matthew et al. 1996). War wounds were

[4] The Monteggia fracture is a fracture of the proximal ulna that may involve the distal humerus or radius dislocation.

predominantly inflicted by arrows (82%), while guns were involved in the remainder. Excluding war and motor vehicle injuries, fractures and dislocations were equally distributed between males and females. Sixty-three out of 100 fractures were caused by domestic accidents, and the remainder were attributed to assault (domestic = 21, criminal = 16). Sixty-five domestic assaults that resulted in any injury were reported, and of these 60 occurred to females, representing 41% of female injury cases. Thirty-three females were assaulted by their husbands, and of these 61% met with an injury to the olecranon or forearm from warding off a blow. Five (7%) men were assaulted by wives and 10 (15%) women were assaulted by a co-wife, while the remaining females were attacked by other family members. In this society wife beating was acceptable to 65% of men and 57% of women, but the use of weapons is discouraged. The skull sustained 79 out of 474 injuries and of these 18% (n = 14) were fractures. Fractures (91%) and dislocations (9%) totalled 146 lesions (31% of all injuries) when the 14 skull fractures were included. The modal distribution of fractures and dislocations differed from the traditional skull-dominated distribution reported above: forearm (25%, one quarter were olecranon fractures), lower leg (18%), humerus (18%), hand and wrist (11%), skull (10%), femur (9%), shoulder dislocation (6%), and finally hip dislocation (3%). Soft tissue trauma represented 26% of all lesions, while the remainder of injuries affected the thorax and spine. Residents of the urban centre of Port Moresby encountered more injuries due to assault (Watters et al. 1996). Soft tissue trauma accounted for 74% of the injuries, fractures 14%, and the balance of the injuries were internal. Like their rural neighbours, wife beating is acceptable but there is a lower tolerance—46% of males and 25% of females approve. However, the majority of assaults (74%) were domestic and affected 20% of injured males and 41% of injured females—the identical incidence of rural female-directed domestic. Usual reasons for assault in the village were sexual jealousy, dislike of the spouse or failure of the wife to perform a domestic duty, while in urban communities alcohol, money problems, and jealousy were perceived causes.

Repetitive injury is a growing concern in the clinical practice, and "injury recidivism"[5] ranged from 1%-49% of all trauma cases (e.g., Hedges et al. 1995; Poole et al. 1993; Reiner et al. 1990; Sayfan and Berlin 1997; Sims et al. 1989). Like general trauma, a pattern emerged among all injury recidivists regardless of their role in the traumatic incident or the ultimate injury mechanism (accidental or intentional), but again, there were exceptions (Dowd et al. 1996; Madden et al. 1997; Sayfan and Berlin 1997). Injury recidivists were typically young males, an ethnic minority, unemployed, and suffered an injury by the age of 20 years; rural residents were just as likely to suffer from repetitive injury as the urban dwellers.

3.2.1.3 A clinical model for palaeotrauma analysis

Although there are and will always be exceptions to the trauma patterns observed among the clinical literature, some common trends were discernible from this clinical survey and serve as a model for palaeotrauma studies:

1. culture played an important role,
2. males were more often injured, and were the most frequent participants in assault,
3. both males and females were aggressors, victims, or adversaries,
4. the economically active age group (20-50 years) was most often injured; assault injuries peaked between 20-30 years; and injuries to older adults and children were due to falls,
5. the majority of injuries involved the skull in assault cases,
6. haematomas, contusions, and lacerations comprised 70% or more of the lesions; fractures accounted for the remainder of injuries with dislocations being sporadic, if observed at all,
7. some injuries were strongly associated with violence, such as the fractured mandible, but many injuries were mutual to both intentional and nonintentional injury spectrums,
8. fists were the preferred weapons of assault among Western culture samples, while method of attack was diverse in non-western countries,

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[5] The term "recidivism" derives from criminology and refers to a habitual or chronic relapse back into crime by the perpetrator, but the term was introduced into the medical literature by Reiner et al. (1990).

9. interpersonal violence was multicausational, although socioeconomic factors were major contributors,

10. a small group of individuals experience injury throughout their lives,

11. though not discussed, substance abuse was a predisposing factor to assault in all studies.

3.2.2 Review of the nonhuman primate literature

Sixty years ago Schultz (1939) proposed that cause and reaction to injury among ancient humans should be analogous to nonhuman primates owing to the similarity in physical, technological, and social environments. He found a high frequency of fractures (36% all bones) among individual adult gibbons (*Hylobates lar*) and 14% had multiple injuries, but unlike ancient humans, the gibbons experienced greater frequencies of femoral and humeral fractures, which he attributed to their arboreal habitat. He observed that many of the long bone lesions were adequately healed without medical intervention, and often exhibited less deformation than the healed fractures of ancient humans. He concluded that the aesthetic quality of healed human injuries was not a reliable indicator of an ancient society's medical knowledge, a point that has been reiterated by various palaeopathologists (Bennike 1985; Bourke 1972; Lovell 1990a).

Bramblett (1967) observed that 81% of a sample of adult Darajani baboons (*Papio cynocephalus*) had at least one instance of trauma. Very few upper limb lesions were found, but like Schultz, he noted many lesions on the phalanges and lower leg. The high frequency of injuries among young males was attributed to active play. He mentioned that although fights were frequent, they were often resolved without physical contact, aggressors often chasing their prey through the trees causing the heavy baboon to fall or they forced their quarry to drop to the ground by shaking the tree branch; therefore, the injury that was caused by a fall was ultimately the result of aggression. He pointed out that physical aggression was more common within the group over food resources or infant care and intergroup encounters were resolved by display.

Nonhuman primate research is a valuable interpretative model for human palaeotrauma investigations that examine inter-and intra-societal violence. While bioarchaeologists scrutinise clinical research for patterns to distinguish accidental from intentional injuries, primatologists actively observe and record the trauma that results during conflict. Whitten and Smith (1984), for example, logged over 500 hours of 15 minute observations of stumptail macaques (*Macaca arctoides*) on who did what to whom and when, in addition to the resulting wound (abrasions, lacerations, and punctures). Significant differences appeared in wound patterning when adult rank, age, lesion location, and aggression rates were considered. Adult males were wounded more often and more seriously; the higher ranked adults were wounded less often; males were more often attacked in the forequarters and females in the hindquarters. The aggression rate was determined from aggressive behaviour, both contact (bite or hit) and non-contact (e.g., stare, bared teeth, chase, etc.) aggression, as well as submission (e.g., avoid, grimace, cringe, etc.). The assailant and victim were identified—an item that has been overlooked in human palaeotrauma research.

Lovell's (1990b) study of skeletons of free-ranging mountain gorillas (*Gorilla gorilla beringei*) that were originally observed in the wild by Fossey (1983), reported that males experienced a higher frequency of cranial trauma. On the contrary, in a pooled sample[6] of chimpanzees (*Pan troglodytes*), lowland gorillas (*Gorilla gorilla gorilla*), mountain gorillas (*Gorilla gorilla beringei*), Sumatran orangutans (*Pongo pygmaeus abelii*), and Bornean orangutans (*Pongo pygmaeus pygmaeus*), Lovell (1990a, 213) observed that females sustained a greater frequency of cranial trauma than males and concluded that both were similarly involved in confrontations. She suggested that sex-patterned trauma be evaluated within the species to truly interpret trauma in relation to specific documented behaviour. Lovell tested trauma patterns against other forms of behaviour documented for each species. As hypothesised, she found that orangutans bore

[6] With the exception of the free-ranging mountain gorillas studied by Fossey(1983), Lovell's (1990a, 15-18) sample consisted of museum specimens obtained from early 19^{th}-20^{th} century collecting expeditions to Africa.

significantly higher frequencies of long bone trauma, a hazard of their arboreality, while the more terrestrial gorillas suffered from fewer long bone fractures. Orangutans, however, had fewer skull injuries due to their solitary behaviour and hence reduced interaction with their conspecifics (Lovell 1990a, 211-212). Like Schultz (1939), Lovell found that there was little distortion among the healed lesions and because healed injuries denote survival, the individual was not impeded in the search for food, nor were they abused. However, Lovell (1990a) explained that the reproductive success among injured males may have declined as they would likely forfeit their rank and access to breeding females.

Jurmain and Kilgore (1998) considered bites among nonhuman primates to be analogous to the use of weapons by humans and included these injuries in their analysis of sex-related trauma patterns for humans and three species of African great apes (*Pan troglodytes troglodytes, Pan paniscus, Gorilla gorilla gorilla*).[7] A significant difference was found between the sexes, with only male nonhuman primates having bites to the skull. Among other lesions, vault injuries were limited to females, while facial injuries were more predominant among males and when combined with bites, the males bore 94% of all facial injuries. Taking cranial injuries as indicators of interpersonal violence, they concluded that males were more often injured due to aggression, which concurred with behavioural patterns documented in the field. They argued that the male predominated distribution of cranial injuries among great ape species and humans formed a basic pattern, and although there were exceptions, they concluded that the high prevalence of male aggression in comparison to female aggression may be an evolutionary phenomenon.

3.2.2.1 Trauma patterns among nonhuman primates

As with the clinical literature, a comparable injury pattern evolved from nonhuman primate trauma research:

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[7] Human bites are also a common result from assault (e.g., Geldermalsen and Stuyft 1993; Kelly et al. 1996; Loro and Franceschi 1992).

1. social behaviour, activity, and environment influenced the injury pattern, which was species-specific,
2. males contracted more of the injuries,
3. most of the cranial injuries occurred on the face rather than the skull vault and were not random with respect to biological sex,
4. haematomas, contusions, and lacerations were most common,
5. females were victims, aggressors, or equal opponents,
6. the hands and feet exhibited more fractures than any other elements,
7. wound patterns were nonrandom and varied with age, sex, and rank,
8. most injuries healed adequately without debilitating deformation,
9. injuries were often acquired during a confrontation without physical contact between the participants,
10. most individuals displayed one or more lesions, particularly to the hands and feet.

3.3 Palaeotrauma: intentional and nonintentional injuries

Most recently, Larsen (1997, 109-60) and Jurmain (1999, 185-230) provided extensive reviews on the diversity of trauma, with interpersonal violence central to both discussions. Larsen (1997, 109-60) presented a comprehensive regional review of interpersonal violence, notably from North American sites. Jurmain (1999, 185-230), in contrast, considered the role of nonhuman primate and clinical research in palaeotrauma interpretation, and emphasised the need for more rigorous analysis in defining fractures, particularly the parry fracture—a common outcome of interpersonal violence in both clinical and nonhuman primate studies, but mere speculation in archaeological samples. Lovell's (1997) appraisal of trauma analysis synthesised the systematic approach necessary to adequately assess ancient behaviour and provided an overview of injuries typical among archaeological material.

3.3.1 Intentional violence

Domestic and societal violence are perpetual problems in modern society, but are not unique to this century. The archaeological record is rife with remnants of violence, domination, and aggression, which are highly visible in the form of fortifications, walled cities, weapons, victory monuments, and artistic representations (e.g., Ferguson 1997; Filer 1997; Fischer 1961; Maschner and Reedy-Maschner 1998; Nikolaidou and Kokkinidou 1997; Pergerine 1993; Roper 1975; Thordeman 1939). However, Roberts (1991) cautioned that artistic representations may be embellished, while Bar-Yosef (1986) proposed an alternative interpretation of city walls that were typically attributed to defensive fortification. Material culture, therefore, does not provide the absolute evidence that can only be found in the skeletal remains. Although the social context may be difficult to extract in some cases of fatal violence, for example whether a hanging was an execution or self-inflicted, direct skeletal evidence for fatal injuries and violence is irrefutably recognised by embedded points (Anderson 1968; Bennike 1985; Inglemark 1939; Jurmain 1991; Lambert and Walker 1991; Milner et al. 1991; Winlock 1945); perimortem wounds likely made by a weapon (Angel and Bisel 1986; Bennike 1985; Courville 1948; 1949; Courville and Kade 1964; Frayer 1997; Inglemark 1939; Lambert 1997; Winlock 1945); scalping (Bridges 1996; Milner et al. 1991; Willey 1990); decapitation or disembodiment (Milner et al. 1991; Wells 1982; Willey 1990); hanging or strangulation (Bennike 1985); ritual killing (Stead et al. 1986); possible cannibalism (Turner 1993; White 1992); and human sacrifice (Pijoan and Lory 1997). Following this undeniable evidence of lethal trauma, bioarchaeologists enter into the abyss of nonlethal trauma interpretation. Indicators of nonlethal, habitual aggression are much more subtle because death is not usually the desired outcome or consequence of an attack. This review surveys the palaeotrauma literature pertaining to nonlethal intentional violence and accidental injuries rather than the direct evidence of collective violence due to warfare and lethal violence within the community.

Derived from clinical literature and in order of decreasing reliability, osteological indicators of nonlethal interpersonal violence include (Jurmain 1999, 214-215; Jurmain and Kilgore 1998; Maschner and Reedy-Maschner 1998; Walker 1989):

1. multiple injuries,
2. cranial trauma,
3. forearm fracture from direct blow (parry, nightstick fracture).

3.3.1.1 Multiple injuries

Overall patterns of traumatic involvement are the best basis from which to infer aetiology (e.g., Berger and Trinkaus 1995; Jurmain and Kilgore 1998), but are typically limited to the long bones and skull. The smaller bones, though frequently traumatised in clinical assault cases, are equally affected by accidental trauma; however, they serve to strengthen observations made at the individual level. Thankfully, there has been a trend among bioarchaeologists to observe and report the prevalence of trauma for the complete skeleton (e.g., Berger and Trinkaus 1995; Jurmain 1991; Jurmain and Bellifemine 1997; Kilgore et al. 1997; Merbs 1983; Robb 1997). Various case studies have attempted to identify the occupation or activity of the individual based on traumatic lesions observed (e.g., Anderson 1995; Edynak 1976; Hawkes and Wells 1975; Mann 1993; Santos et al. 1998) and even though these interpretations may in fact be correct, Stirland (1996) and Wakely (1996) advise against the temptation to speculate on the ultimate injury mechanism.

Hershkovitz et al. (1996), for example, studied the skeletal remains of two 20th century males, known to have boxed during their lives and observed that their injury patterns were consistent with the types of injuries received during boxing as reported in clinical and sports medicine literature. A similar study of two medieval males from Abingdon (Britain) was limited in the interpretation as neither the occupations nor activities of the men were known (Wakely 1996). Although the complex of injuries observed was strikingly comparable to those resulting from the boxers that were studied by Hershkowvitz et al. (1996), Wakely cautiously concluded that even though two major episodes of documented civil turmoil were associated with the skeletal sample and that the multiple trauma rate was unusually high for the entire Abingdon group (14.6% had combined rib, vertebral and upper limb trauma), the complex of injuries could have been sustained in any manner of activity where individuals practised a more demanding lifestyle.

Some researchers have considered the cumulative injuries of one or two individuals (e.g., Hershkovitz et al. 1996; Wakely 1996), but only rarely has this been mentioned at the populational level. Winlock's (1945) study of slain 11th Dynasty Egyptian soldiers revealed that they were veterans of other battles as old healed wounds, typical of those due to weapons, were observed. Most bioarchaeologists dutifully report the number of individuals that sustained multiple injuries, but venture no further (Alvrus 1999; Grauer and Roberts 1996; Judd and Roberts 1998; 1999; Lahren and Berryman 1984; Robb 1997), although some researchers have included the multiple injury rate for each sex (Jurmain and Kilgore 1998; Kilgore et al. 1997). Multiple injury analysis at the populational level has been completely neglected and it is important that the role of injury recidivism be investigated with the same rigor as single lesions to further refine the demographic pattern of injury within a society.

Smith (1996a) hypothesised that craniofacial injury would result from unsuccessfully obstructed blows. She found that only four out of 135 (3%) Archaic period adults from West Tennessee had penetrating craniofacial trauma, not one of which was associated with forearm trauma, while one Mississippian female out of 153 adults (0.7%) incurred a broken nose without associated forearm injuries. Because the vault injuries were penetrations Smith proposed that the lesions were due to warfare rather than interpersonal violence. She argued that the absence of cranial depression lesions did not support the high frequency of female forearm trauma as being due to violence in this group.[8] Likewise, Kilgore et al. (1997) found no reliable evidence of cranial trauma, but they observed an abundance of ulna fractures among medieval Nubians at Kulubnarti (23.3% of individuals sustained ulna fractures), an injury pattern that they suspected was the consequence of falls on Kulubnarti's rugged basalt landscape. Wilkinson and Van Wagenen (1993) proposed that a low prevalence of post-cranial trauma accompanied by a high frequency of cranial trauma supported interpersonal violence as a valid interpretation because other postcranial injuries would be expected if an accident was involved, notably injuries resulting from falls (e.g., Colles' fracture, lower leg fracture).

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[8] Smith (1996a) identified parry fractures by midshaft or distal shaft location only, although many of the injured ulnae had associated radial injuries; the classification of the parry fractures is, therefore, questionable and the frequency is likely overrepresented.

Conversely, Larsen (1997) countered that if the forearm was raised to protect the skull and did so successfully, a forearm fracture would occur rather than a skull injury.

3.3.1.2 Cranial injuries

Filer (1997, 47) stated that "cranial injuries are particularly useful in understanding human behaviour for, whereas the causative factors leading to fractures of the postcranial skeleton may or may not be accidental, there is less doubt about cranial injuries, which are more likely (but not exclusively) the result of intentional violence," and consequently many investigators have appraised cranial injuries for the sole purpose of determining the degree of interpersonal violence.

Walker (1989) studied the crania of two groups from the Santa Barbara Channel area and found a significant difference in skull injury between the mainland (7.5%) and island (18.5%) groups, which he attributed to competition for the restricted island resources. Jurmain and Bellifemine (1997) also examined the crania of prehistoric peoples from the San Francisco Bay area of Central California (site CA-Ala-329) and found 2.7% of 260 adult crania to be fractured, but only the males were affected. On the basis of the supporting evidence of embedded projectile points, the investigators concluded that violence did exist in this region and was comparable to surrounding sites, although the ancient people from Southern California (Walker 1989) and Baja (Tyson 1977) exhibited a much higher frequency of cranial injury (19.4% and 30%).

Boxing was used as a model for interpersonal violence by Walker (1997) who diligently collected data from more than 2300 archaeological crania from 13 culturally diverse samples with the intent of showing cultural variability in interpersonal violence among ancient people. He found males to be more frequently injured, but when the sexes were pooled, nasal injuries were common to both, more so than other individual elements of the vault. Webb's (1995) study of Australian aboriginals revealed an abnormally high prevalence of cranial trauma among both sexes, up to 27.7% in one geographic region. While interpersonal violence may indeed be an explanation for this phenomenon, other culturally specific behaviour was possible. Both Walker (1989) and Webb (1995, 202) reported that self-inflicted injuries required of ritual were an alternative to accidental injury and interpersonal violence. They recounted ethnographic and ethnohistoric evidence that described the practice of individuals striking their heads with a stone or another object during mourning rituals, an action that would cause depressed fractures, most likely to the frontal and parietal regions of the cranial vault.

3.3.1.3 Parry fracture

Perhaps the most controversial lesion in palaeotrauma analysis is the parry fracture of the ulna (Jurmain 1999; Lovell 1997). In clinical practice a fracture to the forearm, which was held up in defence, is called a "parry" or "nightstick" fracture and most often affects the distal ulna as a transverse fracture line; occasionally, it may include the radius if the blow was strong enough to break both bones (Heppenstall 1980, 496; Richards and Corley 1996; Rogers 1992, 811). The configuration of the injury, however, can result from a mobile object contacting the arm, or when the arm contacts a stationary object; a fall may also cause an isolated ulna fracture, but is infrequent. Because bioarchaeologists will never be certain whether the injury was one of defence, it can only be claimed that the bone displaying this configuration was a "possible" parry fracture. Too often bioarchaeologists assign the forearm injury to the "parry" type based on shaft location only (e.g., Anderson 1995; Edynak 1976; Smith 1996a; Smith 1998; Webb 1995), and fail to evaluate the fracture configuration and radial involvement, both essential to distinguish the lesion aetiology (for detailed discussions see Jurmain 1999, 215-22; Lovell 1997). Most recently, however, Alvrus (1999) produced a detailed analysis of ulna fractures stating the presence or absence of radial involvement as well as diagnostic criteria.

In the palaeotrauma literature, fractures resulting from fending a direct blow (for brevity in discussion, this will be referred to as the "parry" fracture) were first attributed to interpersonal violence by Smith and Wood-Jones (1910), who speculated that the abundance of female forearm injuries was caused by a stick commonly used by modern Nubians to keep order in the household. This interpretation was perpetuated over the following years by eminent palaeopathologists, such as Brothwell (1961), Wells (1964), Snow (1974), and Angel (1986), and is now widespread in palaeotrauma literature.

3.3.1.4 Gender issues: domestic violence

Clinical research reports that males were predisposed to more lethal and frequent violence in comparison to females, and this is especially so among young adults (see clinical discussion above). This was upheld among a geographically and temporally diverse selection of ancient cultures (e.g., Angel and Bisel 1986; Cybulski 1992; Edynak 1976; Frayer 1997; Keenleyside 1998; Lahren and Berryman 1984; Martin 1997; Powell 1988; Robb 1997; Shermis 1983; Smith 1996a; 1989; Walker 1997; Wells 1982). Females incurred higher numbers of overall injuries at La Plata (Pueblo Period) (Martin 1997), and among prehistoric Australians (Webb 1995). Female skull injuries predominated at the Late Woodland (1000-1300 AD) site of Riviere aux Vase, Michigan (Wilkinson 1997; Wilkinson and Wagenen 1993), and among one Aleut and four Eskimo groups (Keenleyside 1998), while more female forearm trauma was observed at Central Valley, California (1500 BC-300AD) (Shermis 1983).

Shermis (1983) was perhaps one of the first bioarchaeologists to compare ancient injury patterns with clinical victims of assault to suggest domestic violence as a cause of injury among archaeological populations, aside from the speculations made by the earlier investigators (e.g., Hawkes and Wells 1975; Smith and Wood-Jones 1910; Wells 1964). Wilkinson and Van Wagenen (Wilkinson 1997; Wilkinson and Wagenen 1993) drew on complementary sources to evaluate cranial injuries as indicators of interpersonal violence among Riviere aux Vase females. Although the frequency of cranial fracture was only 9% (19 out of 307 crania), 79% (n = 15) of the lesions occurred on female crania, contrary to the male prevalence of skull injury in diverse archaeological and clinical samples. The number of ulna injuries was not specified, but the investigators suggested that the females had been bound and unable to defend themselves and therefore, an absence of ulna injury resulted. The researchers proposed that if trauma was accidental, a greater number of postcranial injuries, specifically to the bones of the forearm and lower leg, would be present. They cited various ethnographic references as possible explanations for female abuse in this society; polygamy, for example, known to be strongly associated with female abuse in many modern traditional societies (Ember and Ember 1997; Levinson 1989), was present in this culture. In addition, the lack of injuries consistent with warfare among males at this site and among neighbouring sites argues against collective violence, but abduction of young females from neighbouring groups during raids may have occurred. Ethnohistoric documents recorded that raids accompanied by the abduction and torture, and subsequent adoption of women into the perpetrator's group, was rampant at the Riviere au Vase site during the Late Woodland period. However, the ethnohistoric record was silent on domestic abuse, although this may be a result of selective recording or indifference on the part of the observers.

3.3.1.5 Status

Research that investigated interpersonal violence as a factor of social status relied heavily on funerary analysis to determine the relative status of the individuals. Lahren and Berryman (1984) examined fracture patterns to determine activity variations between high and low status individuals from a non-fortified Mississippian site at Chucalissa (1000-1600 AD). High status males presented significantly more fractures than their lower status brothers. Parry and skull fractures assigned to aggression, in addition to multiple injuries, were most frequent among the high status males. Powell (1988, 144-146) studied the skeletal remains from Mississippian Moundville to determine differences in health and disease according to status. The Moundville elite males had the fewest fractures in contrast to the elite Mississippian males from Chucalissa (Lahren and Berryman 1984) and Etowah (Blakely 1980) who had higher rates of healed fractures than the nonelites. Success at warfare enhanced male status, which was distinguished in the Mississippian burial practices by restricted burial locations and high status goods. Powell (1988) attributed the absence of fractures at Moundville to the lack of high status males in the sample, accompanied by poor preservation; the absence of trauma among elite females was credited to their lack of involvement in strenuous or hazardous activities.

Smith (1996b; 1998) relied on burial analysis as a means of assigning status to determine a high status warrior class of males among 97 Late Bronze Age Athenians. Three high status males exhibited long bone or skull trauma, with one injury the result of a bladed weapon. Smith suggested that although the low prevalence of trauma refuted a high status warrior class, warriors that were killed in battle may have been buried where they were slain, rather than transported back home.

It is reasonable to presume that individuals deemed to be of slave status would bear greater amounts of injuries than their unbonded neighbours, but this was not the case among a small urban New Orleans sample of European and Afroamerican adults (ca. 1720-1810 AD) (Owsley et al. 1987), where few injuries existed. The investigators noted that there was a distinct difference in lifestyle for the urban and rural slave that may explain the lack of trauma among the domestic city slaves. The urban slaves led comfortable lives as domestic servants or became skilled tradesmen, whereas their rural counterparts may have experienced more injuries from heavy farm labour or abuse.

3.3.2 Nonintentional injury

In clinical practise, specific injuries to the forearm (Colles' fracture, Smith's fracture, isolated radial fractures, and oblique shaft injuries) are reliable indicators of a fall (Rogers 1992), while other lesions are ambiguous in aetiology and strongly mediated by the environment (Ortner and Putschar 1981, 73). Lovejoy and Heiple (1981), for example, accredited traumatic lesions (3% of all long bones observed) observed among the Late Woodland Libben people to accident from daily hazards on the basis of the high prevalence of clavicular injuries (5.8%), Colles' fractures (not specifically stated, but at most 3.5%), and low prevalence of skull injury (0.2%). During the last two decades, some researchers adhered to the Libben example and assessed the natural environment, as well as the specific challenges of daily living that may have predisposed the society in question to accident. At medieval Kulubnarti in Nubia, the long bone fracture frequency (3.7%) and the presence of only one questionable skull fracture were analogous to the results from the Libben sample (Kilgore et al. 1997) and the high prevalence of Colles' (5%) and paired forearm (3.7%) fractures were likely due to mishaps on Kulubnarti's rocky terrain or falls from ladder access to the emergent two-story houses. The lack of skull trauma at Kulubnarti and Libben supported Smith's (1996a) premise that the absence of cranial trauma was a poor indicator of interpersonal violence. Alvrus (1996; 1999) studied adults from Semna South, another Nubian site neighbouring Kulubnarti and found that forearms bore the brunt of postcranial injuries. Alvrus' detailed description revealed that nearly half of the injuries displayed lesions characteristic of a clinical parry fracture, while the others were possibly the outcomes of falls on the treacherous terrain; close interaction with animals, especially as horses and the cattle-driven water wheel had been introduced; and wrestling, a favourite sport among the ancient Nubians. A desert environment and rocky terrain were also proposed by Webb (1995) as the agent for broken legs (45% of the total fractured bones) among prehistoric Australian desert dwellers. As opposed to other areas of Australia this high prevalence of leg injuries reflected the distances travelled in search of food, water, and camp sites, as well as hunting activities, which in Australia involve climbing over rocky terrain and running over open plains and savannah.

Judd and Roberts (1999) examined the long bone fractures from two rural medieval British sites and compared the results to similarly recorded urban British samples dated to the medieval period. Using modern rural societies as a model, they discovered that the ancient rural samples studied had a higher prevalence of trauma than their urban neighbours, just as in modern societies (e.g., Björnstig et al. 1991; Boyle et al. 1997; Brison and Pickett 1992; Pratt et al. 1992). The rural way of life, specifically, the close proximity of animals, farming chores, and ploughed fields has been suggested as a contributor to injury in other regions as well, for example, Nubia (Alvrus 1999; Judd 1999), Romano-Britain (Molleson 1992), and Upper Canada (Jimenez 1991; 1994).

3.4 Survey of palaeotrauma in the ancient Nubian vicinity

The oldest Nubian cemetery (ca. 12,500-9000 BC), as well as some of the earliest evidence for collective violence, was found at Site 117 in Sahaba, 3.0 km north of Wadi Halfa (Anderson 1968). Over 110 stone points or barbs penetrated the vertebrae, thoraxes, arms, and skulls of 24 out of 59 (40.7%) adults and children, while the burial fills produced a further 73 loose lithic points; cutmarks were observed on the bones of eight individuals (Anderson 1968; Wendorf 1968). Most of the nonlethal injuries were typical of those achieved from falls, although the six ulna lesions were located on the distal or midshaft sections of the bone; however, no cranial trauma was observed. Podzorski's (1990) reanalysis of the bones from 853 individuals recovered from the Predynastic cemetery (N 7000) at Naga-ed-Dêr in Middle Egypt, combined with archival field notes and photographs,[9] documented 14 cases of long bone fracture, and of these, seven ulnar lesions were attributed to nonlethal violence based on their distal shaft location. Only two males bore nonlethal skull injuries, which were not accompanied by other injuries. One lesion penetrated the left parietal, while the second injury shattered the left zygomatic, an injury strongly associated with interpersonal violence in the clinical setting. Podzorski (1990) did not associate these injuries with collective violence.

Smith and Wood-Jones (1910) recorded 160 injuries[10] from their diverse sample of 5000 to 6000 people from Lower Nubia that spanned from the Predynastic (4000 BC) to Christian (1450 AD) periods. They explained that the low prevalence of foot fractures was due to the lack of footwear, curbs, steps, and stairways, which predisposed modern populations to slips and falls; likewise, the low prevalence of hand injuries was ascribed to a lack of machinery and industry (Smith and Wood-Jones 1910, 296-298). Biga and Hesa were two cemeteries situated on islands composed of rocky granite boulders, a notorious feature of the *Batn el Hajar* region. Smith and Wood-Jones (1910, 322) proposed that this treacherous landscape may have presented obstacles to the residents and predisposed them to femoral and lower leg fractures. They speculated that a blow with a staff or *naboot*[11] produced the single ulna injuries, particularly among females. This oft-cited study, which branded the ancient Nubians as vicious woman-batterers,

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[9] The human remains were excavated from 1901-1904, and although extensively studied, no comprehensive investigation was undertaken before much of the physical collection was destroyed due to a lack of space, which necessitated the use of archival data for the most recent skeletal analysis (Podzorski 1990, 1, 9-13).
[10] Many of the injuries were classed by anatomical region, such as the forearm, hand, ribs, spine, and leg.
[11] Smith and Wood-Jones (1910, 297) described the *naboot* as follows: "For all ordinary purposes of offence and defense—short of those of actual warfare—the Nubian and Egyptian native is in the habit of using a stout staff called the *naboot* and in domestic affairs it is apt to be the final appeal of authority… but the *naboot* has a much wider range of utility than the use in these ordered bouts of fencing, and the women in these ancient burials show a high proportion of fractured forearms."

exemplified the need for a comprehensive method of trauma analysis to determine a trauma frequency that represented all observed bones, and prompted future investigators to address the issue, for example, Lovejoy and Heiple (1981).

The rocky *Batn el Hajar* region of the Nile River's Second Cataract was also implicated as a fracture risk by Kilgore et al. (1997) who expanded on Burrell et al.'s (1986) earlier investigation of people from medieval Christian Kulubnarti (ca. 550-1500 AD), and by Alvrus (1999), who observed individuals from Semna South where the burials were predominantly dated to the Meroitic period (ca. 300 BC-350 AD).[12] Disparity existed in the fracture distribution among these neighbouring sites. At Kulubnarti, only one disputable skull lesion was observed, while the forearm experienced nearly 75% of all injuries (Kilgore et al. 1997). On the contrary, the Meroitic people of Semna South sustained 53.9% of 117 fractures to the skull and 22% to the forearm. Alvrus (1999) accredited the high prevalence of skull trauma affecting 17.9% of her sample to an era of unrest during the Meroitic period. The long bone fracture rate from Semna South was 8.9%, but at Kulubnarti it was dramatically higher (32.9%) (Kilgore et al. 1997).

Filer's (1998) study of 42 Christians from medieval Soba, situated near the southerly plains of the Sixth Cataract, found no evidence of fracture. This maintained Burrell et al's (1986) and Kilgore et al.'s (1997) conclusion that the Christian period was peaceful in contrast to the troubled earlier eras and that the rocky terrain of *Batn el Hajar* predisposed its inhabitants to falls. Conversely, Armelagos' (1969) analysis of skeletal remains from the Wadi Halfa region, located on a fertile plain north of *Batn el Hajar*, revealed the frequency of cranial trauma to be similar between the Meroitic (14.2%) and Christian (13.4%) periods, while postcranial trauma increased in frequency from 5.6% to 11.3%.

In her study of 309 skulls from Nubia's earliest city at Kerma (1750-1500 BC), Filer (1992) found a preponderance of depressed cranial lesions among the 11% injured, and of

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[12] Fifty-four burials were dated to the Ballana Period (ca. 350-550 AD) and 18 burials derived from a Christian context (ca. 550-1400 AD).

those injured, 44.1% were female. Filer (1992) observed one possible nasal fracture and one mandibular fracture and interpreted all of the lesions as the result of intragroup squabbling. Injuries to the face were negligible in comparison to those of the vault for both Kerma and Semna South. Only one mandibular fracture was noted at Semna South, but 10 of 72 (13.9%) nasal bones observed were fractured, which contributed to 8.5% of all fractures (Alvrus 1999). Depressed cranial lesions on Nubian and Egyptian skulls have been credited to blows from fists or blunt objects, such as maceheads or sling stones (e.g., Courville 1949; Gurdjian 1973, 11; Nielsen 1970; Smith and Wood-Jones 1910, 38).

Direct evidence of collective violence is not unknown for Upper Nubia, but most injuries reported were due to accidental or nonlethal interpersonal violence. Environmental factors, such as a rocky landscape and riverine location, placed the inhabitants at an increased risk of fall-related injuries, with fractured forearms often the result, while the lower leg was seldom affected. The distribution of skull lesions indicated that the vault was a favoured target as opposed to the facial area, although females from Semna South displayed a higher frequency of craniofacial trauma. Much variation existed between the locales and temporal periods, and, as yet, no clear pattern of injury has been ascertained.

3.5 Summary

Clinical and nonhuman primate research function as viable models from which to assess palaeotrauma and the results can be assimilated to form an injury profile for the ancient sample to be interpreted within the cultural, historical, and environmental context. Past palaeotrauma research has examined ancient warfare, status, domestic violence, occupation, sports, and residence both diachronically and synchronically, but many geotemporal and topical voids, begging for investigation, continue to exist.

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Table 3.1: Trauma mechanisms in developing countries

Citation	Country	Economy	Injury Mechanism (%)				
			Falls	Assault	MVA	Burns	Other
Crandon et al. 1994	Jamaica	regional	11	52	20	7	10
DeSouza 1968	Uganda	regional	19	35	27	9	10
Ebong 1978	Nigeria	urban	59	1	29		11
Matthew et al. 1996	Papua New Guinea	rural	28	56	14		2
Mock et al. 1995	Ghana	rural	12	5	29	16	38
Odero and Kibosia 1995	Kenya	urban	17	40	18	3	22
Watters et al. 1996	Papua New Guinea	regional	44	38			18

MVA = Motor Vehicle Accident

CHAPTER 4

Comparison of recording methods of long bone trauma

"Missing parts bedevil the palaeopathologist's life" (Waldron 1994, 58).

4.1 Introduction

Long bones, commonly used for the systematic analysis of palaeotrauma, reveal aspects of environmental, sociocultural or occupational hazards in which ancient people lived (e.g., Brothwell and Browne 1994; Grauer and Roberts 1996; Judd and Roberts 1998; 1999; Jurmain 1991; Kilgore et al. 1997; Lovejoy and Heiple 1981; Neves et al. 1999), while exclusive studies of skull fracture evaluate violence within the community (e.g., Filer 1992; Jurmain and Bellifemine 1997; Owsley 1994; Walker 1989; Walker 1997; Wilkinson 1997; Wilkinson and Wagenen 1993). The trauma profile created by these two methods of investigation permits researchers to assess the prevalence of trauma within and among cultures; however, a host of problems beset methods of trauma recording although numerous recommendations have been made. These proposals highlighted trauma classification (e.g., fracture, dislocation, soft tissue trauma, and surgical procedures, such as trephination and amputation), fracture typology (e.g., complete, oblique, and comminuted), and measurements of bone displacement (e.g., alignment and apposition) (e.g., Buikstra and Ubelaker 1994; Lovell 1997; Merbs 1989; Ortner and Putschar 1981; Roberts 1991; Steinbock 1976; Thillaud 1996). These lesion descriptors are well understood, but a perennial issue with fracture recording is the integrity of the bone due to differential preservation—how much of a bone is required to include it in the sample under observation?

Differential bone preservation is indeed a confounding issue in archaeological skeletal analysis and although various protocols exist for reporting palaeotrauma, investigators modify these methods to suit their research problem. While necessary, this may create results that are incomparable to other data and in times of global repatriation of skeletal collections the luxury of future primary data gathering is not always feasible. An additional factor to consider in bioarchaeological recording design is the accordance with clinical methods. Bioarchaeology increasingly relies on medical studies to aid palaeotrauma interpretation; it follows that a clinically based method of recording is desirable. Bioarchaeologists need not "reinvent the wheel," but must attempt to make their recording techniques more compliant. A flexible recording system that allows for maximum extraction of data is essential, while simultaneously being efficient for use when time is critical. This investigation compared various palaeotrauma recording methods by using the long bones of one skeletal sample only as an example to determine if there really was a significant difference among the results obtained. A biocultural interpretation was not the desired outcome for this particular investigation, but the results will be integrated with the trauma patterns observed in the following chapter.

4.1.1 Review of trauma recording protocols that address the preservation problem

Lovejoy and Heiple's (1981) analysis of the Late Woodland skeletal sample from the Libben site in Ohio was a pivotal point in human palaeotrauma recording that addressed skeletal completeness in archaeological collections and examined human palaeotrauma as a viable research area. Not only was there a problem of the skeletons lacking some osseous elements, but also the bones present were not always complete. They remedied this situation by including only "complete" bones in their sample and excluded incomplete bones with fractures. They expressed the fracture frequency for each bone element (e.g., ulna, femur, etc.) as a percentage of the proportion of traumatised bones per total number of bones observed. This method of representing fracture frequency is analogous to the "tooth count" method used in dental disease analysis to establish the frequency of disease for each tooth type and to account for variable preservation (Lukacs 1989, see discussion of three methods of data presentation p. 271-273). Perhaps the "bone count" may be an appropriate term for this recording method that can be applied to most palaeopathological lesions. The fault of this method is that it overlooks fractures that may occur on the fragmentary bones. Bennike (1985, 56-59) attempted to circumvent this problem by listing the number of fractured fragments observed, but did not provide a description or include them in her calculations.

The degree of completeness of the bone is recognised as a problem and several researchers have subjectively estimated the wholeness of the bone. For example, long bone preservation has been scored as a percentage of the complete bone, as minimally damaged, or not scored at all. Other researchers are very explicit. White (1992, 109) encountered a culturally manufactured fragmentary collection of bones in his investigation of cannibalism in the American Southwest. White's objective was to determine the sequence of processing and thus he was required to work backward, consequently establishing a systematic method of recording differential preservation. In this comprehensive analysis of differential preservation in human bone White borrowed heavily from zooarchaeology to devise a recording system compatible for fragmentary remains. He separated the long bone into three segments (proximal and distal portions each exhibiting some part of the articular surface or epiphyseal plate and the shaft) that generated three additional combinations of elements: proximal or distal portion with 50% of the shaft present, and complete, which consisted of 50% or more of the three segments (White 1992, 132). White reiterated the importance of reporting the number of specimens that displayed the attribute under investigation (in his case, cutmarks) to the number of specimens capable of exhibiting the attribute and labelled the result as the "*real incidence.*"[1] White (1992, 295) proposed that data be presented as an NISP (number of identified species) of the elements present (bone count), the MNI (minimum number of individuals), and a survival value for an element or element portion (number of affected elements observed per number of elements expected).

Melbye and Fairgrieve (1994) faced a similar challenge when they examined the scattered and butchered remains of a small sample from Saunaktuk in the Canadian Northwest Territories. To quantify lesions per fragment type was not reliable as the frequency would vary with the number of fragments. Like White, they sorted fragments by elements and attempted to reconstruct complete bones, which proved to be unsuccessful. They mapped "neighbourhood areas" of trauma clusters onto a line drawing of each element to permit an examination of the role of the muscle attachment in relation to the cut or preferred areas of mutilation. Trauma was expressed as the occurrence of trauma per identifiable element.

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[1] Waldron (1994, 43-4) discussed the use of the terms incidence and prevalence.

Robb (1997) also endorsed the need for data that permitted comparison among populations in various geographic and temporal contexts. He followed the detailed skeletal inventory recording method recommended by the Palaeopathology Association (Rose et al. 1991), but divided the shaft into three segments as suggested by Buikstra and Ubelaker (1994, 7-8)—therefore, each long bone consisted of five segments (proximal/medial, middle, and distal/lateral shafts; proximal/medial and distal/lateral epiphyses) in the initial inventory. Although Buikstra and Ubelaker suggested 75% of the bone be present for inclusion, Robb observed segments for trauma if more than 50% of the segment was present. Robb (1997, 132) excluded the epiphyses from his count of segments available for observation under the assumption that the "...majority of trauma occurs on the diaphysis...," but incorporated the epiphyseal segments into the total fractured segment count, which distorted his frequency of trauma. The exclusion of the epiphyses totally neglects the more subtle depression fractures associated with the articular surfaces, avulsion lesions, and dislocations and thus, his calculated results are incomparable for investigations that require all segmental data; the raw data, however, were included and all segments can be reassessed as necessary.

Walker (1997) developed a method to account for partial remains of the cranial vault by recording fragmentary bones as partial individuals. Therefore, an individual with only one half of the cranial vault present contributed 0.5 to the sample of cranial vaults available for observation, while an individual with an undamaged cranial vault counted as 1.0 toward the total number of cranial vaults available for observation. The sum of these scores was the "effective number of individuals" and the fracture frequency for the cranial vault was calculated as the percentage of fractures per effective number of individuals. This recording method was recently applied to a long bone fracture analysis by Alvrus (1999), who calculated the effective number of individuals as the product of the total number of elements observed that were 75% or more complete and the average completeness of element under observation.

The above review surveyed various palaeotrauma recording strategies in use for long bones, but a comparison of these methods has yet to be undertaken to ascertain if and to what extent variation exists among the final results. This investigation undertook this task.

4.2 Materials and methods

4.2.1 The skeletal material and archaeological context

The skeletal material studied in this investigation was excavated from two neighbouring rural cemeteries (P37 and O16) in Upper Nubia that were dated to the Kerma Ancien (2500-2050 BC) and Moyen (2050-1750 BC) periods.[2] The cemeteries were situated along the Nile River, near the modern Sudanese town of Dongola, about 70 km upriver from the ancient type-site of Kerma (Figure 4.1). The skeletal sample consisted of 55 adults—28 males and 27 females. Dimorphic variations of the innominate and the skull as summarised by Buikstra and Ubelaker (1994) were observed to determine the sex of each individual. Measurements of the femoral, radial, and humeral heads, as well as the bicondylar width of the femur complemented the observations. Age at death was determined by degenerative changes to the pubis, auricular surface of the innominate, and sternal rib end (Buikstra and Ubelaker 1994).

4.2.2 Methods

4.2.2.1 Elements examined

For each individual all major long bone elements (clavicle, humerus, ulna, radius, femur, tibia, and fibula) were observed macroscopically for healed or healing antemortem fractures and treated individually. The clavicle occasionally is neglected in long bone analysis, although anatomically it is classed as a long bone (Gray 1974, 33). Some investigators, for example Smith and Wood-Jones (1910), combined the two bones of the forearm or lower limb into one unit, but this does not allow for an accurate comparison for specific bone injuries and limits the comparability of the sample, although it is desirable for interpreting the injury mechanism (Jurmain 1999, 214-222; Lovell 1997).

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[2] The skeletal remains were excavated by the author, local Sudanese workers from the Dongola vicinity, and fellow members of the Sudan Archaeological Research Society's Northern Dongola Reach Survey (NDRS) team from 1994-97 under the direction of Dr. Derek Welsby (1996; 1997) of the British Museum's Department of Egyptian Antiquities.

4.2.2.2 Determination of long bone segments

Buikstra and Ubelaker (1994, 7-8) published recommendations for standardised skeletal data collection to facilitate comparability and to extract the maximum amount of data from the material studied. They proposed that long bone shafts be divided into proximal, middle, and distal thirds, while the epiphyses be recorded separately. Each segment was scored complete if more than 75% of the segment was present. Traumatic lesions were recorded by bone and section (Buikstra and Ubelaker 1994, Attachment 25). This "5-segment method" accords with the clinical system of reporting fracture injury location (e.g., Gustilo 1991; Müller et al. 1990). For ease in documentation the lateral segments of the clavicle were classed as "distal" or "distal interarticular" and the medial portions as "proximal" or "proximal interarticular." The segment was not necessarily intact, but may have consisted of pieces that could be conjoined to form at least 75% of the segment.

One obstacle persists—how is each segment consistently determined? It is comforting for bioarchaeologists to know that this dilemma plagues clinical recording where segments are often arbitrarily determined as well (e.g., Schultz 1990). Both proximal and distal articular portions encompass the metaphyses and epiphyses of the bone, but there is no standard landmark that determines where the metaphysis ends and the shaft begins (Müller et al. 1990, 10). Müller and colleagues (1990, 10) proposed that the "system of squares" be utilised where the proximal and distal interarticular segments composed of the epiphyses and metaphyses are delimited by a square whose sides are the same length as the widest part of the epiphysis in question (Figure 4.2).

Once these end segments are determined, the shaft of the complete bone can be evenly subdivided into proximal, middle, and distal thirds, except for the proximal interarticular femur, which is defined by a horizontal line that traverses the inferior edge of the lesser trochanter. Their calculations for the forearm and lower leg interarticular segments were determined with both bones articulated, which is not always practical for archaeological material. To compensate for this, I proposed that the length of the square be increased to twice the width for the ulna and fibula interarticular segments. While this is practical for undamaged bones, incomplete bones still pose a problem and their segments must be compared to an entire bone of similar robusticity to identify the size of the segment present.

