

# Comparison of the Post Treatment Outcomes of a Conservative Physiotherapy Protocol for Subacromial Impingement Syndrome in Terms of Acromion Morphology

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## ABSTRACT

**Objective:** The present study aimed to compare the results of a conservative physiotherapy (CP) protocol for subacromial impingement syndrome (SIS) in terms of the morphological types of acromion.

**Methods:** Fifty patients participated in the present study, and they were divided into 3 groups according to the acromion morphology types. A 8-week CP (4-week treatment period at the clinic and, in addition, an exercise program at home for 4 weeks) was applied to all patients. The patients were evaluated in terms of pain (at rest and activity) by the Visual Analog Scale, range of motion (ROM), joint position sense (laser pointer), muscle strength (digital dynamometer), and functionality (the Shoulder Pain and Disability Index, SPADI) before and after the treatment.

**Result:** In the pre- and post-treatment changes (delta), the shoulder flexion angle increased less in the type 3 group than in the type 1 and type 2 groups ( $p < 0.05$ ). In the shoulder abduction angle, there was a similar increase in the type 3 group compared to the type 2 group, while there was less increase in the type 1 group ( $p < 0.05$ ). It was determined that there was more deviation in the change value of shoulder abduction position sense in the type 3 group compared to the other groups ( $p < 0.05$ ). There was no difference between the groups in the change values of pain, muscle strength, or the SPADI score ( $p > 0.05$ ).

**Conclusion:** Type 3 acromion may have a handicap in improving shoulder flexion and abduction ROM and shoulder abduction position compared to other types.

**Keywords:** Subacromial Impingement Syndrome, Shoulder pain, Acromion, Physiotherapy

## INTRODUCTION

Subacromial impingement syndrome (SIS) affects a wide range of populations with various symptoms and pathologies. The most frequent symptoms are pain, weakness, and loss of motion caused by catching muscle tendons in the shoulder [1]. Also,

proprioceptive deficits could occur in the shoulder joint after shoulder pathologies and injuries, because of the damage to the capsule, ligaments, glenoid labrum, or-pericapsular muscles [2, 3]. Many researchers claim that the morphological type of the acromion is related to SIS. The coracoacromial ligament,

coracoid process and the acromion all form the coracoacromial arch which is the superior border of the subacromial space (SS). Structures around the shoulder like the tendons of rotator cuff muscles, the long head of the biceps brachii muscle tendon and the bursa traverse through the SS. Some studies stated that the hook-shaped acromion could be related to a higher prevalence of SIS, whereas not all researchers have determined this [4-7]. Even if this knowledge does not explain all of the anatomical handicaps that cause impingement syndrome, the structures that pass through the SS in different congestions depending on the type of acromion, may change the probability of pathologies related to this region.

The effect of acromion morphology on the healing processes of pathologies related to the shoulder joint has aroused curiosity. Therefore, some researchers have examined the relationship between the healing outcomes of different types of treatment methods and acromion morphology. However, studies correlating acromion morphology with healing outcomes after conservative physiotherapy methods in SIS are rare [8-10].

Conservative physiotherapy methods on SIS are aimed at achieving pain relief, increasing muscle strength, gaining joint range of motion and sense of joint position, and increasing functionality [8]. Conservative treatment methods include prevention by ergonomics in daily life, resting methods for the joint by orthosis, medical treatment, steroid injections to the SS, and various conventional treatment methods of physiotherapy such as electrotherapy, manual therapy techniques, and exercises [11].

To the best of our knowledge, there is no study comparing the effectiveness of a conservative treatment protocol according to acromion types. The aim of this study is to investigate the effectiveness of conservative treatment on pain, range of motion,

joint position feeling, muscle strength, and shoulder disability level in acromion types. In the current study, we examined whether the results of an applied conservative physiotherapy protocol on patients with SIS would make a difference in the healing of pain, range of motion, muscle strength, position sense, and functionality according to the acromion types of patients and assessed the predictive value of acromial morphology in the treatment outcome of patients.

