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The relationship between vertebral compression rates and systemic inflammatory scores in osteoporotic vertebral fractures

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Abstract. – OBJECTIVE: There are many scientific reports on systemic inflammation scores (SIS) associated with decreased bone mineral density in osteoporotic vertebral disease. However, there are no studies on the association of inflammation scores with the risk of collapse in osteoporotic vertebral collapse fractures. The aim of this study was to examine the correlation between the product of platelet and neutrophil counts (PPN), platelet/lymphocyte ratio (PLR), neutrophil/lymphocyte ratio (NLR), and systemic immune inflammation index (SII) derived from complete blood count analysis in cases of osteoporotic vertebral fractures and fracture severity based on vertebral collapse rates.

PATIENTS AND METHODS: This study is a retrospective analysis of a cohort of 50 patients aged 50 years or older who presented with osteoporotic vertebral fractures and underwent kyphoplasty at our clinic from 2018 to 2023. The study included both men and women. Computed tomography (CT) and magnetic resonance imaging (MRI) were used to diagnose and differentiate osteoporotic vertebral compression fractures from burst fractures and pathologic fractures. All compression rate measurements were performed with CT. The compression rate of the most affected vertebra (MAV-CR) was calculated. Groups were divided into two categories based on their compression rates: <50% and ≥50%. Initial PPN, PLR, NLR, and SII parameters were used as systemic inflammation scores.

RESULTS: No statistically significant differences were found between MAV-CR groups in PPN, PLR, NLR, and SII parameters ($p>0.05$). No statistically significant correlation was observed between inflammation scores and MAV-CR groups ($p>0.05$). In this comparison, no significant difference was observed between the selected CBC parameters and the groups divided according to the compression rate (WBC: $p=0.725$, PC: $p=0.069$, NC: $p=0.732$, LC: $p=0.513$). ROC analysis was performed to analyze the diagnostic tests (AUC=0.372 for PPN, AUC=0.509 for PLR, AUC=0.525 for NLR, and AUC=0.435 for SII). None of the systemic inflammation scores had any predictive value for osteoporotic vertebral collapse fractures.

CONCLUSIONS: Although it has been established in the scientific literature that systemic inflammation scores are associated with osteoporotic vertebral fractures, our analysis indicates no statistically significant correlation between the parameters of PPN, PLR, NLR, and SII and the severity of compression fractures in individuals with osteoporotic vertebral fractures. In this study, using systemic inflammation scores as a predictive test for the severity of osteoporotic vertebral fractures does not seem appropriate.

Key Words:
Osteoporosis, Vertebral fracture, Systemic inflammation, Neutrophil/lymphocyte ratio, Systemic immune inflammation index.

Abbreviations
SIS: Systemic Inflammation Scores; PPN: Product of Platelet and Neutrophil Counts; PLR: Platelet/Lymphocyte ratio; NLR: Neutrophil/Lymphocyte ratio; SII: Systemic Immune Inflammation Index; CT: Computed Tomography; MRI: Magnetic Resonance Imaging; ASA: American Society of Anesthesiologists; WBC: White Blood Cell count; PC: Platelet count; NC: Neutrophil count; LC: Lymphocyte count; MAV: Most Affected Vertebra; MAV-CR: Most Affected Vertebra Collapse Rate; ROC: Receiver Operating Characteristic; AUC: Area Under the Curve.

Introduction

Osteoporosis is a prevalent condition frequently found in women after menopause, and it is linked to the natural process of aging, the onset of menopause, reduced estrogen levels, and systemic inflammation[1]. The significance of inflammation in the etiology of osteoporosis, specifically in the bone remodeling process involving bone production and destruction, has been well-established in the scientific literature[2,3]. The primary and easily accessible quantitative data for acquiring medical

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information about inflammation are obtained through the complete blood count and usual biochemical testing. Furthermore, other alternative markers of inflammation have been found alongside conventional signs, such as leukocyte count, C-reactive protein (CRP), and procalcitonin. The parameters for evaluation include the neutrophil/lymphocyte ratio (NLR), platelet/lymphocyte ratio (PLR), the product of platelet and neutrophil numbers (PPN), and the systemic immunological inflammation index (SII). The parameters for consideration are produced from data received by a comprehensive analysis of blood components, known as a complete blood count. These markers help to determine the existence and extent of inflammation. Studies[4] in the scientific literature have reported a negative connection between the SII and the NLR with bone matrix density. The recent acknowledgment needs further expansion on the correlation between inflammatory indicators and the incidence of vertebral collapse in individuals with osteoporotic vertebral fractures.

Examining potential associations between inflammatory markers and rates of collapse in osteoporotic vertebral compression fractures could provide a beneficial risk assessment tool for predicting the degree of collapse in the event of a prospective vertebral fracture among persons diagnosed with osteoporosis. The main aim of this study is to investigate the potential association between inflammatory markers and the incidence of vertebral collapse in people diagnosed with osteoporotic vertebral fractures.

Patients and Methods

Study Design

This study retrospectively analyzed data from the medical records of patients diagnosed with osteoporotic compression fractures who underwent kyphoplasty in the Department of Neurosurgery of the Prof. Dr. Cemil Tascioglu City Hospital between January 1, 2018, and January 1, 2023. All procedures followed were in accordance with the ethical standards of the responsible committee for human experimentation (institutional and national) and the Helsinki Declaration of 1975, as revised in 2013. Ethics committee approval was taken from the University of Health Sciences, Prof. Dr. Cemil Tascioglu City Hospital (No.: 64/2023).

