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A comparison of two surgical methods in the treatment of shoulder adhesive capsulitis

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Abstract. – OBJECTIVE: The purpose of the study was to compare the outcomes of arthroscopic capsular release surgery and manipulation of patients with resistant primary adhesive capsulitis (AC) under anesthesia.

PATIENTS AND METHODS: The study comprised forty-four patients who had surgery after being given a diagnosis of primary AC. Patients who had both passive and active glenohumeral and scapulothoracic movements equal to or less than 100° elevation and less than 50% of external rotation compared to the contralateral side were considered to have resistant adhesive capsulitis and were included in the study. Conservative treatments such as intra-articular steroid injections and physical therapy had failed to relieve the pain in these patients for at least six months. The patients who took part in the trial underwent manipulation under anesthesia (group 1) and arthroscopic capsular release (group 2) operations. The chosen surgical procedure was chosen at random and based on the surgeon's Preferences. Examining the patients' demographic information. After treatment, the patients were examined at three-month, six-month, and one-year intervals. Joint range of motion, visual analogue scale (VAS), and Constant-Murley shoulder scores were all recorded. Statistics were used to compare the outcomes of the two surgical techniques in this study both before and after the procedure.

RESULTS: The study's participants' gender, side, extra procedure, and age factors did not show a statistically significant difference between groups 1 and 2 ($p<0.05$). According to the age, gender, side, additional process, and homogeneous distribution throughout the groups.

No statistically significant difference was discovered between groups 1 and 2 in any of the measurements taken from study participants during the follow-up period: Pre-op visual pain scores (VPS), Post-op 3rd month VPS, Post-op 1st year VPS, Pre-op Constant score, Post-op 6th month Constant score, and Post-op 1st year Constant score ($p<0.05$). The change in VPS and Constant Score values over time did not show a statistically significant difference between the groups ($p<0.05$). A statistically significant difference between the groups was discovered in each of the Pre-op period and Post-op 6th month VPS assessments ($p<0.05$).

CONCLUSIONS: Although there was no statistically significant difference between the two studied therapies, the surgical method was shown to be more beneficial in both groups the shorter the pre-op period was between the onset of the complaints and the operation.

Key Words:
Adhesive capsulitis, Manipulation, Arthroscopic capsulotomy.

Introduction

Adhesive capsulitis (AC), often known as frozen shoulder, is an inflammatory condition of the shoulder brought on by the rigidity of the glenohumeral capsule[1]. Clinically, the afflicted shoulder shows discomfort, stiffness, and mobility restriction. One crucial physical examination indicator for the diagnosis of the condition is the loss of the passive range of motion (ROM) of the shoulder[2,3]. AC is categorized as either primary or secondary. The primary illness often develops slowly, is idiopathic, and frequently coexists with other conditions including hypertriglyceridemia, thyroid disease, thyroid medicine, diabetes mellitus, or cervical spondylosis. Usually, secondary illness arises as a result of shoulder stress or injury. Rotator cuff tears, fractures, surgery, and immobilization are typical ailments[4,5]. The prevalence of AC is estimated to affect 2-5% of the population and it affects women more than men[6-8]. The highest incidence is seen in people between the ages of 40 and 60 years[9]. 14-20% of patients develop similar symptoms in the contralateral shoulder[10,11]. AC is defined in "three clinicopathological stages" (freezing, frozen and thawing) that we find practical to decide on the treatment plan[10,12]. Stage 1 (the freezing phase) might take between

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two and six months. Clinically, it is mostly characterized by moderate to severe pain and some ROM restriction. The terminal period shows the loss of ROM. It can be mistaken for rotator cuff disorders. Stage 2 (the frozen phase) might last between four and twelve months. Patients report more pain in the early stages, but as the stage progresses, joint stiffness becomes a more common complaint than pain. Stage 3 (the melting phase) might take six months to two years. Clinically, this stage is distinguished by the gradual fading of some discomfort and stiffness. Up to 90% of patients who have frozen shoulder have responded well to conservative treatment[13-15]. It is essential to treat the underlying illness while treating frozen shoulder disease because in untreated illnesses the severity of the condition may be high, and the symptoms may be persistent[10].