## MATERIALS AND METHODS

### *Study Design and Participants*

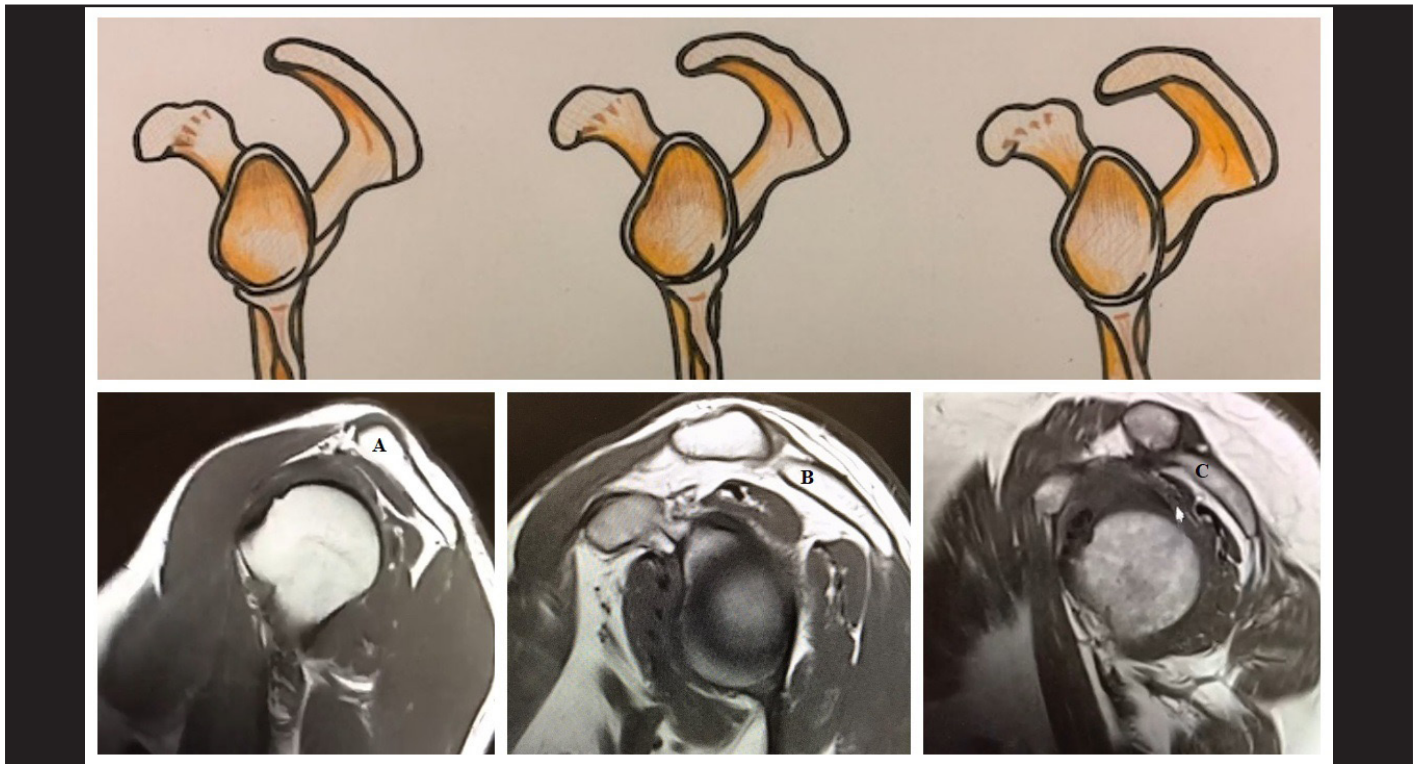
The research related to human use has complied with all the relevant national regulations and institutional policies and has followed the tenets of the Declaration of Helsinki. All patients had been informed about the treatment procedure and patient consent had been received.

This prospective study was conducted between October 2019 and April 2020. Patients who were diagnosed with SIS by the physician with magnetic resonance imaging (MRI) and clinical diagnostic tests, who had not received any treatment from the shoulder joint before, and who were undergoing physiotherapy treatment for the first time were included in this study. Patients with a history of upper extremity surgical operations or fractures of the upper extremities, those with acute cervical disc herniation or a neuromuscular disease, who were receiving medical therapy for pain relief, and who attended the treatment sessions less than 80% were excluded.