4.2.2.3 Inclusion of the long bone segment

Once the segment's position was identified, the segment was assessed to determine if an adequate amount of bone was present from which to observe lesions and was subsequently recorded as present or absent. In his analysis of fragmentary commingled bones, White (1992) considered a segment represented by 50% or more of its bone to be complete; Robb (1997) followed this recommendation in his analysis. The Palaeopathology Association (Rose et al. 1991) proposed that only one-third of a segment need be present for inclusion, while Buikstra and Ubelaker (1994, 8) advocated that a majority (i.e., 75%) of each segment be accounted for. A conservative approach was taken in my analysis and the threshold chosen was 75% presence for each segment. It may be argued that if all five segments for each bone element, for example, an ulna, were represented by exactly 75% of their area, in reality only 75% of the ulna would be available to examine. What really is being investigated here, however, is the visibility potential of the fracture in the bone recovered and 75% of a segment should reveal some evidence of a complete fracture, if present. The determination of 75% of each segment is judgmental and relies on comparison to a complete segment of similar form.

4.2.2.4 Determination of healed fracture presence

Various researchers summarised the accepted characteristics of healed long bone fractures as follows (e.g., Jurmain 1991; Kilgore et al. 1997; Smith 1996):

1. visible callus formation,
2. angular deformity of bone; no callus observed, but a fracture line may be visible on x-ray,
3. nonunion of healed bone—fractured ends are sealed and blunted.

The appearance of any of these injuries was noted as a healed fracture, while breaks that showed no indication of healing were excluded from the sample. The information retrieved for each injury consisted of the sex of the individual, bone element, side, and segment location only, as this was an analysis in recording under the constraint of differential preservation rather than a biocultural interpretation of fracture patterning.

4.2.2.5 Recording methods

The recording methods that were compared in this study are summarised in Table 4.1 and each method (1-4) consisted of two variations, "a" and "b," with the "b" methods adding partial fractured bones to the complete bone corpus of the "a" methods. The following relationships were calculated for each method:

1. bone count (number of lesions observed per total number of bones available),
2. individual mean trauma count (number of fractures observed per number of individuals in sample),
3. mean multiple injury (number of fractures per number of injured individuals),
4. individual count (number of individuals with one or more injuries per number of individuals in sample).

The "segment count" method examined all segments deemed recordable by 75% or more bone present. In contrast to bone count methods, a tally was made of each segment type for the bone elements and the number of fractures observed stated. The "segment count" frequency (White's "real prevalence") was calculated:

$$\text{segment count frequency} = \frac{\text{segments with fractures}}{\text{segments observed}} \times 100\%$$

4.2.2.6 Preservation and analysis

The amount of bone available for observation (survival index) can be assessed using the following formula:

$$\text{survival index} = \frac{\text{number of segments observed}}{\text{number of segments expected}}$$

Chi-square tests were performed to determine if a statistically significant difference was present in fracture frequencies among segments, bones, and between the sexes; the Yate's correction for continuity (χ_c^2) was used if the values for any cell were less than 5. The level of significance chosen was .05 and degrees of freedom (df) was "1" unless otherwise indicated.

4.3 Results

4.3.1 Bone count

The fracture prevalences for the recording systems that employed variations of the "bone count" method are shown in Table 4.2 and varied inversely as more long bones were added to the sample for both "a" and "b" methods. However, the addition of fractured bone segments to the "a" methods (i.e., the "b" methods) produced an increase in fracture frequency in comparison to the "a" methods, for each of the four methods. Table 4.3 displays a matrix of p-values calculated from chi-square analyses between the methods when the total fracture prevalences were compared. There were no significant differences between any of the four "a" methods, nor were there significant differences between the "a" and "b" methods for each of the four methods tested. Methods "1b" and "2b," however, exhibited statistically significant differences when compared to some of the other recording schemes.

4.3.2 Individual count

Table 4.4 summarises the mean number of fractures observed per individual, the mean multiple injury score, and the individual count of injured people. In this sample, the mean number of fractures per person ranged from 0.4 when bones with all five segments present were observed to 0.5 when all fractures were included, which was not significantly different. The mean multiple injury score or number of fractures per injured person spanned from 1.7 where the "b" recording methods were employed to 1.9 when the "3a" and "4a" methods were used; the lowest possible score, "1," would denote that each injured person sustained one lesion only. The "individual count" method expresses the percentage of afflicted individuals within the sample. Individuals that met with one or more injuries ranged from 21.8% of the sample when the bones with five segments present were evaluated to 30.9% when all fractures were reported, which was not significant ($\chi^2 = 1.17$, $p = 0.279$). The inclusion of these three interpretative frequencies provides an accurate summary of injury for the sample; for example, with Method "2a" an average of 0.4 injuries per individual was observed, but when only the injured individuals were included 21.8% of the group bore 1.8 lesions each.

4.3.3 Segment count

The fifth method of recording injury included all segments if 75% or more of the bone was present. Tables 4.5 and 4.6 tally the fracture prevalence for males and females respectively; a chi-square analysis found no significant difference in the presence of lesions between the sexes ($\chi^2 = 2.23$, $p = 0.135$). A chi-square analysis between the fracture distribution among the five locations revealed that a level of significant difference was approached among males ($\chi_c^2 = 9.29$, $p = 0.053$, $df = 4$), and existed among females ($\chi_c^2 = 22.26$, $p < 0.000$, $df = 4$). When the segments for both sexes were pooled, 28 fractured segments were observed among 2652 total segments and the "segment count" frequency of fractures among the total observed bones was calculated to be 1.1%.

A fracture pattern was common to both sexes—the distal shaft was the most frequently injured location, while the forearm and foreleg were the most commonly injured bones. The forearm injuries occurred on the middle and distal shafts in all cases. Lower leg injuries presented a unique pattern: the tibial fractures were located on the proximal and distal articular surfaces, while fibular fractures were observed on the shaft only. Neither sex sustained fractures on the more proximally located humerus and femur.

4.3.4 Preservation

The percentage of preserved bone (White's survival rate) for the entire sample was 68.9% (2652 segments recovered per 3850 segments expected).[3] For the 28 males, 77.9% (1526 recovered segments per 1960 expected segments) of the expected long bones survived, while the amount of female long bones preserved—59.6% (1126 recovered segments per 1890 expected segments)—was significantly less ($\chi^2 = 150.01$, $p < 0.000$). These results can be expressed as an index of preservation that describes the proportion of surviving

[3] 55 individuals X 14 long bones each X 5 segments = 3850 expected segments.

female bones to those of the males, or vice versa. In this sample, the sex differential preservation index would be 0.77 (0.596/0.779) or 76.5%. There was no significant difference between the sexes in the proportions of left and right bone segments available for observation ($\chi^2 = 0.25$, $p = 0.615$). When bone preservation between the sides was considered within each sex cohort, however, a significant difference was noted for both males ($\chi^2 = 11.38$, $p = 0.007$) and females ($\chi^2 = 10.16$, $p = 0.001$), which favoured the preservation of the right side as opposed to the left side.

4.4 Discussion

All of the bone count recording methods assessed in this comparative analysis have distinct advantages and disadvantages, which are summarised for the "a" methods, as well as the "segment count" method in Table 4.7. The "b" methods retain the advantages and disadvantages of the "a" methods, but report all available fracture data. Therefore, the "b" methods make some allowances for differential preservation and raise the fracture frequency from the "a" method. The fracture frequency, however, will likely decrease as more fragmentary untraumatised long bones are included in the observable sample. Noticeable differences were observed between all of the bone count methods, and although only four comparisons were significantly different, this emphasises that variation will exist between recording methods. However, if only complete undamaged bones were included in the fracture evaluation for this sample, six out of 28 (21%) of the fractures would be excluded, which may affect the interpretation of the fracture pattern. In this analysis, five of the partially complete bones excluded from Method "1a" present accident-associated fractures; by their exclusion the prevalence of violence-related injuries becomes more prominent. Likewise, differences in fracture frequency existed among the individual counts, which were not significant within the sample, but may affect comparisons with other samples.

Few meaningful results existed at the populational level when other frequencies were compared. The mean number of fractures, for example, distributes the prevalence of injury over the entire population and allows the investigator to evaluate the trauma potential of the entire group with that of another. Here, the mean number of fractures per person ranged from 0.4 for "complete" bones to 0.5 when all fractured bones were included, and therefore, each individual had less than one fracture in all cases. Likewise, in terms of real injury, the mean multiple injury score, which may be an indicator of interpersonal violence or a particularly hazardous environment if high, was the same for all methods used—each injured person contracted less than two fractures on average.

The "segment count" method does not enhance fracture recording more than any of the "b" methods. However, it provides a quick means of assessing the amount of preserved bone available for any palaeopathological analysis. In this case, for example, less female bone was available for analysis than male bone, and therefore, the number of fractures discovered among females may be misrepresented in comparison to the male sample. Besides preservation between the sexes, preservation between the sides can also be evaluated, which is particularly useful information for handedness, bone geometry, and other activity-related studies. A second advantage of the "segment count" method is that it presents a locational distribution of injury, which provides an overview of the types of injury to expect. In this case for example, fractures located on the distal long bone, with the exception of the ulna, are frequently associated with indirect forces, while injuries to the articular surfaces are often associated with direct impaction forces (Adams and Hamblen 1992; Rogers 1992). Distal ulna injuries are most often the result of a direct force (Rogers 1992, 816, 828; Schultz 1990, 265) and may alert the investigator to look for other signs of intentional trauma. Because the distribution of the fracture location is similar for both sexes, a hypothesis that there is no difference in the injury patterns and mechanisms between the sexes could be tested.

The fracture statistics and statistical relationship between methods will vary should this analysis be reproduced with other skeletal samples, but significant differences may exist if the collection is severely damaged due to environmental or cultural vectors. The choice of recording method, therefore, should be dependent primarily upon the overall integrity of the preserved bone, for example, a sample consisting of poorly preserved long bones would be most accurately analysed by the "4b" or "segment count" method. On the contrary, if all elements are undamaged the bones can quickly be scored using the "1a" method and division of the bone into segments is unnecessary except for determining the location of the fracture among the fractured bones.

Lovejoy and Heiple's (1981) implementation of the "bone count" method revolutionised palaeotrauma recording and interpretation, but as they neglected the fragmentary remains potential data may have been lost.[4] The "segment count" method, facilitated by Buikstra and Ubelaker's (1994) suggestions for long bone skeletal inventory and palaeopathological recording, should be reflected in the analysis and presentation of palaeotrauma data at the populational level, as it accounts for the majority of preserved bone that is frequently damaged in archaeological contexts and provides a quantifiable assessment of the amount of bone that was available for analysis. Nevertheless, it is the "bone count" and "individual count" trauma frequencies that are fundamental for sociocultural interpretation and render the sample comparable to other findings. Depending on the method of analysis selected, an inventory of fractured bones that were *excluded* from the analysis is essential, as it reports all available data; in doing so, other investigators have the option of including fragmentary bones in their analysis (see Bennike 1985, Table 8).

4.5 Conclusions

This investigation evaluated the long bone fracture frequencies obtained by commonly utilised methods of analysing palaeotrauma to assess whether meaningful differences in fracture frequencies really existed when the skeletal sample was held constant. Some statistical variation among the results was observed, but they did not occur between the recording method proposed by Lovejoy and Heiple (record complete undamaged bones only) and any of the other methods that included partial bones in the inventory. However, if only complete bones were included in the fracture evaluation of this sample 21% of the injuries would be excluded. The omission of this data could affect the comparisons of injuries between the sexes, the multiple trauma analysis, and the prevalence of accidental versus intentional injuries. The preservation analysis of the segments indicates that 69%

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[4] The collection studied by Lovejoy and Heiple (1981) has not been examined for excluded trauma data to the best of the author's knowledge.

of the expected bones are available for analysis, and therefore, some allowance must be made for damage in the future fracture analysis of this collection, although it is also desired that all pathological data be examined. Method "3b" is preferred as it includes all fracture data, yet allows for up to 20% of each bone to be damaged. Method "4b" is an alternative; however, a greater element of uncertainty is introduced as up to 40% of the bone is permitted to be absent.

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Table 4.1: Summary of "bone count" recording methods

Method	a	b
1: Undamaged bone	A tally was made of all bones represented by 5 complete, undamaged segments; segments on which the lesion occurred were noted.	All damaged bones with fractures were added to the numbers of bones and fractures tallied in 1a.
2: Minor damage, but all 5 segments present	A tally was made of all bones represented by 5 segments that were 75% or more complete; segments on which the lesion occurred were noted.	Traumatised bones with less than 5 segments that were 75% or more complete were added to the numbers of bones and fractures tallied in 2a.
3: Some damage, allows for 1 segment to be absent	A tally was made of all bones represented by 4 or more segments that were 75% or more complete; segments on which the lesion occurred were noted.	Traumatised bones with less than 4 segments that were 75% or more complete were added to the numbers of bones and fractures tallied in 3a.
4: Heavy damage, allows for 2 segments to be absent	A tally was made of all bones represented by 3 or more Segments that were 75% or more complete; segments on which the lesion occurred were noted.	Traumatised bones with less than 3 segments that were 75% or more complete were added to the numbers and fractures tallied in 4a.

Table 4.2: Fracture prevalence and frequency for long bone count recording methods

Method [1]	1a			1b			2a			2b		
Element	n	N	%	n	N	%	n	N	%	n	N	%
Clavicle	1	56	1.8	2	57	3.5	1	56	1.8	2	57	3.5
Humerus	0	35	0.0	0	35	0.0	0	51	0.0	0	51	0.0
Ulna	8	52	15.4	9	53	16.9	8	54	14.8	9	55	16.4
Radius	5	47	10.6	5	47	10.6	5	50	10.0	5	50	10.0
Femur	0	35	0.0	0	35	0.0	0	55	0.0	0	55	0.0
Tibia	6	34	17.7	8	36	22.2	6	52	11.5	8	54	14.8
Fibula	2	41	4.9	4	43	9.3	2	43	4.7	4	45	8.9
Total	22	300	7.3	28	306	9.2	22	361	6.1	28	367	7.6
Method	3a			3b			4a			4b		
Element	n	N	%	n	N	%	n	N	%	n	N	%
Clavicle	2	66	3.0	2	66	3.0	2	75	2.7	2	75	2.7
Humerus	0	71	0.0	0	71	0.0	0	79	0.0	0	79	0.0
Ulna	8	64	12.5	9	65	13.9	9	80	11.25	9	80	11.3
Radius	5	64	7.8	5	64	7.8	5	79	6.3	5	79	6.3
Femur	0	77	0.0	0	77	0.0	0	90	0.0	0	90	0.0
Tibia	7	71	9.9	8	72	11.1	8	89	8.9	8	89	8.9
Fibula	2	67	2.9	4	69	5.8	2	85	2.3	4	87	4.6
Total	24	480	5.0	28	484	5.8	26	577	4.5	28	579	4.8

[1]Method Description: (1a) long bones counted included all bones represented by 5 complete undamaged segments; (1b) included bones from (1a) plus all damaged fractured long bones; (2a) long bones counted included all bones with 5 segments present that were at least 75% or more complete; (2b) included bones from (2a) plus fractured long bones with 4 or fewer segments present that were at least 75% or more complete; (3a) included all bones represented by 4 or more segments that were at least 75% or more complete; (3b) included bones from (3a) plus fractured long bones represented by less than 4 segments that were at least 75% or more complete; (4a) included all long bones represented by 3 or more segments that were at least 75% or more complete; (4b) included bones from (4a) plus traumatised long bones represented by less than 3 segments. n = fractures observed; N = number of long bones observed;

% = n/N X 100% (the fracture frequency).

Table 4.3: Matrix of p-values calculated between bone count methods for the total fracture frequencies using chi-square analysis

Method[1]	1a	1b	2a	2b	3a	3b	4a
1b	0.416						
2a	0.525	0.135					
2b	0.885	0.477	0.413				
3a	0.178	0.023*	0.129	0.114			
3b	0.389	0.073	0.851	0.283	0.589		
4a	0.081	0.006*	0.283	0.044*	0.707	0.345	
4b	0.129	0.012*	0.403	0.076	0.902	0.490	0.791

[1]Method Description: (1a) long bones counted included all bones represented by 5 complete undamaged segments; (1b) included bones from (1a) plus all damaged fractured long bones; (2a) long bones counted included all bones with 5 segments present that were at least 75% or more complete; (2b) included bones from (2a) plus fractured long bones with 4 or fewer segments present that were at least 75% or more complete; (3a) included all bones represented by 4 or more segments that were at least 75% or more complete; (3b) included bones from (3a) plus fractured long bones represented by less than 4 segments that were at least 75% or more complete; (4a) included all long bones represented by 3 or more segments that were at least 75% or more complete; (4b) included bones from (4a) plus traumatised long bones represented by less than 3 segments.*significant at $\alpha=0.05$.

Table 4.4: Fracture statistics calculated from individual counts for each recording method

Method[1]	Fractures Observed (n)	Individuals with lesions (n')	Individuals Observed (I)	Mean (n/I)	Mean Multiple Injury (n/n')	Individual Count (n'/I) %
1a	22	12	55	.4	1.8	21.8
1b	28	17	55	.5	1.7	30.9
2a	22	12	55	.4	1.8	21.8
2b	28	17	55	.5	1.7	30.9
3a	24	13	55	.4	1.9	23.6
3b	28	17	55	.5	1.7	30.9
4a	26	14	55	.4	1.9	25.5
4b	28	17	55	.5	1.7	30.9

[1]Method Description: (1a) long bones counted included all bones represented by 5 complete undamaged segments; (1b) included bones from (1a) plus all damaged fractured long bones; (2a) long bones counted included all bones with 5 segments present that were at least 75% or more complete; (2b) included bones from (2a) plus fractured long bones with 4 or fewer segments present that were at least 75% or more complete; (3a) included all bones represented by 4 or more segments that were at least 75% or more complete; (3b) included bones from (3a) plus fractured long bones represented by less than 4 segments that were at least 75% or more complete; (4a) included all long bones represented by 3 or more segments that were at least 75% or more complete; (4b) included bones from (4a) plus traumatised long bones represented by less than 3 segments.

Table 4.5: Fracture prevalence by segment count for males

Bone		Proximal Articular			Proximal Shaft			Middle Shaft			Distal Shaft			Distal Articular			Total Segments Observed		
Element	**Side**	**n**	**N**	**%**	**n**	**N**	**%**	**n**	**N**	**%**	**n**	**N**	**%**	**n**	**N**	**%**	**n**	**N**	**%**
Clavicle	Left	0	19	0.00	0	20	0.00	0	22	0.00	0	23	0.00	0	22	0.00	0	106	0.00
	Right	0	19	0.00	0	21	0.00	1	21	4.76	0	22	0.00	0	20	0.00	1	103	0.97
Humerus	Left	0	15	0.00	0	18	0.00	0	20	0.00	0	21	0.00	0	19	0.00	0	93	0.00
	Right	0	19	0.00	0	23	0.00	0	24	0.00	0	24	0.00	0	22	0.00	0	112	0.00
Ulna	Left	0	18	0.00	0	21	0.00	0	20	0.00	3	20	15.00	0	17	0.00	4	96	4.17
	Right	0	20	0.00	0	23	0.00	1	23	4.35	3	22	13.64	0	20	0.00	3	108	2.78
Radius	Left	0	18	0.00	0	21	0.00	2	21	9.52	0	19	0.00	0	19	0.00	2	98	2.04
	Right	0	21	0.00	0	23	0.00	1	22	4.55	1	20	5.00	0	19	0.00	2	105	1.90
Femur	Left	0	23	0.00	0	22	0.00	0	25	0.00	0	22	0.00	0	21	0.00	0	113	0.00
	Right	0	24	0.00	0	24	0.00	0	26	0.00	0	24	0.00	0	25	0.00	0	123	0.00
Tibia	Left	1	21	4.76	0	20	0.00	0	24	0.00	0	24	0.00	1	22	4.55	2	111	1.80
	Right	2	22	9.09	0	23	0.00	0	26	0.00	0	24	0.00	1	24	4.17	3	119	2.52
Fibula	Left	0	17	0.00	1	25	4.00	0	25	0.00	1	24	4.17	0	24	0.00	2	115	1.74
	Right	0	20	0.00	0	27	0.00	0	27	0.00	1	26	3.85	0	24	0.00	1	124	0.81
Total		**3**	**276**	**1.09**	**1**	**311**	**0.32**	**5**	**326**	**1.53**	**9**	**315**	**2.86**	**2**	**298**	**0.67**	**20**	**1526**	**1.31**

n = number of fractured segments observed; N= segments observed; % = n/N X 100%

Table 4.6: Fracture prevalence by segment count for females

Bone		Proximal Articular			Proximal Shaft			Middle Shaft			Distal Shaft			Distal Articular			Total Segments Observed		
Element	Side	n	N	%	n	N	%	n	N	%	n	N	%	n	N	%	n	N	%
Clavicle	Left	0	11	0.00	0	15	0.00	0	16	0.00	0	17	0.00	0	15	0.00	0	74	0.00
	Right	0	13	0.00	0	13	0.00	0	17	0.00	1	19	5.26	0	17	0.00	1	79	1.27
Humerus	Left	0	11	0.00	0	15	0.00	0	19	0.00	0	20	0.00	0	14	0.00	0	79	0.00
	Right	0	15	0.00	0	16	0.00	0	21	0.00	0	23	0.00	0	19	0.00	0	94	0.00
Ulna	Left	0	16	0.00	0	18	0.00	0	17	0.00	1	14	7.14	0	9	0.00	1	74	1.35
	Right	0	17	0.00	0	19	0.00	0	20	0.00	1	19	5.26	0	12	0.00	1	87	1.15
Radius	Left	0	13	0.00	0	17	0.00	0	18	0.00	0	15	0.00	0	11	0.00	0	74	0.00
	Right	0	17	0.00	0	18	0.00	0	20	0.00	1	15	6.67	0	14	0.00	1	84	1.19
Femur	Left	0	17	0.00	0	17	0.00	0	20	0.00	0	15	0.00	0	14	0.00	0	83	0.00
	Right	0	16	0.00	0	18	0.00	0	23	0.00	0	20	0.00	0	15	0.00	0	92	0.00
Tibia	Left	0	12	0.00	0	17	0.00	0	20	0.00	0	17	0.00	1	12	8.33	1	78	1.28
	Right	2	15	13.33	0	17	0.00	0	23	0.00	0	18	0.00	0	13	0.00	2	86	2.33
Fibula	Left	0	6	0.00	0	16	0.00	0	19	0.00	0	15	0.00	0	11	0.00	0	67	0.00
	Right	0	4	0.00	0	18	0.00	0	21	0.00	1	18	5.56	0	14	0.00	1	75	1.33
Total		**2**	**183**	**1.09**	**0**	**234**	**0.00**	**0**	**274**	**0.00**	**5**	**245**	**2.04**	**1**	**190**	**0.53**	**8**	**1126**	**0.71**

n = number of fractured segments observed; N= segments observed; % = n/N X 100%

Table 4.7: Summary of "a" bone count and segment count recording methods

Method	Advantages	Disadvantages
1a: Undamaged bone	• examines only bone available • fast • no judgement calls	• ignores fractures present • complete preservation is rare in archaeological collections
2a: Minor damage, but all 5 segments present	• allows for minor damage and more data • visual potential for complete bone retained	• must estimate 75% of segment; judgmental • ignores fractures present • slower due to time to establish segments
3a: Some damage, allows for 1 segment to be absent	• allows for a portion of bone to be absent (20%)	• judgmental, slower • introduces uncertainty
4a: Heavy damage, allows for 2 segments to be absent	• includes more bones (60%) present and more lesions	• shows the greatest significant difference when compared with other "a" methods • judgmental, slower • greatest uncertainty
5: Segments	• assesses all bone present and allows for damage • specific segments can be analysed • records all data • percentage of complete bone automatically calculated • collapsible raw data • most adaptable for all archaeological conditions (e.g., cremation) • can be used to calculate survival rate of bones	• judgmental • most time consuming data collection, entry, and analysis

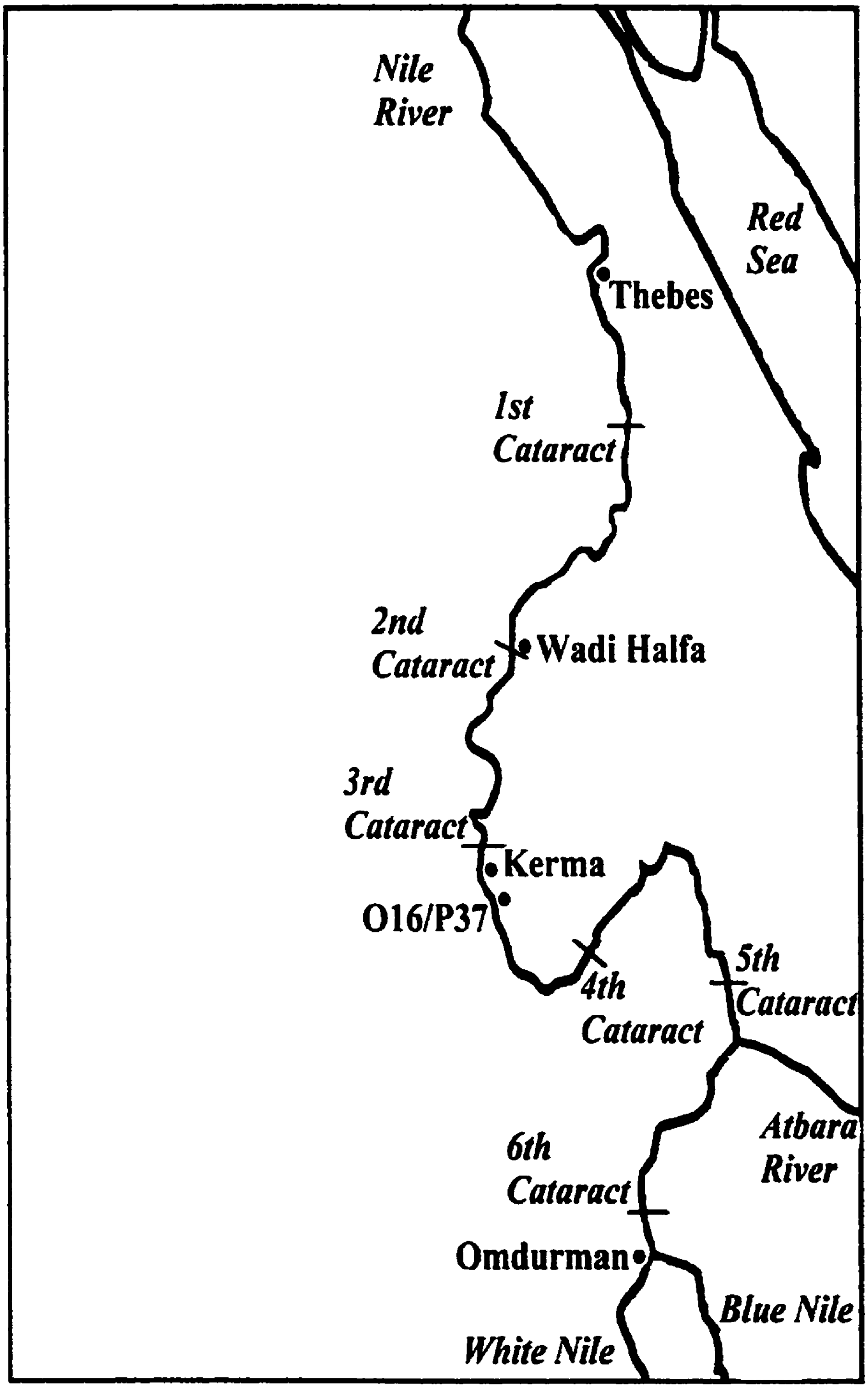
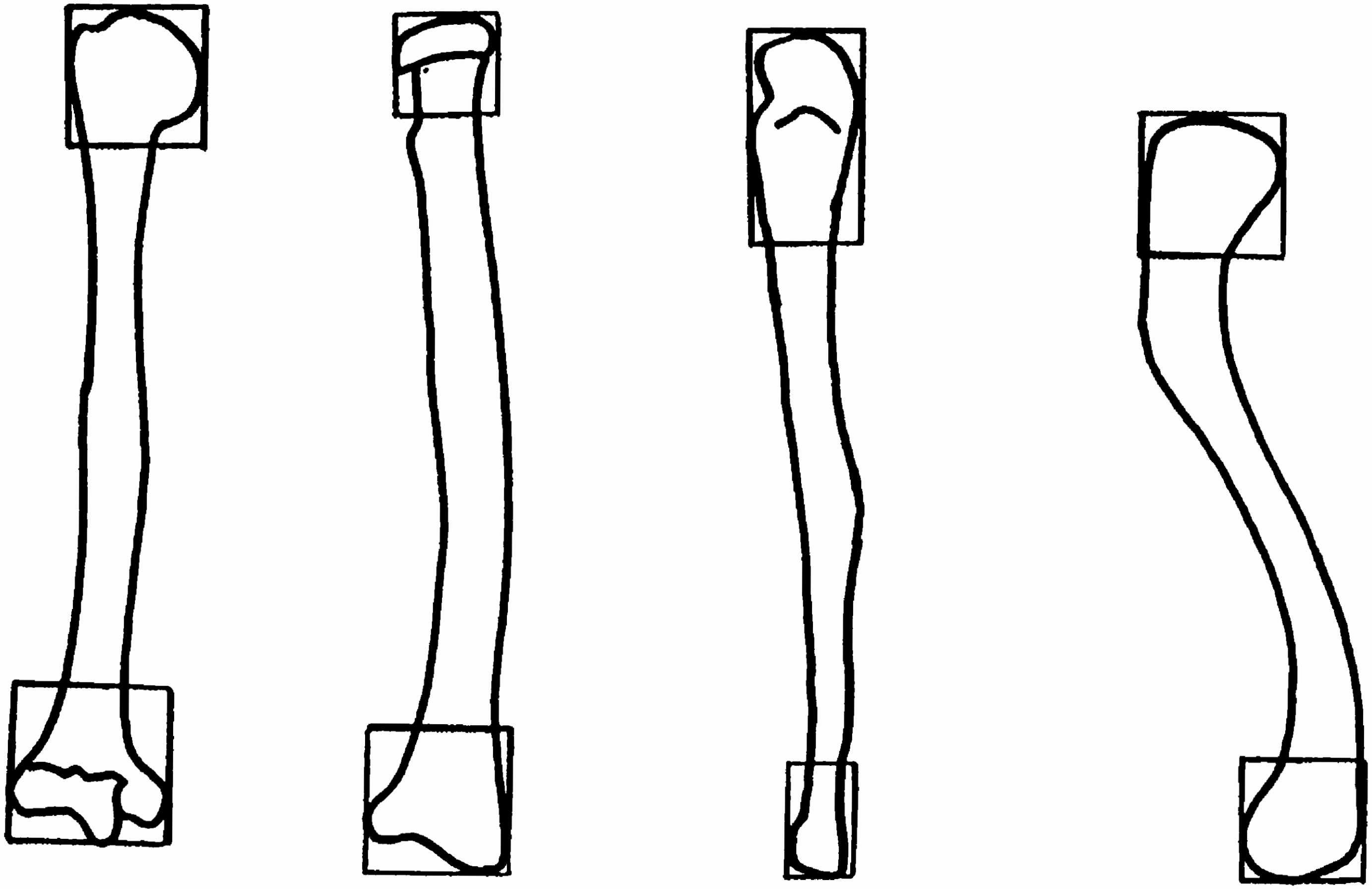


Figure 4.1: Location of NDRS sites O16 and P37



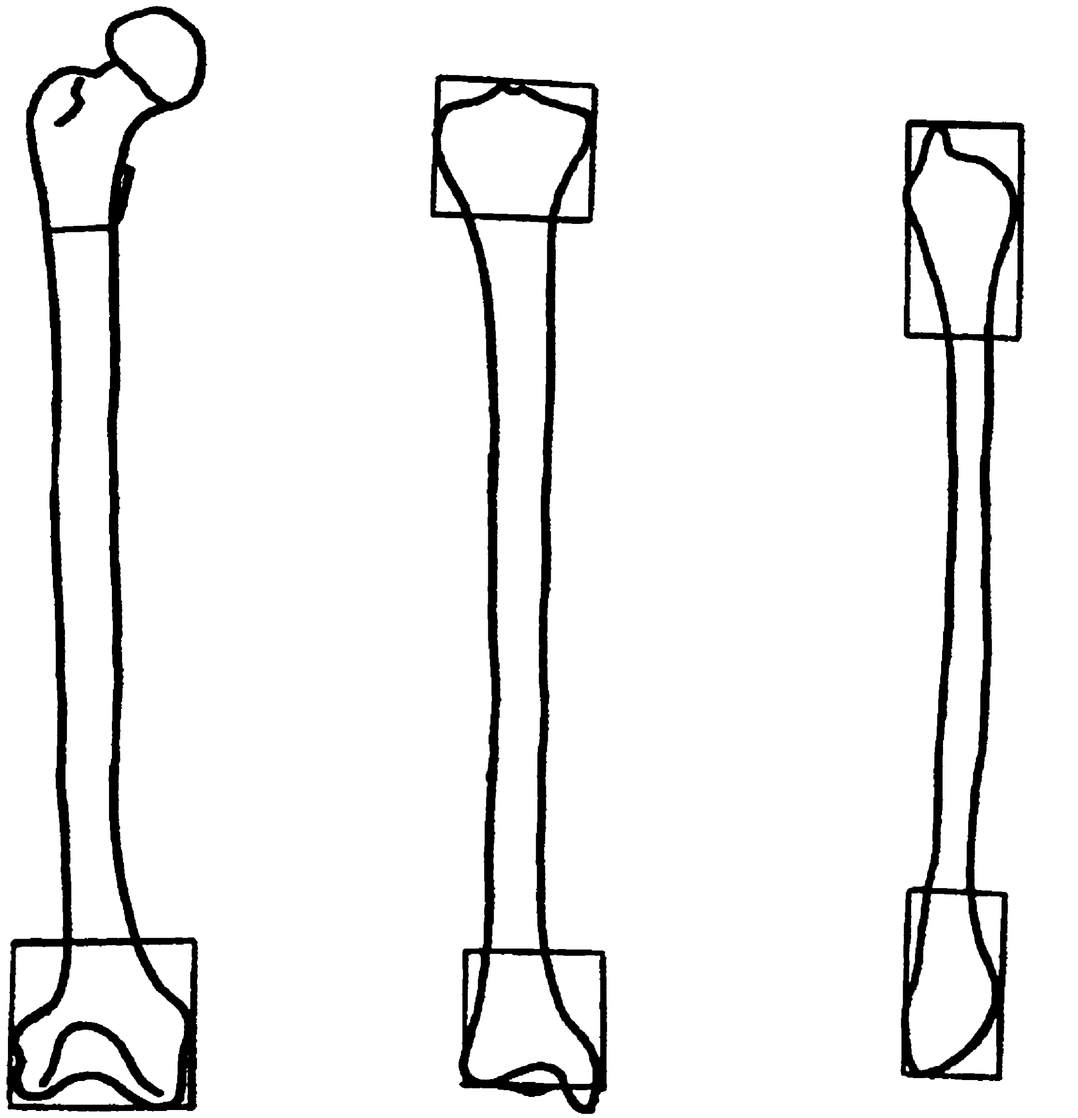
humerus (width = length)

radius (width = length)

ulna (2X width = length)

clavicle (width = length)

Figure 4.2: Width and length ratios for epiphyseal calculation using the "square method" (continued next page)



femur
(width = length)

tibia
(width = length)

fibula
(2 X width = length)

Figure 4.2: Width and length ratios for epiphyseal calculation using the "squares method" (continued)

CHAPTER 5

Trauma at the city of Kerma during the Kerma Classique period

5.1 Introduction

Violence, defined as the physical form of aggression (e.g., Berkowitz 1993; Levinson 1989), occurs cross-culturally with varying intensity at all levels of society—the family, the community, and the state. The smallest unit, the family, is viewed as the microcosm of society, and although perceptions of violence differ among cultures, the level of violence within the household tends to positively correlate to the level of violence within the state (Mckendrick and Hoffman 1990, 164). By analogy, ancient societies that condoned warfare and human suppression, as evidenced by archaeological and historical records, may also have been equally aggressive in a domestic setting and, therefore, suitable for an investigation of ancient interpersonal violence.

The presence of warfare, that is, aggression between culturally different political communities (Otterbein 1968), is easily identified in the archaeological record by fortifications, settlement patterns, military weapons and armour, political documents, victory monuments, and artistic renditions (e.g., Ferguson 1997; Filer 1997; Fischer 1961; Maschner and Reedy-Maschner 1998; Nikolaidou and Kokkinidou 1997; Pergerine 1993; Roper 1975; Thordeman 1939). Direct osteological evidence for warfare has included projectile points embedded in bone (e.g., Anderson 1968; Bennike 1985; Jurmain 1991; Lambert 1997; Milner 1995; Wendorf 1968; Winlock 1945) and other injuries inflicted by weapons, such as, knives, spears, maces, and axes (e.g., Bennike 1985; Bridges 1996; Fiorato et al. in press; Frayer 1997; Inglemark 1939; Lambert 1997; Wells 1982; Wenham 1989; Wood-Jones 1908). These fatal injuries are readily observed and interpreted, but the determination of nonlethal domestic or acquaintance violence is much subtler. The lesions are normally less serious and therefore, comparatively more difficult to detect. In fact, evidence of frequent physical conflict may be completely absent in the skeletal remains because haematomas, abrasions, and lacerations are the more predominant consequences of physical assault or accident (e.g., Butchart and Brown 1991; Odero and Kibosia 1995; Shepherd et al. 1988; Shepherd et al. 1990).

Before analysing nonlethal trauma patterns within a culture, it is essential to consider all trauma and establish if lesions traditionally associated with interpersonal violence were represented skeletally. Clinical literature and nonhuman primate field observations provide effective models with which to compare human palaeotrauma. Although there are deviations from the injury pattern produced by assault due to cultural impositions of acceptable physical targets (e.g., Burbank 1994; Matthew et al. 1996), a general assault injury pattern has emerged cross-culturally (e.g., Burbank 1994; Butchart and Brown 1991; Chalmers et al. 1995; DeSouza 1968; Ebong 1978b; Geldermalsen 1993; Geldermalsen and Stuyft 1993; Greene et al. 1997; Khalil and Shaladi 1981; Mock et al. 1995; Muelleman et al. 1996; Mwaniki et al. 1988; Shepherd et al. 1987; Shepherd et al. 1988; Shepherd et al. 1990; Watters et al. 1996; Whitten and Smith 1984; Zachariades et al. 1990). Males are the most frequent participants in assault and the economically active age group sustains most injuries (20-40 years of age). The wound patterns are nonrandom with the majority of injuries affecting the skull, and of these, craniofacial injuries are most prevalent (as high as 90%) with less than 30% manifest as fractures. Contusions, haematomas, and lacerations represent the majority of postcranial lesions, while fractures and a small number of dislocations make up the difference (approximately 30%), and finally, the hands are the preferred method of assault.

Bioarchaeologists[1] are restricted in their assessment of nonlethal injury patterns by the absence of soft tissue in most samples and the inability to determine the age at which the fracture occurred. However, certain osseous lesions derived from the clinical patterns of nonlethal physical aggression are discernible on human bone when healed. Primary lesions suggestive of interpersonal violence in archaeological skeletal remains include: cranial injuries attributed to direct blows, multiple lesions from habitual or severe assault, and isolated distal ulna shaft fractures (parry fractures), deemed to be the outcome of diverting a blow to the head (e.g., Jurmain 1999, 214-215; Jurmain and Kilgore 1998; Lahren and Berryman 1984; Lambert 1997; Lovell 1997; Martin 1997; Maschner and Reedy-Maschner 1998; Shermis 1983; Smith 1996; Walker 1989; Walker 1997; Walker

[1] Researchers studying nonhuman primate trauma in skeletal collections also face this problem (Bramblett 1967; Jurmain 1989; 1997; Jurmain and Kilgore 1998; Lovell 1990a; 1990b; 1991; Schultz 1939).

et al. 1997; Wilkinson 1997; Wilkinson and Wagenen 1993). Other injuries are also acquired during a violent incident, for example, muscle pulls (*myositis ossificans traumatica*), dislocations, and fractured extremities and ribs, but in isolation these injuries could be a consequence of any action.

The attribution of cranial injury to nonlethal violence and the prevalence of multiple lesions are relatively straightforward concepts, when compared to the identification of the more complex "parry" fracture, and much of the problem is due to inadequacies in palaeotrauma recording (Jurmain 1999, 214-222; Lovell 1997). In clinical practice, isolated ulnar fractures are most frequently associated with a direct force and normally occur on the more vulnerable distal half of the bone when raised to protect the head from a blow (e.g., London 1991, 40; Rogers 1992, 816-817; Schultz 1990, 265; Seligson and Voos 1997, 83). This injury, often referred to as the "parry" or "nightstick" fracture, is physically recognised by its isolation, linearity, lack of soft tissue damage, and simple callus, but too often bioarchaeologists identify the "parry" fractures solely by a distal or midshaft location (Jurmain 1999, 217; Lovell 1997).[2] Because isolated ulna shaft injuries may also result from an indirect force, such as a fall, the lesion's configuration must be closely scrutinised in order to classify it correctly.

This investigation first examined the occurrence of healed trauma among the urban inhabitants of Kerma (Upper Nubia) dated to the Kerma Classique Period (1750-1550 BC), when collective violence (warfare) was known to exist, to discover if any of the acknowledged skeletal indicators of nonlethal violence were present. The expected skeletal injury pattern for nonlethal violence included isolated distal ulna shaft fractures, cranial injuries, and multiple trauma. Second, the frequency and pattern of trauma in the sample was discussed in comparison to other ancient Nile Valley societies to ascertain whether the prevalence of healed injuries, particularly those that are attributed to

[2] Physical anthropologists have cautioned that the term "parry" implies the ultimate aetiology (e.g., Jurmain 1999; Lovell 1997); however, this descriptive eponym continues to be used in clinical descriptions and textbooks.

interpersonal violence, was greater at Kerma, suggesting that interpersonal violence within the community may have been a consequence of intersocietal violence.

5.2 Materials and methods

5.2.1 The archaeological context

Kerma[3] is the type-site for the Kerma culture, the earliest state power that dominated Upper Nubia (located in Sudan above the Second Cataract) over three periods: Kerma Ancien (2500-2050 BC), Kerma Moyen (2050-1750 BC), and Kerma Classique (1750-1500 BC). This ancient city was located 20 km south of the Nile's Third Cataract—a strategic position that monitored trade between Egypt, Central Africa, and the Red Sea until its annihilation in 1520 BC by Thutmose I of Thebes (Figure 5.1).

The relationship between Upper Nubia and Egypt during the Kerma Period was notoriously hostile at times, as Egypt pressed for uncontested access to exotic sub-Saharan raw materials such as ebony, ostrich feathers, and incense, although gold and humans were the most highly valued natural resources (Adams 1977; Amin 1970; Bonnet 1990a; Budge 1907; Reisner 1918; 1923a). Monumental evidence of warfare in Nubia and Egyptian propaganda that commemorated the pharaoh's triumphs over the Nubians often surfaces in the archaeological record and has included commemorative plaques of conquest depicting the Egyptian pharaoh "smiting" his Nubian enemies such as the Sheikh Suleiman rock carving at Wadi Halfa (Filer 1997; Williams 1980); a casemate system with moats three to six meters deep, gates, and towers that protected the city of Kerma (Bonnet 1994); and a system of 11 Egyptian fortresses with names such as "Warding off the Bows" and "Curbing the Countries" that was constructed at the Second Cataract beginning in 1943 BC for protection against Nubian infiltration (Adams 1977; Watterson 1997, 55). Humans were not only traded to Egypt, but were dispensable as burial retainers within the Kerma society, particularly during the later Kerma Classique Period (1750-1500 BC) when "sacrificial corridors" that contained hundreds of people bisected the burial tumuli of the royal families (Kendall 1997; Reisner 1923a). The

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[3] The name "Kerma" was borrowed from the modern town adjacent to the site. The ancient name of this city remains unknown.

militaristic material culture coupled with socially sanctioned ritual deaths implied that aggressive behaviour prevailed during the Kerma Period and the society, therefore, is conducive for palaeotrauma studies.

The success of Kerma and its rulers was apparent in its cemeteries. The graves began as simple pits (ca. 3000 BC) and by the end of the Kerma Classique period the burials culminated into massive tumuli, which surpassed the pyramids of Giza in area (Reisner 1923a, 65). In 1916, George Reisner (1923a; 1923b) excavated seven major tumuli whose surface structure was distinguished from other tumuli by a broad ring of black, ferruginous stones that traced the mound's perimeter (up to 90 m in diameter).[4] White quartzite pebbles covered the ring's interior and a white quartzite cone marked the summit; a crescent of cattle bucrania hugged the southern rim (Reisner 1923a, 64). The subterranean structure was characterised by a vast floor area (up to 200 square metres), "sacrificial" humans (as many as 322 individuals), and the presence of subsidiary graves that flanked the centrally located burial chamber, which housed the prominent or "chief" burial. In addition, Reisner explored 16 one-chamber tumuli (small replicas of the large tumuli, but without the subsidiary graves) and 250 rectangular subsidiary graves that were in close proximity to the great tumuli; 23 small graves were excavated just north of this area in Cemetery B.

The smaller tumuli and subsidiary graves emulated the burial style of the larger tumuli. The prominent burial was that of an individual clothed in linen and covered in ox-hide, whose body rested on an ivory or mica inlaid wooden bed situated on the south side of the tomb. Personal jewellery, a wooden headrest, weapons, ostrich feather fans, and sandals were placed on the bed; bronze toiletries stood at the bed's foot. Pottery vessels surrounded the bed in addition to a haphazard array of other humans and up to six rams. Finely crafted objects accompanied the burials including alabaster goblets, bronze daggers in leather cases, makeup pots, mirrors, combs, ivory carvings, gold, precious stones, and mother of pearl (Bonnet 1990b; Reisner 1923a, 66; 1923b).

[4] Reisner (1923a, 61) referred to this southern part of the Eastern Cemetery as the Egyptian Cemetery due to the overwhelming presence of Egyptian artifacts.

5.2.2 The skeletal sample

The Kerma skeletal remains are curated in the Duckworth Laboratory at the University of Cambridge's Bioanthropology Department. Because skeletal records and reports were unavailable and only the skulls assigned an age and sex, it was essential to examine the skulls and postcrania together and establish the individual's age and sex.

The sex of each individual was assessed by the morphological variation of the skull and pelvis as summarised in Buikstra and Ubelaker (1994, 16-20). If neither skull nor pelvis was available, dimorphic measurements of the long bones (radial, humerus, and femoral heads; femoral bicondylar width) as described by Olivier (1969) were used to assess biological sex. Age at death was established from scores obtained from the degenerative morphological changes to the pubis (Todd 1921a; 1921b), the sternal rib end (Loth and Iscan 1989), and the innominate's auricular surface (Lovejoy et al. 1985). The ages determined from these methods were collapsed into broad age categories: subadult (<25 years), young adult (25-35 years), middle adult (35-50 years), old adult (50+), and "adult" when bones were too fragmentary to confidently estimate the age. All bones, except for very fragmentary adults and all subadults, were inventoried and examined for trauma. In total of 223 adults, 93 males and 130 females, were represented by postcrania; skull bones were completely or partially absent for 17 males and 19 females.