In conservative treatment, there are treatment modalities, such non-steroidal antiinflammatory drug (NSAD), oral steroids, injectable steroids, physical therapy, hydrodilation, calcitonin, extracorporeal shock wave therapy (ESWT), acupuncture, and nerve blocks[7,16-31]. Patients with chronic problems who have not improved after receiving conservative care for 6-9 months should be given surgical surgery as an option.

Anesthesia-induced mobilization and arthroscopic capsular release are two surgical procedures[15,32,33]. The literature has a large number of studies on surgical treatment. According to the length of the patients' complaints, this study compared two surgical techniques used on patients with primary resistant AC who had not responded to conservative treatment.

Patients and Methods

This study was designed to have a minimum of 27 patients, a medium (0.5) effect size, a 95% confidence interval, and 80% power. Retrospective data on the surgeries carried out by a single surgeon was gathered. The research protocol has received approval from the ethics committee. All of the study participants provided their informed consent. The study comprised 44 individuals who received a diagnosis of primary resistant AC between May 2017 and May 2021 and underwent surgery. Before any surgical procedures were performed on any of the study subjects, shoulder magnetic resonance imaging was used to check for the presence of any additional shoulder lesions. Patients with shoulder osteoarthritis, calcified tendinitis, post-stroke hemiplegia, bone metastases in the shoulder area, rotator cuff diseases, a history of shoulder fracture, or previous shoulder surgery were excluded from the study. Patients with passive and active glenohumeral and scapulothoracic movements equal to or less than 100° elevation and less than 50% of external rotation were classified as having resistant AC and included in the study, as opposed to the contralateral side that is resistant to conservative treatment, such as intra-articular steroid injections and physical therapy for at least six months. Both arthroscopic muscle relaxation surgery (group 2) and manipulation under anesthesia (group 1) were performed on the patients. Following surgery, all patients underwent the same routine for physical therapy and rehabilitation. The surgical technique that was used was chosen at random and based on the surgeon's preferences. The patients' demographic information was looked at. Following treatment, the patients were examined at three-month, six-month, and one-year intervals. Joint range of motion, visual pain scores (VPS), and Constant-Murley shoulder scores were noted. Patients were asked for an average value during the VPS evaluation by taking into account their pain at night, their pain while resting, and their pain while performing daily activities. In this study, two surgical techniques' results were compared before and after surgery and statistically assessed.

Surgical Procedure

Group 1: Manipulation under anesthesia technique

Fluoroscopy was used to carefully perform the flexion-abduction-external-rotation-internal-rotation-and-adduction movements for the affected side shoulder joint while under blocking with general anesthetic or scalene anesthesia in the supine position. The stress in the joint capsule caused a tearing sound to be audible during these movements.

Group 2: Arthroscopic capsulotomy technique

Initially, general anesthesia or a scalene anesthesia blockade were used to perform diagnostic arthroscopy. Shawer was used to debride tissues that were fully loosening under the control of capsule and middle glenohumeral ligament (MGHL) and were compatible with intra-articular synovitis. Bleeding tissues were cauterized. After that, by entering the subacromial space, the subacromial bursa and coracoacromial ligament were

cleaned out. Acromioplasty was then carried out as needed, and the procedure was finished.

Statistical Analysis

The statistical application SPSS 25 (Statistical Program in Social Sciences, IBM Corp., Armonk, NY, USA) was used to analyze the data. The Shapiro-Wilk test was utilized to determine whether the study's data fit the normal distribution[35]. For comparison tests, the significance threshold (p) was set at 0.05.

Since the variables had a normal distribution (p<0.05), parametric hypothesis testing was used to complete the research.