Fifty-two patients diagnosed with SIS were evaluated in the present study. Two patients did not accept the study. Total of fifty Patients were divided into 3 groups according to the stated acromion morphology types. The acromion types of the patients were determined on the shoulder MR images by a radiologist (Figure 1). During the acromion morphology assessment, Bibliani's method was used to define the types. According to this classification, Type I represented a flat shape (n=16), type II a curved (n=20), and type III a hooked (n=14) undersurface of the acromion [12, 13]. The approval of the Human Research Ethics Committee of Hasan Kalyoncu University with the registration number 2019/100 (Date: 01.10.2019). The study permission was taken from Harran University Research and Application Hospital (No: 66063783-622.99).

### **Main Points:**

- The pain levels at rest were higher in type III acromion before the treatment than in other acromion types
- In all acromion types, the healing of pain at rest and pain during activity was similar.
- Type III acromion type may create a handicap in the healing process compared to other acromion types.



**Figure 1.** Acromion types, A: Flat shape (Type I), B: Curved shape (Type II), C: Hooked shape (Type III)

### ***Treatment Protocol***

Five minutes of ultrasound application (Business Line US 50, Medical Italia, Italy) at a frequency of 1 MHz and intensity of 1.5 watts/cm<sup>2</sup>, conventional TENS (frequency 60-120 Hz, BTL-5000, U) for 20 minutes, Codman's exercises, wheel activities for shoulder, isometric exercises and range of motion exercises, shoulder joint capsule stretching, stabilization exercises for scapular region, and muscle strengthening exercises (shoulder flexor, abductor, extensors, internal and external rotator muscles were strengthened with dumbbell and therabands in 2 sets of 15 repetitions) were the contents of the treatment protocol for chronic patients. A cold pack was applied to the shoulder region for 10 minutes after the treatment. All modalities of the treatment protocol were applied for 5 days per week and a total of 20 sessions. After a 4-week treatment period at the clinic, the patients were followed up by an exercise program at home for 4 weeks. The exercises performed in the clinic were also given as part of a home program. All the patients were followed up by daily phone calls.

### ***Assessments Methods***

The study was blinded, and the evaluators did not know which group the patients were in. The shoulder pain at rest and pain during activities were recorded. A Visual Analog Scale (VAS)

was used to determine the pain levels (0-10; 0 means no pain, 10 means the worst pain) [14]. A universal goniometer was used to determine the joint range of motion (ROM). Muscle strength tests for shoulder movements were done by a dynamometer (NK-500, AIPU, Anhui, China) [15]. The joint position sense was evaluated by a laser pointer. During the joint position sense measurements ninety degrees shoulder joint flexion and abduction movements were evaluated. The laser pointer was fixed at 5 cm above the elbow joint with velcro. Then the patient was asked to bring the shoulder joint to ninety degrees of flexion while the patient's eyes were open and the range was measured with a goniometer. The patient held this position for 10 seconds. The projection of the laser pointer on millimeter paper was marked. The patient repeated the movement three times with her eyes open and by imagining the movement. After returning to the neutral position, the patient closed their eyes and repeated the flexion movement three times. The projection of the laser on millimeter paper was marked to state the deviations. The same procedure was performed to measure the joint sense level of shoulder abduction. The starting point was accepted as the origin and during the repetition of motion, the projections of the points on the x and y axes were noted. The deviation between the measurements was calculated [16]. The Shoulder Pain and Disability Index (SPADI) was used to evaluate the level of disability of the participants by

questioning the level of limitation experienced by the participants during personal transportation, care and dressing activities and to measure their current shoulder pain and disability status. The Turkish validity of the scale was conducted by Bumin et al in 2008. The whole scale consists of two subtitles (5 questions for pain sense and 8 questions for disability). These subscales are calculated between 0-100 points (0=no pain, 100=worst imaginable pain) [17].