5.2.3 Recording of trauma

In this analysis the categories of trauma were as follows:

1. fractures, classically defined as an incomplete or complete break in the continuity of bone (Aufderheide and Rodríguez-Martín 1998, 20; Ortner and Putschar 1981, 55; Schultz 1990, 4),
2. dislocations, identified as the complete (luxation) or partial (subluxation) loss of contact between joint components resulting in a modification to the bone (Aufderheide and Rodríguez-Martín 1998, 25; Ortner and Putschar 1981, 85),
3. *myositis ossificans traumatica* or soft tissue trauma, identified by an irregular ossified mass at the site of an avulsion of the tendon or muscle attachment from the bone (Aufderheide and Rodríguez-Martín 1998, 27; Ortner and Putschar 1981, 69).

Each skull bone (frontal, parietal, temporal, occipital, zygomatic, nasal, maxilla, and mandible) that was 75% or more complete was scrutinised for healed injuries associated with skulls and identified by breakage pattern on dry bone as defined in Table 5.1 and illustrated in Figure 5.2. All skull elements were distinguished by side with the exception of the occipital and nasal bones, which were each counted as one bone only; the area of the injury was also calculated.

All long bones (clavicle, humerus, ulna, radius, femur, tibia, and fibula) were examined for evidence of healed trauma. These bones were divided into five segments (proximal and distal interarticular surfaces; proximal, middle, and distal shafts).[5] Since some of the bones were damaged or incomplete, the bone was considered to be "complete" and included in the bone count if four or all five segments of each element were present. Fractured bones with three or fewer bone segments intact were counted as "complete" bones and included in the analysis; unfractured partial bones were excluded from the analysis. Because the inclusion of partial bones is controversial in palaeotrauma analysis and felt by some investigators to inaccurately estimate the fracture count (e.g., Bennike 1985; Lovejoy and Heiple 1981; Nakai et al. 1999), a brief description of the partial bones was noted to accommodate researchers that prefer to exclude partial bones from their analysis.[6]

Antemortem healed fractures were identified by angular deformity, apposition of bone, and complete or partial callus formation. The following information was recorded for each fracture: bone type, side, position on bone (proximal, middle, and distal diaphysis; proximal or distal articular end), the fracture configuration in relation to the long axis of the bone (the length of the fractured bone and its opposite, the angle of the fracture line, and the apposition, angulation, and rotation of the distal fractured segment relative to the proximal fractured segment).[7] Each injury was classified as a fracture type based on its

[5] See Chapter 4 for detailed method.
[6] Bennike (1985) partially overcame this discrepancy by listing the fractured fragments, but without any injury description, and deleted them in her calculations.
[7] See Lovell (1997) for recent definitions and the method for taking these measurements.

configuration (Table 5.1, Figure 5.3).[8] A detailed analysis of the forearm fractures is presented in Chapter 7 and some of the results were incorporated into this investigation.

The metacarpal and metatarsal bones were divided into three segments (proximal, shaft, and distal) and classed as "complete" bones if 75% or more of at least two segments were present. Like long bones, partial fractured small bones (i.e., those represented by one segment only) were included and noted to facilitate variations in trauma recording methods. Carpals, tarsals, and their phalanges were inventoried if they were 75% or more complete, and as above, traumatised bones less than 75% complete were included and documented in the results. The determination and configuration of healed or partially healed injury to the tubular bones was identical to the scheme used to describe the injuries of the appendicular long bones. Carpal and tarsal lesions, as well as injured irregular bones (e.g., scapula, vertebrae, pelvis, and thorax), were described on an individual basis. When callus lines were questionable, magnification (10X) was used to verify the presence of a lesion.

5.2.4 Analysis

Preservation plays a critical role in the analysis of palaeopathology, since complete preservation of the skeleton is rare. Some degree of damage or loss due to taphonomic factors is often sustained with archaeological bone, which poses problems for gathering, reporting, and comparing data. By establishing the percentage of osseous elements available for examination by a segment count, the completeness of any sample can be assessed. For this reason, the amount of bone available for observation was determined for the skull, long bones, and extremities as a percentage of the bone segments recovered compared to the bone segments expected.

Trauma frequency was determined by element count (lesions per bone) to establish patterns of injury for each bone type. At the individual level, trauma frequencies were expressed as an individual count (number of individuals with one or more injuries per

[8] Definitions for fracture types were derived from many sources: (Adams and Hamblen 1992; Müller et al. 1990; Rogers 1992; Schultz 1990; Tehranzadeh 1989).

total individuals), mean trauma count (number of lesions observed per total individuals), and the mean multiple injury (number of lesions per injured individuals). The frequencies of injury types, and locations were determined among the fractured bones. Chi-square tests determined statistically significant variations in fracture patterning between the bones and sexes. The Yate's correction for continuity (χ_c^2) was applied to small samples ($n < 5$), the number of degrees of freedom was "1" unless otherwise stated, and the significance level chosen was 0.05.

5.3 Results

5.3.1 Skull preservation and trauma

An elemental count of skull bones and fractures (Table 5.2) revealed that males experienced more skull injuries than females, although not significantly so, and no partial skulls bore injuries. Female skulls were better preserved when compared to male skulls and therefore, the male fracture frequency may be slightly misrepresented in comparison.

The parietal was the most frequently injured bone followed by the frontal bone for both sexes and neither sex sustained injuries to the temporal or the maxilla bones. In five cases, more than one injury affected a single bone. The lesions were similarly distributed between the sexes, with the vaults bearing the brunt of the 31 injuries. Fifteen of 19 (79%) male injuries occurred on the vault, while 10 of 12 (83%) female injuries affected the vault; the remaining six injuries were observed on the facial area.

A comparison of depression fractures (including crush fractures) to penetration injuries (Table 5.3) demonstrated that the depression injuries prevailed among both sexes; however, one third of the injuries among males were due to penetration in contrast to the females who bore no penetration injuries ($\chi_c^2 = 4.69$, $p = 0.030$). The parietal exhibited the greatest number of depression lesions (males = 7/13, females = 6/12) followed by the frontal bone (males = 2/13, females = 3/12). The depression injuries that were located on the large flat bones of the skull vault ranged in area from 7 to 1326 mm^2 and were typically round, oval, or rectangular in shape (Plate 5.1). Three of the injuries exceeded an area of 1000 mm^2 and all affected females. Depression injuries were distributed equally among the sides for both sexes. Irregularly shaped crush injuries occurred on the fragile narrow expanses of bone, such as the zygomatic or mandible. The penetration injuries that affected six males ranged in area from 13 to 299 mm^2, but only one completely pierced the skull. One penetration injury occurred on the frontal bone and the remainder damaged the parietal; four lesions were located on the left side and two were located on the right side.

5.3.2 Long bone preservation and trauma

Although the total percentage of bone available for observation was similar for both sexes (males = 62.6%, females = 68.6%), the survival of male long bone segments[9] was significantly less than the recovered number of female long bone segments ($\chi^2 = 61.37$, $p = 0.000$). This result was likely a factor of the large size of the segment sample (Shennan 1988, 74) since the relationship was very weak. ($\phi^2 = 0.003$); the difference in preservation, therefore, was not really substantive. The fracture statistics for the Kerma people are shown in Table 5.4. Forty-eight of 223 (17.9%) individuals bore long bone fractures and twice as many males as females suffered from injury ($\chi^2 = 6.71$, $p = 0.009$); the individual mean trauma and mean multiple injury frequencies were similar for the sexes.

The long bone fracture frequency for the sample was 2.4% as 48 of 2029 complete long bones were fractured (Table 5.5). Males experienced significantly more elemental fractures than females ($\chi^2 = 10.80$, $p = 0.001$) and in both instances, the ulna was the most frequently injured bone. Injuries to the males were equally distributed among the other long bones, while additional injuries occurred only on the clavicle, radius, and femur of the females. The left long bones were more frequently injured among males ($\chi^2 = 4.44$, $p = 0.035$), while fractures to the female long bones were evenly distributed between the sides. Twenty-seven out of 48 fractures (56.3%) occurred on the distal or

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[9] 93 males X 14 long bones X 5 segments per bone = 6510 segments of which 4072 were recovered; 130 females X 14 long bones X 5 segments per bone = 9100 segments expected and 6240 recovered. The preservation rate for the combined sample was 66.1%.

distal interarticular segments of the long bone and there was no significant difference between the sexes when the distribution of lesion location was compared. The distribution of long bone fracture types (Table 5.6) shows that oblique and transverse fracture types predominated for both sexes; males sustained a greater variety of fracture types.

The medial articular segments of two clavicles were crushed, and while one case was minor and did not result in dislocation, the second injury altered the sternoclavicular joint and integrity of the manubrium. Three oblique clavicular shaft injuries were displayed by young females. A raised linear callus on a humeral head was accompanied by an eburnated (bone polishing caused by bone rubbing against bone) and flattened facet on the articulating glenoid fossa of one male's shoulder. This modification to the glenoid fossa altered the joint structure and thus, provided evidence of a minor shoulder dislocation. Two other males suffered from oblique medioposterially angled midshaft fractures to the left humerus.

Of the 23 ulnar fractures, 18 may be the result of a direct force injury.[10] Fourteen of these ulnae exhibited the clinical morphology of the "parry" fracture (Plate 5.2): isolated fracture (non-radial involvement), fusiform swelling on the distal third of the shaft, little or no rotation or apposition, and the fracture line was transverse or slightly oblique (Richards and Corley 1996, 912; Rogers 1992; Schultz 1990, 265; Stern 1997, 256). Two ulnae had parry configurations that were accredited to a direct blow, even though a radial injury was also present. The ipsilateral radius was absent in three instances of parry type lesions rendering the aetiology to be uncertain. Four remaining injuries formed two patterns: two ulnae had crushed styloid processes and heads likely due to a direct force, while the two other fractured ulnar shafts were completely unapposed, creating an "S-shaped" shaft deformation. Five isolated radial shaft fractures without ulnar involvement were classified as injuries acquired while protecting the body during a fall (e.g., Adams and Hamblen 1992; Rogers 1992) and included a rotated oblique midshaft fracture, three Colles' fractures, and a depressed radial head injury.

[10] See Chapter 7 for detailed forearm analysis.

Femoral injuries produced complications among four individuals. A middle-aged male experienced a distal oblique femoral injury that was partially healed by a lattice of new bone and complicated by osteomyelitis. Femoral shaft injuries are associated with high-energy trauma as the femur is the most densely mineralised bone and therefore, the most difficult to break (Stern 1997, 322). The lateral action of the superior abductors, the opposing action of the inferior adductors, and the externally directed foot weight force the ends of the broken femur to relocate in an unapposed and overlapped position (Dandy 1993, 246). Two females displayed injuries to the neck of the right femur. The older female had a well healed adduction injury identified by a transverse neck fracture that increased the neck shaft angle. The younger female sustained an abduction injury identified by a vertical shearing line that decreased the neck shaft angle by about 30° and weakened the joint. Both injuries were healed and the individuals remained mobile as eburnation was observed on the femoral heads. A severe crushing injury ossified one male's femur and lower leg into a permanent 60° posterior angle; the normal muscle insertion features along the *linea aspera* and soleal line were minimal. This male also endured a severe slipped femoral epiphysis and flattened acetabular cup that perhaps contributed to the debilitating fall.

One individual bore oblique distal midshaft fractures to the left tibia and fibula, which were healed with little displacement and no complications. The lone fibula fracture occurred proximal to the distal interarticular segment, and the tibial tuberosity of a young male was separated from the tibial shaft, but was unrecovered.

5.3.3 Extremity preservation and trauma

Table 5.7 presents the hand and foot bones with the number of fractures observed among the individual bones and among adults. The extremities were poorly preserved in comparison to the skull and long bones, likely due to exclusion during excavation or loss in storage, although many of the existing bones were enclosed in mummified soft tissue that shrouded them from macroscopic observation—a problem also encountered by other investigators (e.g., Kilgore et al. 1997). The use of radiology, however, is impractical as many extremity lesions, particularly those on the articular surfaces, have been shown to be undetectable in clinical examinations (Juhl et al. 1990). Excluding the sesamoids, the observable quantity of extremities for males was 17.2%[11] and for females was 31.2%, ($\chi^2 = 592.17$, $p = 0.000$), and therefore, the frequencies of fractured male bones in comparison to those of the females may be misrepresented in this sample. In general, the extremities available for observation were underrepresented for the entire sample and this should be taken into consideration when comparing the Kerma skeletal sample to other more intact archaeological skeletal collections.

The prevalence of hand and foot trauma did not vary significantly between the sexes when the individual bones were examined for lesions, nor when the extremities were assessed as anatomical units of the skeleton. Among the hand bones the proximal phalanges were most frequently fractured among males, while the distal phalanges were most frequently fractured among females. When the modal distribution of hand injuries for the pooled sexes was observed, the metacarpals accounted for half of the injuries. The metatarsals were fractured more often among the male foot bones and the distal phalanges were the most frequently fractured foot bone among females. Of the 14 foot bone fractures, the metatarsals represented half of the injuries.

One male and one female bore avulsed hamate hook injuries. Six of the metacarpal injuries were midshaft fractures of the fifth metacarpal and included one on the shaft's neck (Plate 5.3). Two second metacarpal shafts exhibited transverse fractures, two first metacarpals bore articular impactions, and two metacarpals had impacted head injuries. The first proximal hand phalanx accounted for three basal injuries—one avulsion and two depressions; four second proximal hand phalanges encountered one injury each—two oblique fractures, one cut, and one impaction; two middle hand phalanges had impacted heads; and finally, one distal hand phalanx displayed a cut on the tuft.
One male suffered a calcaneus injury to the heel that resulted in a fracture line at approximately 45°. The lesion was exceptionally well-healed, a normal response of isolated calcaneal injuries that are not displaced and do not affect the talocalcaneal joint

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[11] 93 males X 106 bones = 9858 extremity bones, of which 1697 were recovered; 130 females X 106 bones = 13,780 extremity bones, of which 4296 were recovered.

(Adams and Hamblen 1992, 258; Schultz 1990, 121-124). The metatarsal injuries consisted of two impacted bases, two transverse fractures of the fifth metatarsal, and three metatarsal stress fractures. Four proximal foot phalanges exhibited the following injuries: one crushed head, two midshaft fractures, and one impacted base. The balance of the injuries consisted of one middle foot phalanx base avulsion and one distal foot phalanx base impaction.

5.3.4 Other trauma

Many of the traumatic lesions were observed in the thoracic region. One female sustained transverse fractures to spinous processes of C-7, T-1, and T-2, while one male bore a similar injury to a thoracic vertebra—injuries typical of extreme flexion or rotation on one side (London 1991, 65). Another female had a crushed C-7 spinous process and scapula. Spondylolysis, the separation of the neural arch from the vertebral body, was observed on the fifth lumbar of four young females and three males. Two males incurred transverse fractures to the proximal sternum. Rib fractures were observed on six females and five males. A transverse patellar fracture was the lone injury born by one female.

Myositis ossificans traumatica (exostosis) due to muscle ossification resulting from trauma was observed on assorted larger bones. Two females exhibited *myositis ossificans traumatica* on the femur, which was manifest on one female at the attachments of the *glutei minimus* and *medius* of the greater trochanter, and on the other female as a smooth linear lesion along the *linea aspera* that spanned 132.9 mm in length. The femur of one male presented *myositis ossificans traumatica* surrounded by periostitis along the superior *linear aspera*. Humeral lesions occurred at the deltoid insertions of two females and at the *brachialis* insertion of one male. A middle-aged male displayed lesions on the left scapular spine, the left tibia superior to the tuberosity, and the *subscapularis* insertion of the left humerus. The lateral malleolus of an older female's fibula exhibited ossified tissue at the insertion area of *peroneus brevis*. Other smaller lesions were observed between the intercostal insertions of the eighth and ninth ribs of one male and on the ischium of another male.

5.3.5 Modal distribution of injuries and multiple trauma

The modal distribution of the 156 injuries (fractures, dislocations, *myositis ossificans traumatica*) observed among the Kerma adults revealed that the skull and face bore the majority of injuries (20%) followed by the trunk (19% combined total of scapula, rib units, vertebral column, and pelvic injuries), the ulna and hands (15% each), the feet (9%), the femur (5%), the humerus and radius (each with 4%), the clavicle and tibia (3% each), the fibula (2%), and lastly the patella (1%). Table 5.8 displays the prevalence of all injuries (fractures, dislocations, and soft tissue lesions) for the 223 Kerma adults. The majority of individuals (60.5%) did not suffer from trauma and no significant difference was determined in the proportion of injured to non-injured individuals between the sexes. Forty-eight of the 88 individuals bearing lesions (54.5%) had one injury only. Although 23.7% of the males suffered multiple trauma in contrast to 13.9% of the females, this was not a statistically significant difference.

5.4 Discussion

5.4.1 General pattern of injury at Kerma

Injuries due to falls and assault account for the majority of lesions in most modern societies, and this was likely true at Kerma as well. Clinical findings reported that males bear the brunt of traumatic injuries, whether fractures or soft tissue trauma, to all regions and generally, the facial area of the skull is most frequently injured no matter what the mechanism (e.g., Brismar and Tunér 1982; Butchart and Brown 1991; Chalmers et al. 1995; Greene et al. 1997; Mock et al. 1995; Nordberg 1994; Shepherd et al. 1987; Shepherd et al. 1990). Some exceptions existed (1978a; Ebong 1978b; Prince et al. 1993; Sahlin 1990), but the most notable was a study of Papua New Guinea villagers, where collective and interpersonal violence is endemic, and the humerus was most often fractured, followed by the forearm (Matthew et al. 1996). The modal distribution of injuries to the Kerma people revealed that the skull was the most frequently injured area, although it was the skull vault that sustained the majority of the injuries. When the elemental fracture frequencies were examined, the skull was also the most frequently fractured anatomical area (11.2%).

Aside from the high prevalence of skull fractures among most clinical studies, the remaining fracture frequencies do not form a consistent pattern. This may be attributed to variations in patient inclusion or recording, for example, in some studies extremity fractures included those of the limbs, hands, and feet (e.g., Emile and Hashmonai 1998; Shepherd et al. 1988). In investigations of assault where the skull was the most commonly injured anatomical area, the second most frequently injured location was the hands (Brink et al. 1998; Shepherd et al. 1990; Spedding et al. 1999), the upper limb (Shepherd et al. 1988), the ankle (Wladis et al. 1999), and the extremities (combined upper and lower limbs, hands, and feet) (Emile and Hashmonai 1998). When the modal distribution of fractures was examined among the Kerma people the trunk (scapula, ribs, sternum, vertebral column, and pelvis) fractures were second in prevalence; however, isolated ulnae were the second most frequently fractured bone (8.3%) when frequencies of injury among bones available for examination were assessed. Males suffered a higher frequency of fractures than females in all cases, except for the clavicle, hand and foot phalanges, and patella.

5.4.2 Accidental injury

Aside from the five radial injuries, many of the long bone lesions observed are also typical outcomes of falls. The two crushed medial clavicle ends were unusual injuries and were likely the result of a lateral blow to the shoulder that forced the clavicle to shift anterior to the manubrium; the mechanism could be intentional or received from falling onto the shoulder (London 1991, 23). Three oblique clavicular shaft injuries were displayed by young females. Two were completely unapposed, which is the normal healing pattern for the clavicle due to the excess weight of the humerus when unsupported by the clavicular strut (Dandy 1993, 182). The injury occurs when the clavicle snaps under the weight strain from bracing the fall rather than force the stronger ligamental attachments to move at each clavicular end—one cannot ascertain, however, the cause of the fall.

One individual bore well healed oblique distal midshaft fractures to the left tibia and fibula, a routine injury associated with an acute angular force (Adams and Hamblen

1992, 232). A lone fibula fracture occurred proximal to the distal interarticular segment and was likely broken due to a lateral shearing rotation, or going over on the ankle (Adams and Hamblen 1992, 246). Soft tissue trauma observed on the fibula of another female may be due to ankle adduction and perhaps was associated with her Colles' fracture.

A rather extraordinary injury was a transverse posterior patellar fracture of one young female, the solitary injury observed on this person. Patellar injuries can be the result of a violent contraction of the quadriceps muscle to prevent a fall, a direct blow or fall directly on the knee cap, or the result of continued stress from running or long distance walking (Adams and Hamblen 1992, 215-6; Rogers 1992, 1257)

The possibility of sports-related injuries cannot be overlooked, as the Nubians were renowned for their archery and wrestling abilities, which were often depicted in Egyptian art (e.g., Carroll 1988; Filer 1997; Fischer 1961). Two males suffered from oblique midshaft humeral fractures and in both cases the distal humerus was angulated medially and posteriorly in relation to the proximal segment. The oblique nature of the fracture indicates that a torsional twisting force was involved, a routine injury in arm-wrestling or a fall on the hand (London 1991, 26-27). Another injury explained by a more active life style was an avulsed tibial tuberosity, an injury provoked by repetitive avulsion during the growth years and associated with sports or activities that require rapid acceleration and deceleration (Kujala et al. 1985). And finally, three older adults experienced metatarsal stress lesions, indicators of excessive walking, marching, or running (Black 1983; Linenger and Shwayhat 1992).

The configuration of the rib lesions aids in distinguishing between direct and indirect trauma (Galloway 1999, 107-9); examples of the Kerma rib lesions are shown in Plate 5.4. Transverse rib injuries are most often associated with a direct blow, which may break one or more ribs, typically involve the sixth to eighth ribs, and affect the left side more often. Rib lesions that are oblique are caused by crushing or bending and tend to break on the lateral curve creating sharp points as a result; these injuries are typical of falls from heights. Multiple rib lesions are associated with interpersonal violence, especially when other injuries are involved (Butchart and Brown 1991; Geldermalsen 1993; Muelleman et al. 1996). In the Kerma sample, eight of 11 individuals suffered transverse rib lesions, and five of these people also had skull or long bone injuries. Although isolated rib injuries may be the outcome of a direct blow they may also be caused by stress or perhaps a harsh cough (Adams and Hamblen 1992, 99; Dandy 1993, 161).

The majority of the hand injuries among the Kerma group were simple oblique or transverse metacarpal shaft fractures and impaction injuries to the heads and bases of the metacarpals and phalanges. While these injuries are typical outcomes of offensive actions, any of these lesions may also be due to nonhuman involvement or accident (e.g., Brismar and Tunér 1982; Butchart and Brown 1991; Chalmers et al. 1995; Geldermalsen 1993; Greer and Williams 1999; Kraemer and Gilula 1992; Shepherd et al. 1990). Two hamate hook injuries were observed and may be the result of a number of mechanisms. The injury occurs in isolation and is chronic among athletes where equipment handles can cause a direct blow, such as a tennis racket, bat or golf club, although it has also been attributed to a fall on a dorsiflexed wrist or direct blow (Boulas and Milek 1990; Redler and McCue 1988). While the causes of extremity fractures are clinically diverse, interpersonal violence remains a recurrent aetiology (Brismar and Tunér 1982; Butchart and Brown 1991; Chalmers et al. 1995; Geldermalsen 1993; Geldermalsen and Stuyft 1993; Muelleman et al. 1996; Shepherd et al. 1988; Shepherd et al. 1990). No doubt a sizeable portion of extremity fractures was the product of interpersonal violence in archaeological samples.

5.4.3 Nonlethal interpersonal violence injuries and comparison to other Nile Valley samples

The injury pattern at Kerma was comparable to the clinical model for interpersonal violence: males suffered the most from major lesions deemed diagnostic of interpersonal violence and more males than females exhibited multiple trauma; skull injuries were most common, followed by the parry fracture, and fractures were much more common than dislocations. For both the males and females, more injuries (about 80%) occurred on the skull vault as opposed to the craniofacial area, which contradicted the clinical pattern.

In order to determine whether this was a culturally mediated injury pattern and whether or not Kerma experienced a higher level of interpersonal violence due to the state's penchant for aggression and suppression, it was necessary to compare the fracture patterns from Kerma to palaeotrauma analyses from other Nubian cultures, which are located on the map in Figure 5.1. Table 5.9 presents the frequency of skull and direct force ulna fractures among individuals for Nile Valley samples that were obtained from the modal distribution of fractures[12] from Sahaba (Anderson 1968), Naga-ed-Dêr (Podzorski 1990), Semna South (Alvrus 1996; 1999), Soba (Filer 1998), Kulubnarti (Kilgore et al. 1997), and the Archaeological Survey of Lower Nubia (ASNL) (Smith and Wood-Jones 1910); the p-value obtained when each sample was compared to the Kerma fracture frequency is indicated. The number of individuals that bore skull fractures was significantly higher at Kerma when compared to the skull fracture frequencies from the other samples, with the exception of Semna South. The Kulubnarti people experienced significantly more direct force ulna injuries in comparison to Kerma. All other samples, except for Sahaba, displayed significantly fewer direct force ulna injuries than the Kerma sample. Filer (1997) observed no injuries among 42 individuals from Soba, a Christian Period site that was located near the fertile plain of the Nile's confluence. Anderson's (1968) skeletal analysis of the 47 adults from Nubia's oldest cemetery at Sahaba, 3.0 km north of Wadi Halfa, reported 11 cases of healed long bone fractures with five out of 47 individuals suffering isolated middle or distal ulna fractures. There was no evidence of cranial trauma, although cutmarks and stone points embedded in bone, which denote collective violence, were observed. Podzorski's (1990) reanalysis of the bones recovered from the Predynastic cemetery (N 7000) at Naga-ed-Dêr in Middle Egypt, relied heavily on archival field notes and photographs.[13] She credited five distal ulnar lesions and two

[12] The modal distribution of fracture provides a count of traumatised bones only and the number of elements observed is often unknown (e.g., Podzorski 1990; Smith and Wood-Jones 1910); this method of analysis was most recently revived by Berger and Trinkhaus (1995).

[13] The human remains were excavated from 1901-1904, and although extensively studied, no comprehensive investigation was undertaken before much of the physical collection was destroyed, which necessitated the use of archival data for the most recent skeletal analysis (Podzorski 1990, 1, 9-13).

fractured skulls to interpersonal violence. Smith and Wood-Jones (1910) recorded comparatively few skull injuries from their temporally diverse Lower Nubian sample, but observed that the forearm generated the greatest frequency of fractures. They speculated that a blow with a staff or *naboot*[14] produced the injury, particularly among females. When one considers that between 5000-6000 skeletons were examined and only 27 (0.5%) individuals, 10 of which were female, suffered from these "parry" type injuries, the actual number of people that suffered this ulna injury that was possibly a result of violence, was considerably lower compared to other groups. Although this type of analysis does not account for differential preservation, when the injuries were pooled the Kerma people experienced an overall higher frequency of violence-related fractures than other samples.

5.4.3.1 Comparison of the Kerma sample to two systematically analysed skeletal samples from Upper Nubia

The two systematic skeletal investigations of societies located in the rocky *Batn el Hajar* region of the Nile River's Second Cataract provided regional comparative material for the Kerma society at the expense of temporal variation (Table 5.10). Kilgore et al. (1997) examined all of the bones of 146 adults from Kulubnarti, a Medieval Christian site (ca. 550-1500 AD), while Alvrus (1999) observed the crania and long bones of 480 adults from Semna South where the burials were predominantly dated to the Meroitic period (ca. 300 BC-350 AD).[15] The number of fractured long bones observed at Kulubnarti was significantly higher than that of Kerma (χ^2=6.21, p = 0.013), while the Kerma people suffered a greater prevalence of long bone trauma than the group from Semna South (χ^2=3.69, p = 0.056). There was no significant difference in the prevalence of adults with multiple skull or long bone fractures among the injured adults at Kerma (13/47, 27.7%%), Semna South (26/99, 26.3%), or Kulubnarti (13/48, 27.1%).

[14] Smith and Wood-Jones (1910, 297) described the *naboot* as follows: "For all ordinary purposes of offence and defence—short of those of actual warfare—the Nubian and Egyptian native is in the habit of using a stout staff called the *naboot* and in domestic affairs it is apt to be the final appeal of authority... but the *naboot* has a much wider range of utility than the use in these ordered bouts of fencing, and the women in these ancient burials show a high proportion of fractured forearms."

[15] Fifty-four burials were dated to the Ballana Period (ca. 350-550 AD) and 18 burials derived from a Christian context (ca. 550-1400 AD).

5.4.3.1.1 Ulna injuries

Eighteen out of 23 (78.3%) ulna lesions were attributed to direct force trauma (includes crush injuries) among the Kerma people and of these injuries, 16 (69.6%) met all of the "parry" fracture criteria that were listed previously.[16] Among the Kulubnarti adults 22 out of 34 (64.7%) ulna fractures may be due to a direct force injury,[17] while nine of the 21 (42.9%) fractured ulnae matched the full parry fracture morphological criteria among the Semna South group.[18] The frequency of ulna fractures attributed to direct force (and by inference violence) among the ulnae observed was significantly greater at Kerma (18 out of 276) when compared to Semna South (9 out of 493) ($\chi^2 = 11.52$, $p = 0.001$), while the frequency of direct force ulna fractures was slightly less among the Kerma ulnae when compared to the ulnae from Kulubnarti (22 out of 260).

It has been argued that the parry fracture is also the outcome of a fall, although the Colles', Smith's, radial head, Galeazzi, and paired radioulnar fractures are more widespread consequences (e.g., Loder and Mayhew 1988; Richter et al. 1996; Rogers 1992).[19] These more universal fall-related injuries should at least occur more frequently than the fall-related ulna fracture that bears a transverse fracture line diagnostic of direct force trauma. The "fall" injuries should also occur with a similar regularity among groups inhabiting the same environment, such as the Nile Valley, where reliance on the river for food, water, and transport requires careful footing and navigation to avoid falls, slips or trips upon slippery rocks. It follows that people residing in more topographically treacherous regions, such as the *Batn el Hajar*, would experience an even higher frequency of forearm fractures that are diagnostic of falls. As expected, significantly more fall-related forearm fractures occurred among the Kulubnarti group (16 fractures among 146 adults) in comparison to the fall-related injuries among the Kerma people (6 fractures among 223 people) (χ^2=10.76, $p = 0.001$). However, there was no significant

[16] Three parry type lesions that did not have the ipsilateral radius present for confirmation were excluded.
[17] The presence of rotation or apposition was not stated, nor was the presence or absence of the ipsilateral bone. Therefore, the number of lesions that conform to the classic "parry" description may be overrepresented by this figure.
[18] The parry frequency at Semna South may be underrepresented since associated radial fractures and/or ulna shaft rotation were unknown in six cases.
[19] See Chapter 7 for definitions of these fractures.

difference in the percentage of the sample that suffered from fall-related forearm injuries between Kerma and Semna South, where five of these injuries were observed among 480 people. Considering the similarity of locale, it is curious that more individuals suffered fall-related forearm fractures at Kulubnarti than at Semna South (χ^2=33.96, $p < 0.000$). Likewise, the lower leg, clavicle, and humerus, all contenders for injuries received from falls from heights or standing level (e.g., Agarwal 1980; Loder and Mayhew 1988; Richter et al. 1996; Rogers 1992), were substantially lower in fracture frequency than the ulna and no significant difference in the fracture frequencies for these injuries was observed among the three skeletal samples. It is noteworthy that in Agarwal's (1980) investigation of a hilly region of India, where 65% of injuries were due to falls on uneven paths or from trees, that 1130 out of 1992 (57%) fractures and dislocations involved the humerus, distal radius, proximal ulna, and radioulnar fractures, while a further 10% involve the tibia and fibula—distal ulna fractures were not even observed unless they were included with the 40 (2%) miscellaneous upper limb fractures. Since the transverse distal or distal/middle junction of the ulna shaft is not the most prevalent injury received during a fall, the abundance of isolated transverse ulna shaft injuries must be explained by another aetiology indigent to all groups. In clinical practice this common aetiology is personal assault.

5.4.3.1.2 Cranial injuries

The lone Kulubnarti skull lesion was unconfirmed as traumatic,[20] while the adults from Semna South suffered a significantly higher frequency of skull injury when compared to the Kerma group (χ^2=4.39, $p = 0.036$). Among the Kerma group, variously shaped depression injuries that did not affect the inner skull table were the norm and ranged from 7 to 1326 mm^2 in area, with the average size being 405 mm^2. Oval and round depression lesions were typical among vaults from Semna South, although much smaller (95 mm^2 on average). These injuries were analogous to those observed by previous investigators of

[20] One individual at Kulubnarti was originally thought to have a small depressed skull fracture (Kilgore et al. 1997), but more recently the aetiology of this lesion classed as undetermined (L Kilgore, personal communication, November 1999).

Nubian and Egyptian skull trauma who proposed that the lesions were the outcome of blows from fists or blunt objects, such as maceheads or sling stones (e.g., Courville 1949; Filer 1992; Gurdjian 1973, 11; Nielsen 1970; Smith and Wood-Jones 1910, 38). The clinical evaluation of this injury is scarce, although the use of stones as weapons retains popularity among modern societies (e.g., Babapulle et al. 1994; Crandon et al. 1994; Emile and Hashmonai 1998; Geldermalsen 1993; Geldermalsen and Stuyft 1993; Nahlieli et al. 1993). However, a small study (n = 20) in Samoa confirmed that depression injuries measuring 707 to 3317 mm² in diameter were produced by intentional stoning and that individuals recovered completely (Judd 1970). Although Kulubnarti and Soba adults did not suffer from any cranial trauma, other Christian sites from the Wadi Halfa region of Lower Nubia revealed that the frequency of trauma between the Meroitic (14.2%) and Christian (13.4%) periods was similar (Armelagos 1969), and the people of the Christian period were, therefore, not immune to head injuries.

Table 5.11 presents the modal distribution of skull vault and facial trauma between the sexes for Kerma, Semna South, and the Archaeological Survey of Lower Nubia (ASLN). In contrast to the clinical model, more vault fractures than facial fractures were sustained by both sexes from Kerma and Semna South, and although there was no significant difference, the Semna South females had noticeably more facial fractures that the other groups. The distribution of skull fractures from the ASLN sample supported the clinical model and this dispersal of injuries was significantly different from Kerma (χ^2=7.95 p = 0.005) and Semna South (χ^2= 9.53, p = 0.002). This variation may be due to the multi-temporal context of the ASLN sample or alternatively, may reflect the culture pattern of injury in Lower Nubia. Some societies develop rules for acceptable interpersonal violence (i.e., what is a safe part of the body to attack; what weapon may be used, or what price will be paid in "blood money" for the location of the injury) as a method of resolving disputes and this will influence the observable injury pattern (e.g., Evans-Pritchard 1940; Kennett 1968; Matthew et al. 1996). The indigenous Australians of Mangrove , for example, sanction the use of gender-specific weapons (e.g., the *nulla nulla* is a three foot long women's fighting stick) to strike or block blows and limit targets to the legs, arms, and fingers—striking the head and chest is forbidden (Burbank 1994, 74). In the Mangrove society, therefore, nonlethal skull trauma would be infrequent, while limb and finger fractures would be endemic.

Bioarchaeologists (e.g., Jurmain and Kilgore 1998; Kilgore et al. 1997; Smith 1996; Smith 1997) have argued that the presence of craniofacial trauma is directly related to the level of interpersonal violence in a society. If this was the case, then interpersonal violence would be unknown at Soba, Kulubnarti, and Sahaba, even though multiple injuries and parry fractures existed, but would be common at Kerma and Semna South. While this pattern of injury may reflect cultural patterning of acceptable violent behaviour, it may indicate successfully deflected blows to the skull, with the ulna absorbing the full impact and thus, fracturing. A clinical analysis of isolated ulna shaft injuries in Pretoria, for example, found that direct assault with a wooden baton, fended off by the forearm, occurred in all 63 cases examined (DuToit and Gräbe 1979). Associated skull injuries were observed in 27% of all cases and injuries to the ipsilateral radius affected 8% of the patients. According to clinical studies, the stick was a popular weapon in other developing countries as well (e.g., Crandon et al. 1994; DeSouza 1968; Geldermalsen 1993; Geldermalsen and Stuyft 1993), while a close analogy is the use of baseball bat as a weapon in Western societies (Berlet et al. 1992; Bryant et al. 1992). Most individuals chose any suitable object close at hand and this selection varied with the individual's biological sex (see Babapulle et al. 1994 for an interesting survey of weapon choices in Sri Lanka; Butchart and Brown 1991; Chalmers et al. 1995; Geldermalsen 1993; Geldermalsen and Stuyft 1993). The use of the staff as a weapon in ancient Nubia was first proposed by Smith and Wood-Jones (1910) based on ethnographic observation. Carroll (1988) and Filer (1997) have since presented more convincing evaluations of the wooden staff as a Nubian fighting tool by its presence in early Nubian and Egyptian artistic representations of sports and battle, and its role in training recruits in the pharaoh's army. Filer (1997) referred to tomb paintings that depicted mock scrimmages among boatmen who wielded their punting poles against each other. And finally, the staff was omnipresent in Egyptian art as a traditional walking companion for males, an emblem of male authority, a postural or support aid, crutch, or male leisure accessory (Loebl and Nunn 1997), and thus was indeed a very convenient weapon—at least among males. Even more interesting, was the presence of throwsticks, measuring up to 75.5 cm, which accompanied several of the Kerma retainers in the sacrificial corridors as well as individuals in the smaller subsidiary graves (Reisner 1923b, 245-346). Hardwood throwsticks that were imported from the African interior were a valued possession among the Egyptian elite since the fourth millennium and were frequently depicted in hunting scenes, but were also burnished as weapons (see, Kendall 1988, 703-707, for a discussion of the throwstick and its representation in art among modern and ancient societies). The throwsticks were associated with males in artistic representation and, therefore, were another convenient weapon for some males. However, while throwsticks may have been wielded as a weapon on occasion, the possibility of ancient hunting accidents cannot be neglected!

The presence of the three indicators of interpersonal violence was inconsistent among the ancient Nile Valley skeletal samples. The Kerma people and adults from two other systematically examined samples (Kulubnarti and Semna South) encountered similar levels of multiple injuries. Although the Kulubnarti people suffered the most long bone injuries, many of the forearm injuries, which represented 75% of all injuries observed, were credited to accident rather than interpersonal violence. Kerma adults also experienced a high frequency of forearm injuries, but here the fractures were more characteristic of those caused by a direct force. Individuals from Semna South, in contrast, bore fewer parry lesions, but sustained an excessive amount of skull trauma. However, when the skull and direct force ulna fracture frequencies were pooled, the fracture frequency for violence-related injuries among all of the skulls and ulnae observed was nearly identical between Kerma (39/463, 8.4%) and Semna South (72/840, 8.6%). The pooled violence-related fracture frequency of the Kulubnarti group was lower (22/392, 5.6%), but not significantly so. The injury patterns of the Kerma and Semna South samples shared some characteristics, which suggest cultural congruency with respect to nonlethal intentional trauma—males sustained more lesions, cranial injuries were more frequent than other injuries followed by the ulna, and the skull vault sustained more fractures than the craniofacial region.

5.5 Conclusions

The purpose of this investigation was to ascertain whether the ancient people of Kerma exhibited any of the traditional skeletal indicators of interpersonal violence (healed cranial and parry fractures, as well as multiple lesions) and to evaluate the frequency of these lesions, if any, with other Nubian cultures. When all anatomical regions were examined for injuries (fractures, dislocations, and *myositis ossificans traumatica*) it was observed that 39.5% of the Kerma people had one or more injuries. The Kerma people displayed diagnostic skeletal markers of nonlethal violence, and these injury frequencies were observed as follows among the sample: skull fractures (11.2%), direct force ulna fractures (6.5%), and multiple injuries (18%). However, the Kerma injury pattern for interpersonal violence contradicted the clinical model on two aspects when fracture frequencies were examined. First, the skull vault was more frequently injured than the facial area among the Nubians, which may indicate a cultural preference for avoiding the facial area during altercations. Second, isolated ulna injuries followed the skull as the second most frequently fractured element, while hand injuries dominate this position in many clinical studies.

When the frequency values of individuals with skull or direct force ulna fractures from six ancient Nile Valley skeletal samples were compared to the Kerma sample, and differential recording procedures and preservation were not controlled for, the Kerma people experienced a higher overall frequency of violence-related injuries. An evaluation of two systematically analysed Upper Nubian samples from Semna South and Kulubnarti, dated to the Meroitic and Christian periods respectively, yielded some contrast in injury pattern to that of Kerma when the indicators of interpersonal violence were examined independently: the frequencies of multiple injuries (skull and long bone fractures only) were similar, individuals from Kulubnarti bore more ulna fractures (although these were not rigorously defined as direct force fractures), and the people from Semna South sustained more skull fractures. However, when the elemental frequencies of direct force ulna and skull fractures were combined the fracture prevalences of violence-related injuries among the Kerma and Semna South people were nearly identical, while the fracture prevalence of these pooled injuries among the Kulubnarti people was lower.

These higher prevalences of individual and elemental fracture frequencies of skull and direct force ulna injuries, which have been associated with interpersonal violence, among the Kerma people may reflect the "culture of violence" of the Kerma state as demonstrated by the material culture.

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Table 5.1: Descriptive identification of fracture types

Fracture *(force)*	**Description** (Adams and Hamblen 1992; Müller et al. 1990; Rogers 1992; Schultz 1990; Tehranzadeh 1989).
Skull and post-cranial fractures (See Figures 5.2 and 5.3)	
Linear ***(indirect, skull only)***	A force with a large mass (e.g., solid wall) causes the contact area to bend inward and forces a corresponding outward bending of bone elsewhere in the skull that follows the path of least resistance.
Crush ***(direct)***	A low velocity impact forces one bone surface against a point of resistance. The bone is crushed and the number of fractured segments cannot be identified (e.g., a femur or pelvis crushed under a steel beam or boulder); when the fragments can be counted, the fracture is comminuted.
Depression ***(direct)***	External bone is driven internally by a low velocity blunt surface, to create a localised crushed depression at the point of contact, surrounded by an area of radiating or concentric lines that result from forced outbending. In contrast to the penetration lesion, the extent of the external bone damage is greater than the area of the lesion at the greatest depth of the injury. The lesion's sides gently slope towards its centre (e.g., the circular area left by a blow with a small rock).
Compression ***(direct)***	Two opposing forces drive opposite surfaces of one bone (e.g., medial and lateral, left and right, or superior and inferior) toward each other and crush both sides.
Penetration ***(direct)***	The external surface of the bone is driven internally by a high velocity and sharp object, to create a localised lesion marked by sharp edges perpendicular to the cortex. In the skull, punctures cause fragmentation of the inner bone table and eject bone fragments into the brain to create a larger area of damaged bone internally than externally, the opposite of the depression injury (e.g., an injury created by a knife or bullet).
Other post-cranial fractures (See Figure 5.3)	
Transverse ***(direct)***	A force perpendicular to the longitudinal axis creates a single linear fracture line that bisects the vertical bone axis at an angle <45°.
Oblique ***(indirect)***	Angulated and compressive forces create a line that bisects the vertical bone axis at an angle >45°.
Spiral ***(indirect)***	Rotational and longitudinal forces encircle the bone to create a single fracture curve with a steep vertical step.
Impaction ***(indirect)***	Telescopic: the bone is driven into itself at the point of the force of resistance, thus shortening its length.
Avulsion ***(indirect)***	A portion of bone is pulled from its original position by a tensile force created by a ligament or tendon attachment, causing the bone, being weaker, to release.
Stress ***(repetitive)***	Repetitive forces cause small subcortical breaks that may eventually become a complete fracture.
Incomplete	Only one cortex of the bone has been broken due to bending or buckling.