Since repeated measurements were conducted with the assumption of normality, comparisons in dependent paired groups were undertaken using the paired samples t-test to see whether there was a difference between the groups. Multiple normal distributions, variance homogeneity controls, and repeated measures of variance analysis (repeated measures of ANOVA) were employed in the analyses.

An expanded version of the test of significance between two pairings for more than two groups is the ANOVA with repeated measurements. As opposed to one-way ANOVA in independent groups, this approach offers the chance to look at changes over time[34]. When one of the components is repeated, a two-way ANOVA analysis for repeated measurements is utilized. For instance, in these trials, groups are the first element, while time is the second. One of the elements is time, which is measured repeatedly. The goal is to determine whether there are any differences between the experimental and control groups regarding the dependent variable's change over time[35]. As a result of the analysis, both in-group and inter-group changes according to time can be compared, and at the same time, the probability of rejection rate while the H_0 hypothesis is true, i.e., the "Type I error", will decrease and consistent results will be obtained[36].

In the analysis of categorical data, cross tables were created, and Chi-squared analysis was performed.

Results

Comparison of Demographic Variables Between Groups

It was evaluated whether the participants included in the study differed between the groups according to the demographic variables, and the results are given in Table I.

According to the gender, side, extra procedure, and age factors of the study participants, there was no statistically significant difference between

Table I. Comparison of the groups according to the distribution of demographic variables.

Variable	Group		Surgery		Control	Test value	p-value
			Group 1	Group 2	Total		
Gender	**Women**	**N**	17	11	28	0.218[a]	0.641
		%	68.0%	61.1%	65.1%		
	Men	**N**	8	7	15		
		%	32.0%	38.9%	34,9%		
Side	**Right**	**N**	16	14	30	0.962[a]	0.327
		%	64.0%	77.8%	69.8%		
	Left	**N**	9	4	13		
		%	36.0%	22.2%	30.2%		
Comorbidite	**Yes**	**N**	2	8	10	**0.706[a]**	**0.006***
		%	8.0%	44.4%	23.3%		
	No	**N**	23	10	33		
		%	92.0%	55.6%	76.7%		
Total			25 (58.1%)	18 (41.9%)	**43**		
		Surgery	**Mean±sd**		**Min-Max**	**Test value**	**p-value**
Age		**Group 1**	59.32 ± 11.11		33-80	1.749[b]	0.088
		Group 2	53.22 ± 11.51		38-76		

Test value[a]: Chi-squared Test value (χ^2), sd: standard deviation, Test value[b]: test of significance (t-test) of the difference between two means, p-value: statistical significance, *p<0.05: there is a statistically significant difference between the groups.

Table II. Comparison of scores between groups.

Variable	Group	Mean±sd	Test value	*p*-value
Pre-op period	1	8.24 ± 1.64	-2.034	0.048*
	2	9.39 ± 2.06		
Follow-up period	1	16.6 ± 3.73	-0.319	0.751
	2	16.94 ± 3.11		
Pre-op VPS	1	8.24 ± 0.97	-1.920	0.062
	2	8.78 ± 0.81		
Post-op 3rd month VPS	1	6.28 ± 1.1	0.449	0.656
	2	6.11 ± 1.37		
Post-op 6th month VPS	1	2.72 ± 0.79	-2.443	0.019*
	2	3.33 ± 0.84		
Post-op 1st year VPS	1	0.68 ± 0.75	-1.213	0.232
	2	0.94 ± 0.64		
Pre-op Constant score	1	27.16 ± 4.4	1.995	0.053
	2	24.83 ± 2.64		
Post-op 3rd month Constant score	1	49.48 ± 6.36	1.984	0.054
	2	46 ± 4.54		
Post-op 6th month Constant score	1	68.6 ± 6.41	1.013	0.317
	2	66.67 ± 5.83		
Post-op 1st year Constant score	1	88.16 ± 5.59	0.410	0.684
	2	87.5 ± 4.6		

sd: standard deviation, Test value: test of significance (*t*-test) of the difference between two means, *p*-value: statistical significance, VPS: visual pain scores. *: $p<0.05$: there is a statistically significant difference between the groups.