Only individuals who had undergone surgical kyphoplasty for an osteoporotic compression fracture were included in the study. Individuals who did not undergo surgery were excluded from the study. Pertinent case data, including age, gender, and osteoporosis diagnosis, were extracted from the patients' medical records. The degree of vertebral compression and collapse rates were determined by CT scans. In cases where an individual had multiple vertebral level compressions, the vertebra with the most significant degree of collapse, referred to as the most affected vertebra (MAV), was then included in the study. The collapse rate of the most affected vertebra (MAV-CR) was calculated. Vertebral collapse rates were categorized into two groups using a threshold of 50%.

Peripheral CBC values obtained prior to surgery were analyzed during the initial admission of the patients. Inflammatory markers were calculated using white blood cell (WBC), platelet (PC), neutrophil (NC), and lymphocyte (LC) counts, and systemic inflammation scores PPN, PLR, NLR, and SII were analyzed. SII was determined using the following formula: platelet count multiplied by neutrophil count divided by lymphocyte count.

Inclusion and Exclusion Criteria

Inclusion criteria included individuals classified as ASA 1, 2, or 3 between the ages of 50 and 90 years. Both men and women, regardless of gender, were eligible for inclusion. The difference between osteoporotic vertebrae and burst fractures and pathologic fractures, which are other causes of fracture, was demonstrated by preoperative CT and MRI imaging of the patients. The exclusion criteria for this study include the following: patients classified as ASA 4 in the preoperative anesthesia evaluation due to inability to assume the prone position. Also, individuals who are morbidly obese and patients who are either younger than 50 years or older than 90 years.

Statistical Analysis

SPSS 15.0 for Windows (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Descriptive statistics were reported as numbers and percentages for categorical variables and mean, standard deviation, minimum, and maximum for numerical variables. Two independent group comparisons of numerical variables were performed using the Student's *t*-test when the normal distribution condition was met and the Mann-Whitney U test when the condition was not met. Independent group comparisons of numerical variables were performed with the one-way ANOVA test when the numerical variables met the condition

of normal distribution in the groups and with the Kruskal-Wallis' test when the condition was not met. Subgroup analyses were performed with the Mann-Whitney U test in a nonparametric test and interpreted with Bonferroni correction. Relationships between numerical variables were analyzed by Pearson's correlation analysis when the parametric test condition was met and by Spearman's correlation analysis when the condition was not met. The alpha level of statistical significance was accepted as $p<0.05$. Statistical analysis was performed between the MAV-CR groups according to the inflammation scores and whether it could be used as a diagnostic test.

Results

The study includes a total of 50 cases. The study participants were selected from the age group between 50 and 90 years. The mean age of the cases was 68.8 (9.6) years. Of the total cases, 11 cases (22%) were in the age range of 50-59 years. Similarly, 15 cases (30%) were in the age range of 60-69, while 16 cases (32%) were in the age range of 70-79. Finally, 8 cases (16%) were found in the 80-89 age group. In terms of gender, the data shows that 39 cases (78%) were female, while 11 cases (22%) were male. Of the total number of cases, 12 cases (24%) were ASA 1, 25 cases (50%) were ASA 2, and 13 cases (26%) were ASA 3. The MAV was L1 in 23 cases (46%), followed by T12 in 9 cases (18%), L2 in 6 cases (12%), L3 in 5 cases (10%), L4 in 4 cases (8%), L5 in 2 cases (4%), and T11 in 1 case (2%). Based on the analysis of MAV-CR, the group with a collapse rate lower than 50% was composed of 19 cases (38%). Conversely, the group with a collapse rate of 50% or greater was made by 31 (62%). The study observed that the number of affected vertebrae (NoAV) was distributed as follows: 38 cases (76%) had 1 NoAV, 7 cases (14%) had 2 NoAV, 4 cases (8%) had 3 NoAV, and 1 case (2%) had 4 NoAV (Table I).

All CBC parameters used to calculate systemic inflammation scores were WBC (10^3/uL): 7.56 (±1.98), PC (10^3/uL): 276.3 (±69.2), NC (10^3/uL): 4.87 (±1.63), LC (10^3/uL): 1.99 (±0.80). The calculated inflammation scores were PPN: 1,385.0±661.3, PLR: 163.1±79.6, NLR: 2.96±1.95, SII: 817.1±536.2 (Table II).

CBC parameters WBC, PC, NC, and LC used to calculate inflammation scores were compared according to age, ASA score, and NoAV. There was no statistically significant linear relationship between preoperative CBC and SIS levels and age, ASA score, and NoAV levels (Table III, Figure 1).

The patients were divided into 4 groups according to their age: 50-59, 60-69, 70-79, and 80-89 years. Preoperative CBC and SIS levels were compared in age groups, male and female sex, and ASA score, and no statistically significant difference was found (Table IV).

Table I. Distribution of the general demographic characteristics of the cases.