Table 5.2: Distribution of fractured skull segments among Kerma adults

Element	Males			Females			Total		
	n	N	%	n	N	%	n	N	%
L Frontal	2	71	2.8	1	108	0.9	3	179	1.7
R Frontal	1	69	1.5	2	109	1.8	3	178	1.7
L Parietal	5	71	7.0	3	109	2.8	8	180	4.4
R Parietal	3	72	4.2	2	109	1.8	5	181	2.8
L Temporal	0	72	0.0	0	107	0.0	0	179	0.0
R Temporal	0	71	0.0	0	106	0.0	0	177	0.0
Occipital	0	72	0.0	1	109	0.9	1	181	0.6
L Zygomatic	1	62	1.6	0	85	0.0	1	147	0.7
R Zygomatic	1	61	1.6	0	88	0.0	1	149	0.7
Nasal	1	49	2.0	1	61	1.6	2	110	1.8
L Maxilla	0	62	0.0	0	91	0.0	0	153	0.0
R Maxilla	0	66	0.0	0	97	0.0	0	163	0.0
L Mandible	1	52	1.9	0	73	0.0	1	125	0.8
R Mandible	0	49	0.0	1	74	1.4	1	123	0.8
Total segments observed (O)	15	899	1.7	11	1326	0.8	26	2225	1.2
Expected segments (E)		1302			1820			3122	
Preservation (O/E X 100%)*		69.1			72.9			71.3	
Complete skulls	11	76	14.5	10	111	9.0	21	187	11.2

n = number of fractures observed; N = number of segments present; % = n/N X 100%; L = left, R = right; *male vs. female preservation based on 14 segments per person ($\chi^2 = 5.38$, $p = 0.020$)

Table 5.3: Types of skull fractures among Kerma adults

Type of Injury	Males		Females		Total	
	n	%	n	%	n	%
Depression	13	68.4	12	100.0	25	80.6
Penetration	6	31.6	0	0.0	6	19.4
Total injuries	19	100.0	12	100.0	31	100.0

n = number of fractures observed; %= n/Total injuries X 100%

Table 5.4: Long bone fracture statistics for Kerma adults

Descriptive Statistic	Males	Females	Total
Individuals observed (I)	93	130	223
Injured individuals (n')	24	16	40
Number of fractures (n)	30	18	48
Individual count (n'/I X 100%)	25.8	12.3	17.9
Individual mean trauma (n/I)	0.3	0.1	0.2
Mean multiple injury (n/n')	1.3	1.1	1.2

Table 5.5: Distribution of long bone fractures among Kerma adults

Element	Side	Males			Females			Total[1]		
		n	N	%	n	N	%	n	N	%
Clavicle	Left	1	49	2.0	1	77	1.3	5	258	1.9
	Right	0	49	0.0	3	83	3.6			
	Combined	1	98	1.0	4	160	2.5			
Humerus	Left	3	58	5.2	0	90	0.0	3	313	1.0
	Right	0	63	0.0	0	102	0.0			
	Combined	3	121	2.5	0	192	0.0			
Ulna	Left	10	53	18.9	6	82	7.3	23	276	8.3
	Right	5	56	8.9	2	85	2.4			
	Combined	15	109	13.8	8	167	4.8			
Radius	Left	1	55	1.8	2	86	2.3	7	288	2.4
	Right	2	57	3.5	2	90	2.2			
	Combined	3	112	2.7	4	176	2.3			
Femur	Left	1	67	1.5	0	95	0.0	5	333	1.5
	Right	2	72	2.8	2	99	2.0			
	Combined	3	139	2.2	2	194	1.0			
Tibia	Left	2	69	2.9	0	95	0.0	3	337	0.9
	Right	1	66	1.5	0	107	0.0			
	Combined	3	135	2.2	0	202	0.0			
Fibula	Left	2	33	6.1	0	58	0.0	2	224	0.9
	Right	0	56	0.0	0	77	0.0			
	Combined	2	89	2.3	0	135	0.0			
Total Combined		**30**	**803**	**3.7**	**18**	**1226**	**1.5**	**48**	**2029**	**2.4**

[1]No fractured long bones less than 80% complete were observed.
n = number of fractures observed; N = number of bones observed; % = n/N X 100%

Table 5.6. Types of long bone fractures among Kerma adults

Fracture Type	Males		Females		Total	
	n	%	n	%	n	%
Avulsion	1	3.3	0	0.0	1	2.1
Crush	3	10.0	3	16.7	6	12.5
Depression	1	3.3	0	0.0	1	2.1
Impaction	1	3.3	0	0.0	1	2.1
Oblique	11	36.7	6	33.3	17	35.4
Transverse	13	43.3	9	50.0	22	45.8
Total Fractures	**30**	**100.0**	**18**	**100.0**	**48**	**100.0**

n = number of fractures; % = n/Total Fractures X 100%

Table 5.7: Distribution of extremity fractures among bones and individuals at Kerma

Bone Group	Males			Females			Total		
Hand	**n**	**N**	**%**	**n**	**N**	**%**	**n**	**N**	**%**
Carpals	1	174	0.6	1	284	0.4	2	458	0.4
Metacarpals	5	290	1.7	7	477	1.5	12	767	1.6
Proximal phalanges	4	182	2.2	3	262	1.2	7	444	1.6
Middle phalanges	0	59	0.0	2	87	2.3	2	146	1.4
Distal phalanges	0	23	0.0	1	28	3.6	1	51	2.0
Total	**10**	**728**	**1.4**	**14**	**1138**	**1.2**	**24**	**1866**	**1.3**
Foot	**n**	**N**	**%**	**n**	**N**	**%**	**n**	**N**	**%**
Tarsals	1	494	0.2	0	737	0.0	1	1231	0.1
Metatarsals	4	320	1.3	3	506	0.6	7	826	0.9
Proximal phalanges	1	109	0.9	3	162	1.9	4	271	1.5
Middle phalanges	0	17	0.0	1	29	3.5	1	46	2.2
Distal phalanges	0	29	0.0	1	27	3.7	1	56	1.8
Sesamoids	0	16	0.0	0	17	0.0	0	33	0.0
Total	**6**	**985**	**0.6**	**8**	**1478**	**0.5**	**14**	**2463**	**0.6**
Individual Count	**n'**	**I**	**%[1]**	**n'**	**I**	**%**	**n'**	**I**	**%**
Hand	10	93	10.8	13	130	10.0	23	223	10.3
Foot	6	93	6.5	7	130	5.4	13	223	5.8
Preservation[2]	Males			Females			Total		
Total bones observed (O)	1697			4296			5993		
Total bones expected (E)	9858			13780			23638		
Preservation (O/E X 100%)*	17.2			31.2			25.4		

n = number of fractures observed; N = number of bones observed; % = n/N X 100%;
n' = number of injured individuals; I = number of individuals observed;
[1] % = n'/I X 100%; [2]excludes sesamoids; *($\chi^2 = 592.17$, p = 0.000)

Table 5.8: Distribution of multiple trauma frequency among Kerma adults

	Males		Females		Total	
Number of Lesions	**n'**	**%**	**n'**	**%**	**n'**	**%**
0	54	58.1	81	62.3	135	60.5
1	17	18.3	31	23.9	48	21.5
2	13	14.0	12	9.2	25	11.2
3	5	5.4	4	3.1	9	4.0
4	2	2.2	2	1.5	4	1.8
5	0	0.0	0	0.0	0	0.0
6	1	1.1	0	0.0	1	0.5
7+	1	1.1	0	0.0	1	0.5
Total Individuals (I)	**93**	**100.0**	**130**	**100.0**	**223**	**100.0**

n' = number of injured individuals; % = n'/I X 100%

Table 5.9: Frequency of violence-related injuries for Nile Valley skeletal samples

Site (Period) Date	Kerma (Classique) 1750-1500 BC	Sahaba[1] (Qadan) 12500-9000 BC	Naga-el-Der[2] (Predynastic) 4000-3200 BC	Semna South[3] (Meroitic) 300 BC-300 AD	Soba[4] (Christian) 550-1450 AD	Kulubnarti[5] (Christian) 550-1450 AD	ASLN[6] (Mixed) 4000 BC-1450 AD
Individuals	223	47	853	480	42	146	5000
Fractured skulls	21	0	2	63	0	0	17
% individuals with fractured skulls	9.4	0.0	0.2	13.1	0.0	0.0	0.3
P value		**0.029***	**0.000***	**0.158**	**0.038***	**0.000***	**0.000***
Direct force ulna fractures	17†	5	5	9	0	22	27
% individuals with direct force ulna fractures	7.6	10.6	0.6	1.9	0.0	15.1	0.5
P value		**0.492**	**0.000***	**0.000***	**0.064**	**0.023***	**0.000***

[1]Anderson 1968; [2]Podzorski 1990; [3]Alvrus 1996; 1999; [4]Filer 1998; [5]Kilgore et al. 1997;
[6]Archaeological Survey of Lower Nubia Smith and Wood-Jones 1910;
P-value when compared to the Kerma sample; * significant at $\alpha = 0.05$;
† one individual had 2 fractured ulnae.

Table 5.10: Comparison of Upper Nubian fracture frequencies

Site (Period) Date	Kerma (Classique) 1750-1500 BC			Semna South[1] (Meroitic) 300 BC-300 AD			Kulubnarti[2] (Christian) 550-1450 AD		
Element	**n**	**N**	**%**	**n**	**N**	**%**	**n**	**N**	**%**
Long bones									
Clavicle	5	258	1.9	6	309	1.9	1	262	0.4
Humerus	3	313	1.0	11	534	2.1	10	276	3.6
Ulna	23	276	8.3	21	493	4.1	34	260	13.1
Radius	7	288	2.4	5	512	1.0	16	259	6.2
Femur	5	333	1.5	1	540	0.2	3	281	1.1
Tibia	3	337	0.9	5	517	1.0	0	232	0.0
Fibula	2	224	0.9	5	417	1.2	3	218	1.4
Total	**48**	**2029**	**2.4**	**54**	**3322**	**1.6**	**67**	**1788**	**3.8**
Total Individuals (I)		223			480			146	
Total Injured Individuals (n')		40			41			48	
Individual Fracture Frequency (n'/I X 100%)		17.9			8.5			32.9	
Skulls	**21**	**187**	**11.2**	**63**	**347**	**17.9**	**0**	**132**	**0.0**

[1]Alvrus 1996; 1999; [2]Kilgore et al. 1997; n = number of fractured bones;
N = number of bones observed; % = n/N X 100%

Table 5.11: Comparison of skull injury distribution

Site	Kerma				Semna South				ASLN[1]			
	Males		Females		Males		Females		Males		Females	
Total Skull Fractures	15		11		41		22		11		6	
Element	n	%	n	%	n	%	n	%	n	%	n	%
Vault	11	73	9	82	31	76	13	59	3	27	2	33
Face	3	20	1	9	9	22	9	41	8	73	4	67
Mandible	1	7	1	9	1	2	0	0	0	0	0	0

[1]ASLN = Archaeological Survey of Lower Nubia; n = number of fractures observed; % = n/Total Skull Fractures

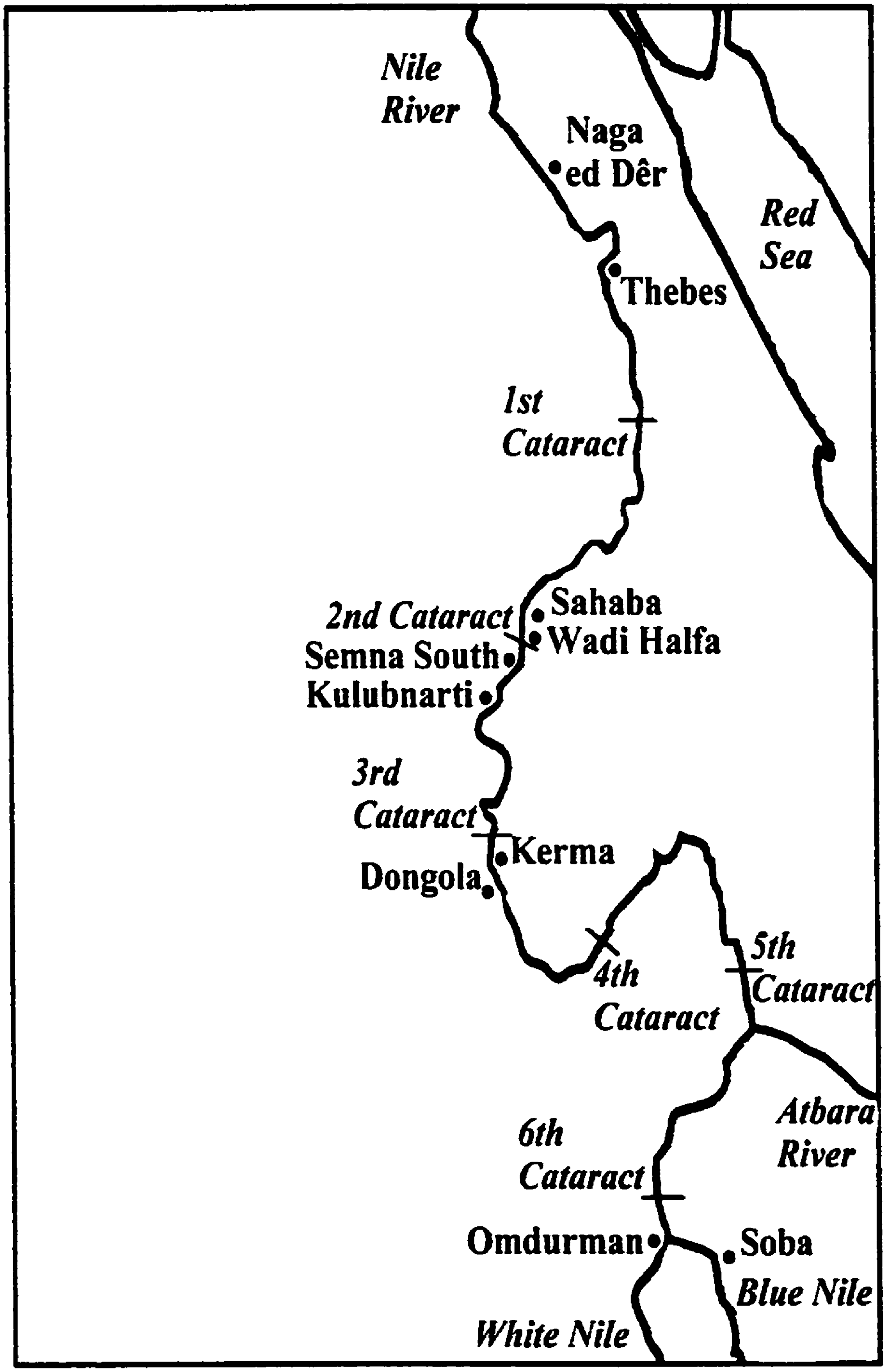

Figure 5.1: Location of Kerma

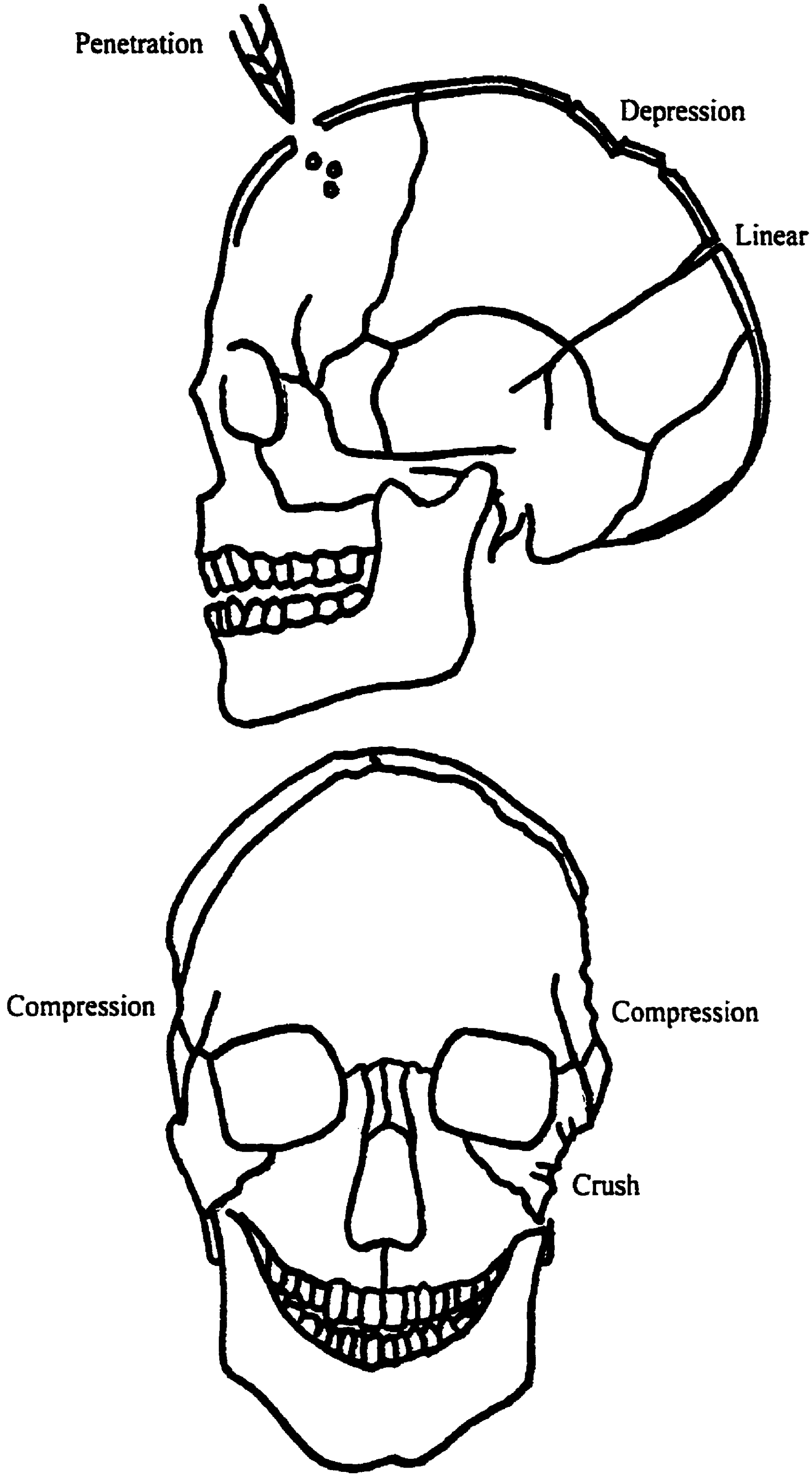

Figure 5.2: Skull trauma visual

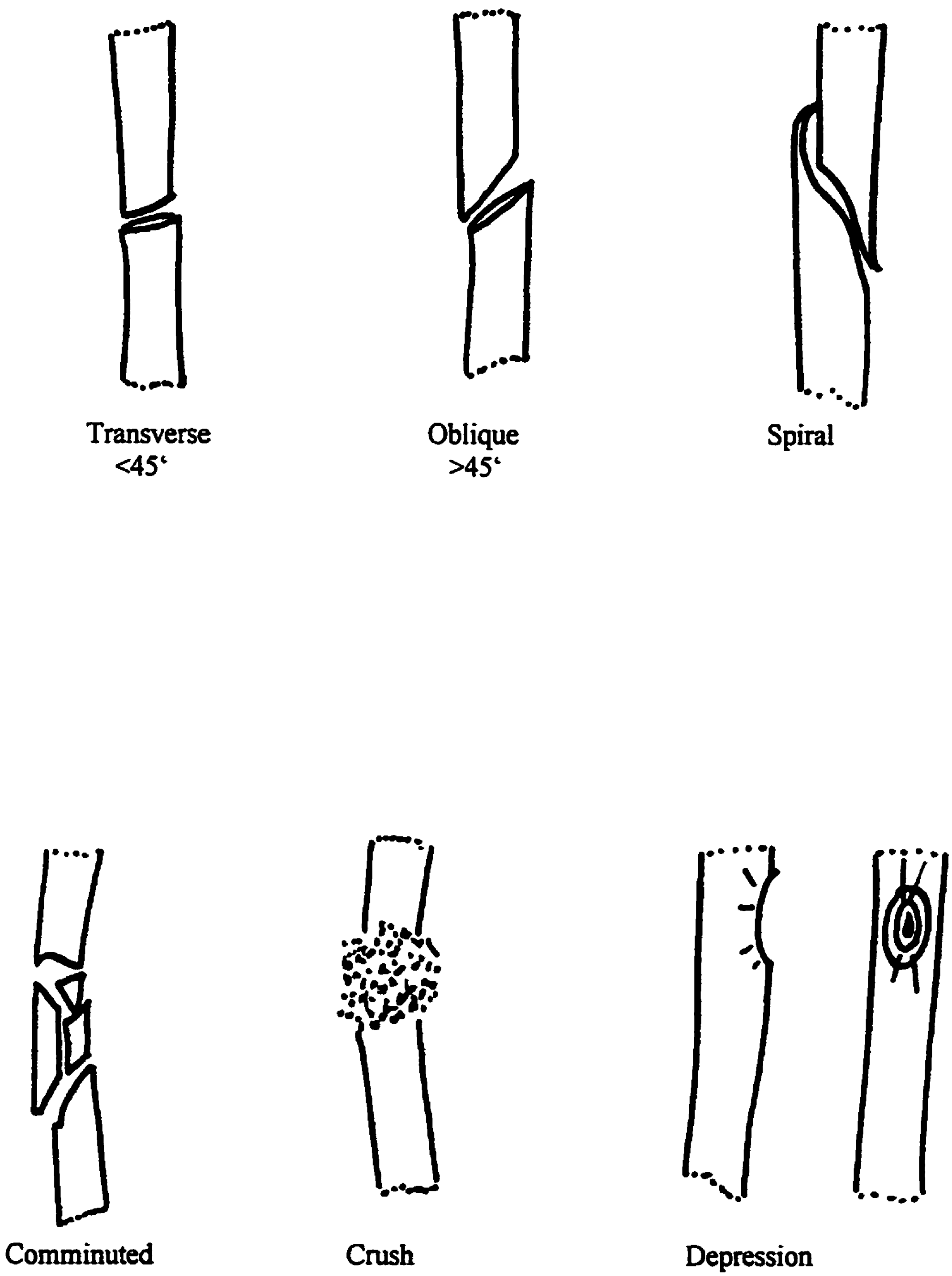

Figure 5.3: Long bone trauma visual (continued on next page)

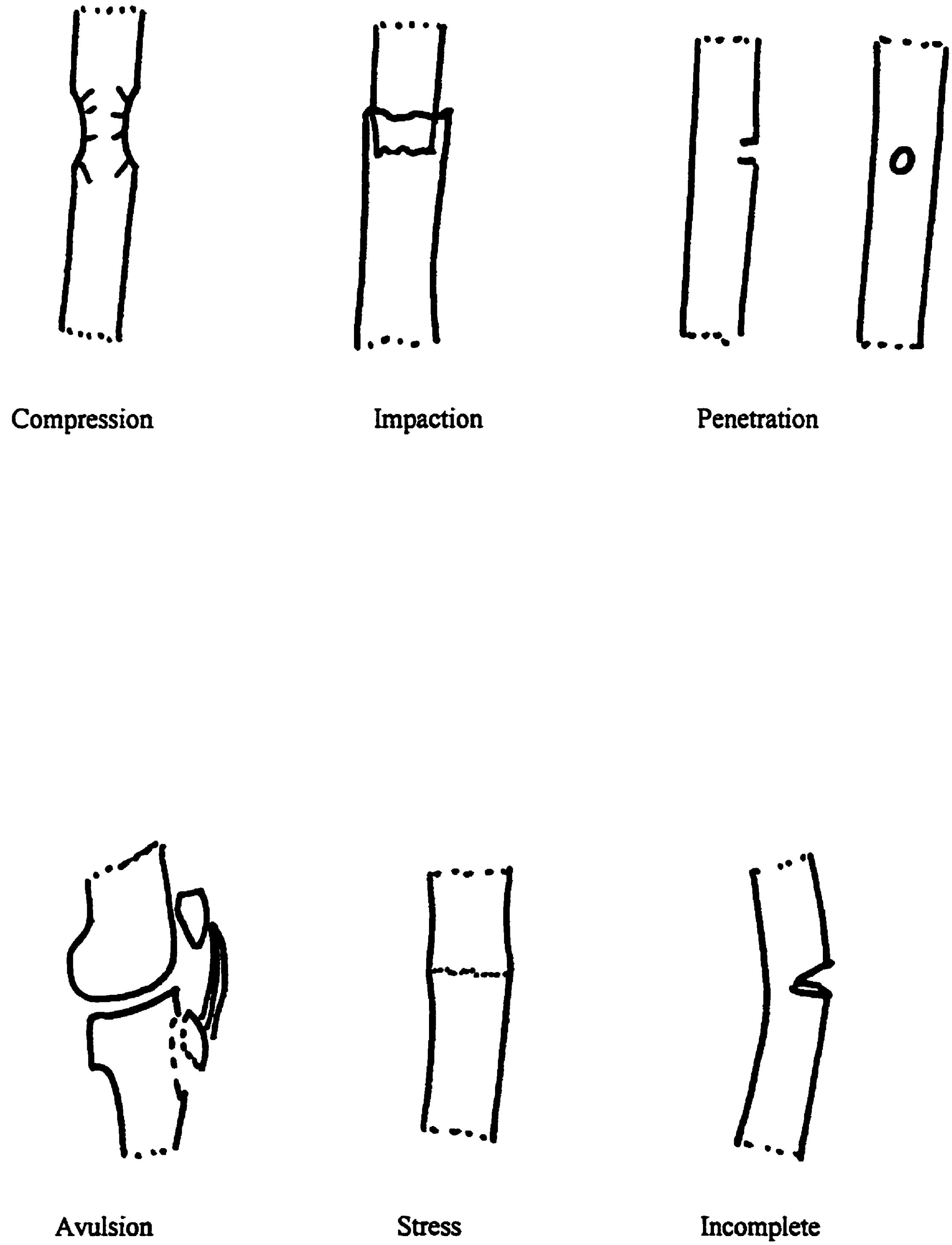

Figure 5.3: Long bone trauma visual (continued)

Plate 5.1: Depression fracture of the right parietal

Plate 5.2: Direct force ulna fractures (parry fracture)

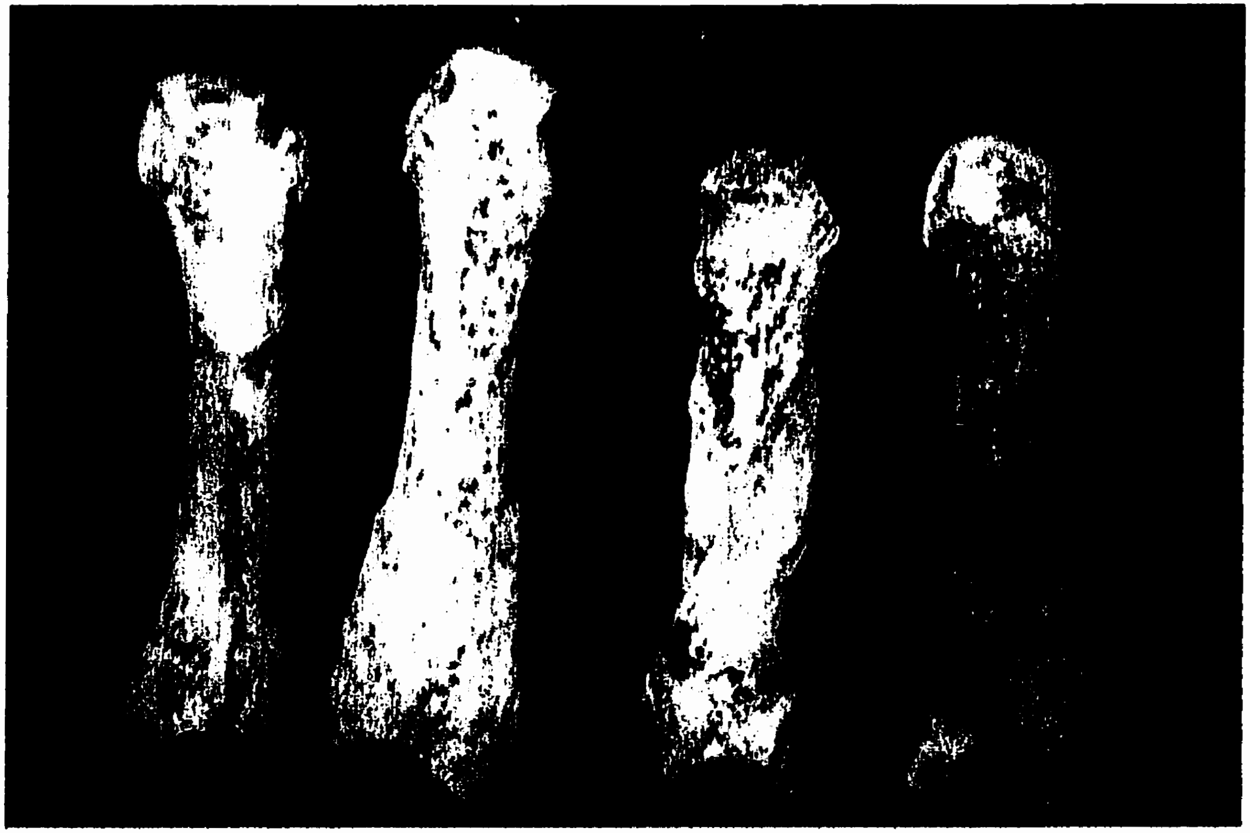

Plate 5.3: Fifth metacarpal shaft fractures

Plate 5.4: Rib shaft fractures

CHAPTER 6

Trauma among ancient Nubian villagers

6.1 Introduction

Trauma aetiology in modern rural societies is often a consequence of assorted occupationally-related hazards not found in urban locales, many of which are due to factors unrelated to modern mechanised equipment, such as the close contact with animals (e.g., Barber 1973; Björnstig et al. 1991; Boyle et al. 1997; Brison and Pickett 1992; Busch et al. 1986; Pratt et al. 1992); the increased age of workers due to non-mandatory retirement (Purschwitz and Field 1990); the intensified periods of harvest by inexperienced or exhausted workers (Hostetler 1993; Stueland et al. 1997); and the daily exposure of children to a hazardous adult working environment (Wilk 1993). While rural workers and their families face a greater injury risk due to the working and living environment, personal injury due to assault, homicide, and violence is often excluded in clinical analyses of rural trauma because the emphasis is placed on preventable occupational injury.

Sociologists attribute the dearth of violent crime in rural areas to the community's collective conscience (for overview see Websdale 1998, 56-58). In rural areas there is less tolerance for individual diversity, and social controls, such as, gossip, shame, and guilt would propel the individual into community prominence for their crime. On the contrary, group cohesion diminishes in urban societies and the community encompasses assorted personalities in a sea of anonymity that cloaks an individual's actions. While it is generally accepted that public violent crime (i.e., crimes involving strangers) is substantially lower in rural than urban areas, clinical literature revealed that domestic or acquaintance violence occurred with equal prevalence in both environments within the same culture (Poole et al. 1993; Websdale 1998, 55-56; Williams et al. 1997; Wladis et al. 1999). By analogy, the prevalence of injury traditionally attributed to nonlethal violence should be of similar frequency among rural and urban archaeological skeletal samples that belong to the same culture. Thus, in order to evaluate interpersonal violence among a rural archaeological skeletal sample, it is also essential that a culturally similar urban skeletal sample be available for comparison. Two such skeletal samples, dated to the Kerma Period (ca. 2500-1500 BC) of ancient Sudanese Nubia, were available for this study. The urban group from the ancient city of Kerma, nucleus of the Kerma empire, was known to have a high prevalence of nonlethal trauma,[1] as well as an affinity for violence, so adeptly recorded by the ancient Egyptians.

Egyptian historic documents vividly traced the trade rivalry and warfare between Egypt and Nubia (e.g., Budge 1907), which is complemented by archaeological evidence of fortification, ritual sacrifice (animal and human), weapons, and conquest during the Kerma Period when the city of Kerma was the focus of Nubian power (e.g., Adams 1977, 179-85; Bonnet 1990a; Bonnet 1990b; 1990d; Breasted 1962a; 1962b; Kendall 1997; Reisner 1923a). Although the rural hinterland south of Kerma was not a major exchange depot for the Egyptians, the rural dwellers interacted with the Kerma traders and adopted many aspects of the popular urban culture such as pottery design, burial practices, and ritual (e.g., Gratien 1999; Welsby 1996; 1997). This fellowship, coupled with Nubia's turbulent relationship with pharaonic Egypt for the control of the Nile trade and Central African resources, afforded a viable venue from which to assess the behavioural influences of an aggressive ancient urban society on its neighbouring inhabitants of the rural hinterland by direct evidence of skeletal analysis.

The clinical literature provides a rich source of epidemiological studies that form a template for bioarchaeological analysis. In cross-cultural clinical research males are more frequently involved in assaults, and haematomas, lacerations, and contusions are the most common injuries, while fractures and dislocations account for a minority of the lesions, usually about 30% (e.g., Butchart and Brown 1991; Chalmers et al. 1995; Geldermalsen 1993; Geldermalsen and Stuyft 1993; Matthew et al. 1996; Shepherd et al. 1988; Shepherd et al. 1990, and many others). The skull is the preferred site of attack in most societies (e.g., Brismar and Tunér 1982; Butchart and Brown 1991; Chalmers et al. 1995; Crandon et al. 1994; Geldermalsen 1993; Geldermalsen and Stuyft 1993; Greene et al. 1997; Khalil and Shaladi 1981; Matthew et al. 1996; Mwaniki et al. 1988; Shepherd et al.

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[1] See Chapter 5.

1988; Shepherd et al. 1990), but there are some exceptions, notably the forearm, ribs, and extremities (e.g., Burbank 1994; DuToit and Gräbe 1979; Mock et al. 1995). Bioarchaeologists who previously investigated human and nonhuman primate skeletal samples consolidated this data and developed a suite of skeletal lesions associated with nonlethal interpersonal violence, which included cranial injury, multiple lesions in varying stages of healing, and single ulna shaft fractures (parry fracture) (e.g., Jurmain 1991; Jurmain 1997; 1999; Jurmain and Bellifemine 1997; Jurmain and Kilgore 1998; Lahren and Berryman 1984; Lambert 1997; Lovell 1990a; 1990b; 1997; Martin 1997; Maschner and Reedy-Maschner 1998; Shermis 1983; Smith 1996; Walker 1989; Walker 1997; 1997; Wilkinson 1997; Wilkinson and Wagenen 1993). The ribs and hands are equally susceptible to harm during altercations, but aside from having extremely ambiguous fracture aetiologies, they often are unrecovered in archaeological excavations (e.g., Kilgore et al. 1997). Because these small bones are seldom presented in trauma analyses (some notable exceptions include, Kilgore et al. 1997; Lovell 1990a; Smith and Wood-Jones 1910), comparisons are restricted to the skull and long bones only, although all observable injuries are integrated into case studies (e.g., Hershkovitz et al. 1996; Pàlfi et al. 1993; Wakely 1996).

This investigation examined healed injuries among individuals from rural settlements of the Kerma period (ca. 2500-1750 BC) in ancient Nubia to determine what proportion of trauma, if any, was characteristic of interpersonal violence, identified by cranial injury, isolated distal ulna fracture, and/or multiple lesions. The frequency distribution of healed traumatic lesions among the rural sample from Kerma's hinterland was compared to that of the inhabitants of the city of Kerma[2] to determine if there was a statistically significant difference in the general trauma prevalence between the sexes and in the skeletal lesions traditionally associated with interpersonal violence, and by inference, a difference in levels of interpersonal violence between urban and rural groups of the Kerma culture. It was expected that the types of injuries attributed to interpersonal violence would be comparable, but that the rural sample would exhibit more accident-related injuries because of the more hazardous rural lifestyle (see, Judd and Roberts 1999).

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[2] See Chapter 5.

6.2 Materials and methods

6.2.1 The archaeological context

The rural skeletal remains were excavated from two cemeteries by myself, local Sudanese workers from the Dongola vicinity, and fellow members of the Sudan Archaeological Research Society's Northern Dongola Reach Survey (NDRS) team from 1994-97 under the direction of Dr. Derek Welsby (1996; 1997) of the British Museum's Department of Egyptian Antiquities. The sites, O16 (N 19° 02.324 E 30°00.000) and P37 (N 19° 00.563 E 30° 36.025), are situated near the modern Sudanese town of Dongola, about 70 km upriver from Kerma (Figure 6.1).

The rural cemeteries, dated to the Kerma Ancien (ca. 2500-2050 BC) and the Kerma Moyen (ca. 2050-1750 BC) periods, were easily identified by scatters of thin-walled red and black burnished pottery indigenous to the culture. The cemetery landscape was also highly visible—circular clusters of white quartzite pebbles interspersed with fragments of basalt and a black ferruginous substance delineated the burials, in stark contrast to the endless expanse of brown quartzite pebbles littering the Nubian Desert. The burial configuration was similarly homogenous, particularly the placement of the body. The Kerma Ancien circular burial pits, 1.0 m in diameter and up to 2.2 m deep, each contained a skeleton placed in the flexed position on an ox-hide shroud (Plate 6.1). The skeleton was consistently laid on its right side, oriented east to west, head to the east and facing north, with the hands placed in front of the face. Simple personal effects such as a faience or ostrich shell necklace, a single stone pendant, or alabaster labrets adorned the individual.

The inclusion of grave goods required a larger burial pit during the Kerma Moyen period, although offerings were less lavish and more uniform than those at the city of Kerma (Bonnet 1990d; Reisner 1923a). Pit diameters expanded to 1.5-4.5 m, yet were shallower—about 1.0-1.5 m deep. A crescent of cattle bucrania embraced the south side of the largest grave at P37 amidst the smaller unadorned graves. This body was laid on an ox-hide shroud in the same position as the earlier period, but shifted to the south side of the grave. Carefully placed pottery bowls were interspersed with meat cuts of sheep or goat and the assemblage was situated north of the body; four goats and an adult dog were interred by the individual's feet. The presence of the goats was interpreted as a sacrifice for the deceased and thought to be the precursor to "human sacrifice" associated with the Kerma Classique period (Bonnet 1990d, 77; Kendall 1997, 60; Reisner 1923a).

6.2.2 The skeletal sample

The trauma analysis assessed 55 adults, 28 males and 27 females, who will be referred to as the Northern Dongola Reach Survey (NDRS) sample. The sex of each individual was established by the dimorphic variation of the skull and innominate as advocated by Buikstra and Ubelaker (1994). If neither skull nor innominate was available, measurements taken from long bones as described by Olivier (1969) were utilised. Age at death was established with scores obtained from the degenerative changes of the pubis (Todd 1921a; 1921b), sternal rib end modification (Loth and Iscan 1989), and changes to the auricular surface of the innominate (Lovejoy et al. 1985). The ages determined from these methods were collapsed into broad categories: subadult (<25 years), young adult (25-35 years), middle adult (35-50 years), old adult (50+), and "adult" when bones were too fragmentary to confidently estimate the age.[3]

6.2.3 Recording of trauma

In this analysis the categories of trauma were as follows:

1. A fracture was defined as an incomplete or complete break in the continuity of bone (Ortner and Putschar 1981, 55; Rogers 1992).
2. A dislocation was identified by the complete (luxation) or partial (subluxation) loss of contact between joint components resulting in bone modification (Ortner and Putschar 1981, 85; Rogers 1992).
3. *Myositis ossificans traumatica* or soft tissue trauma was identified by an irregular ossified mass at the site of an avulsion of the tendon or muscle attachment from the bone (Aufderheide and Rodríguez-Martín 1998, 27; Ortner and Putschar 1981, 69).

[3] Judd (forthcoming) describes detailed osteological analysis.

Each major skull element (frontal, parietal, temporal, occipital, zygomatic, nasal, maxilla, and mandible) that was more than 75% complete, was examined for healed injuries as defined in Table 6.1 and illustrated in Figure 6.2. The following information was recorded for each lesion: side, position on the bone, dimensions, and shape. All skull elements were distinguished by side, with the exception of the occipital and nasal bones, which were counted as one bone only for each element type.

All long bones (clavicle, humerus, ulna, radius, femur, tibia, and fibula) were examined for evidence of healed injury. These bones were divided into five segments (proximal and distal interarticular surfaces; proximal, middle, and distal shafts) that were judged to be intact if more than 75% of each segment was present.[4] Since the bone collection suffered some damage, typically breakage, allowances had to be made for partial bones. Therefore, the bone was considered to be "complete" and incorporated into the bone count if four or all five segments of each bone were present.[5] Fractured bones with three or fewer intact bone segments were also included in the long bone corpus in order to include all trauma data. Because the inclusion of partial bones is controversial in palaeotrauma analysis and felt by some investigators to overestimate the fracture count (e.g., Bennike 1985; Lovejoy and Heiple 1981), a brief description of the injured partial bones was noted to accommodate researchers who prefer to exclude these partial bones from their analyses.[6]

Antemortem healed fractures were identified by angular deformity, apposition of bone, and complete or partial callus formation; x-rays were taken in questionable cases. The following information was recorded for each fracture: bone type, side, position on bone (proximal, middle, and distal diaphyses; proximal or distal articular end), and fracture configuration (the length of the fractured bone and its opposite, the angle of the fracture

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[4] Bone segments have been considered to be complete within a range of 33.3% to 100.0% by various researchers (Buikstra and Ubelaker 1994; Lovejoy and Heiple 1981; Robb 1997; Rose et al. 1991; White 1992). A conservative approach was taken in this investigation and a segment represented by 75% or more bone was considered to be complete as recommended by Buikstra and Ubelaker (1994).
[5] See Chapter 4.
[6] Bennike (1985) partially rectified this problem by listing the fractured fragments separately, but did not include them in her calculations.

line, and finally the apposition, angulation, and rotation of the distal fractured segment in relation to the proximally fractured segment).[7] Each lesion was assigned to a fracture type (Table 6.1, Figure 6.3)[8] based on this information. The results of a detailed forearm analysis that identified the proximate mechanism (direct or indirect force) were integrated into the results to facilitate the interpretation.[9]

The metacarpal and metatarsal bones, as well as the phalanges, were divided into three segments (proximal, shaft, and distal) and those with 75% or more of at least two segments present were classed as complete bones. Like long bones, fractured small bones represented by one segment only were included, but documented in the analysis to accommodate trauma recording variations. The carpals and tarsals were reported in the study if they were 75% or more complete; partial bones that yielded evidence of injury were also included in the sample and noted in the results. The determination and configuration of healed or partially healed injuries to the tubular bones were identical to the processes used to describe the appendicular bones. Injured irregular bones (i.e., scapula, vertebrae, innominates, and thorax) were briefly described on an individual basis. Magnification (10X) verified the presence of healed callus lines that were questionable on the articular surfaces.

6.2.4 Analysis

The amount of bone preserved was determined for the long bones, skull, and extremities as a percentage of the bone recovered compared to the bone expected, in order to assess preservation as possible source of bias in fracture reporting between the sexes. Trauma frequency was expressed by element (lesions per bone) and individual (injured adults per number of individuals) counts that permitted analysis at the populational level and the establishment of injury patterns among the bones themselves. Trauma frequency statistics among individuals included the mean trauma count (number of lesions per number of

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[7] See Lovell (1997) for recent definitions and the method for taking these measurements.
[8] Definitions for fracture types were consolidated from many sources (Adams and Hamblen 1992; Kellam and Jupiter 1992; Müller et al. 1990; Rockwood et al. 1996; Rogers 1992; Schultz 1990; Tehranzadeh 1989).
[9] See Chapter 7.

individuals in the sample) and the mean multiple injury (number of lesions per injured individuals). Chi-square tests determined statistically significant variations in the presence of injury between the bones, sexes, and lesion location within the rural sample and were also employed to compare the sample to the trauma results from Kerma. The Yate's correction for continuity (χ_c^2) was applied to small samples ($n < 5$). The significance level chosen was .05 and the number of degrees of freedom (df) was "1" unless otherwise stated. Because of the small size of the Kerma Moyen sample (12 of the 55 adults), the data for both Kerma periods were combined for this analysis.[10]

6.3 Results

6.3.1 Skull preservation and trauma

The skull bone count and bone survival rate are shown in Table 6.2 and no significant difference was revealed in the "elemental" preservation or injury prevalence between the sexes.[11] Nineteen male and 17 female complete skulls were available for observation and of these, seven (19.4%) displayed vault injuries, but no significant difference in the distribution of skull injuries between male and female skulls existed. Two Kerma Moyen females presented oval-shaped depression fractures on the left parietal (362 and 330 mm² in area), while two Kerma Ancien males received smaller depression injuries on the left side of the skull vault (126 and 109 mm²). Two Kerma Ancien males each had an oval puncture on the right side of their skull vaults (5 and 78 mm²) and a multi-injured male bore a series of small ovoid scattered lesions on the right parietal.[12] One male mandible was severely crushed and was associated with a complete uninjured skull vault. In total six males (31.6%) bore injuries to the skull, while 22.9% (8 out of 35) of the total sample experienced healed skull injuries.

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[10] A detailed trauma analysis for the each period as well as the palaeopathological catalogue is found in Judd (forthcoming).

[11] The expected number of elements for each skull was 14.

[12] The three largest lesions measured 26.7, 33.6, 38.3 mm² and were surrounded by active bone.

6.3.2 Long bone preservation and trauma

Significantly more male long bone (77.9%)[13] was preserved in comparison to the female long bone (59.6%) ($\chi^2 = 150.01$, $p = 0.000$), which may misrepresent the reported fracture frequency results between the sexes. When the sexes were pooled the percentage of long bones preserved for the entire sample was 68.9%.

Fracture statistics for individuals with long bone trauma are shown in Table 6.3. Seventeen of the 55 individuals sustained long bone fractures for an overall individual fracture rate of 30.9%. Although nearly twice as many males as females bore injuries, long bone fracture was independent of biological sex. Table 6.4 records the numbers of complete long bones and fractures observed for males and females. The long bone fracture frequency for the entire sample was 5.8% as 28 out of 484 long bones were injured. No significant difference among elements was found when the prevalence of fractured bones between the sexes was examined, nor was a significant difference noted for either sex when the injuries between the right and left sides were considered. Eleven of the male lesions and six of the female lesions affected the distal or distal interarticular portion of the bone, but no significant difference existed between the sexes. The type of fracture (Table 6.5) provided evidence as to whether a direct or indirect force caused the injury. The angled, oblique fracture lines characterised 35.7% of the lesions and were situated on the distal shaft (1 clavicle, 2 ulnae, 3 radii, 4 fibulae), a combination traditionally associated with indirect trauma. An equal number of fractures (1 clavicle, 7 ulnae, 2 radii) were transverse types, where the break occurred at the point of impact from a direct force (e.g., Adams and Hamblen 1992, 145; Rogers 1992).

Injuries to the shafts of the radius and ulna, however, are controversial in aetiology and interpretation is influenced by the presence of ipsilateral associated fractures in addition to the fracture line (Rogers 1992, 811-836).[14] An independent analysis[15] of forearm

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[13] 28 males X 14 long bones X 5 segments per bone = 1960 bone segments, of which 1526 were recovered; 27 females X 14 long bones X 5 segments per bone = 1890 bone segments, of which 1126 were recovered.
[14] See Jurmain (1999, 214-222) and Lovell (1997) for problems with bioarchaeological interpretations of forearm trauma.
[15] See Chapter 7.

trauma found that the seven transverse ulna lesions met the morphological characteristics of a typical direct force parry fracture—non-radial involvement, fusiform swelling on the distal third of the shaft, minimal displacement (<10° in any plane) if at all or were less than 50% apposed, and the fracture line was ≤ 45° (Richards and Corley 1996, 912; Rogers 1992; Schultz 1990, 265, 816-817). Three individuals sustained grossly rotated paired forearm fractures, where both the ulna and radius were involved. One individual also had a Smith's fracture[16] on the same radius. These individuals presented other long bone injuries and two also experienced nonunion of long bone fractures that were identified by blunted and sealed bone ends (the left radius and right ulna of one Kerma Ancien male (Plate 6.2) and the clavicular fracture of a Kerma Moyen female). Nonunion of the forearm is common in clinical practice and may be the result of lack of control for rotation in healing (Connelly 1981, 27-30).

Two tibial avulsions were present on the proximal shafts of a Kerma Moyen male where both tibial tuberosities were completely detached from the shafts. A distal avulsion of the tibial malleolus of a Kerma Ancien female and five depression lesions occurred on the tibial articular surfaces.

6.3.3 Extremity preservation and trauma

The extremity (hands and feet) inventory, fracture distribution, and preservation calculation for the sample are located in Table 6.6. A significant difference was observed between the sexes for the numbers of extremity bones preserved. Discrete hand fractures were statistically more prevalent among males than females (χ^2=5.80 p=0.016), but there was no significant difference in the fracture frequencies when the hands as units for each adult were compared between the sexes. There was no significant difference observed between the sexes when the bones of the foot were examined for trauma individually or as units for each adult.

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[16] The Smith's fracture is caused by a fall on an outstretched hand or direct blow to the back of the hand (Rogers 1992, 847).

Two males sustained a Bennett's fracture, which is identified by the shearing off of a triangular wedge from the base of the first metacarpal by a misplaced punch (Adams and Hamblen 1992; Rogers 1992, 976; Schultz 1990). Three males had multiple oblique metacarpal shaft fractures (Plate 6.3), while one male and one female had one each of these injuries. Three males exhibited transverse metacarpal shaft fractures and head impactions were noted on the metacarpals of three other males. Injuries to the proximal hand phalanges included eight impacted phalangeal heads of females, four impacted bases of males, one slash on the lateral side of a male's fifth proximal phalanx, and four oblique shaft injuries, again to males. Three individuals each had one distal phalangeal tuft that was sheared off.

Injuries to the metatarsals included five base and one head impaction, as well as an avulsion of the styloid process of the fifth metatarsal. Two Kerma Moyen females suffered a stress injury on the fourth metatarsal; a parallel fracture on the adjacent fifth metatarsal also occurred on one of these females. The majority of the foot phalanges sustained impaction or avulsion injuries, but one first distal phalanx exhibited a longitudinal cut.