groups 1 and 2 ($p>0.05$, Table I). With regard to age, gender, party, additional procedure, and gender distribution, the groups displayed homogeneous distribution. According to the comorbidity status, a statistically significant difference was discovered between groups 1 and 2 ($p<0.05$). Participants' comorbidity status was not distributed in a uniform manner.

Comparison of Scores Between Groups

According to all measurement values for the study's participants, it was assessed to see if there was a difference between groups 1 and 2, and the results are shown in Table II.

A follow-up period, Pre-op VPS, Post-op 3rd month VPS, Post-op 1st year VPS, Pre-op Constant score, Post-op 3rd month Constant score, Post-op 6th month Constant score, and Post-op 1st year Constant score measurement of study participants revealed no statistically significant difference between groups 1 and 2 ($p>0.05$, Table II).

The pre-op period and post-op sixth month VPS measures of the study subjects revealed a statistically significant difference between groups 1 and 2 ($p<0.05$, Table II).

Within and Between Group Comparison of the Change of Period Values

The findings of the test to determine if the period values of the study's participants altered over time within and between groups are shown in Table III.

Within Group and Between Group Comparison of VPS and Constant Score Values Change

It was evaluated whether the measurement values of the participants included in the study changed according to time, both within and between groups, and the results are given in Table IV.

In the measures of the study participants' change in period values over time, there was no statistically significant difference between the groups ($p>0.05$, Table III). According to time, the period value measurements of the subjects in group 1 showed a statistically significant decline ($p<0.05$, Table III).

On the other hand, the increase of period value measurements in group 2 participants was discovered to be statistically significant ($p<0.05$, Table III).

The individuals' VPS and Constant Score values changed with time, but there was no statistically significant difference between the groups ($p>0.05$, Table IV).

The following outcomes were discovered for VPS:

- The measurements of the participants in group 1's VPS levels over time revealed a statistically significant decline ($p<0.05$, Table IV).

Table III. Intra-group and inter-group comparison of period values.

Group	Period	Mean ± sd	Test value[1]	p_1-value	Test value[2]	p_2-value
1	**Pre-op period**	8.24 ± 1.64	2.461	0.001*	0.931	0.535**
	Follow-up period	16.6 ± 3.73				
2	**Pre-op period**	9.39 ± 2.06	1.447	0.001*		
	Follow-up period	16.94 ± 3.11				

sd: standard deviation, Test value[1]: test of significance between two pairs, Test value[2]: ANOVA significance test in repeated measures F Value, p_1-value: within groups comparison significance test result, p_2-value: the result of the ANOVA significance test in repeated measures between groups, $^*p<0.05$: there is a statistically significant difference between in-group measurements, $^{**}p<0.05$: there is no statistically significant difference between the groups.

- A statistically significant rise in the measures of the VPS values of group 2 participants over time was discovered ($p<0.05$, Table IV).

The outcomes for the constant period were as follows:

- There was a statistically significant decline in the measures of the Constant period values among group 1 participants ($p<0.05$, Table IV).
- A statistically significant rise in the measurements of the Constant period values made by group 2 participants over time was discovered ($p<0.05$, Table IV).