Age Mean±SD (Min-Max)	68.8±9.6 (51-89)	
Age n (%)	50-59	11 (22.0)
	60-69	15 (30.0)
	70-79	16 (32.0)
	80-89	8 (16.0)
Gender n (%)	Female	39 (78.0)
	Male	11 (22.0)
ASA Score n (%)	1	12 (24.0)
	2	25 (50.0)
	3	13 (26.0)
NoAV n (%)	1	38 (76.0)
	2	7 (14.0)
	3	4 (8.0)
	4	1 (2.0)
MAV n (%)	L1	23 (46.0)
	L2	6 (12.0)
	L3	5 (10.0)
	L4	4 (8.0)
	L5	2 (4.0)
	T11	1 (2.0)
	T12	9 (18.0)
MAV-CR n (%)	<50%	19 (38.0)
	>50%	31 (62.0)

ASA score: American Society of Anaesthesiologists physical status classification, NoAV: Number of affected vertebrae, MAV: Most affected vertebrae, MAV-CR: Most affected vertebral compression rate, L: Lumbar vertebrae, T: Thoracal vertebrae.

Table II. Preoperative CBC and systemic inflammation scores.

		Mean±SD (Min-Max)
CBC	WBC (10^3/uL)	7.56±1.98 (3.52-11.83)
	PC (10^3/uL)	276.3±69.2 (144-477)
	NC (10^3/uL)	4.87±1.63 (1.99-8.75)
	LC (10^3/uL)	1.99±0.80 (0.5-4.32)
SIS	PPN	1385.0±661.3 (364.2-2986.6)
	PLR	163.1±79.6 (53.5-442)
	NLR	2.96±1.95 (0.7-11.5)
	SII	817.1±536.2 (157.9-2550.3)

CBC: Complete blood count. WBC: White blood cells. PC: Platelet count. NC: Neutrophil count, LC: Lymphocyte count. SIS: Systemic inflammation scores. PPN: Product of platelet count and neutrophil count. PLR: Platelet lymphocyte ratio. NLR: Neutrophil lymphocyte ratio. SII: Systemic immune inflammation index. SD: Standard deviation.

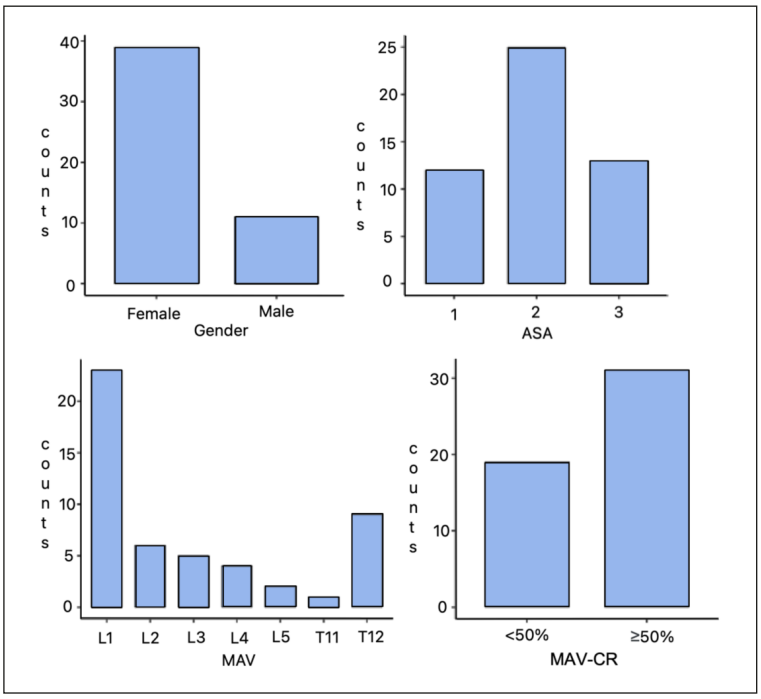

Figure 1. Distribution of cases by gender, ASA scores, most affected verebrae (MAV), and most affected vertebrae compression rate (MAV-CR) groups.

Table III. Comparison of pre-operative complete blood count and systemic inflammation score levels by age, ASA Score and number of affected vertebrae level.

		Age		ASA Score		NoAV	
		r	*p*	*r*	*p*	*r*	*p*
CBC	WBC (10^3/uL)	-0.008	0.957	-0.151	0.295	0.179	0.214
	PC (10^3/uL)	-0.204	0.156	-0.054	0.708	-0.100	0.491
	NC (10^3/uL)	-0.163	0.257	-0.115	0.425	0.084	0.562
	LC (10^3/uL)	-0.166	0.248	-0.223	0.119	0.140	0.332
SIS	PPN	-0.167	0.246	-0.105	0.466	0.001	0.993
	PLR	0.078	0.591	0.184	0.201	-0.121	0.401
	NLR	0.026	0.855	0.077	0.597	-0.094	0.516
	SII	-0.060	0.679	0.009	0.952	-0.098	0.498

ASA score: American Society of Anaesthesiologists physical status classification. NoAV: Number of affected vertebrae. CBC: Complete blood count. WBC: White blood cells. PC: Platelet count. NC: Neutrophil count. LC: Lymphocyte count. SIS: Systemic inflammation scores. PPN: Product of platelet count and neutrophil count. PLR: Platelet lymphocyte ratio. NLR: Neutrophil lymphocyte ratio. SII: Systemic immune inflammation index.

Preoperative CBC and SIS levels were compared in the NoAV, MAV, and MAV-CR groups. WBC, PC, NC, and LC, which are the CBC parameters used to calculate the inflammation scores, were compared according to the MAV-CR groups, which were divided into two groups: <50% and ≥50%. In this comparison, no significant difference was observed between the selected CBC parameters and the groups divided according to the compression rate (WBC: p=0.725, PC: p=0.069, NC: p=0.732, LC: p=0.513, respectively) (Table V).