### Statistical Analysis

The SPSS Package Program was used for the statistical analyses (SPSS 23.0 for Windows, Chicago, IL, USA). The normality distribution of the data was analyzed with the Shapiro-Wilk test. In the presentation of non-parametric data, percentage (Q1:25%, Q3:75%), median was used. The Wilcoxon test was used to compare within-group changes of non-parametric data before and after treatment. The comparison of the differences between the groups before and after treatment was analyzed by the Kruskal-Wallis test. A value of  $P < 0.05$  was considered statistically significant. A post hoc power analysis was performed to determine whether there was a significant difference between the groups in terms of rest pain according to acromion type. The effect size ( $f = 0.537$ ) and power ( $1-\beta$  err probe) of the study conducted with a total of 50 subjects were calculated as 0.919. Post-power analysis was performed with G\*Power 3.1.9.4 (Franz Faul, Universität Kiel, Germany) [18].

### RESULTS

Demographic characteristics of the individuals according to acromion types are given in Table 1. It was stated that 32 % (n=16) of patients had type I, 40 % (n=20) of patients had type II, and 28 % (n=14) of patients had type III acromion.

Intra- and inter-group comparisons of the pre-treatment, post-treatment, and delta (pre-post treatment difference value) values of the groups according to acromion types are shown in Table 2. All groups showed significant improvement in pain scores, joint motion angles, joint position sense, muscle strength, and shoulder disability level before and after treatment ( $P < 0.001$ , Table 2). There was a significant difference in the delta values of flexion and abduction joint angles between the groups ( $P = 0.001$ ,  $P = 0.040$ , respectively). Type 1 acromion and type 2 acromion groups had higher delta values of flexion joint angle than the type 3 group ( $P = 0.002$ ,  $P = 0.003$ , respectively, table 3). In the delta value of the abduction joint angle, a significant difference was found only between the type 1 group and the type 3 group ( $P = 0.049$ , Table 3). A significant difference was found in the delta of abduction joint position sense between the groups ( $P = 0.012$ , Table 3). The abduction joint position sense delta value was lower in the type 3 group than in the type 1 and type 2 groups ( $P = 0.026$ ,  $P = 0.024$ , respectively, table 3).

**Table 1.** Demographic features of the patients.

	Acromion Type 1 Group (n=16)	Acromion Type 2 Group (n=20)	Acromion Type 3 Group (n=14)	
	Median (Q1-Q3)	Median (Q1-Q3)	Median (Q1-Q3)	<i>P</i>
Age (year)	55.5 (45-61.75)	55.5 (43.25-64)	50.5 (44.5-61.5)	0.709
BMI (kg/m <sup>2</sup> )	29.39 (27.8-30.79)	28.09 (26.35-30.74)	29.31 (27.99-30.22)	0.459
	n	n	n	
Sex (female/male)	9/7	13/7	8/6	
Affected Side (right/left)	13/3	15/5	11/3	
Dominant side (right/left)	16	17/3	13/1	