Discussion

Farrell et al[37] evaluated the 15-year results of 19 shoulders of 18 patients with idiopathic AC who had manipulation under anesthesia (MUA) and discovered a consistent improvement in shoulder motions. According to Vastamäki and Vastamäki[38] the MUA treatment demonstrated long-term improvement over a 23-year period when it was administered to 16 shoulders of 15 patients who had idiopathic AC. Kraal et al[39] stated in their 2019 study that they saw an improvement of 85% with MUA, particularly in patients with stage 2 primary AC who were resistant to conservative treatment. A second MUA is advised for patients who experience poor outcomes or recurrent frozen shoulder problems following MUA, with the hope of achieving a successful outcome and a low complication rate, according to a study by Woods and Loganathan[40] encompassing 792 shoulders of 730 individuals. The MUA findings in this investigation agreed with previous research[38-40]. Patients in the study experienced statistically significant decreases in their VPS and Constant scores over time, necessitating no further treatment.

In a trial including 56 patients with AC who had not responded to conservative treatment, Miyazaki et al[41] used lateral decubitus positioning while performing joint debridement, coracohumeral ligament release, subscapularis tenotomy, and circumferential release of the joint capsule. They claimed that patients who received an inferior capsulotomy had better outcomes and that discomfort and range of motion had improved.

The outcomes of arthroscopic surgery in 10 individuals with persistent AC who did not get better with physical therapy were described by Lafosse et al[42]. They advised patients with tight shoulders to undergo an arthroscopic 360-degree capsular release by a surgeon skilled in arthroscopy. According to Kraas et al[32], resistant AC associated with non-surgical treatment or post-traumatic stiffness responds well to arthroscopic therapy. The 7-year long-term outcomes of arthroscopic capsular release therapy in individuals with idiopathic AC were published by Le Lievre and Murrell[43] They discovered that there was a significant improvement in pain, stiffness, and functional status in their trial comprising 49 shoulders of 43 patients. The group 2 patients in this study had arthroscopic capsular release, and the study's findings were consistent with those reported in the literature. The VPS and Constant scores showed a statistically significant improvement over time.

Hamdan and Al-Essa[44] discovered that MUA with a saline injection was a more successful treatment than the other group when they administered MUA alone, MUA with a steroid injection, and MUA with a saline injection on 98 shoulders of 88 patients with primary AC who did not heal with conservative treatment. Injecting MUA, corticosteroids, and local anesthetic into 246 patients with primary AC led Thomas et al[45] to find good and long-lasting relief after treatment, independent of when symptoms first appeared. In their study with 20 patients who had idiopathic AC, Kivimaki and Pohjolainen[46] compared the use of steroid injections and MUA with the use of MUA

Table IV. Within group and between group comparison of measured values.

Group	Measures	Mean ± sd	Test value[1]	p_1-value	Test value[2]	p_2-value
1 (VPS)	Pre-op	8.24 ± 0.97	0.028	0.001*	2.778	0.054**
	Post-op 3rd month	6.28 ± 1.1				
	Post-op 6th month	2.72 ± 0.79				
	Post-op 1st year	0.68 ± 0.75				
2 (VPS)	Pre-op	8.78 ± 0.81	0.035	0.001*		
	Post-op 3rd month	6.11 ± 1.37				
	Post-op 6th month	3.33 ± 0.84				
	Post-op 1st year	0.94 ± 0.64				
1 (Constant score)	Pre-op	27.16 ± 4.4	0.013	0.001*	0.661	0.581**
	Post-op 3rd month	49.48 ± 6.36				
	Post-op 6th month	68.6 ± 6.41				
	Post-op 1st year	88.16 ± 5.59				
2 (Constant score)	Pre-op	24.83 ± 2.64	0.018	0.001*		
	Post-op 3rd month	46 ± 4.54				
	Post-op 6th month	66.67 ± 5.83				
	Post-op 1st year	87.5 ± 4.6				

VPS: visual pain scores, sd: standard deviation, Test value[1]: test of significance between two pairs, Test value[2]: ANOVA repeated measures significance test F Value, p_1-value: the result of the significance test for within-group comparison, p_2-value: the outcome of the repeated measures ANOVA significance test between groups, *p<0.05: there is a statistically significant difference between in-group measurements, **p<0.05: there is no statistically significant difference between the groups.

treatment without injections and found that the latter produced superior recovery. The patients in the research groups of this study did not receive any extra injections. Six papers on the outcomes of arthroscopic capsular release in idiopathic, diabetic, and secondary AC were examined by Boutefnouchet et al[47] in their review. A total of 463 patients were involved in the investigations, of whom 203 had idiopathic disease, 61 had diabetes, and 199 had secondary disease. They went on to explain that arthroscopic treatment, regardless of the cause, had a high rate of success. They discovered that diabetic AC had greater reports of lingering pain and movement restrictions than idiopathic AC.