Systemic inflammation scores, PPN, PLR, NLR, and SII parameters were compared according to MAV-CR groups. No significant difference was observed between the groups divided by 50% compression rate and inflammation scores (PPN: p=0.396, PLR: p=0.912, NLR: p=0.772, SII: p=0.442, respectively) (Table V).

Figure 2 illustrates the distribution of systemic inflammation scores for the PPN, PLR, NLR, and SII values according to the most affected vertebrae compression rate (MAV-CR) groups (Figure 2).

ROC analysis was performed to analyze the diagnostic test. AUC=0.372 for PPN, AUC=0.509 for PLR, AUC=0.525 for NLR, and AUC=0.435 for SII, it was seen that the test

Table IV. Comparison of preoperative complete blood count and systemic inflammation score levels by age group, gender and ASA Score.

			WBC (10^3/uL)	PC (10^3/uL)	NC (10^3/uL)	LC (10^3/uL)	PPN	PLR	NLR	SII
Age	**50-59**	Mean±SD	8.23±2.14	297.6±56.8	5.44±1.91	2.10±0.59	1617.1± 660.0	154.9± 56.1	2.85± 1.41	845.5± 461.4
		Min-Max	5.42-10.99	219-382	2.66-8.75	0.96-2.88	755.4-2861.3	80.8-253.1	1.02-6.03	288.3-1973.3
		Median	8.39	284	5.18	2.08	1616.0	157.2	2.72	796.1
	60-69	Mean±SD	7.44±1.95	275.5±62.5	4.77±1.41	2.01±0.85	1341.8± 575.1	165.2± 90.6	3.08± 2.54	810.7± 567.8
		Min-Max	5.16-11.83	170-394	2.71-6.8	0.5-3.75	521.9-2628	84.5-442	0.99-11.54	242.2-2550.3
		Median	6.73	262	4.57	1.79	1275.2	132.4	2.58	656.2
	70-79	Mean±SD	7.74±1.95	279.9±83.3	4.80±1.73	2.20±0.85	1417.3±796.3	162.1±100.8	2.85±2.17	838.5±680.0
		Min-Max	4.09-11.09	173-477	2.05-8.05	0.59-4.32	473.6-2986.6	53.5-427.1	0.68-9.03	157.9-2276.5
		Median	7.65	260	5.265	2.37	1412.6	136.3	2.06	572.5
	80-89	Mean±SD	6.50±1.74	241.0±63.6	4.41±1.46	1.42±0.30	1082.1± 471.8	172.1± 38.4	3.12± 0.86	747.5± 254.3
		Min-Max	3.52-9.08	144-343	1.99-6.69	1.05-1.84	364.2-1806.3	104.3-237.3	1.90-4.19	346.8-1094.7
		Median	6.225	240.5	4.085	1.43	1089.0	173.8	3.26	793.2
		p	0.298*	0.374*	0.567*	0.141*	0.380*	0.780**	0.615**	0.892**
Gender	**Female**	Mean±SD	7.50±1.87	285.4±66.8	4.85±1.65	1.99±0.76	1428.6± 682.3	169.6± 84.4	3.03± 2.16	862.0± 580.2
		Min-Max	3.52-11.83	173-477	1.99-8.75	0.5-3.75	364.2-2986.6	55.8-442	0.68-11.54	157.9-2550.3
		Median	7.34	275	4.68	2.03	1447.5	168.6	2.64	742.0
	Male	Mean±SD	7.75±2.41	243.9±70.9	4.92±1.65	2.01±0.97	1230.3± 582.9	140.0± 56.8	2.70± 0.94	658.1± 306.7
		Min-Max	4.09-11.09	144-382	2.64-7.38	0.8-4.32	509.5-2208	53.5-241.3	1.38-4.19	318.2-1174.4
		Median	8.39	231	4.94	1.81	1326.8	139.2	2.72	596.4
		p	0.716#	0.079#	0.910#	0.953#	0.385#	0.331##	0.953##	0.393##
ASA Score	**1**	Mean±SD	7.73±1.70	285.2±74.9	4.81±1.54	2.21±0.77	1432.6± 695.6	156.0± 96.1	2.81± 2.22	800.1± 581.4
		Min-Max	5.61-10.73	173-394	2.66-7.03	0.59-3.1	505.4-2628	55.8-427.1	0.99-9.03	186.4-2276.5
		Median	7.56	275.5	4.885	2.555	1486.7	133.2	2.42	686.5
	2	Mean±SD	7.85±2.02	274.5±74.8	5.17±1.76	1.97±0.73	1451.9± 714.3	161.0± 82.7	3.18± 2.21	868.6± 611.0
		Min-Max	5.06-11.83	144-477	2.05-8.75	0.5-3.75	473.6-2986.6	75.9-442	0.68-11.54	157.9-2550.3
		Median	7.51	259	5.18	1.81	1447.5	139.2	2.70	674.8
	3	Mean±SD	6.83±2.10	271.4±55.6	4.34±1.42	1.84±0.96	1212.3±526.8	173.5± 59.8	2.68±1.03	733.8±322.7
		Min-Max	3.52-11.09	183-382	1.99-6.69	0.8-4.32	364.2-2208	53.5-253.1	1.02-4.23	288.3-1174.4
		Median	6.3	270	4.06	1.65	1133.9	174.3	2.39	671.0
		p	0.305*	0.874*	0.328*	0.527*	0.557*	0.395**	0.683**	0.996**

*One-way ANOVA **Kruskal-Wallis. ASA score: American Society of Anaesthesiologists physical status classification. CBC: Complete blood count. WBC: White blood cells. PC: Platelet count. NC: Neutrophil count. LC: Lymphocyte count. SIS: Systemic inflammation scores. PPN: Product of platelet count and neutrophil count. PLR: Platelet lymphocyte ratio. NLR: Neutrophil lymphocyte ratio. SII: Systemic immune inflammation index. SD: Standard deviation.