BMI: Body mass index, *P*: Kruskal Wallis test

**Table 2.** Intragroup comparison according to acromion types

	Acromion type 1 (n=16)			Acromion type 2 (n=20)			Acromion type 3 (n=14)		
	Before	After		Before	After		Before	After	
	Median (Q1-Q3)	Median (Q1-Q3)	<i>P</i>	Median (Q1-Q3)	Median (Q1-Q3)	<i>P</i>	Median (Q1-Q3)	Median (Q1-Q3)	<i>P</i>
PR (cm)	6 (6-7)	4 (3.25-4.75)	*	5 (5-6)	3 (3-4)	*	6 (6-6.25)	4 (3.75-4)	*
PDA (cm)	7.5 (6.25-8)	5 (4-6)	*	7 (7-7.75)	4.5 (3-5)	*	7 (6-8)	5 (4-5.25)	*
Flexion (o)	164 (152-169.25)	175 (166-176)	*	166 (155-171)	175 (170-177)	*	160 (150-163)	163 (156-165)	*
Extension (o)	40 (27-40)	42 (40-44.5)	*	40 (38-40.75)	42 (40-45)	*	40 (37-40.25)	40.5 (40-42)	*
Abduction (o)	158 (145-168)	169 (164-174.75)	*	165 (156-166)	174 (166-175)	*	159 (150-166)	164 (156-171)	*
Adduction (o)	40 (36.5-42)	42.5 (40-45)	*	42 (36-44.25)	45 (42-45)	*	39 (35-42)	44 (40-45)	*
Internal rotation (o)	76.5 (53-84.25)	85 (75-85)	*	76 (65-80)	84.5 (80-85)	*	76.5 (70-82)	83.5 (75-86.25)	*
External rotation (o)	80 (70-84.5)	85 (80-86)	*	76.5 (72-82)	85 (80-87)	*	80 (67.25-83)	85 (78-90)	*
JPSF (cm)	11 (10-12)	8.9 (7.6-10.5)	*	10.9 (9.9-12.5)	8.8 (7-10.1)	*	11.3 (9.6-13)	8.9 (6.7-9.8)	*
JPSA (cm)	11.3 (8.4-12.1)	8 (6.8-9.6)	*	11.9 (9.7-13)	8.5 (7.8-10.2)	*	12.4 (8.7-12.8)	11.5 (8.3-12.1)	*
SF (kg)	6.1 (4.7-7.1)	7.1 (5.5-8.5)	*	6.3 (5.1-7.9)	8.1 (5.5-9)	*	6.8 (5.2-7.5)	7.8 (6.7-8.6)	*
SE (kg)	4.75 (3.6-5.1)	5.1 (4.5-5.5)	*	4.3 (4.1-4.5)	5 (4.5-5.9)	*	4.5 (4.2-5.3)	5.2 (4.5-6.1)	*
SAB (kg)	5.8 (5-7.9)	7 (6-8.5)	*	6.3 (5.2-7.4)	7.5 (6.6-9.3)	*	6.9 (5.25-8.3)	8.1 (6.7-9.3)	*
SAD (kg)	4.1 (3.3-4.8)	4.8 (4.5-5.5)	*	4.4 (4.1-5)	5.1 (4.5-6.4)	*	4.4 (3.9-4.6)	5 (4.5-5.5)	*
SIR (kg)	4.3 (4-4.8)	5 (4.5-5.25)	*	4.3 (3.3-5)	5.2 (4.5-5.7)	*	4.3 (4.2-5)	5 (4.4-6)	*
SER (kg)	4.5 (4.1-5)	5 (4.6-5.5)	*	4.4 (4-5.3)	5 (4.5-5.8)	*	4.4 (4.1-5)	5 (5-5.8)	*
SPADI in pain (score)	67 (63-76)	61 (56-65.5)	*	72 (66-76)	60 (55-66)	*	73 (66-80)	65 (58-70)	*
SPADI functional (score)	63.7 (58.7-69.6)	56.2 (50-61.8)	*	65.6 (61-70)	57.5 (51-62.5)	*	61.8 (60-71)	58 (53.4-63.3)	*
SPADI total (score)	65.7 (61-72)	58.4 (53-62)	*	67 (63-73)	57.6 (53.4-63)	*	66 (62.8-76)	60 (56-65.7)	*

PR: pain at rest, PDA: pain during activity, JPSF: JPS in flexion, JPSA: JPS in abduction, SF: strength of flexion, SE: strength of extension, SAB: strength of abduction, SAD: strength of adduction, SIR: strength of internal rotation, SER: strength of external rotation, JPS: Joint position sense, SPADI: Shoulder Pain and Disability Index \*  $p < 0.001$ ; Wilcoxon paired two sample test