6.3.4 Other trauma[17]

Six Kerma Ancien males suffered damage to the vertebrae, mainly depressed articular facets. In most cases one vertebra only was injured except for one male who bore six adjacent injured elements, four of which were to the spinous processes. A second young male had bilateral spondylolysis that traversed the lower third of the superior articular facets of a lumbar vertebra. Five individuals suffered rib trauma in the form of fracture or soft tissue injury. Three of these people had other injuries, but most notably one male and one female each sustained distal ulna and phalangeal fractures as well. The right superior acetabular rim of an Ancien male revealed a small round puncture surrounded by periosteal bone reaction. One male with multiple injuries exhibited a healed crush fracture on the scapular body (Plate 6.4). This scapula also displayed muscle pull lesions

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[17] The numbers of elements recovered for the remainder of the skeleton are tabulated in Judd (forthcoming).

at the insertion points for the *triceps brachia*, *teres minor*, *teres major*, and *serratus anterior* muscles. The right scapula sustained soft tissue trauma along the medial spine where the *trapezius* muscle inserts.

Aside from the bones mentioned above, five cases of *myositis ossificans traumatica* were noted on the bones of four Kerma Ancien males who suffered injuries at the following locations: the *soleal* insertion of the left proximal posterior tibia and the interosseous insertion of a hand phalanx; the *linea aspera* of the left mid-shaft femur; the *deltoidius* and *brachialis* insertions of the left mid-shaft humerus; and the *adductor magnus* insertion on the right distal femoral condyle.[18] Soft tissue trauma was observed at the *adductor longus* insertion of the right pubis of an older Kerma Ancien female.

6.3.5 Multiple trauma

Many individuals experienced multiple trauma consisting of fractures and soft tissue injury, but most lesions were minor, such as depression fractures to the hand and foot bones or vertebral facets; dislocations were not observed. Significantly more males than females bore some type of injury (Table 6.7) (χ^2=1.92, p= 0.002), but the occurrence of multiple injury was similar between the sexes.

6.4 Discussion

Accidental and intentional injuries were observed in this rural skeletal sample, dated to the Kerma period, from North Dongola Reach vicinity, but how did the injury pattern compare to the neighbouring urban group from Kerma?

The modal distribution of injuries differed between the two groups. Among the rural people, the 151 observed injuries (fractures, dislocations, and *myositis ossificans traumatica*) were distributed as follows: the hands displayed the most injuries (34%) followed by the feet (27%); the trunk (13%); the ulna and tibia (6% each); the skull (5%); the radius and fibula (3% each); and finally the clavicle and femur (1%). In contrast, the 156 injuries met with by the Kerma people included skull lesions (20%), followed by the

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[18] This was a partial bone.

trunk (19%), the hands and ulna (15% each), the feet (9%), the femur (5%), the humerus and radius (4% each), the clavicle and tibia (each with 3%), the fibula (2%), and the patella (1%). Both samples deviate from the clinical modal distribution of fracture where the skull is generally the most frequently injured area followed by the hands in many cases (Brink et al. 1998; Shepherd et al. 1990; Spedding et al. 1999), although variations exist (e.g., Ebong 1978b; Matthew et al. 1996; Prince et al. 1993; Sahlin 1990)

Table 6.8 compares the fracture prevalences of trauma among the most commonly injured bones[19] for the rural sample and the sample from Kerma, while Table 6.9 examines the prevalence of fracture among bones typically associated with interpersonal violence (skull, ulna, and multiple injury) by sex for the two samples;[20] the p-values obtained from the chi-square analyses accompany the tables. A significantly higher number of rural people suffered from one or more injuries when compared to their urban neighbours (80% vs. 39.5%) ($\chi^2 = 29.07$, $p = 0.000$).

When the major injuries associated with nonlethal interpersonal violence were examined, there was no significant difference between the samples in the frequency of isolated skull or direct force ulna injuries, or in the frequency of individuals with combined skull and ulna trauma. The similarity between the samples in the prevalence of cranial and direct force ulna shaft injuries confirmed the clinical premise that interpersonal violence among acquaintances (i.e., known individuals) in urban and rural areas was analogous within a given culture (e.g., Bachman 1994, 7; Poole et al. 1993; Websdale 1998, 56; Williams et al. 1997; Wladis et al. 1999). Female multiple trauma involving the crania and long bones was comparable for both samples and implied that rural and urban females faced mutual challenges in their daily activities or social role. The disparity in male multiple trauma involving the skull and long bones was produced by greater fracture frequencies of the radius, tibia, and fibula, while the addition of the extremities created a higher prevalence of multiple fractures among rural individuals for both sexes. The dissimilarity may be a factor of differential preservation since significantly more long bones and extremities of

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[19] Infrequently injured bones (i.e., sternum, vertebrae, scapula, innominate, and patella) were excluded.
[20] See Chapter 5 for complete trauma analysis of the urban Kerma sample.

the rural group were recovered ($\chi^2 = 11.07$, $p = 0.001$; $\chi^2 = 3457.74$, $p = 0.000$), while the skull elements of 223 Kerma inhabitants were more favourably preserved ($\chi^2 = 41.83$, $p = 0.000$).[21] This was particularly true of the extremity bones from Kerma, which were underrepresented physically or were cloaked in mummified tissue. Variation in activity and behaviour is an alternative explanation, since the landscape and proximity to the Nile River were comparable for both groups.

6.4.1 The role of the environment

Geographical hazards, nonfatal interpersonal squabbling, and weapon assaults are often implicated as factors responsible for traumatic lesions (e.g., Filer 1992; Frayer 1997; Kilgore et al. 1997; Lambert 1997; Shermis 1983; Smith and Wood-Jones 1910, and many others), but other dangers, seeming quite innocent, lurked in the rural areas during the Kerma period. Dental indicators of an animal protein diet (e.g., calculus deposits), combined with the abundance of bovid bones and effigies retrieved from domestic refuse and ritual contexts at Kerma and the neighbouring rural Kerma settlement of Gism el-Arba (Bonnet and Ferrero 1996; Chaix 1988; Chaix 1993; Gratien 1999; Kramar 1994), in addition to the faunal remains from the Kerma Moyen burials of the NDRS and the dental calculus deposits of the rural people (Judd forthcoming), confirm the importance of animals to this culture. The proximity of animals, however, has ominous repercussions. Although Smith and Wood-Jones (1910, 296-298) considered ancient Nubia to be free of occupational hazards, modern emergency units demonstrate that farmers and their families are at greatest risk of fatal and nonfatal injury—a sizeable percentage of nonfatal accidents, 30% to 40%, is blamed on animal assault during the processes of milking, feeding, dehorning, calving, herding, ploughing, cleaning, slaughtering, and maintaining (e.g., Boyle et al. 1997; Brison and Pickett 1992; Busch et al. 1986; Pratt et al. 1992); falls from ladders, lofts, and short heights account for a further 10% of injury (e.g., Cogbill et al. 1991; Jones 1990).

Traditional farming as a contributory factor to long bone trauma was investigated among rural and urban medieval Britons (Judd and Roberts 1999). The long bone fracture

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[21] See Chapter 5 for preservation calculations for the Kerma skeletal material.

frequencies for the medieval farming villages ranged from 2.2% to 3.5% and individual fracture frequencies spanned from 10.7% to 19.4%. Both rates were significantly higher than the craft-oriented urban dwellers whose elemental and individual fracture rates ranged from 0.8% to 4.1% and 4.7% to 5.5% respectively. This long bone injury pattern was reproduced in the Nubian material examined here. Long bone fracture frequencies were reduced from 5.8% among rural residents to 2.4% among the urban dwellers, while the number of individuals with long bone fractures plummeted from 30.9% for the NDRS group to 17.9% for the urban Kerma sample.

The radial fractures observed were characteristic of those received when the body weight shifts over the axis of the bone, such as when one attempts to break a fall with an outstretched hand or when one goes over on the ankle (e.g., Adams and Hamblen 1992, 244-7; Loder and Mayhew 1988; Rogers 1992, 811-25, 841-9; Sacher 1996, 777). Similarly, minor injuries were discovered on the lower leg bones of both samples and were attributed to continual stress on the knee joint, sudden impaction of the joint or going over on one's ankle—none were readily identifiable with direct trauma (e.g., Adams and Hamblen 1992, 246; Rogers 1992, 1270, 1233-4; Sacher 1996, 777). The decrease in the ankle injuries associated with going over on the ankle accompanied by a reduction in radial injuries, more traditionally attributed to breaking falls, may be explained by the differences in urban and rural activities and work areas (e.g., courtyard, riverbank, field, workshop). It was likely that many of the Kerma individuals, particularly those in the mass burial section of the large tumuli, were the king's "retainers," and those from surrounding subsidiary graves were members of the royal entourage or bureaucrats. The urban administrators or even the household slave quite possibly enjoyed a more comfortable existence than the working-class farm family who had greater contact with the daily environmental hazards of the Nile River, desert terrain, and domesticated animals (see, Owsley et al. 1987, for comments concerning differences in working conditions among historic American slaves). While animals were also involved in the rituals at Kerma, their care was likely delegated to the surrounding village peasants, who were unlikely to be interred in the royal tumuli, or perhaps an exclusive or hereditary animal caretaker position existed. Urban specialisations at Kerma included commercial and ritual baking; carving of ivory, bone, mica, faience, tortoise shell, and wood; jewellers; bronze metallurgy; boat building; tanning and perhaps competitive sports, such as wrestling and rowing (Bonnet 1990c; Carroll 1988), and although each had its own unique set of occupational hazards, injury risk would be minimal in comparison to the perils of the rural lifestyle, as it is in the modern context (e.g., Brison and Pickett 1992; Jones 1990; Nordstrom et al. 1995; Pratt et al. 1992; Purschwitz and Field 1990).

Injury aetiology in the rural regions of developing African countries where "traditional" subsistence strategies and lifestyles exist satisfies both the geographic and economic criteria for an effective analogy. Mechanisms of nonfatal injuries have been reported in African villages as follows: falls from trees that resulted in multiple trauma, stumbles into holes at night that produced ankle or lower leg injuries, agriculture, hut wall or roof collapse, trees falling on the individual, household accidents, sharp tool injury, assaults with sticks causing multiple comminuted injuries, boxing, falls at home, striking or receiving a blow, snake and hyena bites, human bites, and knife fights (e.g., DeSouza 1968; Ebong 1978a; Loro and Franceschi 1992; Mock et al. 1995). Sizeable numbers of these injury mechanisms involved physical conflict and no doubt also occurred in antiquity.

6.4.2 The role of the extremities

The high frequency of hand and foot injuries in the rural sample is not unreasonable when compared to modern clinical and nonhuman primate research that found the hands to be the most frequently fractured region (e.g., Barton 1988, vii-ix; Bramblett 1967; Lovell 1990a). Clinical literature reported that hand injuries resulted from sports, agriculture, falls, blunt trauma, machinery, glass, industrial accident, burns, household accident, animal bites, and occupation, in addition to human bites from a tooth-punch injury, direct bites, and fights (e.g., Ip et al. 1996; Jonge et al. 1994; Kelly et al. 1996; Loro and Franceschi 1992; Mock et al. 1995; Redler and McCue 1988; Smith and Barss 1991). Many of the injury mechanisms mentioned above were also present in ancient Nubia, but the rural males and females sustained significantly more injuries to the extremities than their urban compatriots. While this discrepancy may be a consequence of the differential preservation of extremity bones between the two collections or variation in daily tasks, injuries encountered during physical confrontations were also implicated. An analogous situation emerged in nonhuman primate research. Lovell's (1990a) review of nonhuman primate field literature found that interpersonal violence and traps were the primary cause of injury for both sexes, with the hands and feet being the most vulnerable in fights. She observed skeletal evidence for this behaviour in her in-depth analysis of nonhuman primate injury where she found that extremity injuries—usually simple, compression, and ununited fractures—were distributed between both sexes and in most cases more than one element was involved. A corresponding result appeared among the ancient rural Nubians—13 out of 55 (23.6%) people suffered from multiple hand injuries and 10 out of 55 (18.2%) adults experienced multiple foot trauma. Both extremity multiple injury frequencies were significantly higher than that of Kerma where only one individual out of 223 (0.5%) exhibited multiple lesions of the hands (χ^2= 45.19, p = 0.000) and feet (χ^2= 36.51, p=0.000).

In clinical practice, most adult assault victims claim to suffer injuries from a punch, hit, push, or kick (Brismar and Tunér 1982; Chalmers et al. 1995; Goldberg and Tomlanovich 1984; Greene et al. 1997; Muelleman et al. 1996; Shepherd et al. 1990; Zachariades et al. 1990), and therefore, some injuries must appear on the hands of the person delivering the blow (e.g., Shepherd et al. 1990). Offensive hand injuries, many of which were observed among the rural NDRS sample, included metacarpal injuries, particularly the neck where the head is bent dorsally (boxer's fracture), and the base of the first metacarpal when a misplaced punch shears a triangular portion of the articular base away from the shaft (Bennett's fracture) (e.g., Adams and Hamblen 1992, 171; Rogers 1992; Schultz 1990). Other notable offensive hand injuries include the transverse shaft fracture of the fifth metacarpal caused by a side-ways blow by the medial edge of the hand, tooth-punch injuries received by assailant's metacarpophalangeal joint when the fist contacts the teeth and finally, one half of the V-shaped base of the second metacarpal can be sheared off by the blunt edge of the trapezoid when the metacarpal absorbs a blow to its head. Common defensive hand injuries are oblique shaft fractures of the metacarpal (especially the fifth) caused by holding and twisting, a "parrying" fracture to the fifth metacarpal or phalanx when the hand is raised to fend off a blow, and bite injuries from humans or animals causing co-occurring dorsal and palmar damage or amputation (Adams and Hamblen 1992, 171; Rogers 1992, 945-981). Notable among the distal phalangeal injuries were three instances of tuft amputation, which often result from human or animal bites (Loro and Franceschi 1992), in addition to injuries inflicted by weapons (e.g., knives, axes, etc.) and surgical procedures. While some of the hand injuries observed above were likely the result of striking or absorbing a blow, the blow may not necessarily have involved another individual. Alternatively, a blow can be delivered in a socially acceptable venue, such as competitive sports (e.g., Hershkovitz et al. 1996; Mock et al. 1995; Walker 1997), sanctioned dispute settlement (e.g., Burbank 1994) or play among age sets (e.g., Whitten and Smith 1984).

6.4.3 Variation in weapon choice

Although no significant difference in skull trauma prevalence was observed between the two groups, the intensity of the skull vault lesions among urban dwellers was more severe (7 to 1326 mm^2 in area, mean = 405 mm^2) than those of their rural counterparts (Plates 5 and 6). The rural depressed skull fractures ranged from 109 to 362 mm^2 (mean = 232 mm^2), which was much smaller than modern stoning injuries, where the lesions ranged from 707 to 3317 mm^2 in area (Judd 1970). If interpersonal violence was indeed the cause of cranial injury, a greater force, or heavier or sharper weapon inflicted the injuries on many of the urban dwellers at Kerma. Injuries caused by the hands and feet are widespread in clinical reports of violence in less-industrialised societies, although individuals involved in spontaneous physical conflict often grab any object close at hand, such as, a traditionally carried stick or knife, stone, whip, baseball bat, kitchen utensils (e.g., broom, pestle, clay pot), occupational tools, or more creative items (e.g., umbrella, lamp, coconut, and cycle chains); the choice of weapon varied with the biological sex of the assailant and the intended victim (e.g., Babapulle et al. 1994; Burbank 1994; Geldermalsen and Stuyft 1993). At Kerma, any common object, such as, a staff, throwstick, rock, pottery vessel or axe was eligible for use as a weapon to inflict injury and therefore, may account for the more severe lesions, since those produced by the hands and feet would be less prominent (e.g., Bostrom 1997).[22]

A second factor influencing weapon choice at Kerma may have been the desire of the elite to emulate the actions of the ruler, and the severity of some of the urban skull injuries may, therefore, be connected to the urban social hierarchy. The pharaoh's act of "smiting the forehead" with a macehead, battleaxe or sword to subdue the enemy was a frequent theme throughout Egyptian art and textual sources, the most renowned being the Narmer palette dated to 3000 AD (see, Filer 1997 for an excellent review of textual accounts and artistic portrayals of events involving skull injuries in the Nile Valley). The urban elite, many of whom were Egyptians or Egyptianised Nubians (Bonnet 1990a; Bourriau 1991; Kendall 1997; Reisner 1923a; 1923b), may have imitated this practice on a less deadly scale, as a method of exerting power over their minions; this mimicry would also explain the high proportion of skull vault injuries over facial injuries as the preferred injury target. Additional support for this interpretation rests with the burial distribution—the male and female retainers interred in the "sacrificial corridors" of Kerma's royal tumuli bore a higher frequency of skull injuries than the individuals buried in the elite burial vaults or smaller subsidiary burials (χ^2= 9.29, p=0.002). The abundance of the extremity and minor skull injuries observed among the rural group, in contrast to the more severe skull injuries and paucity of extremity lesions experienced by the Kerma adults, therefore, may reflect a variation in weapon choice that was influenced by social position, if some of the injuries observed, particularly those to the skull, were indeed due to interpersonal violence.

6.5 Conclusions

Acute trauma was endemic among the rural North Dongola Reach Survey (NDRS) skeletal sample from the earlier Kerma periods (ca. 2500-1750 BC) and was endured by 80% of the residents, with extremity injuries being particularly widespread. Individuals who experienced long bone fractures represented 30.9% of the sample, and the lesions

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[22] See Chapter 5 for comments about the ubiquity of the staff in Egyptian art and the indigenous Nubian throwstick. All of these objects were ubiquitous throughout Egypt and Sudan.

were uniformly distributed between the sexes. Of the 484 complete long bones available for assessment, 5.8% were injured—the ulnar shaft most frequently (13.8%). The three traditional indicators of interpersonal violence emerged in this sample: cranial trauma, distal ulna shaft (parry) fractures, and multiple injury. Skull trauma, visible as a puncture or minor depression fracture on the parietal or frontal bone, affected 19.4% of the observable crania, while only 2.8% of the facial area was disfigured, which contradicted clinical enquiries. Of the ulnae observed 10.7% exhibited the parry fracture configuration. Multiple trauma was prevalent with the majority of injured individuals (62%) bearing more than one injury.

The rural NDRS and urban Kerma adults suffered from similar frequencies of injuries due to interpersonal violence, although the rural group bore more injuries due to all causes. Because the two samples derived from identical cultural and geographic environments, other factors were influential. Variation in traumatic lesions was due to a greater prevalence of minor forearm and lower leg injuries that are commonly a result of a fall or a loss of balance. The most parsimonious explanation attributes the excess amount of rural long bone trauma to different male activities between the rural and urban workplaces, particularly those involving animals and agriculture. Cultivation and herding activities account for some component of injury pattern discrepancy, but minor skull depression injuries combined with the overwhelming involvement of the extremities in multiple trauma for both sexes suggests that some of these small lesions were the result of customary physical confrontations where the hands and feet were used to resolve issues. While injuries to the hands and feet are markedly commonplace in modern industrialised and developing countries, and represent the consequences of countless possible actions, injuries suffered during physical altercations are a recurring phenomenon. Conversely, the injury pattern at Kerma produced more severe skull injuries and fewer extremity injuries, which likely represented a preference for hand-held objects as weapons among some of the urban dwellers, particularly the elite. Nonetheless, levels of interpersonal violence in the rural and urban Kerma communities were similar, which accords with modern clinical research; however, the individual that inflicted the injury avoided striking the facial area in contrast to the expected clinical patterns, which indicates culturally patterned behaviour between the two societies.

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Table 6.1: Descriptive identification of fracture types

Fracture *(force)*	**Description** (Adams and Hamblen 1992; Kellam and Jupiter 1992; Müller et al. 1990; Rockwood et al. 1996; Rogers 1992; Schultz 1990; Tehranzadeh 1989)
Skull and post-cranial fractures (See Figures 6.2 and 6.3)	
Linear *(indirect, skull only)*	A force with a large mass (e.g., solid wall) causes the contact area to bend inward and forces a corresponding outward bending of bone elsewhere in the skull that follows the path of least resistance.
Crush *(direct)*	A low velocity impact forces one bone surface against a point of resistance. The bone is crushed and the number of fractured segments cannot be identified (e.g., a femur or pelvis crushed under a steel beam or boulder); when the fragments can be counted, the fracture is comminuted.
Depression *(direct)*	External bone is driven internally by a low velocity blunt surface, to create a localised crushed depression at the point of contact, surrounded by an area of radiating or concentric lines that result from forced outbending. In contrast to the penetration lesion, the extent of the external bone damage is greater than the area of the lesion at the greatest depth of the injury. The lesion's sides gently slope towards its centre (e.g., the circular area left by a blow with a small rock).
Compression *(direct)*	Two opposing forces drive opposite surfaces of one bone (e.g., medial and lateral, left and right, or superior and inferior) toward each other and crush both sides.
Penetration *(direct)*	The external surface of the bone is driven internally by a high velocity and sharp object, to create a localised lesion marked by sharp edges perpendicular to the cortex. In the skull, punctures cause fragmentation of the inner bone table and eject bone fragments into the brain to create a larger area of damaged bone internally than externally, the opposite of the depression injury (e.g., an injury created by a knife or bullet).
Other post-cranial fractures (See Figure 6.3)	
Transverse *(direct)*	A force perpendicular to the longitudinal axis creates a single linear fracture line that bisects the vertical bone axis at an angle <45°.
Oblique *(indirect)*	Angulated and compressive forces create a line that bisects the vertical bone axis at an angle >45°.
Spiral *(indirect)*	Rotational and longitudinal forces encircle the bone to create a single fracture curve with a steep vertical step.
Impaction *(indirect)*	Telescopic: the bone is driven into itself at the point of the force of resistance, thus shortening its length.
Avulsion *(indirect)*	A portion of bone is pulled from its original position by a tensile force created by a ligament or tendon attachment, causing the bone, being weaker, to release.
Stress *(repetitive)*	Repetitive forces cause small subcortical breaks that may eventually become a complete fracture.
Incomplete	Only one cortex of the bone has been broken due to bending or buckling.

Table 6.2: Distribution of fractured skull segments for NDRS adults

Element	Males			Females			Total		
	n	N	%	n	N	%	n	N	%
L Frontal	1	17	5.9	0	15	0.0	1	32	3.1
R Frontal	2	17	11.8	0	13	0.0	2	30	6.7
L Parietal	1	18	5.6	2	20	10.0	3	38	7.9
R Parietal	1	19	5.3	0	16	0.0	1	35	2.9
L Temporal	0	18	0.0	0	17	0.0	0	35	0.0
R Temporal	0	15	0.0	0	16	0.0	0	31	0.0
Occipital	0	19	0.0	0	21	0.0	0	40	0.0
L Zygomatic	0	19	0.0	0	15	0.0	0	34	0.0
R Zygomatic	0	19	0.0	0	18	0.0	0	37	0.0
Nasal	0	8	0.0	0	6	0.0	0	14	0.0
L Maxilla	0	15	0.0	0	11	0.0	0	26	0.0
R Maxilla	0	16	0.0	0	14	0.0	0	30	0.0
L Mandible	1	21	4.8	0	17	0.0	1	38	2.6
R Mandible	0	19	0.0	0	17	0.0	0	36	0.0
Total Observed Segments (O)	6	240	2.5	2	216	0.9	8	456	1.8
Expected Segments (E)		392			378			770	
Preservation (O/E X 100%)		61.2			57.1			59.2	
Complete Skulls	6	19	31.6	2	17	11.8	8	35	22.9

n = number of fractured bones; N = number of bones observed;
% = n/N X 100%; L = Left, R = Right

Table 6.3: Long bone fracture statistics for NDRS adults

Descriptive Statistic	Males	Females	Total
Individuals observed (I)	28	27	55
Injured individuals (n')	11	6	17
Number of fractures (n)	20	8	28
Individual count (n'/I X 100%)	39.3	22.2	30.9
Individual mean trauma (n/I)	0.7	0.3	0.5
Mean multiple injury (n/n')	1.8	1.3	1.7

Table 6.4: Distribution of long bone fractures for NDRS adults

Element	Side	Males			Females			Total [1]		
		n	N	%	n	N	%	n	N	%
Clavicle	Left	0	20	0.0	0	13	0.0	2	66	3.0
	Right	1	19	5.3	1	14	7.1			
	Combined	1	39	2.6	1	27	3.7			
Humerus	Left	0	18	0.0	0	13	0.0	0	71	0.0
	Right	0	22	0.0	0	18	0.0			
	Combined	0	40	0.0	0	31	0.0			
Ulna	Left	3	18	16.7	1	12	8.3	9	65	13.8
	Right	4	20	20.0	1	15	6.7			
	Combined	7	38	18.4	2	27	7.4			
Radius	Left	2	19	10.5	0	12	0.0	5	64	7.8
	Right	2	19	10.5	1	14	7.1			
	Combined	4	38	10.5	1	26	3.8			
Femur	Left	0	21	0.0	0	14	0.0	0	77	0.0
	Right	0	26	0.0	0	16	0.0			
	Combined	0	47	0.0	0	30	0.0			
Tibia	Left	2	22	9.1	1	13	7.7	8	72	11.1
	Right	3	25	12.0	2	12	16.7			
	Combined	5	47	10.6	3	25	12.0			
Fibula	Left	2	23	8.7	0	9	0.0	4	69	5.8
	Right	1	25	4.0	1	12	8.3			
	Combined	3	48	6.3	1	21	4.8			
Total Combined		20	297	6.7	8	187	4.3	28	484	5.8

[1] One female's partial right fibula (distal articular and distal shaft segments) displayed an oblique fracture; n = number of fractures observed; N = number of bones observed; % = n/N X 100%

Table 6.5: Types of long bone fractures among NDRS adults

Fracture Type	Males		Females		Total	
	n	%	n	%	n	%
Avulsion	2	10.0	1	12.5	3	10.7
Depression	3	15.0	2	25.0	5	17.9
Oblique	7	35.0	3	37.5	10	35.7
Transverse	8	40.0	2	25.0	10	35.7
Total Fractures	20	100.0	8	100.0	28	100.0

n = number of fractures; % = n/Total Fractures X 100%

Table 6.6: Distribution of extremity fractures among bones and individuals from the NDRS sample

Bone Group	Males			Females			Total		
Hand	n	N	%	n	N	%	n	N	%
Carpals	2	310	0.7	1	268	0.4	3	578	0.5
Metacarpals	13	191	6.8	1	177	0.6	14	368	3.8
Proximal phalanges	9	189	4.8	8	189	4.2	17	378	4.5
Middle phalanges	6	156	3.9	1	142	0.7	7	298	2.4
Distal phalanges	5	181	2.8	3	167	1.8	8	348	2.3
Sesamoids	0	57	0.0	1	10	10.0	1	67	1.5
Total	35	1084	3.2	15	953	1.6	50	2037	2.5
Foot	n	N	%	n	N	%	n	N	%
Tarsals	0	316	0.0	0	216	0.0	0	532	0.0
Metatarsals	3	220	1.4	4	166	2.4	7	386	1.8
Proximal phalanges	11	219	5.0	4	172	2.3	15	391	3.8
Middle phalanges	6	158	3.8	4	99	4.0	10	257	3.9
Distal phalanges	6	186	3.2	2	120	1.7	8	306	2.6
Sesamoids	0	80	0.0	0	56	0.0	0	136	0.0
Total	26	1179	2.2	14	829	1.7	40	2008	2.0
Individual Count	n'	I	%[1]	n'	I	%	n'	I	%
Hand	16	28	57.1	9	27	33.3	25	55	45.5
Foot	16	28	57.1	10	27	37.3	26	55	47.3
Preservation[2]	Males			Females			Total		
Total bones observed (O)	2263			1782			4045		
Total bones expected (E)	2968			2862			5830		
Preservation (O/E X 100%)*	76.3			62.3			69.4		

n = number of fractured bones observed; N = number of bones observed; % = n/N X 100%; n' = number of injured individuals; I = number of individuals observed; %[1] = n'/I X 100%; [2]excludes sesamoids; *(χ^2 = 134.09, p = 0.000).

Table 6.7: Distribution of multiple trauma frequency among NDRS adults

Number of lesions	Males		Females		Total	
	n'	%	n'	%	n'	%
0	1	3.6	10	37.0	11	20.0
1	7	25.0	3	11.1	10	18.2
2	6	21.4	7	25.9	13	23.6
3	2	7.1	4	14.8	6	10.9
4	4	14.3	0	0.0	4	7.3
5	3	10.7	2	7.4	5	9.1
6	4	14.3	0	0.0	4	7.3
7+	1	3.6	1	3.7	2	3.6
Total Individuals (I)	**28**	**100.0**	**27**	**100.0**	**55**	**100.0**

n' = number of injured individuals; % = n'/I X 100%

Table 6.8: Comparison of fracture frequencies between NDRS and Kerma samples

	NDRS (rural)			Kerma (urban)			
Element	n	N	%	n	N	%	**P-value**
Cranium	7	36	19.4	20	181	11.2	0.163
Face	0	26	0.0	4	163	3.1	0.365
Mandible	1	36	2.8	2	122	1.6	0.660
Clavicle	2	66	3.0	5	258	1.9	0.586
Humerus	0	71	0.0	3	313	1.0	0.408
Ulna	9	65	13.8	23	276	8.3	0.170
Radius	5	64	7.8	7	288	2.4	0.039*
Femur	0	77	0.0	5	333	1.5	0.279
Tibia	8	72	11.1	3	337	0.9	0.000*
Fibula	4	69	5.8	2	224	0.9	0.012*
Hands[1]	49	1970	2.5	24	1866	1.3	0.007*
Feet[1]	40	1872	2.1	14	2430	0.6	0.000*
Rib sets	5	55	9.1	13	223	5.8	0.321

n = number of fractures observed; N = total number of bones observed;
% = n/N X 100%; [1]excludes sesamoids; * significant at $\alpha = 0.05$.

Table 6.9: Comparison between the NDRS and Kerma samples by sex for injuries traditionally associated with interpersonal violence

Element compared	NDRS (rural)			Kerma (urban)			P-value
	n'	I	%	n'	I	%	
Skull							
Males	6	19	31.6	15	76	14.5	0.266
Cranium	5	19	26.3	11	72	15.3	0.261
Face	0	11	0.0	3	66	4.6	0.471
Mandible	1	19	5.3	1	49	2.1	0.480
Females	2	17	11.8	11	111	9.0	0.814
Cranium	2	17	11.8	8	109	7.3	0.530
Face	0	15	0.0	2	97	2.1	0.575
Mandible	0	17	0.0	1	73	1.4	0.628
Forearm (direct trauma)							
Males	5	28	17.9	14	93	15.1	0.721
Females	1	27	3.7	3	130	2.3	0.675
Multiple trauma (combined skull and ulna)							
Males	3	28	10.7	4	93	4.3	0.203
Females	0	27	0.0	2	130	1.5	0.519
Multiple trauma (skull and long bones only)							
Males	7	28	25.0	7	93	7.5	0.011*
Female	1	27	3.7	6	130	4.6	0.835
All multiple trauma							
Males	20	28	71.4	22	93	23.7	0.000*
Females	14	27	51.9	18	130	13.8	0.000*

n' = number of injured individuals observed, I = total number of individuals observed
% = n'/I X 100.0%; *significant at $\alpha = .05$

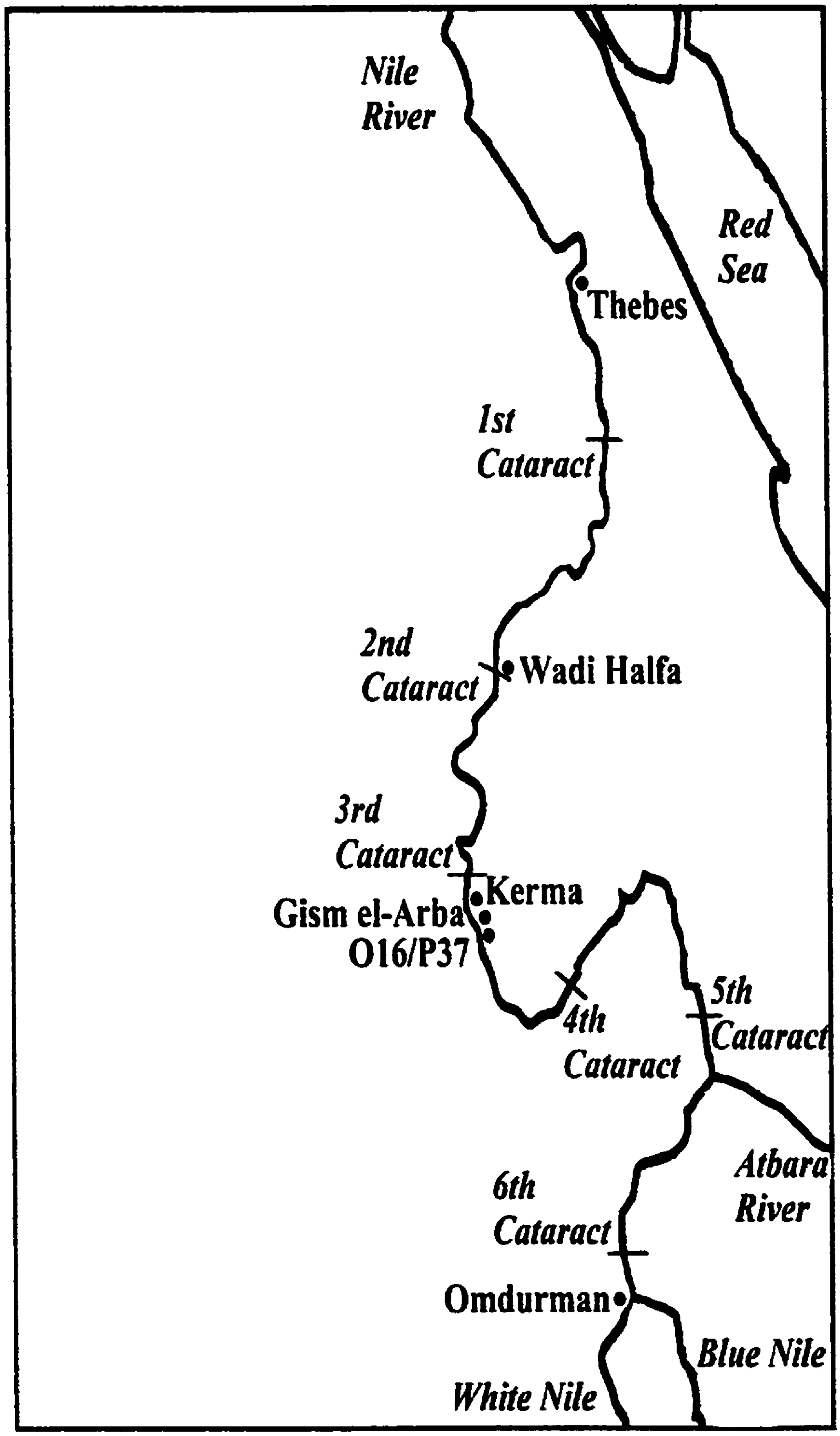


Figure 6.1: Location of NDRS sites (O16 and P37) and Kerma

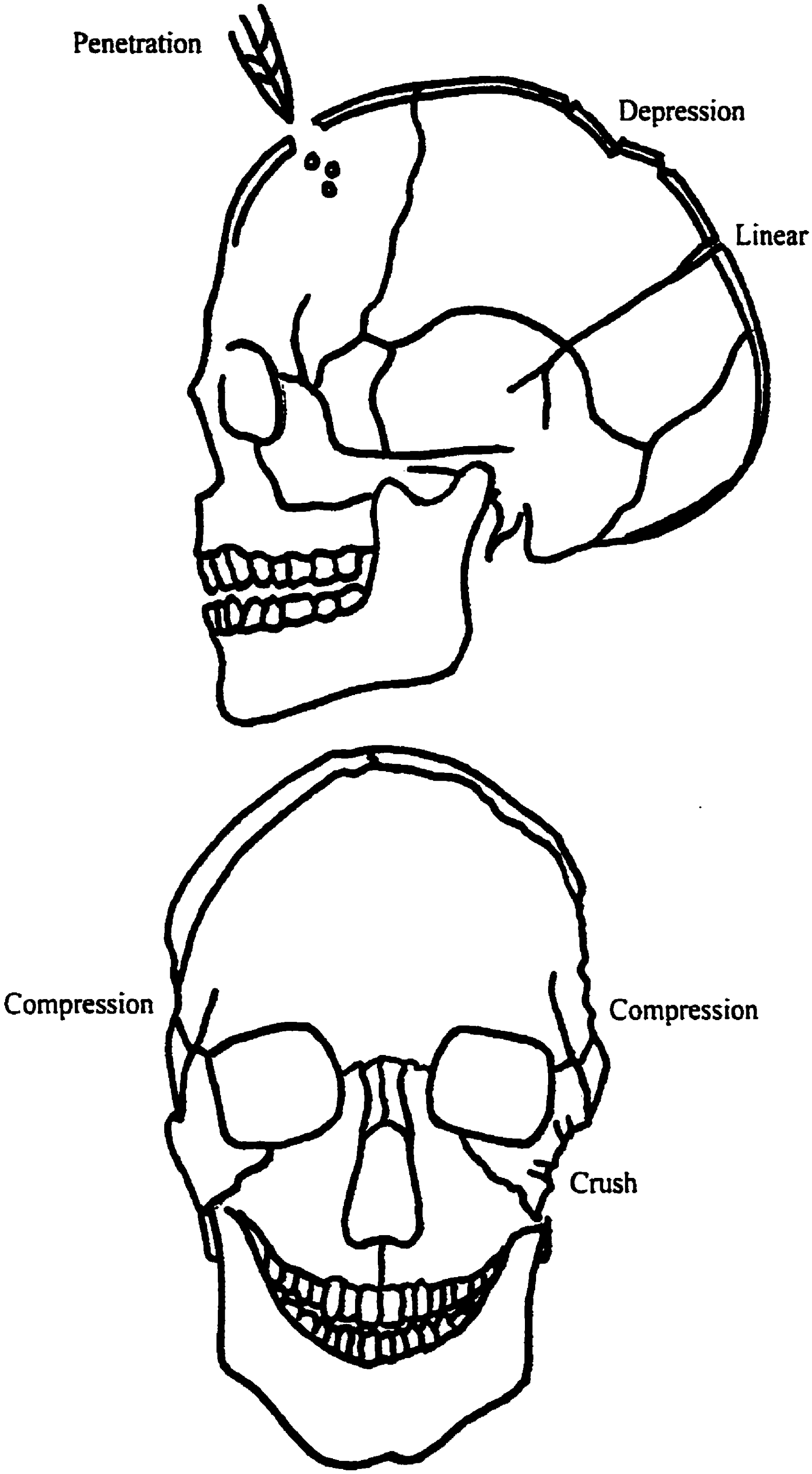


Figure 6.2: Skull trauma visual

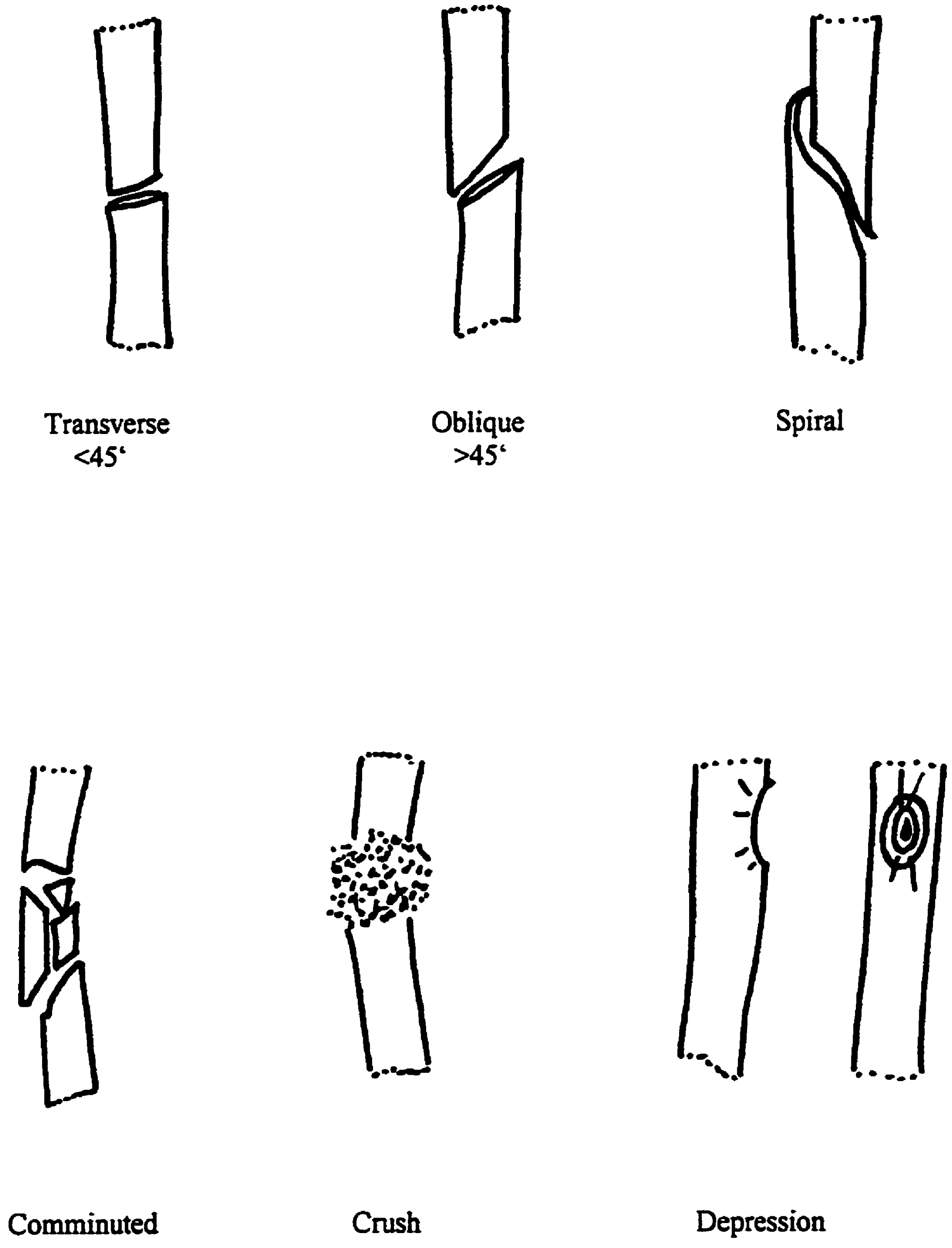
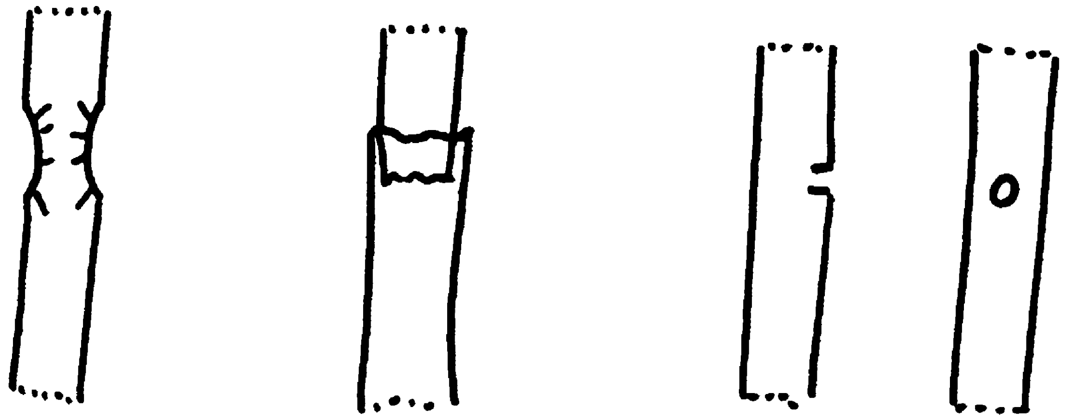
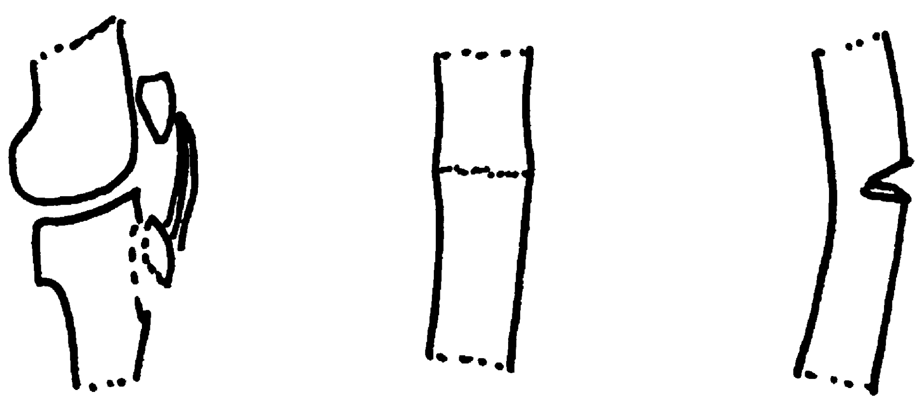


Figure 6.3: Long bone trauma visual (continued on next page)



Compression Impaction Penetration



Avulsion Stress Incomplete

Figure 6.3: Long bone trauma visual (continued)

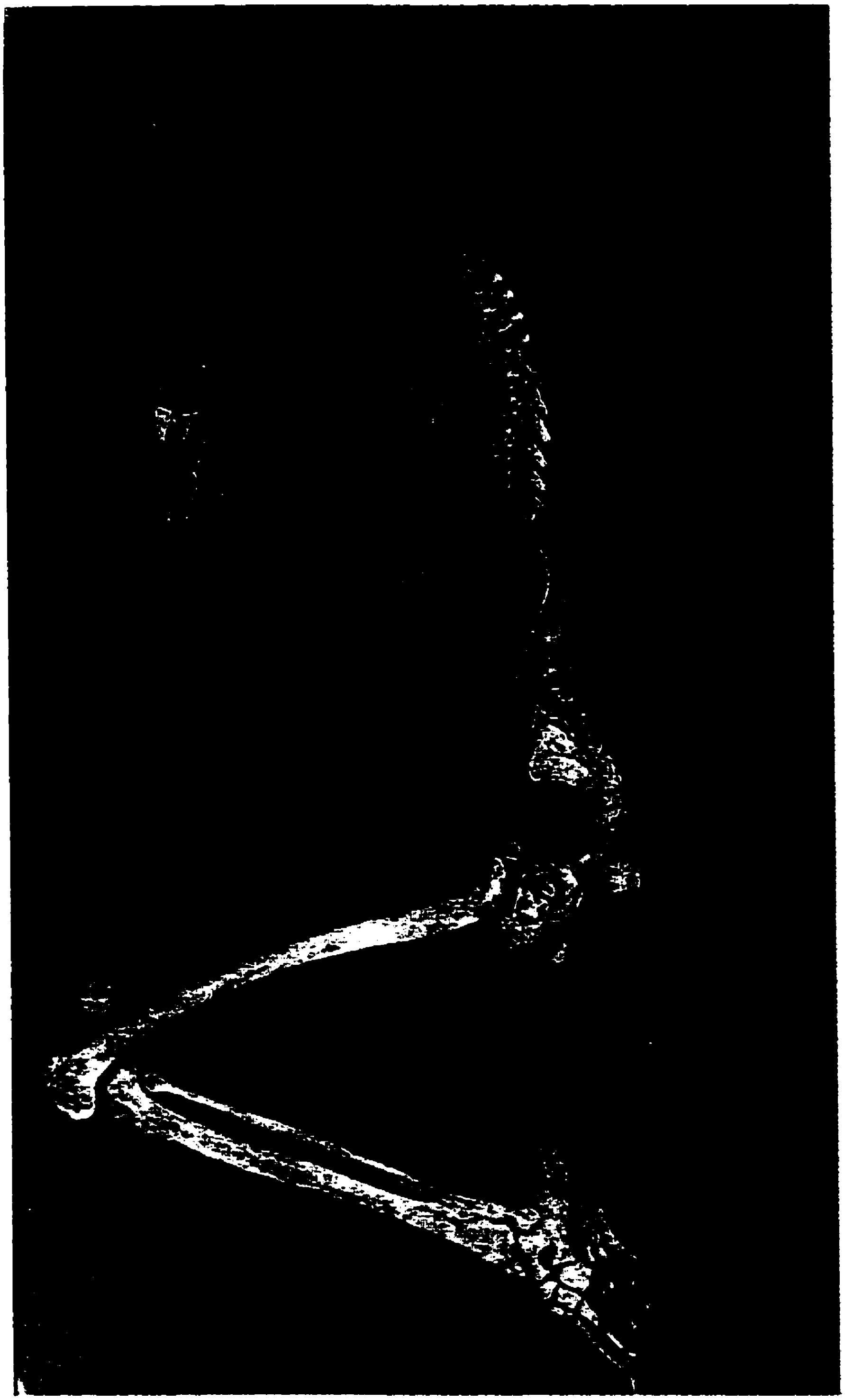


Plate 6.1: Kerma Ancien burial (P37-J3-44)

Plate 6.2: Right paired forearm rotational fracture with nonunion of the ulna

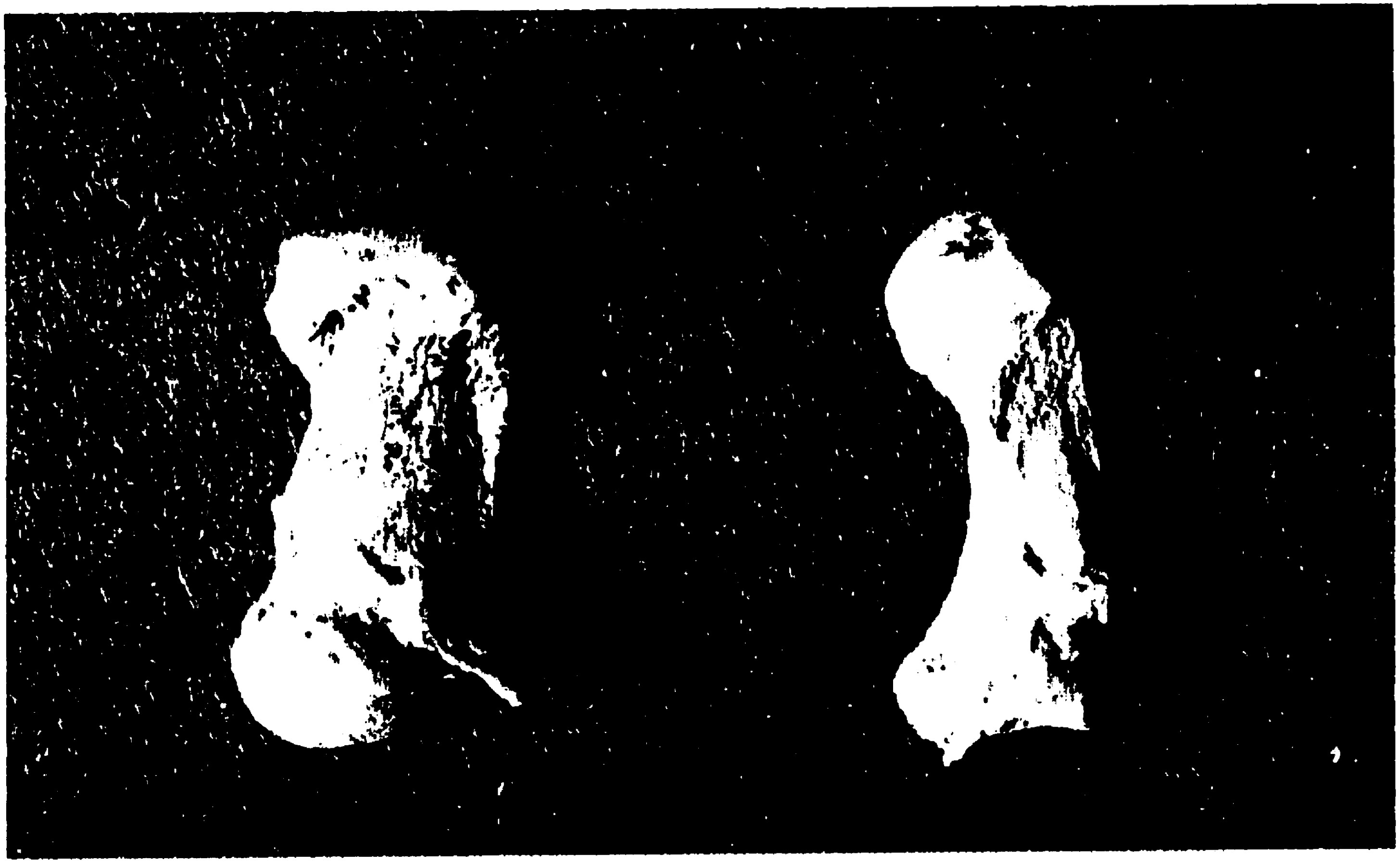


Plate 6.3: Oblique fractures of the first metacarpal shafts

Plate 6.4: Crushed left scapular body

Plate 6.5: Depression fracture of the left parietal (rural skull)

Plate 6.6: Severe depression fracture of the right parietal (urban skull)

CHAPTER 7

The parry problem

"The right ulna was fractured. Typical case. The right ulna was fractured at a somewhat higher level than usual" (Smith and Wood-Jones 1910, 313).