Table V. Comparison of preoperative complete blood count and systemic inflammatory score levels across number of vertebrae, most affected vertebrae, and most affected vertebrae compression rate groups.

			WBC (10^3/uL)	PC (10^3/uL)	NC (10^3/uL)	LC (10^3/uL)	PPN	PLR	NLR	SII
NoAV	**1**	Mean±SD	7.42±1.74	281.0±73.4	4.83±1.52	1.92±0.65	1390.4± 639.3	164.5± 71.3	2.90± 1.55	814.1± 473.7
		Min-Max	4.09-10.93	144-477	2.64-8.05	0.59-3.1	505.4-2986.6	55.8-427.1	0.99-9.03	186.4-2276.5
		Median	7.425	269	4.625	1.825	1449.2	160.4	2.71	708.4
	2	Mean±SD	6.07±1.26	243.3±41.5	3.76±1.43	1.69±0.92	936.5±421.2	190.1±120.0	3.47±3.69	820.1±810.7
		Min-Max	3.52-7.49	183-296	1.99-5.77	0.5-3	364.2-1539.2	77.0-442.0	0.68-11.54	157.9-2550.3
		Median	6.3	231	3.87	1.66	893.6	174.3	2.29	671.0
	3	Mean±SD	10.61±1.30	276.5±67.8	6.20±0.69	3.36±0.81	1749.1± 611.5	86.7±33.5	1.93± 0.55	551.8± 272.1
		Min-Max	8.78-11.83	208-350	5.4-7.03	2.63-4.32	1123.2-2460.5	53.5-133.1	1.38-2.67	318.2-935.6
		Median	10.91	274	6.19	3.245	1706.4	80.2	1.84	476.7
	4	Mean±SD	10.99	327.0	8.75	1.45	2861.3	225.5	6.03	1973.3
		p	0.058#	0.196#	0.091#	0.427#	0.079#	0.684##	0.639##	0.471##
MAV-CR	**<50%**	Mean±SD	7.69±1.53	298.9±54.8	4.97±1.40	2.09±0.68	1487.6±502.9	163.8±78.1	2.89±1.89	836.8±480.8
		Min-Max	5.42-10.45	238-394	2.66-6.81	0.59-2.88	661.2-2628	87.5-427.1	0.99-9.03	242.2-2276.5
		Median	7.64	281	5.18	2.16	1504.8	163.6	2.58	742.0
	>50%	Mean±SD	7.48±2.23	262.4±74.1	4.81±1.77	1.94±0.87	1322.0±742.8	162.6±81.8	3.01±2.02	805.1±574.9
		Min-Maks	3.52-11.83	144-477	1.99-8.75	0.5-4.32	364.2-2986.6	53.5-442.0	0.68-11.54	157.9-2550.3
		Median	6.73	239	4.39	1.69	1133.9	144.6	2.67	656.2
		p	0.725#	0.069#	0.732#	0.5133#	0.396#	0.912##	0.772##	0.442##
MAV	**L1**	Mean±SD	7.08±2.01	264.6±81.6	4.46±1.69	1.97±0.88	1234.6± 712.0	160.9± 84.3	2.78±1.82	747.3±538.8
		Min-Max	3.52-11.09	144-477	1.99-7.38	0.59-4.32	364.2-2838.2	53.5-427.1	0.68-9.03	157.9-2276.5
		Median	6.73	244	4.4	1.81	986.6	157.2	2.64	566.7
	L2	Mean±SD	8.60±2.37	275.5±27.9	5.44±1.46	2.27±0.91	1492.1±406.2	137.8±56.5	2.63±0.91	709.0±204.6
		Min-Max	5.88-11.83	238-317	3.46-6.8	1.1-3.75	1017.2-2038.3	84.5-237.3	1.41-3.64	413.5-949.1
		Median	8.515	271.5	5.805	2.245	1535.8	118.4	2.85	735.5
	L3	Mean±SD	7.20±2.12	274.4±75.8	4.50±2.08	1.91±0.73	1341.7±979.1	164.2±77.6	2.80±1.83	846.8±732.8
		Min-Max	5.61-10.9	190-371	2.66-8.05	1.14-2.8	505.4-2986.6	73.9-254.1	1.04-5.51	196.7-2045.6
		Median	6.54	259	3.98	1.6	893.6	193.0	2.73	768.1
	L4	Mean±SD	7.46±1.62	248.8±36.5	4.80±0.78	2.07±0.90	1195.5±276.1	145.8± 78.5	2.63± 0.94	663.2±280.3
		Min-Max	5.16-8.78	208-296	3.66-5.4	0.99-2.88	874.7-1539.2	75.9-241.4	1.72-3.70	409.9-927.2
		Median	7.94	245.5	5.07	2.20	1184.0	132.9	2.55	657.9
	L5	Mean±SD	9.405±2.24	297.5±41.7	7.12±2.31	2.00±0.77	2164.9±984.7	165.5±84.9	4.10±2.70	1275.7± 986.5
		Min-Max	7.82-10.99	268-327	5.48-8.75	1.45-2.54	1468.6-2861.3	105.5-225.5	2.20-6	578.2-1973.3
		Median	9.405	297.5	7.115	1.995	2164.9	165.5	4.10	1275.7
	T11-T12	Mean±SD	7.96	372	4.57	2.81	1700	132.4	1.63	605
		Mean±SD	7.88±1.72	304.6±63.1	5.29±1.30	1.79±0.68	1597.7±493.7	195.3±95.5	3.77± 3.04	1041.2±605.8
		Min-Max	5.83-10.73	214-382	3.77-7.03	0.50-2.85	1036.8-2460.5	133.1-442	1.39-11.54	528-2550.3
		Median	7.34	293.0	5.77	1.69	1504.8	173.4	2.67	896.5
		p	0.557**	0.629*	0.562*	0.865*	0.646*	0.677**	0.932**	0.487**