Forsythe et al[48] conducted a randomized controlled meta-analysis research, reviewing 66 papers involving 4,042 shoulders. Physical therapy and intra-articular injections were used as the principal treatments in the research they analyzed. They concluded that the best treatments were physical therapy and medicines to lessen discomfort, arthroscopic surgery to increase range of motion, physical therapy and anesthesia-induced manipulation to enhance functional status. 22 trials comprising 989 patients were reviewed comprehensively by Grant et al[49]. Despite the fact that 21 studies showed level 4 evidence, they reported that the quality of the evidence was poor. However, arthroscopic capsules used in place of or in addition to MUA alone have shown little promise for leasing. In a study including 79 patients, Lee et al[50]evaluated MUA and arthroscopic capsular release therapy in individuals with idiopathic AC refractory compared to conservative treatment and discovered similarities between the two approaches. It was discovered in this study that group 1 and group 2's treatment outcomes were comparable. Vastamäki et al[51] indicated that MUA, which will be performed within 6-9 months from the onset of symptoms, produced a statistically significant better recovery and was the most suitable in time in their analysis of 65 shoulders of 57 patients. In this study, it was discovered that the treatments were more successful since there was less time between the onset of the complaints and the surgical intervention in both groups.

The outcomes of 315 patients with AC to whom Jenkins et al[52] used MUA were published. As a result, they discovered that there was no discernible difference between the control patient group and

the diabetes patient group in terms of the Oxford shoulder score and range of motion, and that diabetic patients required substantially more reprocessing. The presence of comorbidity in terms of diabetes could not be assessed in this investigation.

The total complication rate and reintervention rate in the literature are 0.4% and 14%, respectively[52]. After MUA in patients with AC, Loew et al[53] discovered iatrogenic damages (anterior-posterior superior labrum tears, subscapularis tears, anterior labral separation, and MGHL tears) in intra-articular structures. After MUA, Magnussen and Taylor[54] described cases of glenoid fracture.

Even though they are uncommon, complications during MUA can include humeral shaft fracture, rotator cuff rupture, dislocation of the shoulder, labral tear, nerve injury, and complicated regional pain syndrome, especially while obtaining terminal range of motion[41,44,53-55]. In this study, one patient died from COVID-19 in the fourth post-operative week, one patient acquired mediastinal emphysema from connective tissue disease, and one patient experienced a superficial infection that required broad-spectrum antibiotics for two weeks. Other than this, no problems were seen, and no other treatment was necessary. Two patients in group 1 and three patients in group 2 received postoperative supplementary physical therapy.

The early results, the small number of patients in the groups, the risk of bias in patient selection as a result of surgeons' lack of patient blindness, and the difficulty to assess patients, particularly those with diabetes, are some of the study's shortcomings.

Conclusions

As the interval between the onset of the complaints and the operation (pre-op period) shortened, it was discovered that surgery was more beneficial in both groups, although there was no statistically significant difference between the assessed treatments.

Conflict of Interest
The Authors declare that they have no conflict of interests.

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Informed Consent
All of the study participants provided their informed consent.

Ethics Approval
The research protocol has received approval from the ethics committee of Malatya Turgut Özal Univesity (2021/99).

Authors' Contributions
Bünyamin Ari: Writing-Review and Editing. Tarik Altinkiliç: Data Curation, Writing-Original draft.

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