"The 'parry fracture,' as this trauma is known, is an index of strife in a group. The frequency of Colles' fracture is an index of clumsiness" (Armelagos et al. 1982, 40).

7.1 Introduction

Indiscriminately crediting archaeological skeletal fractures to interpersonal violence rouses the ire of bioarchaeologists. The most notorious culprit is the "parry" fracture of the ulna, loosely described as "an isolated fracture of the ulnar shaft—usually in the middle or distal third, produced by a blow and *not* involving the radius" (Jurmain 1999, 219, gleaned from a survey of clinical definitions).

The medical use of eponyms, such as the "parry" fracture, was common in the past, particularly in the 19th century, when fracture description was established by clinical presentation and palpation until the advent of the x-ray (Schultz 1990, 238). Fractures were frequently named to honour the physician that fully described them, for example, the Colles', Smith's or Galeazzi fractures, while other colourful fracture eponyms were derived from a specific aetiological mechanism, such as, the boxer's fracture, bumper fracture, clay shoveller's fracture, and baseball finger (e.g., Rogers 1992, 102; Schultz 1990). These activity-related eponyms pose the same problem as the "parry" fracture does in bioarchaeological interpretation—their very name promotes a specific injury mechanism. Lovell (1997) and Jurmain (1999, 215-8) argued that some researchers automatically classify the ulna shaft fracture as a "parry" or "nightstick" fracture, without considering the involvement of the ipsilateral radius, the location of the lesion, the fracture line, and associated complications, all necessary components required to interpret the aetiology of the forearm fracture. They cautioned that the term "parry" conjures an image of fending a blow, even though it may not have been the mechanism of injury, and may, therefore, influence the interpretation. The qualitative definition of the parry fracture, which was stated above, does not particularly illuminate the physical configuration of the parry lesion and it is understandable why a variety of ulna shaft fractures have been misinterpreted as a parry lesion by bioarchaeologists. The "blow" is the critical factor of the definition that distinguishes this lesion from all other forearm fractures and can be confirmed by the injured person in clinical settings, but cannot be identified with certainty in an archaeological specimen. The assignment of a lesion to a "possible" parry fracture, however, can certainly be improved upon by a more rigorous analysis of forearm fractures in palaeotrauma investigations.

Bioarchaeologists dutifully record (or should record) a specific suite of measurements to facilitate fracture description or evaluate healing (e.g., Grauer and Roberts 1996; Judd and Roberts 1998; 1999; Lovell 1997; Roberts 1988). These measurements have most recently been grouped under the acronym LARA—length of the bone, apposition, rotation, and angulation (Lovell 1997). Although standards for what constitutes a successfully healed lesion in palaeotrauma analysis have been published only recently (Grauer and Roberts 1996), palaeotrauma literature is mute on the role that these measurements play in defining fracture types. Clinical definitions that employ these measurements exist, but can be daunting as they involve hierarchies of subtypes that are neither practical nor economical for populational palaeotrauma analysis and interpretation, although they are indispensable in case studies or a detailed skeletal report. I propose that general definitions of forearm fractures derived from both quantitative and qualitative clinical descriptions be used in palaeotrauma analysis to explicitly distinguish the parry fracture from other forearm injuries.

It is essential that the presence or absence of the ipsilateral forearm bone be recorded for trauma data collection as the fracture's isolation affects the etiological interpretation.[1] This neglect to identify the presence of the adjacent bone is perhaps facilitated by the protocol favoured for the systematic analysis of long bone trauma, that in itself was a

[1] It might be useful to consider this recording method for lower leg lesions as well (tibia and fibula), although the fracture aetiology of these bones is not as controversial as that of the forearm.

major coup for trauma analysis when proposed by Lovejoy and Heiple (1981). This method of analysis, now standard, presents the trauma frequency for each element type (number of fractured elements per number of elements observed) and the overall fracture rate (total number of fractured bones per total number of bones observed). While the instances of individuals that incurred a forearm injury involving both the radius and ulna may be mentioned (e.g., Grauer and Roberts 1996; Judd and Roberts 1998; 1999; Jurmain 1991; Kilgore et al. 1997), the presence of the complementary bone is unreported if it is uninjured, which hinders the researcher's interpretation of the injury mechanism. This omission was recently tackled by Alvrus (1999) who, in her analysis of Nubian long bone fractures, reported the presence or absence of the associated radius, location on the shaft, and presence of rotation.

The purpose of this investigation was to further refine the forearm fracture pattern observed, and thus facilitate interpretation, in the simultaneous trauma analyses of two culturally related skeletal samples found to have high frequencies of trauma. This was achieved first, by distinguishing common forearm injury types by quantitative and qualitative criteria collected from clinical literature, and second, by determining the proximate injury mechanism—direct or indirect force—for each fracture observed. The usefulness of the recording measurements in fracture analysis was discussed.

7.2 Materials and methods

7.2.1 The skeletal sample and archaeological context

The data presented here derived from the general trauma analyses of two archaeological skeletal samples from the Kerma period (ca. 2500-1500 BC) of Nubia, Egypt's southern neighbour (Figure 7.1).[2] Both samples, although dissimilar in socioeconomic complexity, were found to have a high prevalence of trauma, particularly forearm fractures. In the rural sample (NDRS) from the Dongola vicinity,[3] 55 adults were examined (28 males and

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[2] See Chapters 5 and 6.

[3] The rural skeletal remains were excavated from two cemeteries by myself, local Sudanese workers from the surrounding villages, and fellow members of the Northern Dongola Reach Survey (NDRS) team from 1994-97 under the direction of Dr. Derek Welsby (1996; 1997) of the British Museum's Department of Egyptian Antiquities. The sites are situated near the modern Sudanese town of Dongola, about 70 km upriver from Kerma, which is 20 km south of the Nile's Third Cataract.

27 females) and of these, 10 (18.2%) adults were found to have one or more forearm injuries. The sample from Kerma[4] consisted of 223 adults (93 males and 130 females), 28 (12.6%) of whom had forearm injuries. The sample size for this analysis, therefore, consisted of 38 individuals who experienced forearm trauma from an original group of 278 people.

7.2.2 Data recorded

Forearm injuries were examined in the following groups:

1. both bones of one forearm involved,
2. isolated radial fractures,
3. isolated ulna fractures.

Data recorded for each element included: sex of individual, side injured, the presence or absence of the ipsilateral bone, the length of the injured bone, the length of the callus, the distance from the bone's distal articular surface to the lesion's centre, the maximum unalignment in any direction, the apposition of the two fractured ends once healed, and the angle of the fracture line from the horizontal plane. To account for variation in bone length among individuals, I developed an *adjusted distance to the centre of the lesion* ratio, which was calculated as follows:

$$\frac{\text{distance to the lesion centre from the distal articular surface of the bone}}{\text{length of bone}}$$

The average length of the ulna was calculated for each sex in order to estimate the adjusted distance to centre of the lesion for individuals whose ulnae were incomplete (female mean ulna length = 259 mm; male mean ulna length = 276 mm); likewise, the mean length of the female radius (233 mm) was used to estimate the adjusted distance to the lesion's centre for the female radial injuries.

[4] The cemetery at Kerma was first excavated by George Reisner (1923a; 1923b) in 1916 and the skeletal remains are presently curated in the Duckworth Laboratory at the University of Cambridge's Bioanthropology Department.

7.2.3 Types of diagnostic forearm shaft fractures

The quantitative data collected from each traumatised bone were used to classify each lesion by acute proximate mechanism (direct or indirect trauma) (see, Lovell 1997) and common eponyms, if existing.[5] Injuries that were not classified by the eponyms listed below were discussed independently.

7.2.3.1 Injuries caused by indirect force

The Colles' fracture (Figure 7.2) is identified by a transverse fracture line (≤ 45° from the horizontal plane)[6] that occurs within 38 mm (or 1.5 inches) proximal to the radiocarpal joint (Connelly 1981, 1010; Rogers 1992, 842-7). This is accompanied by the dorsal compaction of the distal segment, which may or may not involve the joint;[7] the healed fracture is often described as a "dinner fork" deformity. Radii whose adjusted distance to the lesion's centre was less than .2[8] were closely scrutinised for this fracture configuration. The Colles' injury is associated with a fall onto the outstretched palm of the hand where the distal radius is forced posteriorly and the anterior surface undergoes tension to culminate in a transverse fracture on the anterior side. The distal ulna, particularly the styloid process (Moore's fracture), may be fractured simultaneously (Adams and Hamblen 1992, 150-1; Loder and Mayhew 1988; Rogers 1992, 841-2; Schultz 1990, 248-9).

Smith's fracture (Figure 7.3) is similar to the Colles' injury and has been referred to as a "reverse Colles' " fracture (Osterman and Bora 1980; Rogers 1992, 847-8; Smith and Floyd 1988). The fracture appears not more than 38 mm (1.5 inches) above the radiocarpal joint, but the distal radius is angulated volarly rather than dorsally: the deformity resembles a "garden spade" (Connelly 1981, 1021). The fracture does not

[5] Although the use of eponyms is supposedly discouraged (Rogers 1992, 102; Schultz 1990, 238), they continue to be used in standard orthopaedic and radiological reference texts, but are accompanied by descriptions (Browner et al. 1992; Rogers 1992; Schultz 1990).
[6] Other clinicians (Browner et al. 1992; Müller et al. 1990) suggest 30° as the breakpoint between the transverse and oblique fracture lines.
[7] Colles originally emphasised the lack of radiocarpal joint involvement to dispel the belief that all wrist injuries were dislocations (Osterman and Bora 1980).
[8] This distance was determined from the average clinical distance of the lesion above the radiocarpal joint (38 mm) divided by 190 mm, which is the lowest value of the range of radial lengths published by Olivier (Olivier 1969, 232).

extend into the radiocarpal joint and an associated ulna injury is uncommon (Adams and Hamblen 1992, 159; Rogers 1992, 847). Although Smith attributed the injury to a fall on the back of the hand when the wrist was flexed ventrally, a backward fall onto the outstretched hand or blow to the back of the wrist or knuckles are equally possible (Heppenstall 1980; Rogers 1992, 847; Smith and Floyd 1988).

7.2.3.2 Injuries caused by direct force

The definition of a "parry" fracture (Plate 7.1) is dependent upon its mechanism, that is, an isolated fracture of the ulna's distal shaft is the result of a direct blow to the forearm sustained when the arm is raised to protect the head, and except for this aetiology, isolated ulna fractures are rare (Rogers 1992, 816, 28; Schultz 1990, 265, and many others). In this position, the ulna receives the full force of the blow as it is superficial to the radius; the radius may also break if the force is excessive, although this is uncommon clinically (DuToit and Gräbe 1979; Heppenstall 1980).[9] Richards and Corley (1996, 912) described the parry fracture in quantitative terms as follows: the majority of parry fractures usually occur on the distal third, the distal segment is minimally displaced ($\leq 10°$ in any plane) if at all or is less than 50% apposed horizontally in relation to the proximal segment, and the line of fracture is transverse to slightly oblique. An ulna fracture that fulfils these criteria, but is not the result of a direct blow, therefore, is not really a parry fracture and is verbosely referred to as "an isolated fracture of the ulna shaft without radial involvement" (Richards and Corley 1996, 911). In this analysis, the "possible" parry[10] fracture was identified by the absence of radial involvement, a fracture line $\leq 45°$,[11] a location below the midshaft (< .5 adjusted distance to the lesion's centre, although in clinical practice the lesion is more common below the distal third, i.e., .3 adjusted

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[9] In their study of direct blow injuries to the forearm, Dutoit and Gräbe (1979) found that the ipsilateral bone was involved in 8% of the cases; they also employed three degrees of fracture severity in his classification.

[10] A parry fracture observed in the archaeological context can only be a "possible" parry injury, as the ultimate mechanism, on which the definition of the parry fracture rests, will never be known. For brevity, the term parry fracture is used in this paper, but the ambiguity of the term is understood.

[11] Because some researchers (e.g., Browner et al. 1992; Müller et al. 1990) consider transverse fracture lines to be <30°, 45° is the upper limit of the transverse fracture allowance that already borders on being "slightly oblique."

distance to the lesion's centre), and either minor unalignment (≤ 10°) in any plane or horizontal apposition from the diaphysis (< 50%).

7.2.3.3 Injuries caused by a direct or indirect force

The Monteggia fracture (Figure 7.4) involves a fractured ulna with an associated radial head or distal humeral epiphyseal involvement and nearly always occurs on the proximal third of the ulna (i.e., > .7 adjusted distance to the centre of the lesion) (Rogers 1992, 817; Wilson and Cochrane 1925). While the original injury was described as a proximal ulna fracture with an anterior displacement of the proximal radial segment, the classification was broadened by Bado (1967) to include all directions of radial head displacement, as well as a fractured radial head. When the fracture line occurs on the proximal third of the shaft it does not divide the supinator and pronator muscles and, therefore, little rotational deviation is noticeable in this injury. The injury is due to a fall or direct blow to the posterior forearm that is incurred when the forearm is raised very high in front of the face to deflect a blow (Adams and Hamblen 1992, 144-5; DeSouza 1968; Heppenstall 1980; Rogers 1992, 817-22).

Single radius injuries (Galeazzi fracture) (Plate 7.2) are unstable and result in some dislocation of the distal radioulnar joint (Rogers 1992, 811-4, 822-5; Schultz 1990, 254). These injuries are most commonly proximal to the junction of the middle and distal thirds of the bone (i.e., >.3 adjusted distance to the lesion's centre) and the fracture line is oblique (>45°). They involve a noticeable rotational deformity and nonunion or malunion between the fragments, particularly among adults, unless treated with open surgery. The rotational deformity is caused by the location of the fracture below the *pronator teres* insertion on the midshaft, whose action forces the proximal radial fragment into pronation across the ulna or by the supination of the proximal radius when the fracture occurs above the *pronator teres* insertion (Figure 7.5) (Ralston 1967, 170).

Like the Galeazzi fracture, fractures involving the paired radius and ulna (Plate 7.3) are easily identified by the gross deformity caused by rotation of the bone shafts (for brevity, this lesion will be referred to as a *paired rotational fracture*). The Galeazzi and paired rotational fractures are the results of an indirect force, such as a fall on the outstretched hand, where the force of the impaction is transmitted up the bone shaft to produce an oblique fracture line (>45°). A direct blow, identified by a transverse line (≤ 45°) may fracture the radius or cause both bones to break simultaneously, but is rare in clinical cases due to the position of the radius in relation to the superficial ulna when the arm is raised to defend the head (Adams and Hamblen 1992, 145-6, 149-50; DuToit and Gräbe 1979; Heppenstall 1980; Rogers 1992, 811-4, 822; Schultz 1990, 256).

7.2.4 Analysis

Chi-square analysis and the Yate's correction for small samples (n < 5) were used to assess the nominal variables. The statistical significance was set at 0.05 for all tests and the number of degrees of freedom (df) was "1" unless otherwise stated.

7.3 Results

7.3.1 Both forearm bones fractured

Table 7.1 presents all forearm injuries that involved both bones of one forearm, that is, the ulna and radius. Of the 38 individuals with forearm trauma, four (10.5%) exhibited injury to both bones of the same forearm. One male's combined forearm rotational injury (P37-J3-44) was the classic result of a forearm injury sustained while bracing oneself during a forward fall with the forearm pronated—gross rotation was present, the radial fracture was at a higher level than the ulna fracture, and the healing was complementary on each bone. This individual also had an ununited left radial injury received during pronation as well as a Smith's fracture. As the Smith's fracture cannot occur concurrently with the rotational injury, it was sustained at some point in time prior to or following the rotational injury, although both may have occurred in sequence during a single traumatic event. When considered with the similarly injured and ununited fracture of both forearms, it is most likely that the individual attempted to prevent a fall by extending both arms forward. The location of the left radial injury was 23 mm lower than that of the right radial injury and when combined with the lack of the ulnar involvement disclosed that the right forearm absorbed the brunt of the fall.

The configuration of a second male's (Individual 131) associated forearm fractures (transverse ulna shaft fracture and crushed distal radius) suggested that a direct crushing force caused the injuries rather than an indirect force. The forearm fractures suffered by a Kerma female (193) were uncharacteristic of a fall on an outstretched hand owing to a large disparity in the distances between the lesions on the two bones, but may indicate a temporal lag between injury episodes. The radial fracture line was transverse, but slightly rotated—a configuration more likely acquired from absorbing a direct force. The final adult (P37-G3-23) with combined forearm lesions presented a minor Colles' injury and a medioposteriorly angled oblique ulna fracture, a typical outcome of a fall on an outstretched hand.

7.3.2 Isolated radius fractures

Seven individuals suffered isolated radial fractures,[12] which were complemented by an uninjured ipsilateral ulna and were characteristic of an indirect injury mechanism (Table 7.1). Among the males, Individual 57 exhibited a depressed radial head—a common injury received during a fall onto an outstretched hand (Rogers 1992, 790-2). In this instance, the indirect force, which was transmitted through the shaft to the point of resistance, depressed a small area of the radial head below the articular surface.

The Colles' fractures displayed by the females conformed to the classic Colles' fracture pattern. All injuries occurred at the same location, well below the 38 mm breakpoint originally suggested by Colles, and were situated on the distal tenth of the bone when the adjusted distance to the lesion's centre was considered. In the three cases of isolated Colles' fractures (Individuals 60, 92, 203) the radius was the individual's only injured bone in two instances; Individual 203 suffered soft tissue trauma to the fibular malleolus, a lesion attributed to ankle adduction that may have precipitated a fall (Adams and Hamblen 1992, 252; London 1991; Rogers 1992, 1355; Schultz 1990). The fourth Colles' lesion (Individual P37-G3-23) was associated with an ipsilateral ulna injury and discussed above.

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[12] Two injuries occurred on the left radius of Individual P37-J3-44.

Three rotational injuries were observed on isolated radii; the two injuries of individual P37-J3-44's left radius were described above. Three male single radial injuries (Individuals 98, P37-J3-36, and P37-K3-48) were typical of those obtained from a fall on an outstretched hand and clearly displayed some degree of shaft rotation.

7.3.3 Isolated ulna fractures

Twenty-eight single ulna injuries occurred among eight females and 19 males (Table 7.2), and of these 28 fractures, 21 were identified as parry fractures according to the metrical and visual criteria (Plate 7.4). An additional three fractures fulfilled all of the quantitative criteria for a parry type lesion, except that the ipsilateral radius was absent, which weakens the argument for a direct force injury, and the proximate injury mechanism was, therefore, classified as uncertain.

Two females displayed ulnar head trauma, which may be the result of a direct blow or sudden twisting action often accompanying an indirect force, that is, a fall on an outstretched hand; in the latter case the radius is most often involved and the ulna styloid avulsed in the process (Mayfield et al. 1992; Rogers 1992, 855). Only one ipsilateral radius was accounted for (Individual 39) and no visible fracture was observed; thus this ulna injury was likely due to a direct force. The minor injury experienced by Individual 192 involved a healed styloid avulsion and as the radius was unavailable, the aetiology of this injury remains unknown, but was most likely due to a sudden twist or fall (Rogers 1992, 855). A third female ulna injury (Individual 31), not classified as a parry fracture, was an unaligned oblique injury that was angled medioposteriorly. A similar fracture configuration was observed on one male ulna (Individual 104)—the shaft was completely unapposed medioposteriorly and formed a distinctive "S-shape" (Plate 7.5). Neither individual sustained any other injuries and the ipsilateral radius was present in both cases; both were likely due to a backward fall, since the oblique fracture line indicates an indirect as opposed to direct mechanism of injury.

7.4 Discussion

The Colles', Smith's, and rotational injuries fall into easily distinguishable categories that present little aetiological ambiguity concerning the proximate mechanism, but single shaft fractures of the ulna are more difficult to categorise perhaps because the descriptive criteria have been meagre in palaeotrauma analysis, and quantitative criteria nonexistent. The parry fracture is the most poorly defined and controversial injury owing to its implications for social behaviour in ancient societies—interpersonal violence, particularly "wife-beating" (e.g., Jurmain 1999, 215-7; Lovell 1997; Rogers 1992, 816). The cavalier assignment of any ulna shaft fracture to a parrying aetiology may perpetually cast an ancient culture as a violent and abusive society, as was the case of the ancient Nubians (Smith and Wood-Jones 1910, 297; Wells 1964, 53), where the high frequency of the parry fracture was the result of expressing fractures as frequencies within the modal distribution, rather than as a frequency of all ulnae or individuals observed.[13] Lovejoy and Heiple (1981) corrected this reporting method of fracture frequency, but injury classification remains suspect as the criteria for the parry lesion are often reduced to one variable—a distal or midshaft ulna fracture. This minimalist approach neglects the linear displacement of the distal fragment, the angle of the fracture line, and the involvement of the ipsilateral radius, all highly indicative of an injury caused by indirect force and easily observed during the analysis. A scheme consisting of qualitative and quantitative criteria was proposed here to facilitate fracture classification in order to determine the proximate cause of forearm fractures among individuals from two Nubian samples of the Kerma period, and subsequently, enhance the injury pattern interpretation at the individual and populational levels.

7.4.1 The effect of the parry criteria

The configuration (i.e., measurements of alignment, location, and lack of radial involvement) of 21 of 32 ulna shaft fractures met all proposed criteria for a parry fracture, except for the actual ultimate mechanism, the "blow," which is known only in clinical cases. Only two out of 10 females exhibited ulna lesions that were confirmed to be unaffected by the radius and, therefore, were attributed to a direct blow causing a parry

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[13] See Chapter 5 for a revised fracture prevalence rate for the Archaeological Survey of Nubia collection.

fracture. One female exhibited injuries to the two bones of one forearm that were likely unrelated and the ulna injury, therefore, met the parry criteria. When extrapolated to include the entire sample, three out of 157 females (1.9%) may have been involved as a victim, attacker, or opponent in a violent encounter. Had the parry lesion been identified by location alone on the distal ulna, 10 out of 157 females (6.4%) would have exhibited the lesion, which was significantly greater ($\chi^2 = 0.16$, $p = 0.047$). Likewise, when the parry fractures are rigorously identified, the fracture frequency of parry fractures among all ulnae observed (n = 194) was significantly lower when compared to the overall ulna fracture frequency ($\chi^2 = 0.13$, $p = 0.048$). However, a more liberal estimate of interpersonal violence would include all direct force injuries where the radial involvement was unknown, but other parry criteria met. In this sample, four additional females were likely involved in a violent encounter with another human or an object, but were missing the ipsilateral radius. Also, a direct force that crushed the highly cancellous ulna head and did not affect the radius was responsible for at least one other ulna fracture among females. Therefore, the involvement of females in interpersonal violence among this sample from the Kerma period may have been as high as 5.1% (8 out of 157), but the absence of the telltale ipsilateral radius weakens the argument.

When the males were observed, the involvement of the quantitative data did not significantly alter the frequency of ulna injuries attributed to direct force among elements or individuals had the parry criteria not been applied. Nineteen males out of a sample of 121 (15.7%) bore 20 ulna fractures resulting from a direct force, possibly during a confrontation, while ulna injuries to the two remaining males were more characteristic of an indirect force. The interpretation of fractures due to direct force remained unchanged for the Kerma period samples—the males experienced a significantly higher frequency of ulna injury (19 out of 121) due to a direct force than the females (3 out of 157) ($\chi_c^2 = 1.41$, $p = 0.000$) and no significant difference was observed between urban and rural sex cohorts when the sexes were compared between the sites.

When quantified details were added to the analysis of ulna shaft fractures from other collections, significant differences were observed. Alvrus (1996; 1999) supplied some additional qualitative information for all distal and midshaft ulna fractures (presence or absence of radial involvement, presence of rotation, and the numbers of ulnae injured per person) in her investigation of 480 adults from Semna South in Upper Nubia. When these criteria were added, only nine ulnae displayed a parry configuration with radial uninvolvement, which is associated with parry lesions, rather than the 21 ulna fractures reported. This proved to be significant when I compared the frequencies of the fractured ulnae among the total number of ulnae observed (9/493 vs. 21/493; $\chi^2 = 4.95$, $p = 0.026$) and the frequencies of individuals with parry fractures (9/480 vs. 21/480, $\chi^2 = 4.95$, $p = 0.026$). Kilgore et al. (1997) reported the location of the injury and presence of radial fractures in their evaluation of trauma among people from medieval Kulubnarti in Upper Nubia. This additional information revealed that 22 out of 34 ulnae exhibited distal or midshaft injuries with no associated forearm fractures. Although this difference only approached significance when the frequencies of possible parry fractures among the 276 ulnae observed were compared to all ulna fractures observed among 276 ulna ($\chi^2 = 1.29$, $p = 0.091$), the addition of quantitative data, radial presence, and the number of fractured ulnae sustained by the individual for all Kulubnarti forearm injuries may further refine the proximate mechanisms for this sample.

Although the frequencies of injuries attributed to direct force and possibly interpersonal violence declined for the three Nubian samples (Kerma/NDRS, Kulubnarti, and Semna South) when additional fracture data were provided, the intersample interpretation remained unaffected; that is the Kulubnarti people still experienced the greatest number of ulnae injuries attributed to direct force and the Semna South people suffered the least. However, some of the criteria used to define the parry fracture are absent from the Kulubnarti and Semna South samples, such as, the fracture line, angulation, presence of rotation, and the presence or absence of the ipsilateral bone for all fractured forearms, which may alter the fracture frequencies of proximate forearm fracture mechanisms, and thus, the interpretation of interpersonal violence and accidental injury among these three societies.

7.4.2 Differential diagnosis of the parry fracture

An explicit definition that applies quantitative and qualitative guidelines may indeed provide a useful tool to aid in distinguishing possible parry lesions from lesions sustained from an indirect injury mechanism; however, a second problem persists—differential diagnosis. The parry fracture may easily be confused with the ulna stress fracture (e.g., Kitchin 1948), an uncommon injury in clinical practice, which likely also occurred in antiquity. This ulna fracture does not involve the radius and is most often the result of a force bearing down at 90° to the ulna midshaft while the forearm is supinated and flexed at a 90 ° angle from the elbow to facilitate lifting heavy loads. This type of exertion is observed in farming activities, for example, hay and manure shovelling (e.g., Evans 1955; Kitchin 1948; Troell et al. 1941); sports, such as gymnastics, weight-lifting, golfing, tennis, fencing, and bowling (e.g., Hamilton 1984; Koskinen et al. 1997); or other miscellaneous stressful actions (Morris and Blickenstaff 1967, 178-179). The incomplete stress fracture is indistinguishable from the healed parry fracture when the aetiology of the injury is unknown even in clinical practice since the perfect alignment, smooth layers of periosteal bone that form a "spindle-shaped" or fusiform swelling around the shaft in advanced stages of continued stress, and location at the midshaft are common characteristics of an extremely limited clinical sample (Morris and Blickenstaff 1967, 178-9; Rogers 1992, 826). Once broken, the sclerosed fractured ends form a pseudoarthrosis that permits the forearm to move freely with little pain (Evans 1955). Early treatment of the palpable stress fracture consists of a simple cast only, a method similar to the splint treatment common among the ancient Egyptians and Nubians (Smith 1908; 1910, 293-4). Closer examination of the parry fractures revealed that six of the ulnae belonging to urban Kerma individuals (Individuals 5, 20, 145,156, 187, and 193) exhibited no unalignment (0°) and were in 100% apposition, although only two fractures (Individuals 5 and 156) were located above the distal third of the shaft. It is noteworthy that spondylolysis of the fifth lumbar vertebra, also associated with heavy lifting (Kennedy 1989; Merbs 1989; Morris and Blickenstaff 1967, 184-5), occurred in three of the six cases (Individuals 5, 20, and 193). Spondylolysis of the fifth lumbar was noted on the skeletal remains of one rural male (P37-K4-28), who displayed a parry lesion on each ulna, although the injuries were located on the distal third of the shaft and slightly angulated (10°). The correlation between forearm midshaft fractures that may be due to activity stress and spondylolysis of the fifth lumbar warrants further investigation and illustrates the need for all injuries, even the minor ones, to be considered in the fracture pattern of the individual to evaluate trauma aetiology. While stress fractures have been proposed as an alternative to the parry fracture in bioarchaeological analysis (Alvrus 1999; Lovell 1997), the extreme paucity of their presence in clinical practice, notably in occupations that involve lifting and among agricultural workers, should be analogous for archaeological skeletal samples, since clinical research is fundamental to our interpretation of palaeotrauma, although some of the disparity may be due to underreporting.[14]

7.5 Conclusions

Standard measurements have previously been utilised to assess healing success of fractures and knowledge of medicine within a society, but can also aid palaeopathologists in identifying fracture types, specifically the controversial parry fracture. Allocation of forearm fractures to types and mechanisms has previously been based on broad qualitative observations, even though a range of measurements is normally collected during palaeotrauma analysis. Quantitative guidelines that define the lesion's configuration allow for greater ease to objectively compare common forearm injuries rather than rely solely on subjective visual descriptions. The addition of this information does not endorse an uncontested interpretation of forearm trauma and may not even affect the results significantly, but if the proximate mechanism of the forearm fracture can be determined more reliably, the involvement of other injuries experienced by the individual may enhance our interpretation of ancient behaviour and lifestyles.

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[14] Lovell (personal communication, July 2000) suggested that illegal migrant workers and manual labourers in more isolated locations are unlikely to report these injuries.

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Table 7.1: Paired forearm and radial fractures

Provenience	Sex	S	BL	LL	DC	AJ	AL	AP	FL	FX	S	BL	LL	DC	AJ	AL	AP	FL	FX	Proximate Mechanism
Ulna/Radius																				
131	M	L	291	46.0	44.0	0.2	13°	100.0	10°	T	L	272	62.3	31.2	0.1	0°	100.0	10°	U	Direct
P37-J3-44	M	R	250	54.0	98.0	0.4	20°	0.0	56°	R	R	234	45.0	92.0	0.4	20°	0.0	60°	R	Indirect
193	F	R	258	20.0	16.5	0.1	0°	100.0	10	T	R	239	35.0	60.7	0.3	10°	100.0	15°	R	Direct
P37-G3-23	F	R	244	34.0	62.0	0.3	10°	100.0	30°	T	R	223	4.0	8.0	0.1	15°	100.0	5°	C	Indirect
Radius Only																				
57	M										L*		25.0		1.0	0.0	0.0	0.0	HD	Indirect
98	M										R*	270	35.0	130.0	0.5	67°	64.0	60°	R	Indirect
P37-J3-36	M										L*	255	34.5	102.0	0.4	15°	75.8	35°	R	Indirect
P37-J3-44	M										L*	234	34.0	75.0	0.3	20°	0.0	35°	R	Indirect
											L*	234	29.0	13.0	0.1	0.0	100.0	65°	SM	Indirect
P37-K3-48	M										R*	264	36.6	57.5	0.2	14°	100.0	10°	R	Indirect
92	F										L*		26.0	10.0	0.1	24°	100.0	19°	C	Indirect
60	F										L*		5.0	14.5	0.1	5°	100.0	<5°	C	Indirect
203	F										R*	238	33.1	16.5	0.1	12°	100.0	<5°	C	Indirect

M = Male, F = Female; S = Side, L = Left, R = Right, BL = Bone length (mm), LL = Lesion length (mm), DC = Distance to centre of lesion (mm), AJ = Adjusted distance to centre of lesion, AL = Maximum unalignment, AP = Apposition, FL = Fracture line; FX = Fracture type, T = Transverse fracture, U = Crush fracture, R = Rotational fracture, C = Colles' fracture, HD = Radial head fracture, SM = Smith's fracture; * ipsilateral bone present.

Table 7.2: Single ulna fractures

Individual	Sex	S	BL	LL	DC	AJ	AL	AP	FL	Type	Proximate Mechanism
3	M	L*	266	50.4	130.0	0.5	5°	100.0	10°	Parry	Direct
5	M	L*	265	24.0	85.1	0.3	0°	100.0	20°	Parry	Direct
52	M	L*	265	30.5	93.4	0.4	5°	100.0	5°	Parry	Direct
156	M	L*	280	36.0	133.0	0.5	0°	100.0	30°	Parry	Direct
187	M	L*	293	53.7	45.0	0.2	0°	100.0		Parry	Direct
20	M	L*	244	28.7	59.3	0.2	0°	100.0	10°	Parry	Direct
51	M	L*	273	28.0	23.0	0.1	10°	55.5	28°	Parry	Direct
141	M	L*	285	45.2	89.6	0.3	5°	100.0	45°	Parry	Direct
164	M	L*	284	32.5	55.0	0.2	10°	100.0		Parry	Direct
88	M	R*	268	35.0	95.0	0.4	5°	100.0	10°	Parry	Direct
145	M	R*	273	37.1	18.0	0.1	0°	100.0	10°	Parry	Direct
166	M	R*	296	30.0	46.0	0.2	5°	100.0	22°	Parry	Direct
220	M	R*	277	43.6	76.2	0.3	10°	100.0	17°	Parry	Direct
P37-J3-48	M	L*	283	51.5	60.0	0.2	10°	77.0	20°	Parry	Direct
P37-J3-46	M	L*		39.0	40.0	0.2	15°	78.3	15°	Parry	Direct
P37-K4-28	M	L*	263	39.9	48.1	0.2	10°	100.0		Parry	Direct
P37-K4-28		R*	261	36.8	57.6	0.2	10°	100.0	7°	Parry	Direct
P37-K3-31	M	R*		50.8	35.0	0.1	10°	90.0	17°	Parry	Direct
P37-G4-36	M	R*	283	61.6	60.0	0.2	14°	95.0	5°	Parry	Direct
101	F	L		30.0	30.0	0.1	15°	70.0	5°	Parry	Uncertain
140	F	L	271	22.0	25.0	0.1	5°	100.0	17°	Parry	Uncertain
219	F	L	244	20.0	18.0	0.1	10°	100.0	45°	Parry	Uncertain
28	F	L*	263	27.2	96.0	0.4	5°	100.0	15°	Parry	Direct
P37-F3-22	F	L*	257	27.3	36.2	0.1	5°	100.0	19°	Parry	Direct
104	M	R*	305	18.0	46.0	0.2	19°	100.0	60°	Oblique	Indirect
31	F	L*		45.8	30.0	0.1	14°	72.0	60°	Oblique	Indirect
39	F	L*		24.0	7.0	0.1	Head			Crush	Direct
192	F	R		6.0	4.0	0.1	Head			Crush	Uncertain

M = Male, F = Female; S = Side, L = Left, R = Right; BL = Bone length (mm), LL = Lesion length (mm), DC = Distance to centre of lesion (mm), AJ = Adjusted distance to centre of lesion, AL = Maximum unalignment, AP = Apposition, FL = Fracture line, Type = Fracture type;* ipsilateral bone present.