-not included in the analysis *One-way ANOVA **Kruskal-Wallis #Student *t*-test ##Mann-Whitney U test. NoAV: Number of affected vertebrae. MAV: Most affected vertebrae. MAV-CR: Most affected vertebral compression rate. L: Lumbar vertebrae. T: Thoracal vertebrae. CBC: Complete blood count. WBC: White blood cells. PC: Platelet count. NC: Neutrophil count. LC: Lymphocyte count. SIS: Systemic inflammation scores. PPN: Product of platelet count and neutrophil count. PLR: Platelet lymphocyte ratio. NLR: Neutrophil lymphocyte ratio. SII: Systemic immune inflammation index. SD: Standard deviation.

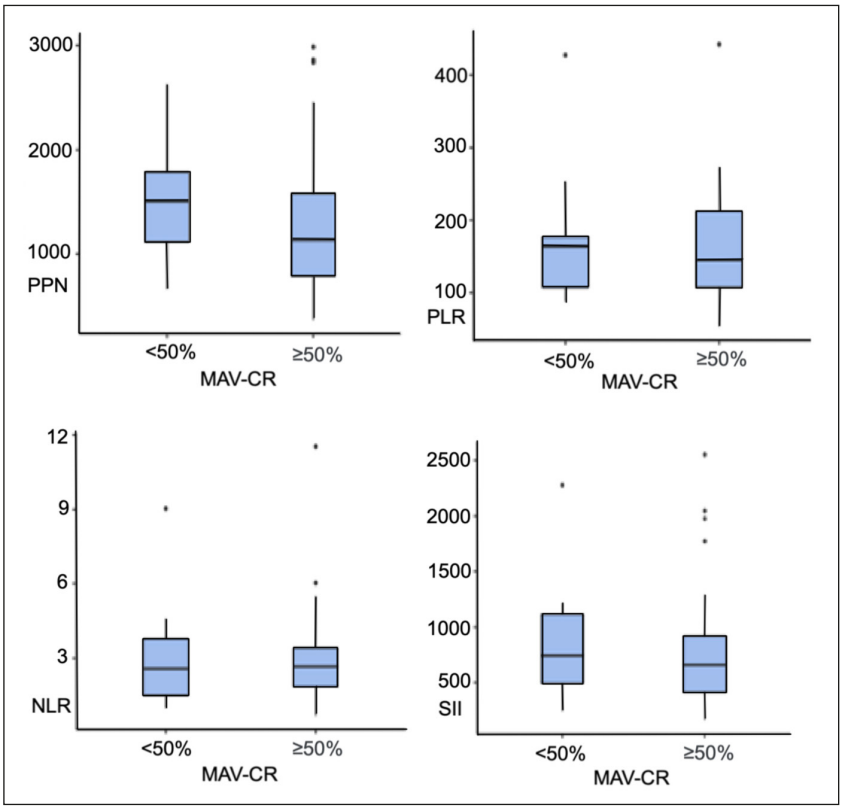

Figure 2. The distribution of systemic inflammation scores for the product of platelet and neutrophil counts (PPN), platelet / lymphocyte ratio (PLR), neutrophil / lymphocyte ratio (NLR), and systemic immune inflammation index (SII) values according to the most affected vertebrae compression rate (MAV-CR) groups.

success was at a "failed" level for all parameters and no cut-off value was selected. Figure 3 displays the ROC analyses of the PPN, PLR, NLR, and SII values for collapse rates in osteoporotic vertebral fractures and shows that they are not suitable for use as predictive tests.

Discussion

The CBC is an easy-to-obtain, inexpensive, and widely used diagnostic tool, making it a valuable test for identifying the presence of inflammation. The purpose of this study was to investigate the potential correlation between inflammation scores derived from peripheral CBC results in cases of osteoporotic vertebral compression fractures and rates of osteoporotic vertebral collapse calculated by CT. In addition, the study aimed to determine the feasibility of using these inflammation scores as a diagnostic tool. The authors of this study were motivated by numerous studies that reported a negative correlation between bone matrix density and inflammation scores[5]. These studies led them to formulate a scientific research question regarding the potential relationship between collapse rates and inflammation scores in osteoporotic compression fractures. Consequently, the study was designed to investigate this relationship. The primary finding of this study is that there was no statistically significant difference between the MAV-CR groups categorized as <50% and ≥50% and the inflammation scores, PPN, PLR, NLR, and SII parameters. Therefore, the MAV-CR test is not recommended for diagnostic purposes.

Inflammation scores can be determined by using absolute WBC, PC, NC, and LC obtained from CBC. The parameters of interest in our study are inflammation scores that have been extensively studied and documented in the existing literature. These scores include the PPN, PLR, NLR, and SII, all of which are relevant to our investigation.

The balance between bone formation and destruction, regulated by the activity of osteoblasts and osteoclasts, is responsible for determining bone density. This balance leads to the development of osteopenia and osteoporosis when bone resorption is increased[6]. The activation of inflammation and subsequent increase in osteoclast activity leading to bone destruction can be attributed to suppression of the immune system and impairment of lymphocyte function, particularly in the bone marrow[7,8]. A cross-sectional study by Öztürk et al[9] included 1,635 individuals

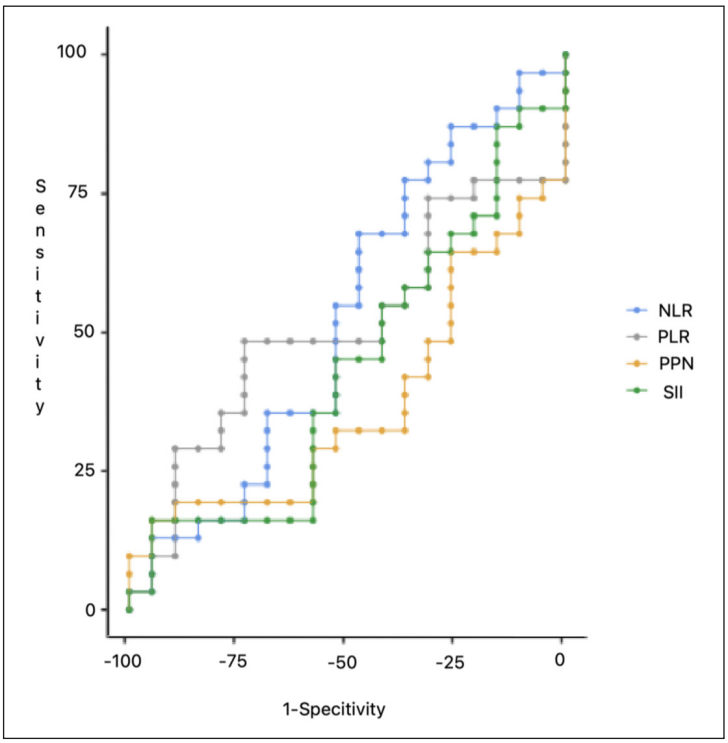

Figure 3. ROC analysis of the product of platelet and neutrophil count (PPN), platelet/lymphocyte ratio (PLR), neutrophil/lymphocyte ratio (NLR), and systemic immune inflammation index (SII) values for collapse rates in osteoporotic vertebral fractures.

aged 65 years and older. The results of this study indicated an elevated level of NLR in elderly individuals and those diagnosed with osteoporosis. Consequently, inflammation has been suggested[9] to play an important role in bone remodeling. The insignificance observed in our study may be due to the inclusion of patients who were younger than 65 years. It is believed that the inclusion of individuals aged 65 years and older as the threshold for osteoporosis may introduce bias, as osteoporotic fractures resulting from bone resorption may manifest at earlier stages of life.

According to a multicenter prospective cohort study[10] with 238 cases, the SII value is a reliable predictor in postmenopausal osteoporotic patients and a simple, inexpensive biomarker that can differentiate osteoporotic fracture risk. Based on the results of a cross-sectional study[11] with a sample size of 413 cases, there is an inverse correlation between the SII values of postmenopausal women and their bone matrix density. These findings suggest that SII values may serve as a predictive measure of bone loss in this specific population of women.

In a cross-sectional study[12] of 893 postmenopausal women, it was found that the SII value may be a predictor of osteoporosis in those older than 50 years and that there is an increased risk of osteoporosis with SII, NLR, and PPN values. Another cross-sectional study[13] of 4,092 women older than 20 years found that SII levels were negatively associated with bone matrix density in postmenopausal women, but not in premenopausal women. In contrast to the findings of this study, our study of osteoporotic patients with fractures does not provide data on fracture rates. While SII and other inflammatory measures have been proposed as predictive indicators of bone density in these abovementioned studies, they do not show a similar rate of change in compression rate.

Similarly, in a study[14] of 80 patients with osteoporotic vertebral or femoral neck fractures, NLR was associated with the severity of osteoporotic fractures, with more severe osteoporotic fractures occurring at higher NLR values. Although this study mentioned that vertebral fractures were categorized into moderate and severe fractures, similar to femoral neck fractures, it is unclear which values were used to categorize vertebral fractures, and the study seems to focus more on femoral neck fractures. In light of this aspect of the study, we believe that an investigation of osteoporotic vertebral fractures is needed. Our current research attempts to focus on the issue from this angle.

Based on the current collection of literature, we have formulated a research study within our clinical setting to examine the potential correlation between rates of osteoporotic vertebral collapse and inflammation scores.

While a previous study[13] reported the significance of NLR in receiver operating characteristic analysis, it is important to note that this significance was assessed specifically for osteoporotic femoral neck fractures. However, the evaluation of osteoporotic vertebral fractures was not explicitly mentioned[13]. Based on the results of this study, there was no statistically significant difference in the NLR, which is consistent with the results of other inflammation scoring systems. Therefore, it is imperative to conduct multicenter studies to determine the potential correlation between inflammation scores and fracture severity.