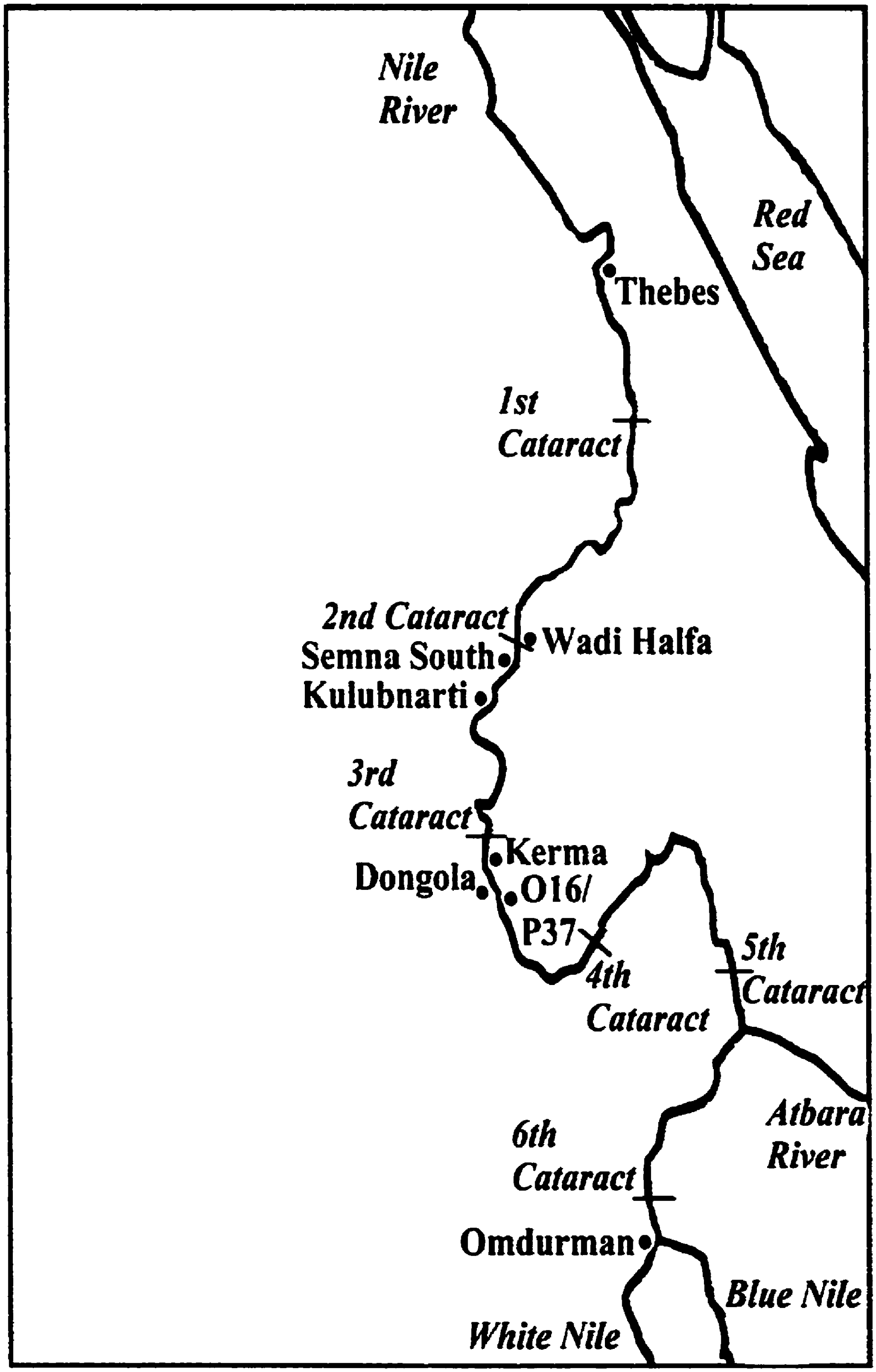

Figure 7.1: Location of NDRS sites (O16 and P37) and Kerma

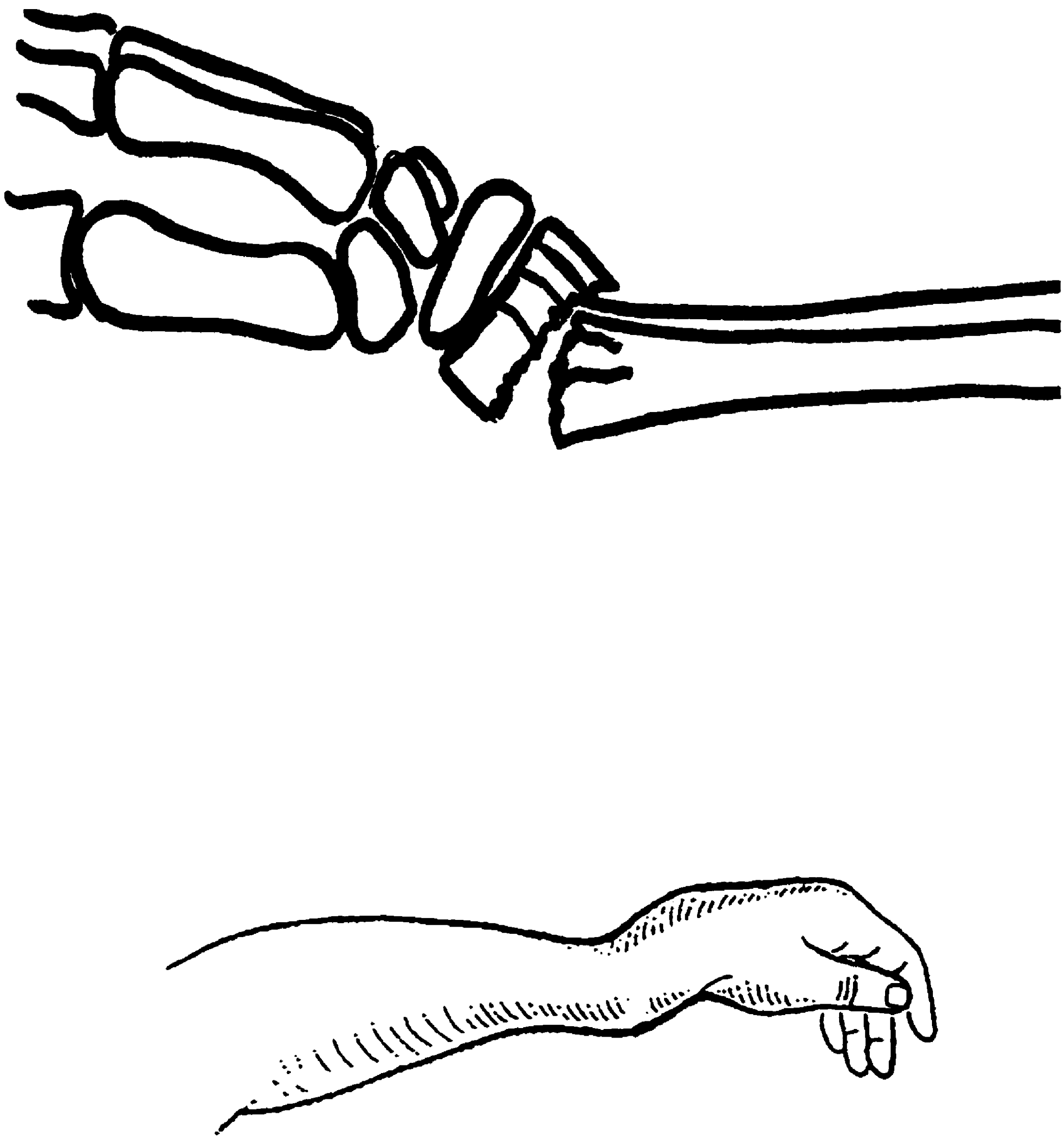

Figure 7.2: Colles' fracture and "dinner fork" deformity
(modified from Connolly 1981, 1010)

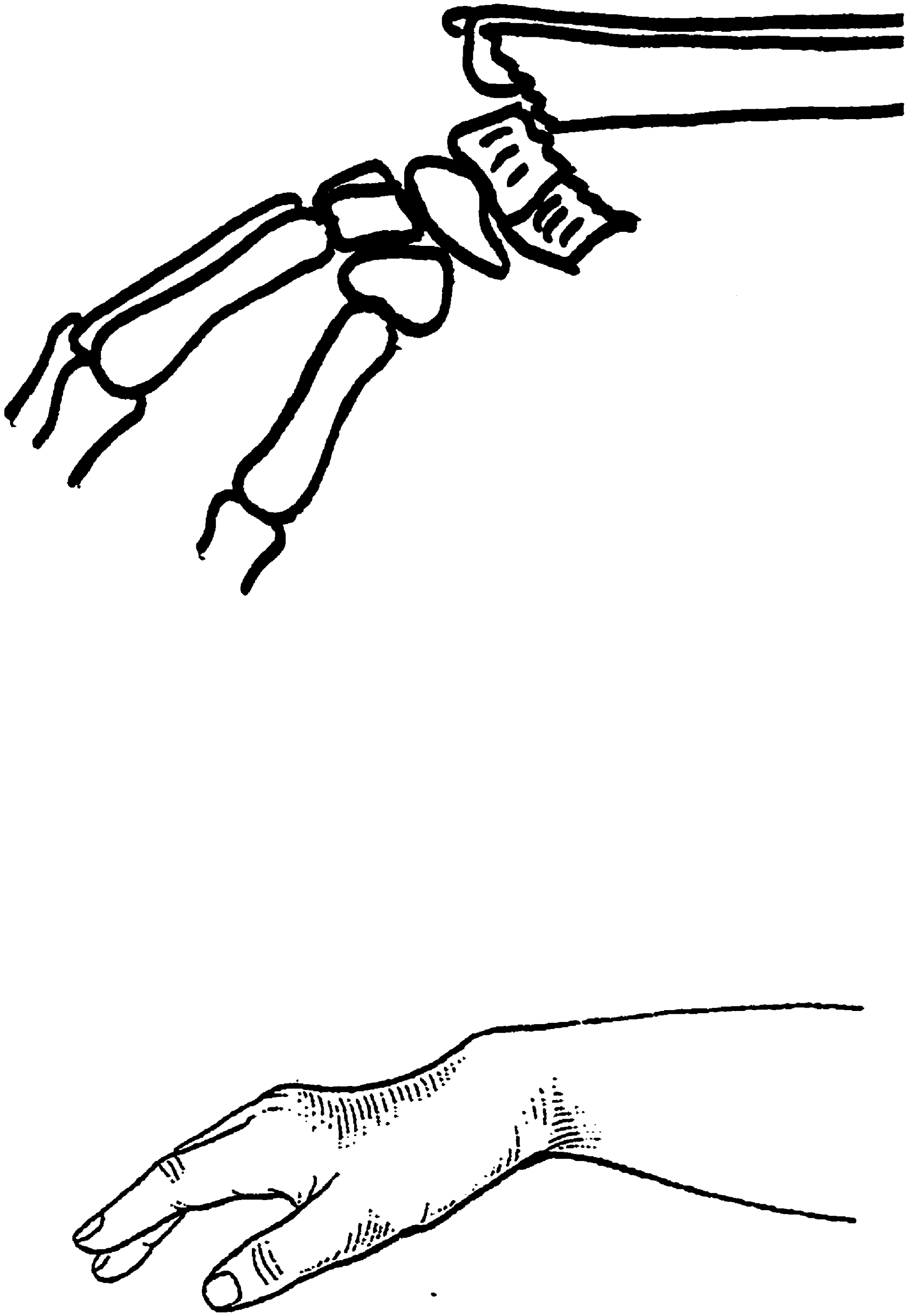

Figure 7.3: Smith's fracture and "garden spade" deformity
(modified from Connolly 1981, 1021)

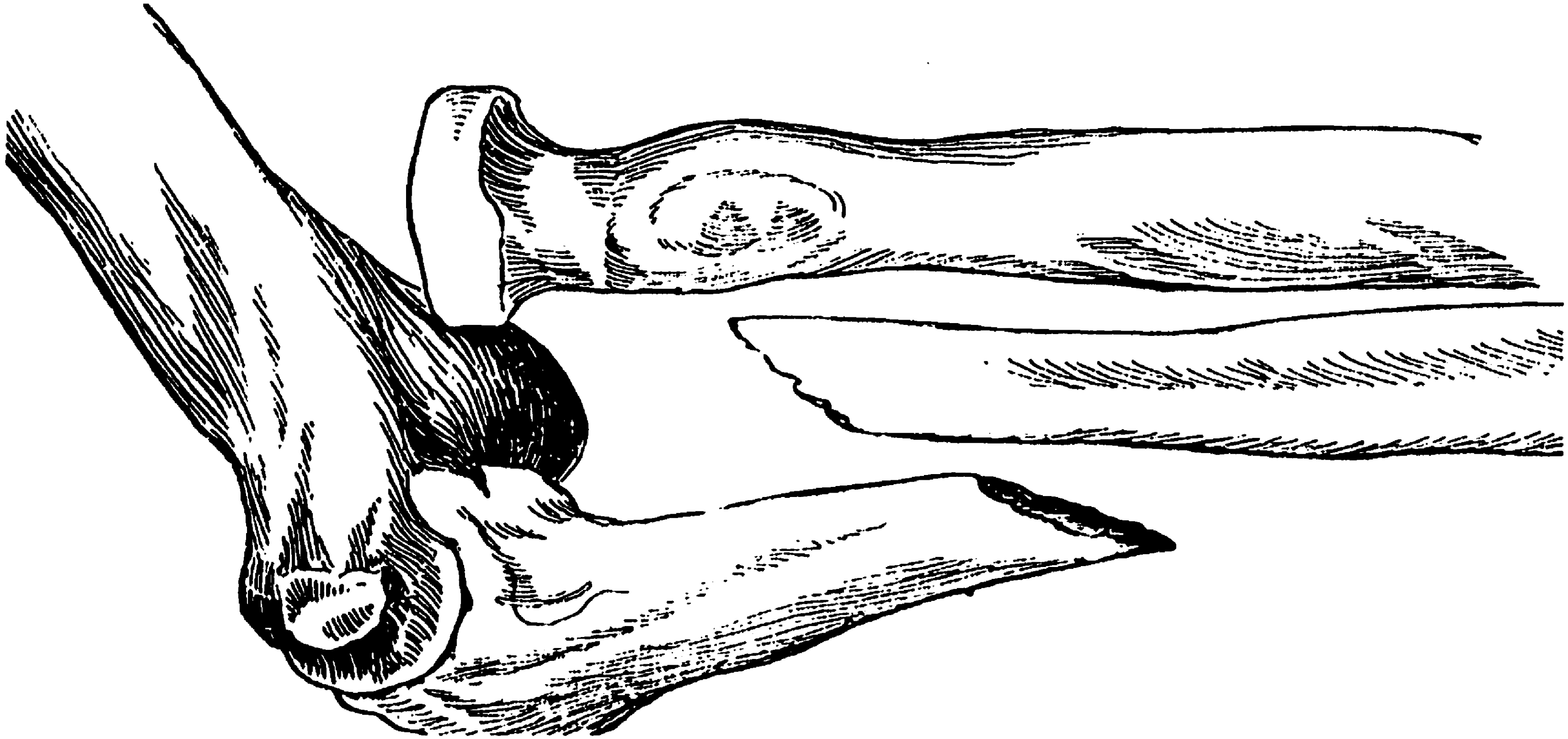

Figure 7.4: Monteggia fracture (modified from Wilson and Cochrane 1925, 222, figure 285)

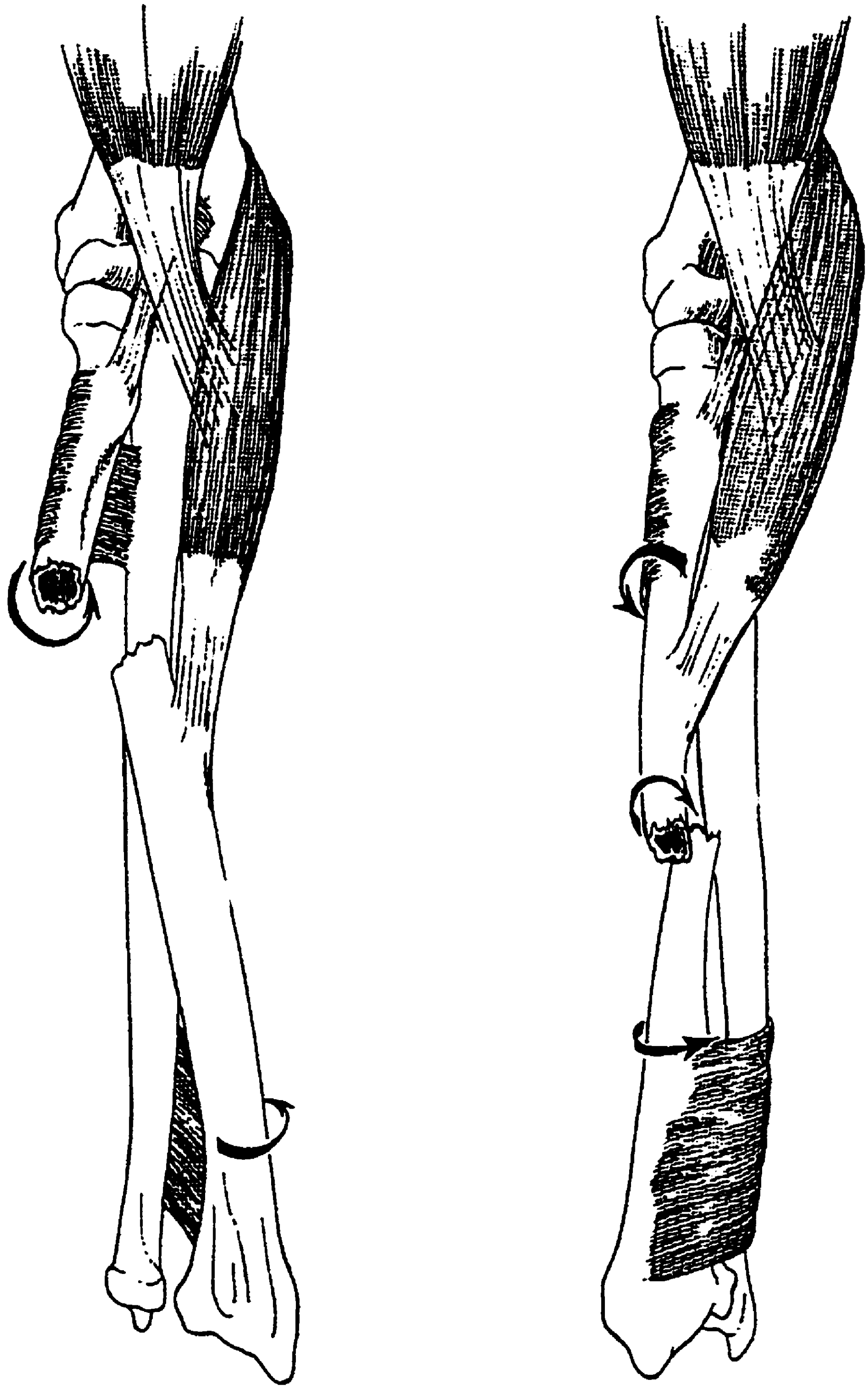

Figure 7.5: The *pronator teres* muscle
The *pronator teres* muscle forces the proximal radius into supination when the fracture occurs above the insertion point of the *pronator teres* (left) and forces the proximal radius into pronation when the fracture occurs below the *pronator teres* insertion (right) (modified from Ralston 1967, 10-3).

Plate 7.1: Direct force left ulna fracture (parry fracture, anterior view)

Plate 7.2: Galeazzi fracture of the left radial shaft (anterior view)

Plate 7.3: Right forearm paired rotation fracture with ulnar nonunion complicated by infection (posterior view)

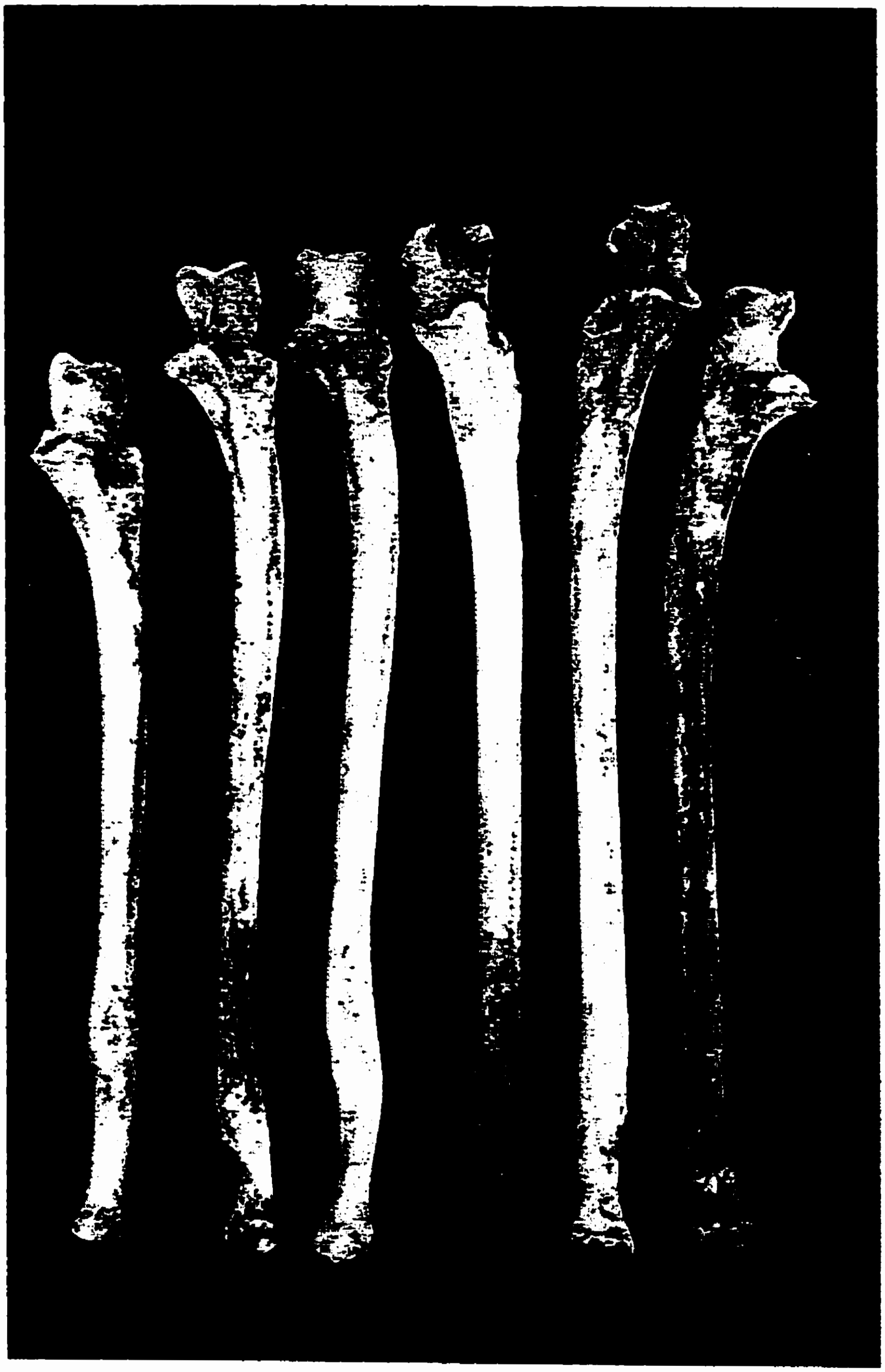

Plate 7.4: Distal ulna direct force injuries (parry fractures; second from the left is an unapposed indirect force injury)

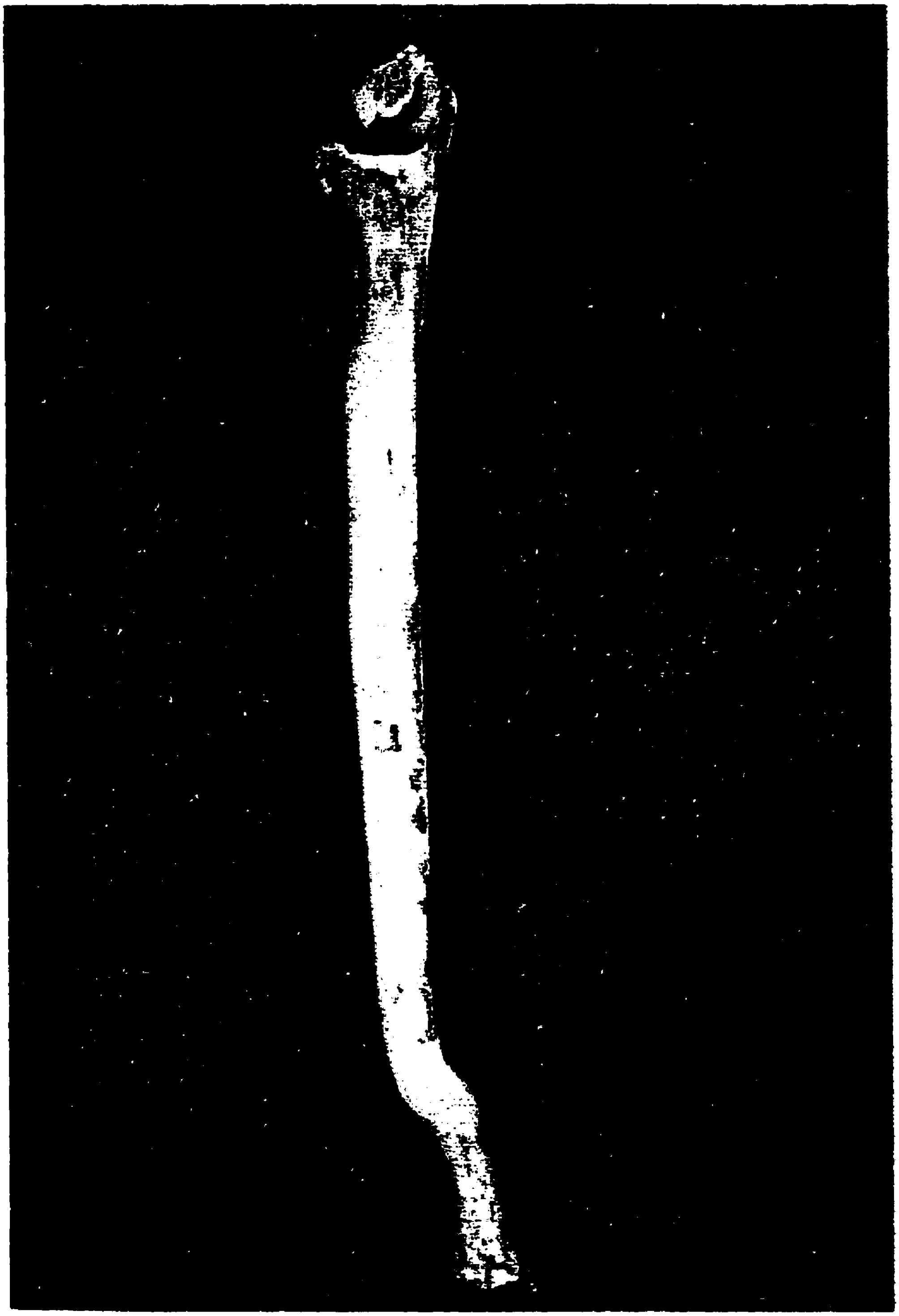

Plate 7.5: S-shaped oblique right distal ulna fracture with no apposition (anterior view)

CHAPTER 8

Ancient injury recidivism: an example from the Kerma period of ancient Nubia

"trauma is a chronic recurrent disease" (Sims et al. 1989, 946).

8.1 Introduction

Trauma, long regarded as an outcome of chance, now ranks as "a chronic and recurrent disease" (Sims et al. 1989) and clinicians have developed a profile of the people who have experienced repeat injury—the injury recidivists[1] (Hedges et al. 1995; Kaufmann et al. 1998; Poole et al. 1993; Reiner et al. 1990; Smith et al. 1992; Williams et al. 1997). As a result of repeat injury, these individuals accumulate an aggregate of traumatic lesions over their lifetime, which is precisely what bioarchaeologists observe in archaeological skeletal collections. In the past, however, bioarchaeological interpretation has been limited by the absence of clinical literature on accumulative injury, with which to assess multiple trauma at the populational level.

8.1.1 The clinical studies

Sims et al. (1989) challenged the traditional notion that injury transpired because of chance circumstances, and considered how an individual's lifestyle might influence their vulnerability to trauma over time. They found that 44% out of 263 consecutive assault admissions to an inner city Detroit hospital were repetitive casualties and victims of impoverished lifestyles involving substance abuse, unemployment, poverty, and crime. Reiner et al. (1990) refined the profile in a less volatile urban environment (Newark, New Jersey) and observed that 23% (n = 138) of consecutively admitted assault patients were injury recidivists, and of these, 53% were traumatised by the same mechanism as before (most frequently penetrating injury). Similar results were found among male assault admissions in Washington, DC, where 49% of the cases were injury recidivists and unemployment was revealed as the foremost factor (Goins et al. 1992). The recidivist profile, in many respects, resembled that of the general trauma casualty (e.g., Crandon et al. 1994; DeSouza 1968; Ebong 1978; Matthew et al. 1996; Mock et al. 1995; Watters et

[1] The term "recidivism" derives from criminology and refers to a habitual or chronic relapse back into crime by a perpetrator, but was introduced to the medical literature by Reiner et al. (1990).

al. 1996)—the injured person was typically male (97%); an ethnic minority; younger than the average trauma patient (mean age was 26 years); suffered the first injury, on average, at 20 years of age; and reappeared in the trauma unit within five years. Curiously, the injuries received were no more life threatening than those of other first time presenters of trauma. Recidivism in Oakland (California), though similar in profile, produced a dramatically lower frequency of repeat trauma—342 out of 10,525 (3%) individuals were involved (Smith et al. 1992). The investigators attributed the lower incidence to their inclusion of all trauma patients, rather than those suffering from serious assault only (i.e., Goins et al. 1992; Reiner et al. 1990; Sims et al. 1989) and therefore, these results produced a more realistic image of recidivism susceptibility to all types of injury mechanisms.

An investigation in Jackson, Mississippi (Poole et al. 1993) initiated a new dimension into injury recidivism research. The sample differed in that Mississippi was predominantly rural and Poole's sample consisted of 200 cases of all types of injury (e.g., falls, burns, motor vehicle accidents, and assault) that required hospitalisation. The results were startling—first, the rural injury recidivist rate was 40%, nearly equal to that of the inner city of Detroit and Washington, DC, and second, there was no difference in injury recidivism for accidental or intentional injury victims, although the injury recidivist profile was identical to that found by previous investigators. Hedges et al. (1995) also included all types of trauma in their analysis of 22,213 injury admissions in San Diego and calculated a repeat rate of only 1%. Assault ranked highest of all repeat injury mechanisms (38%) followed by falls (9%),[2] but the injury recidivist characteristics supported the original model. Madden et al. (1997) tested the injury recidivist model to determine if injury recidivists in Raleigh (North Carolina) were most likely to be young black males. They discovered that injury recidivism was indiscriminate of race, biological sex, and age, but a previous assault injury within the past year was highly related to a return visit. This study was influential to injury recidivism research in that an individual's inclusion in the study did not require hospital admission, and therefore minor injuries, such as, fractured fingers, were included. Also unique was that all people who

[2] Motor vehicle injuries were not stated here, as they do not influence palaeotrauma.

presented with injury during a one year period were tracked for injury for the year following their initial visit. The injury recidivism rate was 22%, and of this group, 78% returned one time, 16% returned two times, and 6% returned more than three times in the period of one year. A year long study of a rural sample from West Virginia found that 12% of injured individuals were injury recidivists (Williams et al. 1997). Repeat injury was not associated with the individual's biological sex; however, age decreased with increasing repeat trauma, while increased returns by an individual resulted in more overexertion and violence-related injuries. A statewide survey of injury recidivism in Nevada revealed that 2% of 10,137 injured patients were injury recidivists, and those suffering from interpersonal violence were at a greater risk of repeat injury (Kaufmann et al. 1998).

Little injury recidivism research exists outside of the United States, with the exception of a nationwide New Zealand study (Dowd et al. 1996), where no demographic pattern was found among injury recidivists with repetitive assault injuries, and an investigation from Israel (Sayfan and Berlin 1997). Sayfan and Berlin's (1997) study of injury recidivism in a conservative rural Israeli society not only diversified the geographical scope of this new area of inquiry, but perhaps provided a more appropriate model with which to assess multiple trauma among ancient people. Thirty percent of 100 injured adults were injury recidivists and among them, most were young males, but socioeconomic and cultural factors were inconsequential.

The profile of the injury recidivist was similar in all studies, although there were some exceptions—the individual was male, younger than the average age of the nonrecidivist trauma patient, of low socioeconomic status, unemployed, and frequently involved in illicit behaviour (e.g., crime, substance abuse). Depending on the research design, injury recidivism ranged from 1% to 49%. Methodological problems persist in this topical research area, and are reminiscent of those encountered in palaeotrauma research, for example, the length of the study period, sample size, definition of significant injury, types of injury included in the study (assault only or all types of mechanisms), and many more (e.g., Dowd et al. 1996; Greer and Williams 1999; Hedges et al. 1995; Smith et al. 1992).

However the findings available to date provide an alternative means of assessing multiple injury among ancient people and the injury recidivist profile, common to the majority of the investigations, offers a the paradigm with which to evaluate ancient multiple trauma.

8.1.2 Palaeotrauma, age, and multiple injury

Since Lovejoy and Heiple's (1981) elemental analysis revolutionised human palaeotrauma recording, most bioarchaeologists produce a systematic assessment of discrete fractures for a sample and explain the patterns observed in terms of demographics, culture, and environment. One problem still persists in the epidemiological evaluation of ancient trauma, and that is the inability to determine the individual's age when the injury occurred, unless it was shortly before death (Roberts 1988). Not only does this create difficulties in determining which age groups were at greatest risk of injury in a given society, but the ability to detect which injuries occurred simultaneously, in the case of multiple trauma, is also restricted.

Some bioarchaeologists addressed the demographic problem by applying Buhr and Cooke's (1959) analysis of years at risk of fracture for each bone to archaeological samples using the age at death of individuals with fractures (e.g., Burrell et al. 1986; Lovejoy and Heiple 1981; Neves et al. 1999). In their study of age-related fractures among Oxford infirmary fracture patients,[3] Buhr and Cooke (1959) observed that certain bones were prone to fracture at specific ages. The researchers generated fracture curves that characterised the most susceptible individuals; for example, injuries to the hands and feet peaked among young males, a pattern that was termed the "A-curve," or work-related curve, while femoral head fractures increased with age and appeared as a "J-curve." Lovejoy and Heiple (1981) applied this analytical method to a Late Woodland archaeological skeletal sample from the Libben site, and found two peak periods of discrete long bone fracture—adolescence to young adult and old age. They concluded that the people were relatively peaceful and that the injuries, which affected the sexes indiscriminately, were accidental, and a factor of increasing age rather than violence. An investigation of two ancient Nubian groups discovered an age-related change in injury

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[3] Repeat admissions were not identified.

pattern over time (Burrell et al. 1986). The Early Christian group exhibited an A-pattern of injury, particularly among males, while the Late Christian sample yielded a U-curve, that is, the youngest (less than 10 years old) and oldest cohorts bore fractures. An improvement in general health status during the later period was proposed as an explanation for the U-shaped curve—the children enjoyed healthier, more active lives and, therefore, were predisposed to more fracture-inducing activities; the older people survived their fractures of youth and lived longer because of the more amenable environment (see Wood et al. 1992, for a discussion of the "osteological paradox"). A more recent study of prehistoric Chileans found that the long bone fractures were age-related and that young adults suffered the least from injury (Neves et al. 1999). In all cases, the total number of fractures among individuals for each age cohort was evaluated at the expense of the individual's cluster of injuries.

In palaeotrauma analysis, the multiple trauma component typically consists of a multiple injury rate for the sample (number of individuals with multiple trauma per number of individuals observed), a multiple injury rate for those with trauma (number of individuals with multiple lesions per number of individuals with trauma), and possibly a mean injury rate for both of the above (number of lesions per number of individuals with and without multiple trauma) (e.g., Alvrus 1999; Cybulski 1992; Judd and Roberts 1998; 1999; Jurmain and Kilgore 1998; Kilgore et al. 1997; Lahren and Berryman 1984; Lovell 1990; Robb 1997). Some researchers have ventured to report the multiple injury rate for each sex (Jurmain and Kilgore 1998; Kilgore et al. 1997). An analysis of the accumulated number and types of injuries born by an individual at the time of death may reveal greater insight into age-related activity within the society, and the clinical concept of injury recidivism, by its focus on the accumulation of injury, provides a fresh perspective on this long-neglected area of palaeotrauma research.

8.1.3 The goals of this investigation

It was proposed that in samples where multiple injuries were prominent, particularly lesions indicative of nonlethal interpersonal violence (cranial and direct force isolated ulna fractures) or accidental falls (e.g., Colles', Smiths', Galeazzi, and paired forearm rotational fractures),[4] that a second level of analysis should follow, which may further elucidate patterns of injury unique to the culture. While it is difficult to determine whether archaeological injuries were simultaneous, the panorama of injuries displayed by a person may be the result of injury recidivism rather than a single traumatic episode. This study evaluated the multiple injury patterns of two ancient Nubian samples in order to:

1. define the demographic pattern of multiple injury,
2. ascertain if there was a difference in this injury pattern between these two samples that represented rural and urban communities of the same culture,
3. assess the association of nonlethal violence- and accident-related injuries to multiple trauma.

8.2 Materials and methods

The trauma data presented here derived from the trauma analyses of two archaeological skeletal samples from the Kerma period (ca. 2500-1500 BC) of ancient Sudanese Nubia.[5] Both samples, although divergent in socioeconomic complexity, were discovered to have had comparably high prevalences of general trauma in addition to the traditional skeletal indicators of nonlethal interpersonal violence (cranial injury, forearm fracture, and multiple injury) when compared to other archaeological samples.[6] Kerma,[7] the type-site for the Kerma culture, was one of the earliest cities that dominated Upper Nubia (above the Second Cataract) and monitored the Nile trade with the African interior. The ancient city was situated 20 km south of the Nile's Third Cataract, and 70 km upriver from the cemeteries of the Dongola vicinity, from where the rural skeletal samples were excavated (Figure 8.1). The rural skeletal sample,[8] dated to the Kerma Ancien and Moyen periods (ca. 2500-1750 BC), consisted of 55 adults, 28 males and 27 females, and of these 80%

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[4] See Chapter 7 for definitions of these fractures.
[5] See Chapters 5 and 6.
[6] See Chapters 5 and 6 for a review of the skeletal indicators of violence.
[7] Kerma is the name of the modern town adjacent to the site. The ancient name of this city remains unknown.
[8] The rural skeletal remains were excavated from two cemeteries by myself, local Sudanese workers from the Dongola vicinity, and fellow members of the Sudan Archaeological Research Society's Northern Dongola Reach Survey (NDRS) team from 1994-97 under the direction of Dr. Derek Welsby (1996; 1997) of the British Museum's Department of Egyptian Antiquities.

met with at least one injury, while 61.8% sustained two or more lesions. The royal cemeteries and subsidiary graves of Kerma were dated to the Kerma Classique period (ca. 1750-1500 BC) and yielded 93 male and 130 female skeletons,[9] 39.5% of whom suffered at least one injury, while 18% of the sexed sample bore two or more injuries.

The biological sex of the 278 skeletons was assigned by dimorphic criteria of the skull and pelvis, as recommended by Buikstra and Ubelaker (1994). Intermittent preservation necessitated that other methods be employed and therefore, measurements from long bones, as described by Olivier (1969), were utilised. Age at death was calculated from scores obtained from the degenerative changes of the pubis (Todd 1921a; 1921b), sternal rib end modification (Loth and Iscan 1989), and changes to the auricular surface of the innominate (Lovejoy et al. 1985). The age cohorts were broadly defined as subadult (<25 years), young adult (25-35 years), middle adult (35-50 years), old adult (50+), and "adult" when bones were too fragmentary to confidently estimate the age.[10] In this investigation, only individuals for whom age and sex could be assigned were included.

In clinical investigation, injury recidivism was determined by the number of times that an individual sought medical treatment for an injury, but the exact numbers of injuries presented on each occasion were unstated. On the contrary, in palaeotrauma analysis, bioarchaeologists have no means of knowing the number of episodes during which an individual received injuries, while the total number of injuries displayed by each person is reported. Each adult was grouped according to sex, age, and site as exhibiting no injury, one injury only, or two or more injuries, and all injuries were included (e.g., skull, long bones, hands, feet, torso). For each site, the frequencies of adults who presented solitary or multiple trauma with violence- and accident-related injuries were compared to the frequencies of adults with solitary or multiple trauma where no specific injury mechanism was observed. Violence-related trauma included cranial fractures and direct force forearm fractures (e.g., the parry fracture), while accident-related injuries consisted

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[9] The skeletal material from Kerma was excavated by George Reisner (1923a; 1923b) in 1916 and is currently housed in the Duckworth Laboratory of the University of Cambridge's Bioanthropology Department.
[10] Judd (forthcoming) provides a detailed osteological analysis.

of indirect force fractures of the forearm (e.g., Colles', Smiths, single radius, and paired bone fractures).[11] These results were subsequently compared between the sites. The samples were then assessed using skull and long bone injuries only. An inventory of adults bearing isolated violence- or accident-related fractures and multiple trauma is appended. Chi-square tests determined whether any differences were statistically significant, the Yate's correction for continuity (χ_c^2) was applied to small samples, and the number of degrees of freedom was "1" unless otherwise stated; the significance level chosen was 0.05.

8.3 Results

The demographic distributions for both samples are presented in Figure 8.2, while Table 8.1 inventories the raw counts of lesions sustained by the sexes for each age cohort for both sites. Of 54 aged and sexed rural individuals,[12] 43 (80%) suffered one or more injuries, which was significantly greater than their urban neighbours where 88 (42%) of 212 people incurred some form of injury ($\chi^2 = 25.02$, $p = 0.000$). When multiple injuries were considered for the two samples, 63% of the total rural sample sustained multiple injuries compared to only 19% of the total urban sample ($\chi^2 = 110.13$, $p = 0.000$). The modal distributions revealed that slightly more males presented multiple injuries (NDRS: 59%, Kerma 55%) than the females in both groups.

When the individual counts of multiple injury (number of injured individuals per total individuals) were examined for each sex, more rural males (20 out of 27, 74%) experienced multiple injuries than the rural females (52%) and significantly more rural males displayed multiple injuries than the urban males (25%, $\chi^2 = 21.46$, $p = 0.000$). Significantly more urban males bore multiple injuries than the urban females (15%, $\chi^2 = 3.69$, $p = 0.055$), as did the rural females ($\chi^2 = 18.51$, $p = 0.000$). Among individuals

[11] A detailed analysis of forearm trauma was reported in Chapter 7 where forearm fractures were analysed to determine if the injuries were due to direct force, suggesting violence, or indirect force, which implied an accidental injury.

[12] In the previous trauma analyses reported in Chapters 5 and 6, age was not factored into the analysis, therefore, the frequencies presented here are slightly lower, as not all adults could be aged reliably.

under 35 years of age, more rural adults (53%) met with multiple trauma in comparison to the urban group (45%).

Figures 8.3 and 8.4 depict the frequency distribution of multiple injury for the pooled sexes by age cohort for NDRS and Kerma samples respectively. The frequency of rural young adults displaying lesions varied directly with the increase in the number of lesions, but the frequency of injured urban young adults decreased with the number of visible lesions. Fewer rural middle-aged adults experienced multiple injuries than the younger group, although the majority (55%) did suffer from multiple lesions. The opposite trend was observed among the middle-aged urbanites who were increasingly represented as the number of injuries increased; however, the majority (56%) experienced no injuries. All of the older rural adults sustained two or more injuries, while the majority of urban elders suffered no trauma.

In the present analysis, it was observed that 34 out of 43 (79%) of the rural injured adults and 40 out of 88 (46%) of the urban injured adults met with multiple trauma ($\chi^2 = 11.65$, $p = 0.001$). Table 8.2 tallies the frequency of multiple injury for each sex by age cohort for the two samples; the p-values that resulted when the two samples were compared accompany these results. The pattern of multiple injury was comparable between the sexes for each sample, and in all but one case, the males showed a greater prevalence of multiple injury than the females, although the differences were insignificant. Multiple injury was higher among the rural adults when compared to the urban group for all cohorts and was most frequent in the young and old adult categories, while multiple injuries were highest among Kerma's middle-aged adults for both sexes. A significant difference existed between all sexed age groups when the samples were compared, except for the subadults of both sexes and middle-aged females. There was no significant difference in the age distribution of multiple injuries when the sexes were examined separately for each sample ($df = 3$).

Table 8.3 presents the raw counts of adults with single or multiple injuries by mechanism (violence-related injury, accident-related injury, and unknown mechanism).[13] The modal distributions of the frequencies are depicted graphically in Figure 8.5. Individuals with injuries diagnostic of a fall on an outstretched hand were in the minority for all categories. People with multiple injuries experienced a higher frequency of skeletal indicators of violence in comparison to those who had an isolated violence-related injury (NDRS: $\chi^2 = 1.22$, $p = 0.036$; Kerma: $\chi^2 = 7.04$, $p = 0.008$). Forearm injuries, diagnostic of an accident, were not significantly associated with multiple trauma, although they occurred more frequently in an aggregate of injuries than in isolation. No significant difference was observed for violence- or accident-related injury and the presence or absence of other trauma when the samples were compared. When the involvement of minor bones with violence-related multiple injuries was assessed, hand and/or foot injuries occurred more often among the rural group than the urban group ($\chi_c^2 = 4.06$, $p = 0.011$). Among individuals with accident-related multiple injuries, only the hands were involved more frequently among the rural people in comparison to the urban people ($\chi_c^2 = 2.93$, $p = 0.029$). There was no significant difference between the sites in the involvement of the ribs with injuries of violence or accident.

Table 8.4 tabulates the raw counts of individuals with skull and long bone injuries only by mechanism, and Figure 8.6 displays the modal distributions of their frequencies. Although substantially more elements were associated with violence for most of the injury cohorts, no significant differences were noted between the number of injuries incurred and the mechanisms for either site, nor were significant differences observed between the sites when mechanism cohorts were contrasted by the numbers of injuries observed.

[13] The two individuals who suffered both accident- and violence-related injuries were classified as "violence-related" as the presence of violence-related injuries more strongly predict injury recidivism in clinical research.

8.4 Discussion

Bioarchaeologists have made great strides in recording and reporting palaeotrauma, but little attention, if any, has been given to the distribution of multiple trauma at the populational level perhaps for lack of a comparative clinical model. Clinical investigations do not assess the accumulation of trauma in the sense that bioarchaeologists do, but within the last decade a topical trend in clinical research has been the study of chronic, recurrent trauma, referred to by clinicians as "injury recidivism," and this concept lends itself to the assessment of accumulated injuries among ancient people. Clinicians developed a profile of the injury recidivist, and very few exceptions exist. The habitual recidivist was male, received the first injury by about 20 years of age and the second injury before the age of 30 years, and a similar mechanism was involved. Socially, they came from a lower socioeconomic background and were unemployed ethnic minorities; when injury recidivists who suffered from assault only were examined, substance abuse and criminal activity were also influential factors. Location of residence was inconsequential, and although some researchers found that injury recidivists were predisposed to both accident and assault injuries, most found that one occurrence of violence-related trauma predisposed the individual to later injuries, which in some cases for very active injury recidivists, proved fatal. This investigation examined three aspects of the injury recidivist profile among two ancient skeletal samples: demographic (age and sex distribution of injury), residence (rural or urban), and finally, involvement of palaeopathological indicators of violence (cranial fracture and direct force forearm trauma) and accident (indirect force forearm trauma).

8.4.1 The demographic pattern

The pattern of age-related multiple trauma followed identical paths for the sexes within each sample, and all rural age groups consistently displayed more multiple injuries regardless of sex. Males comprised the greatest proportion of multi-injured adults for both samples, which adhered to the clinical pattern for injury recidivism. The lower prevalence of multiple injury among the subadults for both samples concurred with the clinical model as most would not yet have encountered their first or second injury, although the possibility of severe soft tissue injury cannot be neglected. The rural group sustained more injuries, generally to the extremities, while injuries among the urban youth were diverse and involved the skull and long bones. In the urban sample, three individuals under 25 years, all female, suffered violence-related injuries (Plate 8.1), but in only one case were the injuries multiple.[14] It is after this age that significantly more rural adults exhibited multiple trauma. Because the demographic distributions and local landscapes were identical for each sample, this variation must be due to behaviour or changing social roles with increased age, which may have influenced the individual's environmental exposure and activity, rendering the rural group more vulnerable to injury, while being comparatively more "protective" of the urbanites.

8.4.2 The rural and urban residence pattern

The multiple injury pattern observed at Kerma contrasted noticeably to that of the rural group. Not only was there a greater prevalence of multiple injury among the rural age and sex cohorts, but where the rural sample exhibited a bimodal distribution of multiple injury prevalence, only one peak was observed at Kerma, and that was among the middle-aged adults. The injury distribution displayed among the rural group was similar to some clinical findings, where two peak periods of increased trauma were observed, and also reflected general trauma trends (e.g., Buhr and Cooke 1959). The first peak occurred among the economically active and adventurous young adults, while a resurgence in multiple trauma occurred among the oldest cohort.

Adults under 35 years of age composed 52% of the NDRS skeletal sample and sustained 53% of the multiple injuries, which was similar to the Kerma group where a nearly identical number of young adults (53%) accounted for 45% of the multiple injuries. While this may reflect the supposedly lower life expectancy of past peoples, it may also be a factor of injury recidivism, possibly leading to a premature death in some cases, particularly for those involved in military activity. The Nubians were renowned for their archery ability and skill with a dagger, and in many cases, people from Kerma were

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[14] In the case of 192 the injury, though typical of the parry injury, does not have the ipsilateral radius and was classed as uncertain in the analysis.

interred with their weapons (Bonnet 1990b; Fischer 1961; Reisner 1923a; 1923b, 187-94).

The low prevalence of accumulated injury among the urban elders was in sharp contrast to the accumulated injuries (none of which were age-related) born by all NDRS adults over 50 years and, in fact, the majority of older urbanites (66%) experienced no trauma at all. This contradicts the clinical expectation that injuries increase in frequency as the years accumulate and the individual survives (e.g., Buhr and Cooke 1959; Zylke 1990). In clinical practice, the increase in trauma among elderly people is recognised as a consequence of age-related sensory deterioration (e.g., loss of sight and hearing) that renders them more vulnerable to accident, and age-related loss of bone mass that predisposes the weakened bone to fracture during a fall (Buhr and Cooke 1959; Matkovic et al. 1993; Stini 1990). All of the rural adults over 50 years old sustained multiple lesions, however, the fractures that are most typical of age-related falls, for example, femoral head and distal radius fractures, were absent. In clinical research, the absence of age-related injury among older rural adults has been attributed to their more physically arduous rural lifestyle, as high levels of activity throughout an individual's lifetime are thought to enhance bone strength, and thus increase resistance to the fractures associated with increasing age (e.g., Agarwal 1980; Jónsson et al. 1992; Sernbo et al. 1988; Stini 1990). Mays (2000) suggested that once old age was attained, exposure to risky activities was reduced, and that the injury pattern observed reflected the accumulated fractures acquired during the activities of youth and middle age. While this may have been true among Mays' urban skeletal sample from Victorian London, individuals that live and work in an agricultural environment continue to labour well into old age in modern society (e.g., Purschwitz and Field 1990), and likely older adults continued to contribute to the rural family's livelihood in the past.

Two factors influenced the high prevalence of multiple trauma observed among the rural adults. First, proportionally more bone was available for analysis among the rural people, particularly the hands and feet,[15] which contributed to a large majority of the rural

[15] See Chapters 5 and 6.

injuries. Second, many of the injuries sustained by the rural people may reflect the hazardous nature of the ancient rural environment and its increased potential for accident (Plate 8.2) (Alvrus 1999; Judd and Roberts 1999; Molleson 1992).[16] That the urban people, or at least a sizeable majority (59%), did not suffer from any osseous injury attests to the less demanding lifestyle—for most. Because Kerma was the state centre, it was also the focus of less physically exerting administrative, religious, and craft activities, which may explain the lower prevalence of injury among the older urban adults. Seventy percent of the urban individuals were excavated from the "royal tombs" and therefore, likely experienced a longer, more gentile lifestyle in keeping with their status as members of the royal family, administrators, court personnel, business people, or religious specialists, although some had military affiliations that predisposed them to an earlier death (Bonnet 1990b). A feature of the royal burials was the "sacrificial corridor" deemed to be the final resting place of an assortment of the ruler's retainers or slaves (Bonnet 1990a; Bonnet 1990b; Kendall 1997; O'Connor 1991; Reisner 1923a), and although the social role of these individuals is not fully understood, they may have enjoyed a less strenuous daily routine, particularly in their old age, relative to that of their rural neighbours (see, Owsley et al. 1987, for differences in urban and rural slave labour in historic North America).