The existing literature indicates a robust correlation between osteoporosis and estrogen deficiency, with scientific studies documenting the impact of estrogen deficiency on the inflammatory process and subsequent bone degradation[15]. However, it should be noted that estrogen deficiency cannot be attributed to only one factor in the inflammatory process leading to bone destruction. Therefore, this study included both sexes, including individuals of both sexes diagnosed with osteoporotic vertebral fractures, rather than focusing only on postmenopausal women. Nevertheless, the majority of cases are relevant to women. While previous literature has suggested that inflammation scores, specifically the SII, may serve as a predictive tool for osteoporosis in postmenopausal women, this study did not include data on the severity of osteoporotic vertebral fractures.

Limitations

The strength of the study is that it focused on a single site and included all osteoporotic vertebral fractures regardless of gender. In addition, because the inflammation scores were continuous numerical factors and the collapse rates were categorical variables that could be divided into two groups, the statistical analysis was more understandable and reliable. Disadvantages of the study include its single-center and retrospective nature, which resulted in a small number of cases, and the lack of bone densitometry. Multicenter prospective studies with a large number of cases are needed to obtain more significant results.

Conclusions

A statistical relationship between the PPN, PLR, NLR, and SII parameters used as inflammation scores and the severity of osteoporotic vertebral fractures could not be established in this study. Therefore, they may not be appropriate as risk predictors for osteoporotic vertebral fractures. Clinical trials with larger sample sizes are needed to confirm the results of this study.

Conflict of Interest

The author reports no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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Ethics Approval

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2013. Ethics committee approval was taken from the University of Health Sciences, Prof. Dr. Cemil Tascioglu City Hospital (No.: 64/2023).

Informed Consent

Written informed consent was obtained by patients before the study.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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References

1) Rodriguez-Morales J, Méndez-Viveros A, Pineda-Hernández C, Parra-Romero G, Ariñez-Barahona E, Guartazaca-Guerrero S, Méndez-García LA. Incidence of neurosurgical pathology of the spine in population of Mexico City. Cir Cir 2021; 89: 806-810.
2) LeBoff MS, Greenspan SL, Insogna KL, Lewiecki EM, Saag KG, Singer AJ, Siris ES. The clinician's guide to prevention and treatment of osteoporosis. Osteoporos Int 2022; 33: 2049-2102.
3) Uysal E, Cine HS, Cetin E. The necessity and timing of exercise after lumbar disc herniation surgery. Eur Rev Med Pharmacol Sci 2023; 27: 9521-9529.
4) Chen S, Sun X, Jin J, Zhou G, Li Z. Association between inflammatory markers and bone mineral density: a cross-sectional study from NHANES 2007-2010. J Orthop Surg Res 2023; 18: 305.

5) Cine HS, Uysal E, Gurbuz MS. Is neutrophil-to-lymphocyte ratio a prognostic marker for traumatic brain injury in the pediatric population? Eur Rev Med Pharmacol Sci 2023; 27: 9729-9737.
6) Chen TZ, Lu XJ, Wu DZ, Meng FF, Qin RJ. Efficacy of minimally invasive transforaminal lumbar interbody fusion plus cement-augmented pedicle screw fixation in the treatment of degenerative lumbar spine disease with osteoporosis in the elderly. Eur Rev Med Pharmacol Sci 2023; 27: 6573-6582.
7) Dirckx N, Hul M Van & Maes C. Osteoblast recruitment to sites of bone formation in skeletal development, homeostasis, and regeneration. Birth Defects Research Part C 2013; 99: 170-191.
8) Weitzmann MN. T-cells and B-cells in osteoporosis. Current Opinion in Endocrinology, Diabetes, and Obesity 2014; 21: 461-467.
9) Öztürk ZA, Yesil Y, Kuyumcu ME, Bilici M, Öztürk N, Yeşil NK, Özkaya M, Kısacık B, Kepekçi Y, Arıoğul S. Inverse relationship between neutrophil lymphocyte ratio (NLR) and bone mineral density (BMD) in elderly people. Arch Gerontol Geriatr 2013; 57: 81-85.
10) Fang H, Zhang H, Wang Z, Zhou Z, Li Y, Lu L. Systemic immune-inflammation index acts as a novel diagnostic biomarker for postmenopausal osteoporosis and could predict the risk of osteoporotic fracture. J Clin Lab Anal 2020; 34: e23016.
11) Du YN, Chen YJ, Zhang HY, Wang X, Zhang ZF. Inverse association between systemic immune-inflammation index and bone mineral density in postmenopausal women. Gynecol Endocrinol 2021; 37: 650-654.
12) Tang Y, Peng B, Liu J, Liu Z, Xia Y, Geng B. Systemic immune-inflammation index and bone mineral density in postmenopausal women: A cross-sectional study of the national health and nutrition examination survey (NHANES) 2007-2018. Front Immunol 2022; 13: 975400.
13) Zhang J, Jiang J, Qin Y, Zhang Y, Wu Y, Xu H. Systemic immune-inflammation index is associated with decreased bone mass density and osteoporosis in postmenopausal women but not in premenopausal women. Endocr Connect 2023; 12: e220461.
14) Zhu H, Li Z, Zhou Y, Zheng R, Diao C, Li K, Feng Q, Wang D. Neutrophil-lymphocyte ratio as a risk factor for osteoporotic vertebrae fractures and femoral neck fractures. Medicine (Baltimore) 2022; 101: e32125.
15) Weitzmann MN, Pacifici R. Estrogen deficiency and bone loss: an inflammatory tale. Journal of Clinical Investigation 2006; 116: 1186-1194.