8.4.3 Injuries of nonlethal violence

In the clinical analysis of injury recidivism, injuries are classified as assault, falls, motor vehicle accident, and so on. In palaeotrauma analysis, we are limited to proximate mechanisms (direct, indirect, stress, and pathological forces) and can only attempt to determine if healed injuries were due to violence or accident, at best. Forearm and skull injuries are the most useful lesions for diagnosing the ultimate mechanism in broad terms (e.g., violence or accident) for archaeological samples, but even then we are restricted to speculation, since *any* injury may be due to either intentional or nonintentional causes. A Colles' fracture of the forearm, for example, is universally associated with a fall on an outstretched hand (e.g., Adams and Hamblen 1992; Buhr and Cooke 1959; Loder and Mayhew 1988; Paton 1992; Rogers 1992, and many others), but whether that fall was

[16] See Chapter 6 for a discussion on the role of agriculture in trauma.

catalysed by a third party during a confrontation or was the result of a fall due to clumsiness eludes the investigator. Likewise, the parry fracture (Plate 8.3), notorious for its misuse in bioarchaeological interpretation (Jurmain 1999; Lovell 1997), may indeed have been the result of blocking a blow from an attack, but alternatively it may have been a defensive gesture to protect the head from a falling object. The consistent location and configuration of the "possible" parry lesions, however, suggested that the injuries were intentional and the result of a similar mechanism, rather than the more random distribution of injuries associated with accidents (Galloway 1999a).

8.4.3.1 The skull and forearm injuries

The previous trauma analyses[17] revealed no significant differences in skull or direct force forearm injuries between the NDRS and Kerma samples, although combined multiple injuries revealed that the NDRS collection bore a significantly higher frequency of multiple trauma. When multiple injury patterns that involved all bones were scrutinised, however, a different portrait of the past behaviour emerged. The rural adults with skull or direct force forearm fractures invariably had other lesions, while among the Kerma group, only 64% (21 out of 33) of individuals with violence-related injuries incurred multiple trauma. A greater percentage of multi-injured rural people, therefore, were prone to more extensive injuries from a single confrontation than the urban group based on these indicators. Alternatively, from a recidivistic perspective, the presence of violence-related fractures predisposed the rural group to more repeat injuries at some point in their lives, whether accidental or intentional, as predicted from clinical models. The presence of an accident-related forearm injury was not significantly associated with multiple trauma at either site.

Some bioarchaeologists have argued that the presence of skull injuries were undisputed indicators of interpersonal violence, while parry lesions were questionable and due to any number of causes (Jurmain 1999; Jurmain and Kilgore 1998; Smith 1996; Smith 1997). Interestingly, injuries involving isolated ulna fractures are nearly always due to fending off a blow in clinical cases (e.g., DuToit and Gräbe 1979; Heppenstall 1980, 496; Rogers

[17] Chapters 5 and 6.

1992, 816, 828), and *no* correlation between skull fracture and forearm injury within a sample appears with regularity in the clinical literature of assault injury. Why then, would bioarchaeologists expect these injuries to coincide in the past?

The appended inventory of individuals that presented injuries diagnostic of accident or violence, in addition to multiple injuries, conforms to this clinical observation. Direct force ulna fractures and skull injuries were, in most cases, mutually exclusive (except for 2 out of 10 cases in the NDRS sample and 5 out of 21 urban cases).[18] This subset of seven individuals with both skull and parry lesions accounted for 23% of all adults with a major skeletal indicator of violence, and all were male except for two urban females aged 25 to 35 years old. Among four of the middle-aged males, the accumulated injuries were quite extensive and involved other long bones as well. The dual presence of these injuries does not necessarily mean that they, along with other minor lesions, occurred during the same incident, although the possibility of a particularly devastating incident cannot be ignored. Perhaps one of the best examples of an injury complex that may have occurred during a single episode was that born by P37-G3-23. This middle-aged female suffered a Colles' injury on the right radius with an associated ulna fracture to the right forearm, in addition to oblique injuries of the right clavicle and fourth metacarpal shaft—an injury cluster associated with a fall on an outstretched hand (Loder and Mayhew 1988).

It is essential that bioarchaeologists acknowledge that fractures account for at most 40% of injuries, whether accidental or intentional, while the remainder of injuries affect the soft tissue only, and the amount of discernible skeletal injuries may be distorted by the weapon preference (e.g., Butchart and Brown 1991; Chalmers et al. 1995; Geldermalsen 1993; Geldermalsen and Stuyft 1993; Khalil and Shaladi 1981; Matthew et al. 1996; Shepherd et al. 1987; Shepherd et al. 1988; Shepherd et al. 1990). Likewise, soft tissue injuries may be responsible for death, but will not be visible in the skeletal record, a point that has been widely overlooked in bioarchaeological research. Therefore, the number of

[18] This excludes Individual 219 that did not have an ipsilateral radius present to fully confirm the parry fracture.

injuries observed and the role of injury in the individual's death will always be underestimated unless the soft tissue is preserved with the skeletal remains.

8.4.3.2 The role of minor injuries

The problems associated with differentiating between ulna stress and specific parry fracture configurations were discussed in Chapter 7. In clinical practice these lesions are identical and the only trait that distinguishes them is their injury aetiology, which is reported by the patient. Because ulna stress injuries are associated with heavy lifting (Evans 1955; Hamilton 1984; Kitchin 1948; Koskinen et al. 1997), the coexistence of other lifting-related injuries, such as spondylolysis of the fifth lumbar vertebrae (Kennedy 1989; Merbs 1989; Morris and Blickenstaff 1967, 184-185), suggested that some of the ulna injuries may have been due to labour rather than defence in the cases of Individuals 5, 20, and P37-K4-28.

At the rural site, more multiple injuries were due to minor skeletal indicators of violence, but the role of the extremities cannot be ignored as they also have been shown to be predictors of injury recidivism due to violence, notably the fifth metacarpal neck fracture (known as the "boxer's fracture) (Greer and Williams 1999), although the mechanism of this lesion is ambiguous. While only one of many punch-related hand injuries (Adams and Hamblen 1992; Cailliet 1975; Jonge et al. 1994; Kraemer and Gilula 1992a; Kraemer and Gilula 1992b; Rogers 1992), 61% of the "boxer's fractures" in Greer and Williams' (1999) investigation were attributed to punching a person or object, while 24% were due to falls or sports. Among the cases that they observed, 27% were injury recidivists, but no difference was detected between recidivism due to intentional or unintentional injuries. Fractures to any metacarpal neck region that result in the dorsal inclination of head are the most common metacarpal injuries in emergency units and are caused by hitting a surface with the fist (e.g., Bora 1980, 588-9; Galloway 1999b, 154), but like the "boxer's fracture" these injuries may be contracted from a fall or sports. More importantly, the second or third metacarpal necks are the more frequent locations for punch-related injuries among professional fighters (Bora 1980, 589; Galloway 1999b, 154) and, therefore, should also be considered particularly when the profession of the individual was unknown. Among the ancient Nubians, 14 people had multiple injuries with metacarpal involvement. Of these, three males with other violence-related injuries displayed broadly defined "boxer's fractures" (lesion on neck of one or more of metacarpals 2 to 5), while four other individuals (including one female) without violence-related injuries exhibited these fractures. In these samples, the presence of the "boxer's fracture" did not aid in differentiating between mechanisms, and to assign interpersonal violence as the injury mechanism based on the "boxer's fracture" would be highly speculative in palaeotrauma analysis.

Other seemingly minor injuries were those of the ribs, which are often implicated in cases of abuse (Walker et al. 1997; Wladis et al. 1999), but may also result from falls, accident, stress due to coughing or activity, or even birth (e.g., DeMaeseneer et al. 2000; Galloway 1999b, 106-109; Sinha et al. 1999; Walker et al. 1997). The angle of the fracture line and location of the lesions, however, aids in identifying the proximate injury mechanism (Galloway 1999b, 107). The oblique fracture line caused by an indirect force, such as a fall, typically occurs at the rib's posterior angle, and if the lesions are bilateral the injury may be the result of crushing. Transverse lesions are more often due to localised blows to the chest or coughing, and may involve one or more ribs. In these two samples, four males, three urban and one rural, with violence-related injuries had rib lesions, but all were angled. One urban male sustained angled rib lesions in addition to a distally fractured fibula and metatarsal stress fracture, both of which are locomotor injuries (Adams and Hamblen 1992, 246; Black 1983; Linenger and Shwayhat 1992; Rogers 1992, 1340-1). Among females, one urbanite sustained posterior angled rib lesions as well as clavicular and two extremity injuries, while six other females, of which five were urban, experienced minor, but transverse lesions to the sternal rib ends; their associated injuries were minor as well (e.g., impacted phalangeal articular surfaces).

8.4.4 Ancient injury recidivists?

When involvement of the minor bones was considered, the hands and feet were implicated in interpersonal violence among the NDRS group, which supports the findings of Chapter 6 that the extremities may have been involved more frequently in interpersonal confrontations among the rural group in contrast to the urban group. However, when only the skull and long bones were considered, as is common in most populational studies of palaeotrauma, the presence of another injured major bone accompanying a skull or direct force ulna fracture was similar for both samples. Among the NDRS group 50% of individuals with one injury of violence had a second lesion on the same bone or had one or more additional injured major bones, while among the Kerma group 33% of those with one injury of violence had an additional lesion on a major bone. That any of these other injured bones occurred preceding to, subsequent to, or simultaneously with the violence-related injury remains unknown, but two conclusions can be drawn from this investigation. First, the majority of skull or parry fractures did not have another major fractured bone present among the skeletal remains, although the frequency was high, particularly for the rural group. Second, had the injuries occurred independently, the range of 33% to 50% of individuals with multiple major bone injuries rests within clinical injury recidivism rates. This higher range is reasonable, as the archaeological skeleton presents a lifetime of accumulated injury rather than injuries collected over a short study period, for example, one to five years, which is typical among clinical research.

When forearm injuries that were diagnostic of falls were considered, all of the rural individuals (n = 2) and four out of seven urban people (57%) had additional injuries to minor bones, but when only the major bones were assessed, the range dropped to 50% (one out of two) for the rural people and 14% (one out of seven) for the urban group. This variation between the samples was likely the result of the more physically demanding rural lifestyle.

Among the pooled sample, more individuals with violence-related injuries experienced additional trauma to other major bones (38%, 17 out of 45 adults), than did those with accident-related trauma (22%, two out of nine adults), although this difference was not significant. Seventeen out of 21 (81%) adults with multiple injuries to major bones bore one or more violence-related injuries, while 60% (28 out of 47) of the adults with single injuries displayed a violent injury, a difference that also was insignificant. Nevertheless, in these two societies, individuals with major violence-related injuries were more likely to have additional long bone or minor bone injuries than people with accident-related lesions, and a segment of this group were likely injury recidivists.

8.5 Conclusions

In the clinical arena, individuals that continually present trauma are referred to as injury recidivists, and are profiled as young ethnic minority males who are unemployed, suffer from socioeconomic problems, and have at least one injury caused by violence. By analogy, multiple injuries sustained by ancient people also may be the result of repeat injuries rather than a single event, and in some cases, may account for premature death. This investigation evaluated the distribution of multiple injury between two ancient Nubian skeletal samples from the Kerma period (ca. 2500-1500 BC), one rural and one urban, to determine if characteristics of the injury recidivism profile, developed by modern clinical researchers, existed in past societies. While injury recidivism cannot be established unconditionally among ancient societies, the pattern of multiple injury among the Kerma culture corresponded to the clinical profile of injury recidivism in many respects:

1. most individuals with multiple injuries were male and less than 35 years of age at the time of death,
2. no significant difference in violence- or accident-related multiple injury was apparent between the rural and urban communities,
3. a high frequency of multi-injured adults displayed one or more skeletal indicators of nonlethal violence.

The topical area of injury recidivism among clinical researchers promises to be a viable resource for palaeotrauma analysis.

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Table 8.1: Distribution of all injuries (raw counts) among aged and sexed cohorts from the NDRS and Kerma samples

Sample	Age cohort (years of age)	No Fractures			One Fracture			Multiple Fractures			Sample Total		
		M	F	T	M	F	T	M	F	T	M	F	T
NDRS	<25	0	3	3	2	0	2	2	1	3	4	4	8
	25-35	0	2	2	2	1	3	9	6	15	11	9	20
	35-50	1	5	6	2	2	4	7	5	12	10	12	22
	50+	0	0	0	0	0	0	2	2	4	2	2	4
	Total	**1**	**10**	**11**	**5**	**3**	**9**	**20**	**14**	**34**	**27**	**27**	**54**
Kerma	<25	2	15	17	1	4	5	0	3	3	3	22	25
	25-35	18	31	49	5	19	24	8	7	15	31	57	88
	35-50	22	20	42	11	4	15	12	6	18	45	30	75
	50+	7	9	16	0	4	4	2	2	4	9	15	24
	Total	**49**	**75**	**124**	**17**	**31**	**48**	**22**	**18**	**40**	**88**	**124**	**212**

M = Number of males, F = Number of females, T = Total number of individuals

Table 8.2: Distribution of multi-injured adults for the sexed age cohorts of the NDRS and Kerma samples

Sex	Age	NDRS			Kerma			P-value
		n'	m	%	n'	m	%	
Male	<25	4	2	50	3	0	0	0.147
	25-35	11	9	82	31	8	26	0.001*
	35-50	10	7	70	45	12	27	0.009*
	50+	2	2	100	9	2	22	0.039*
Female	<25	4	1	25	22	3	14	0.562
	25-35	9	6	67	57	7	12	0.000*
	35-50	12	5	42	30	6	20	0.149
	50+	2	2	100	15	2	13	0.007*
Total		**54**	**34**	**59**	**212**	**40**	**19**	**0.000***

n' = number of individuals with injuries; m = number of individuals with multiple injuries; % = n'/m X 100%; * significant at $\alpha = 0.05$

Table 8.3: Distribution of injured adults with any injuries (raw counts) by presence of possible injury mechanism among the NDRS and Kerma samples

Sample	Injury Mechanism	One Injury	Multiple injuries
NDRS	Violence-related injuries	0	12
	Accident-related injuries	0	2
	Unknown injury mechanisms	9	20
	Total individuals	**9**	**34**
Kerma	Violence-related injuries	12	21
	Accident-related injuries	3	4
	Uncertain forearm injuries	2	1
	Unknown injury mechanisms	31	14
	Total individuals	**48**	**40**

Table 8.4: Distribution of injured adults with skull and long bone injuries (raw counts) by presence of possible injury mechanism for the NDRS and Kerma samples

Sample	Injury Mechanism	One injury	Multiple injuries
NDRS	Violence-related injuries	6	6
	Accident-related injuries	1	1
	Unknown injury mechanisms	6	1
	Total individuals	**13**	**8**
Kerma	Violence-related injuries	22	11
	Accident-related injuries	6	1
	Uncertain forearm injuries	2	1
	Unknown injury mechanisms	4	0
	Total individuals	**34**	**13**

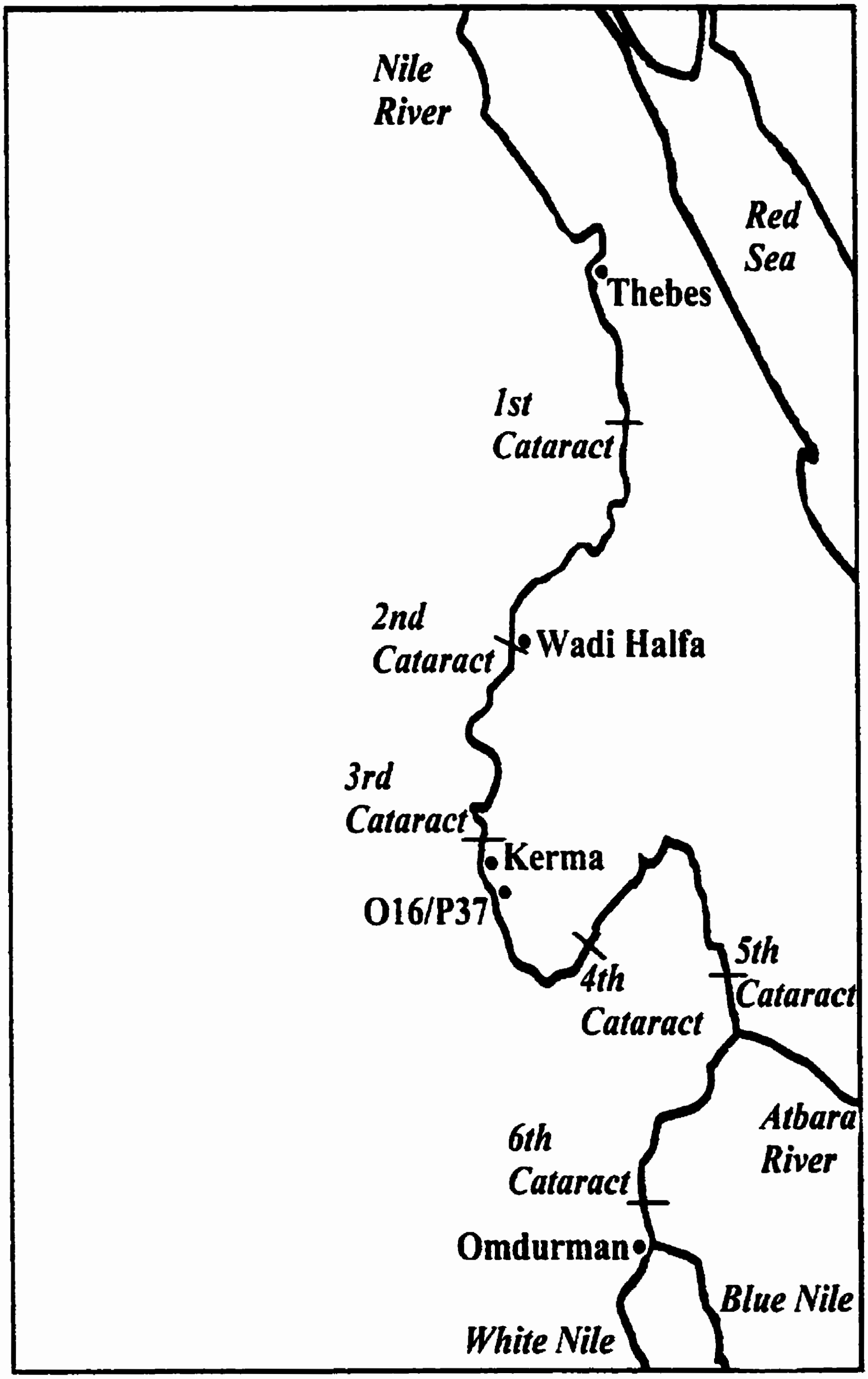

Figure 8.1: Location of NDRS sites (O16 and P37) and Kerma

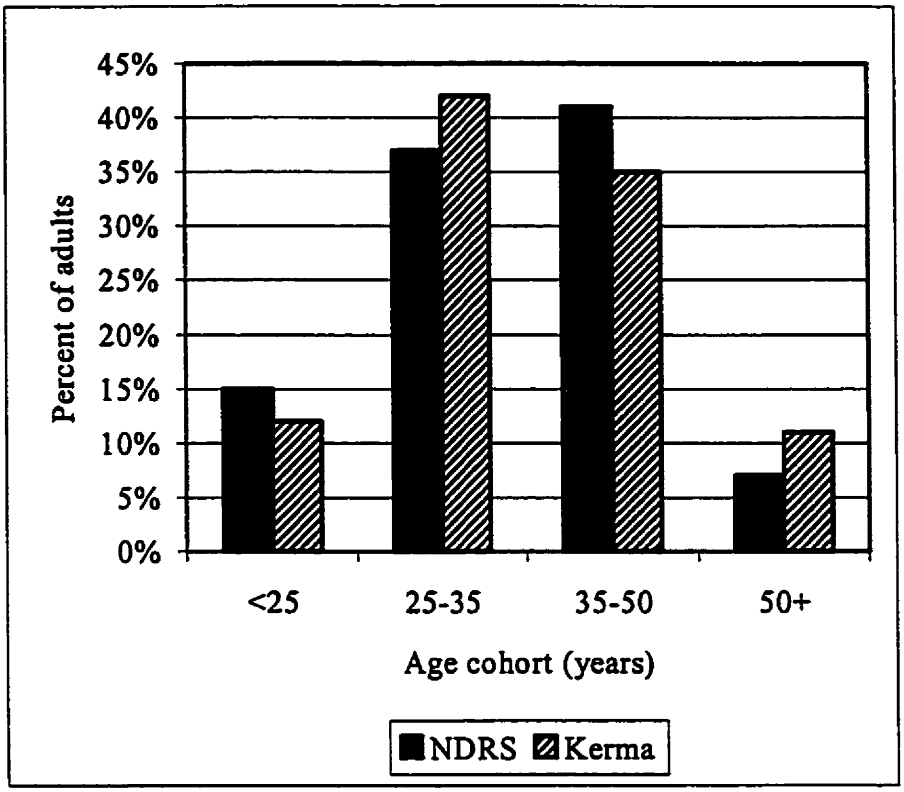

Figure 8.2: Demographic distribution of the NDRS and Kerma adults

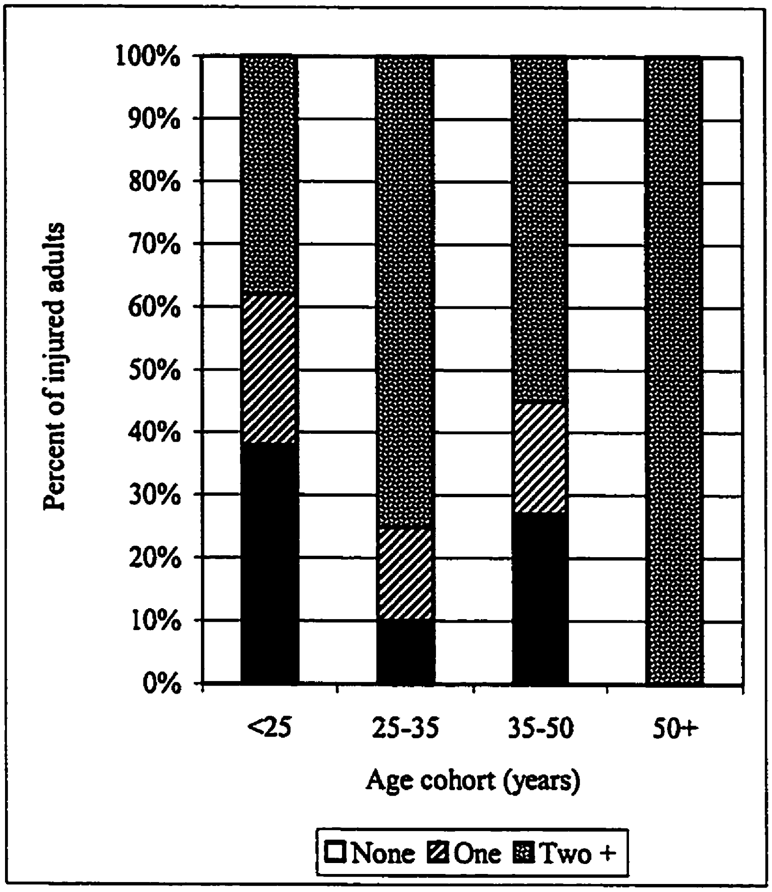

Figure 8.3: Distribution of injured adults by number of injuries and age cohort for the NDRS sample

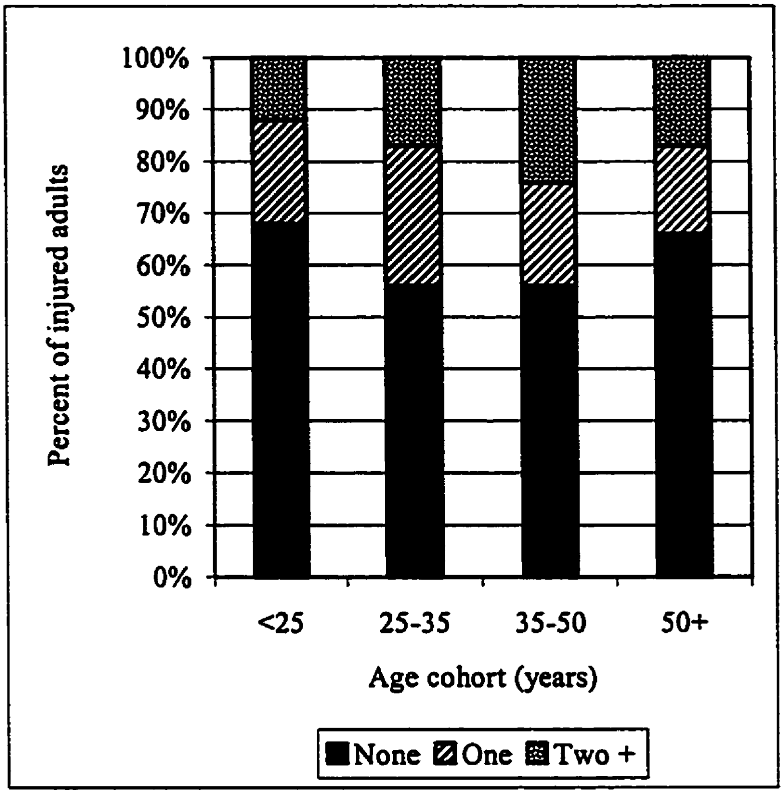

Figure 8.4: Distribution of injured adults by number of injuries and age cohort for the Kerma sample

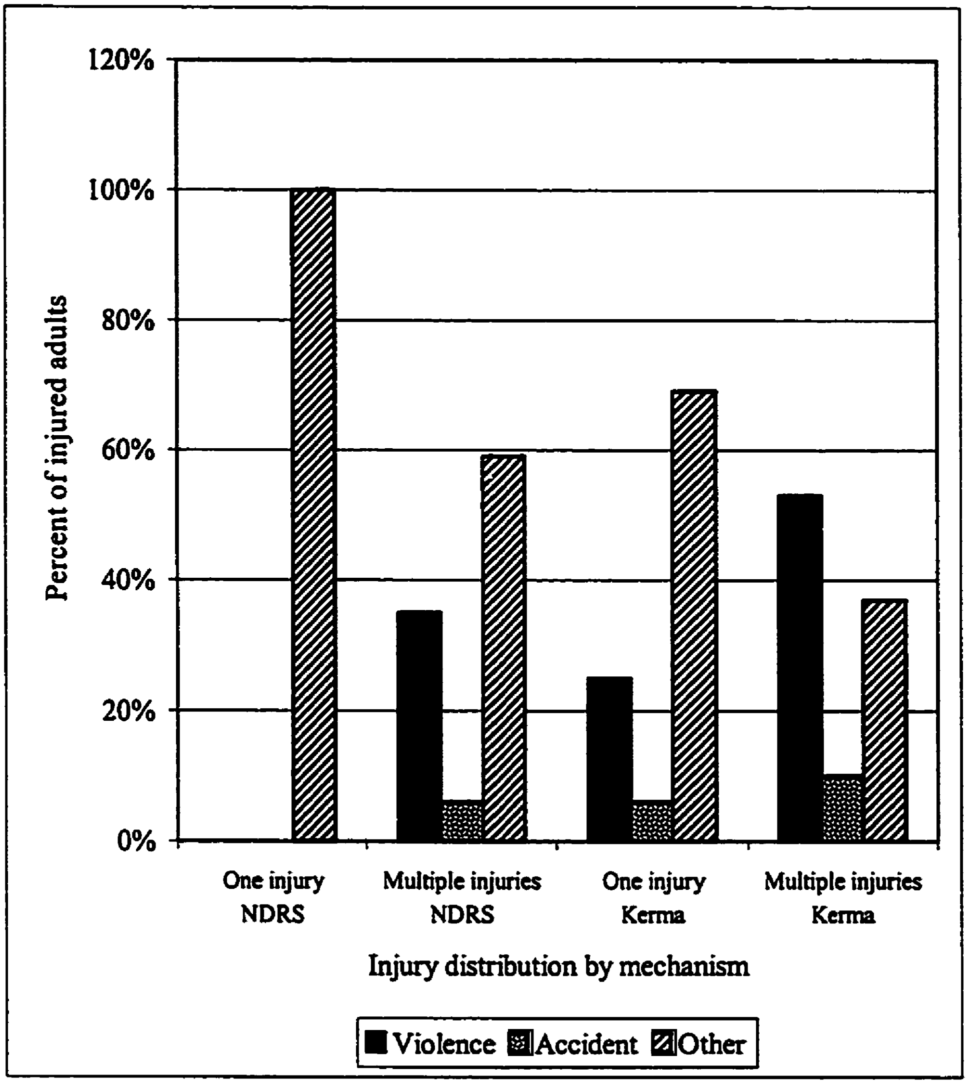

Figure 8.5: Distribution of injury by mechanism (all injuries) for the NDRS and Kerma samples

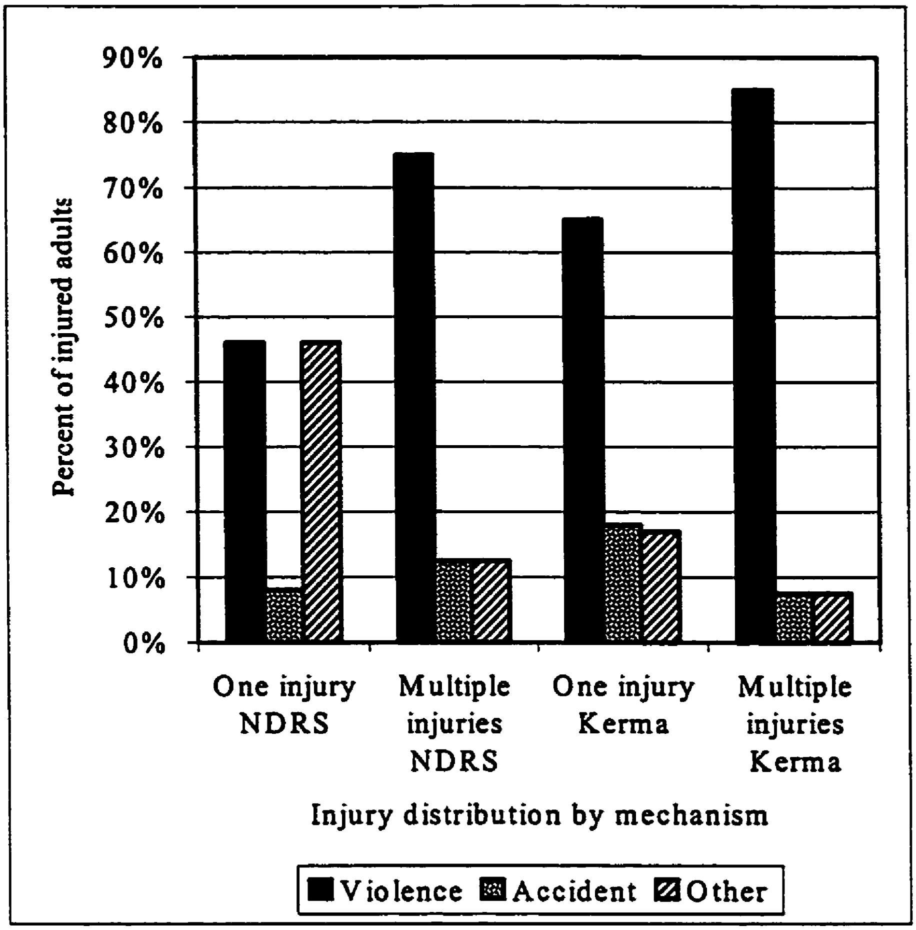

Figure 8.6: Distribution of injury by mechanism for skull and long bones for the NDRS and Kerma samples

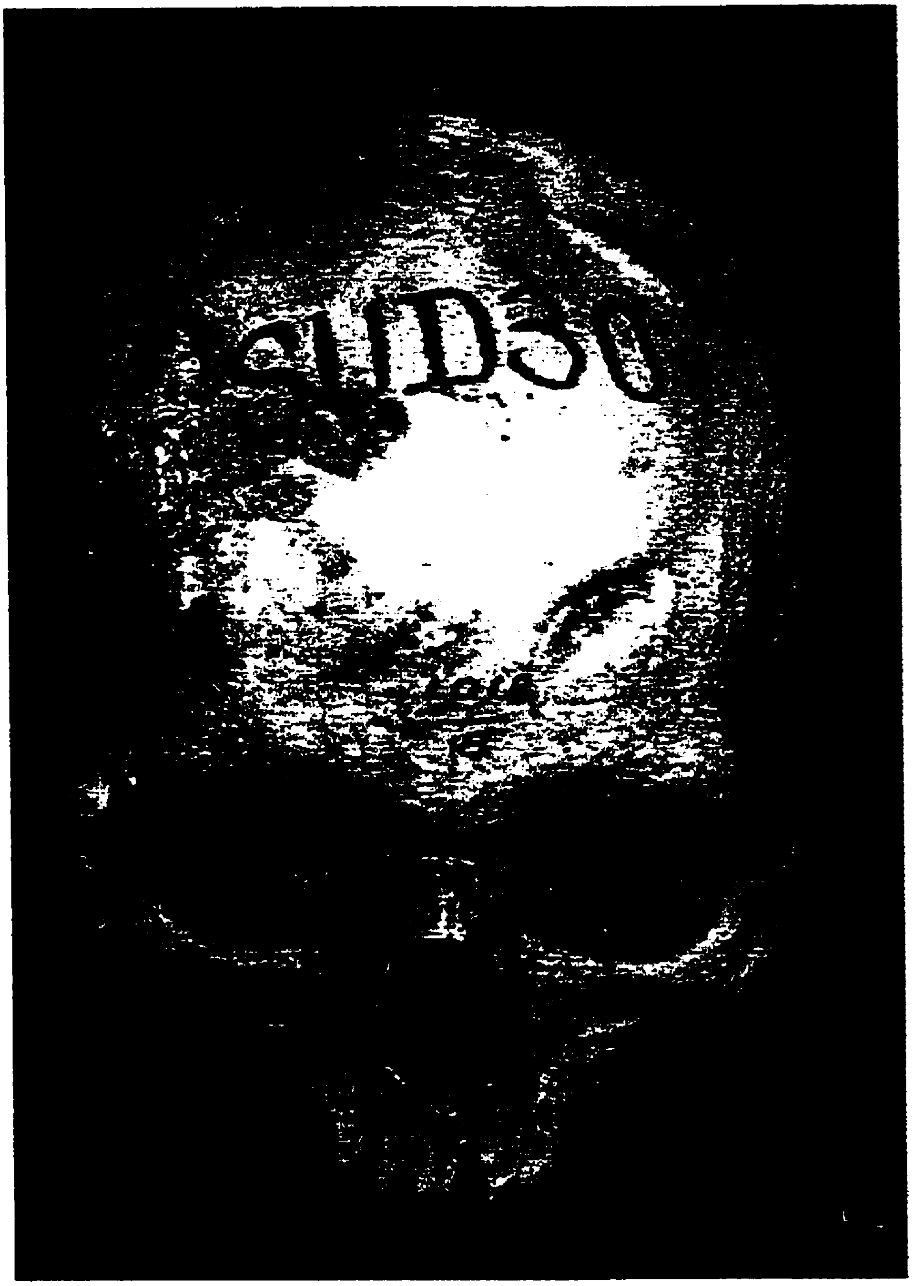

Plate 8.1: Depressed skull fracture on the left frontal bone

Plate 8.2: Indirect force fracture of the left radial midshaft
(Galeazzi fracture, anterior view)

Plate 8.3: Direct force fracture (parry fracture) of the left ulna
(anterior view)

CHAPTER 9

Conclusion

This investigation of ancient palaeotrauma focused on two central themes —enhanced critical evaluation of the injuries observed, and the assessment of interpersonal violence among ancient Nubians of the Kerma culture (ca. 2500-1500 BC).

The selection of trauma recording methods produced differences in fracture frequencies within the sample, which in many cases were insignificant, although the interpretations of intersample comparisons could be affected. The importance of clearly stating the recording method chosen, and noting which traumatised bones were excluded, can only be reiterated. Likewise, forearm injuries, highly indicative of accidental or intentional trauma based on injury configuration, were also critically assessed with quantitative and qualitative criteria that established the nature of the proximate injury mechanism. The overall interpretation of the injury pattern among the two Kerma samples was not altered when the forearm injuries were integrated into the trauma analysis.

The politically and economically expansive Kerma period, and its "culture of violence" exhibited in the archaeological record, may have influenced the higher levels of violence-related injuries that were observed among both rural and urban Kerma communities in comparison to the injury profile of other ancient Nile Valley groups. The distribution of skull injuries for the Kerma people (and the subsequent Meroitic group from Semna South) was contrary to that of the clinical model—the skull vault sustained the majority of injuries as opposed to the face—a deviation that may have reflected a cultural preference for inflicting injury. Although both rural and urban communities bore similar frequencies of violence-related injuries, the severity of some of the skull lesions was greater at Kerma. It was argued that sturdy inanimate objects were more frequently brandished to inflict injury upon the urban people, and indicated that a status-related choice of weapons was possible.

Multiple injury patterns were considered from the clinical perspective of "injury recidivism" or repeat trauma. The multiple injury pattern for the ancient Kerma people was astonishingly similar to the clinical profile—the largest group of individuals bearing injuries were males under 35 years of age; 33% to 50% of individuals with a violence-related injury had one or more additional long bone or skull injuries, and this range increased dramatically when the minor bones were included; and lastly, this profile was analogous for the urban and rural communities.

In summary, this investigation contributed the following to the bioarchaeological reconstruction of the lifeways of past people:

1. Demonstrated that significant differences in results may sometimes occur with the choice of recording methods in palaeotrauma analysis, and that the selection of the method used should reflect the integrity of the skeletal sample. A corollary to this is that the method be clearly stated and that any trauma data excluded should be noted; by doing so, other researchers may choose to include or exclude the data, depending on their research question.
2. Refined forearm fracture classification for palaeotrauma analysis by implementing detailed quantitative and qualitative criteria for identifying the proximate injury mechanism, particularly the parry fracture.
3. Demonstrated the potential use of the clinical model for injury recidivism in the assessment of multiple injury among archaeological skeletal samples.
4. Constructed an injury profile for two socioeconomically diverse Nubian samples dated to the Kerma period (ca. 2500-1500 BC) and determined that a high level of societal violence was mirrored in the domestic realm as interpersonal violence, and that this level of violence was comparable for both rural and urban communities of the Kerma culture, which accorded with the clinical model.
5. Extended the diachronic sequence of trauma in Upper Nubia back to the Kerma period.
6. Enriched the general knowledge of palaeopathology and ancient behaviour among Upper Nubians.

Interpersonal violence in ancient societies, though influenced by violence at the state level, represents the confluence of sociocultural and environmental factors, which was tempered by the individual's behaviour and past experiences....

> The troubles of the young are soon over; they leave no external mark. If you wound the tree in its youth the bark will quickly cover the gash; but when the tree is very old, peeling the bark off, and looking carefully, you will see the scar there still. All that is buried is not dead (Schreiner 1939, 114).

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Appendix I: List of Abbreviations

L	Left
R	Right

Hands

Mc	Metacarpal
Pp	Proximal phalanx
Mp	Middle phalanx
Dp	Distal phalanx

Feet

Mt	Metatarsal
Pp	Proximal phalanx
Mp	Middle phalanx
Dp	Distal phalanx

Other

C-vertebra	Cervical vertebra
T-vertebra	Thoracic vertebra
L-vertebra	Lumbar vertebra
L-5	5^{th} Lumbar vertebrae (spondylolysis)

Appendix I: Multiple injuries of NDRS males

Provenience	Age	Skull	Forearm*	Long bone	Hands	Feet	Other
O16-C3-20	<25				Pp3-L	Mt5-R	
P37-G4-33	<25						
P37-J3-44	25-35	Parietal-L	**Ulna-R, Radius-L, R**	Tibia-L,R Humerus-L, Fibula-L, Tibia-R (2)	Mc1,3,5-R, Dp5-L, Dp4-R, Pp1-L, Mp4-R	Mt1,3,4-R, Pp5-R, Dp1-R	Scapula-L, R; 6 T-vertebrae, 2 ribs,
P37-K3-31	25-35	Frontal-L	Ulna-R		Mc3,Mp2,Pp2-L	Pp2-R	
P37-K3-63	25-35	Parietal-L			Mp4-L, Pp-5-R	Pp4-R	
P37-J3-32	25-35	Frontal-R					L-vertebrae
P37-K3-48	25-35		**Radius-R**		Mp3-L, Pp-L	Mt-1-R	
P37-K4-28	25-35		Ulna-L, R		Dp4-L, L hamate		L-5 vertebra
P37-J3-33	25-35			Fibula-L	Pp1-R	Dp1-L	C-vertebrae
P37-K3-58	25-35				Mc4,Pp4-R;Dp3-L	Pp5-R	
P37-K3-49	25-35				L Trapezoid, Mc1-L	Pp5-L/R,Mp5-R	
P37-J3-36	35-50	Frontal-R	**Radius-L**		Mc4,Mp3-L	Mp4,Pp4-R	
P37-J3-48	35-50	Mandible	Ulna-L		Mp2-R	Mp2,5-R	Clavicle-R, Tibia-L
P37-G4-36	35-50		Ulna-R	Tibia-L		Dp1-L/R, Pp5-R	2 ribs
O16-C3-24	35-50				Mc1-R	Mp5-L	
P37-G3-30	35-50				Mp2-R, Pp5-R	Pp5,Dp3-R	
P37-K4-23	35-50			Femur-L	Mc2,4,5,Pp2-L	Dp1-R	
O16-C3-5	35-50						sacrum, L vertebrae
P37-J3-46	50		Ulna-L		Mc4,Pp5-R	Pp5-L	
O16-D5-1	50			Fibula-L	Dp1-R		

*Bolded injuries were due to indirect force; italicised injuries were due to an uncertain mechanism

Appendix I: Multiple injuries of NDRS females

Provenience	Age	Skull	Forearm*	Long bone	Hands	Feet	Other
P37-G4-48	<25					Mt4,5-L	
O16-C3-2A	25-35				Pp2, Dp3-L		
016-C4-3	25-35			Fibula-R	Dp2-R		
P37-K3-57	25-35				R Hamate	Dp1-R	
P37-K4-19	25-35				Dp3-L	Mt1-R	
P37-G4-32	25-35	Parietal-L				Pp5-L/R	
P37-F3-22	25-35		Ulna-L		Pp5-R	Pp5-L/R	4 ribs-L/R
P37-K3-62	35-50			Tibia-L			1 rib-L
P37-G3-23	35-50		**Ulna-R, Radius-R**	Clavicle-R	Mc4-R	Mp3-R	
016-C3-25	35-50				Mp2-L	Mt4, Mp4-L	
P37-G3-40	35-50				Pp4-L, Pp3-R	Mp5-R	
P37-K3-72	35-50			Tibia-R		Pp5-R,Mp5-R	
P37-F3-19	50	Parietal-L				Mt5-R	
P37-K3-71	50				Pp1,3,5-L	Dp1-L	Pubis-R

*Bolded injuries were due to indirect force; italicised injuries were due to an uncertain mechanism

Appendix I: Multiple injuries of Kerma males (cont'd next page)

Provenience	Age	Skull	Forearm*	Long bone	Hands	Feet	Other
75	25-35	Nasal		Humerus-R			
154	25-35	Parietal-L, Mandible-L			Ppl		
170	25-35	Zygomatic-L					
5	25-35		Ulna-L				L-5
156	25-35		Ulna-L				Sternum, vertebra, rib
57	25-35		**Radius-L**		Pp		
98	25-35		**Radius-R**			Ppl	
131	35-50	Parietal-L/R (5)	Ulna-L, Radius-L	Tibia-L			Scapula-L
		Frontal-L, Zygomatic-R		Humerus-L			Rib-L
52	35-50	Parietal-L (2)	Ulna-L	Tibia, fibula			Pubis
3	35-50	Frontal-R	Ulna-L		Mc5		
187	35-50	Parietal-L	Ulna-L				
168	35-50	Parietal-L					L-5
66	35-50	Frontal-L				Mtl	Rib
183	35-50	Parietal-R					
211	35-50	Parietal-R					

*Bolded injuries were due to indirect force; italicised injuries were due to an uncertain mechanism

Appendix I: Multiple injuries of Kerma males (cont'd)

Provenience	Age	Skull	Forearm*	Long bone	Hands	Feet	Other
164	35-50		Ulna-L		Pp		calcaneus
20	35-50		Ulna-L				L-5
51	35-50		Ulna-L	Humerus-L			
141	35-50		Ulna-L		Mc5		
166	35-50		Ulna-R				
220	35-50		Ulna-R				
88	35-50		Ulna-R			Mt2	
104	35-50		Ulna-R				
145	35-50		Ulna-R				
160	35-50			Femur-R			sternum
40	35-50			Clavicle			manubrium
109	35-50						3 ribs
124	50			Fibula		Mt4	2 ribs
152	50				Mc1	Mt5	

*Bolded injuries were due to indirect force; italicised injuries were due to an uncertain mechanism

Appendix I: Multiple injuries of Kerma females

Provenience	Age	Skull	Forearm*	Long bone	Hands	Feet	Other
167	<25	Occipital, Mandible-R					
142	<25	Parietal-R					
192	<25		*Ulna-R*				
25	<25				Mc1		L-5
81	<25						Ribs-3
193	25-35	Frontal-L	Ulna-R, Radius-R				L-5
219	25-35	Nasal	*Ulna-L*		Dp3		
201	25-35	Frontal-R				Mt5	
111	25-35	Frontal-R					
171	25-35	Parietal-L					
28	25-35		Ulna-L				
101	25-35		*Ulna-L*				
140	25-35		*Ulna-L*	Clavicle-R			
92	25-35		**Radius-L**				
60	25-35		**Radius-L**				
202	25-35					Pp5, Dp1	
91	25-35				Pp2,Mp		Rib
132	25-35						Scapula-R, C-7
95	25-35						2 Ribs
161	35-50	Parietal-L (2)				Mp	
39	35-50		Ulna-L		Mc3		
37	35-50						C-7, T-1, T-2
93	35-50				Mc5		Rib
115	35-50				Hamate		Rib
157	35-50			Humerus-R			Rib
197	50	Parietal-L					
14	50	Parietal-L					
203	50		**Radius-R**	Fibula			
31	50		**Ulna-L**		Pp1		

*Bolded injuries were due to indirect force; italicised injuries were due to an uncertain mechanism