**Table 3.** Comparison of delta values between groups

	Acromion type 1 (n=16)	Acromion type 2 (n=20)	Acromion type 3 (n=14)	
	Delta ( $\Delta$ )	Delta ( $\Delta$ )	Delta ( $\Delta$ )	
	Median (Q1-Q3)	Median (Q1-Q3)	Median (Q1-Q3)	P
PR (cm)	-2 (2-2.75)	-2 (1-2)	-2 (1-2.25)	0.526
PDA (cm)	-2 (2-3)	-2 (2-4)	-2 (1.75-3)	0.527
Flexion (o)	9.5 (14.25-7.25)	8 (14.25-6.25)	4.5 (5.5-1)	0.001 <sup>#</sup>
Extension (o)	2.5 (5-2.5)	2 (5-2)	2 (3-0.75)	0.541
Abduction (o)	9 (19-5.25)	9 (13-5.25)	5 (7.5-4)	0.040 <sup>#</sup>
Adduction (o)	3 (5-0)	3 (5-0)	3 (5-1)	0.982
Internal rotation (o)	7.5 (14-3)	6.5 (12.75-5)	6 (8.25-5)	0.933
External rotation (o)	5 (10-3)	6.5 (10-3)	6 (10.5-5)	0.628
JPSF (cm)	-1.7 (0.9-3.6)	-2.6 (1-3.7)	-2.2 (0.6-3.2)	0.655
JPSA (cm)	-1.7 (1.1-3.5)	-2.1 (0.9-3.5)	-0.9 (0.5-1.2)	0.012 <sup>#</sup>
SF (kg)	1.1 (1.4-0.6)	1.1 (1.8-0.4)	1 (1.4-0.75)	0.976
SE (kg)	0.6 (0.9-0.2)	0.7 (1.3-0.4)	0.7 (1-0.4)	0.492
SAB (kg)	0.85 (1.5-0.4)	1.1 (1.8-0.7)	1.2 (2.2-0.7)	0.258
SAD (kg)	0.45 (1-0.2)	0.5 (0.5-0.3)	0.7 (1-0.2)	0.978
SIR (kg)	0.5 (0.5-0.32)	0.65 (1.5-0.5)	0.7 (1-0.47)	0.091
SER (kg)	0.5 (0.8-0.25)	0.55 (1-0.35)	0.8 (1-0.5)	0.326
SPADI in pain (score)	-7 (4-12)	-10 (4-15)	-6 (4-12.5)	0.622
SPADI functional (score)	-6.8 (2.8-10)	-10 (2.8-13.75)	-6.8 (2.5-10.3)	0.485
SPADI total (score)	-8 (3.2-10.7)	-10.7 (3.4-14.4)	-6.5 (4.2-9.2)	0.346

PR: pain at rest, PDA: pain during activity, JPSF: JPS in flexion, JPSA: JPS in abduction, SF: strength of flexion, SE: strength of extension, SAB: strength of abduction, SAD: strength of adduction, SIR: strength of internal rotation, SER: strength of external rotation, JPS: Joint position sense, SPADI: Shoulder Pain and Disability Index, <sup>#</sup> p <0.05; Kruskal Wallis test.

## DISCUSSION

In the current study, in which we aimed to investigate whether the conservative physiotherapy protocol we applied to SIS patients made a difference in the improvement of pain, range of motion, joint position sense, muscle strength, and shoulder functionality level according to acromion types, it was determined that the treatment results of the study protocol showed differences in range of motion and partially in joint position sense in terms of SIS. In the delta values of flexion joint angles before and after treatment, the type 3 group showed less improvement than the type 1 and type 2 groups. In abduction joint angle, the type 3 group showed less improvement than the type 1 group. Abduction

joint position sense showed more deviation in type 1 and type 2 groups than in type 3 groups. It was determined that pain values, muscle strength, and shoulder functionality levels improved after the CP protocol, but acromion morphology had no effect on the improvement in these parameters.

SIS is the most common pathology of the shoulder. Physiotherapy management of SIS includes multiple interventions such as exercise, electrotherapy, advice, and education [19]. Hot packs, cold packs, ultrasounds, conventional TENS, and exercise are also the physical therapy modalities in the conservative treatment of SIS [8]. Many studies have indicated that there

is strong evidence for exercise to reduce pain and improve functionality in short-term follow-up treatment in SIS [20]. In a study that examined the effects of physiotherapy in SIS, it was emphasized that one of the major effects of physiotherapy is pain. Conservative physiotherapy has been shown in randomized controlled studies to improve joint position sense in patients with SIS [2,3]. In addition, previous studies have found that conservative physiotherapy has positive effects on shoulder joint range of motion in SIS patients [8,21]. Sixteen studies were examined by Kromer et al. [21] and they stated that the addition of manual therapy techniques to the treatment gave better results in terms of pain reduction. In the same literature review, it was stated that physiotherapy provides an increase in functionality in some studies, while some do not. In a meta-analysis study by Hanratty et al. [20] was stated that exercise has a small positive effect on muscle strength in short-term treatments of SIS patients. Lombardi et al. [22] who determined that muscle strength increases after a short-term treatment, emphasize that muscle strength develops only in the flexion direction and not in other directions. In our study, all groups showed a decrease in pain at rest and pain in activity, an increase in shoulder joint angles, an increase in shoulder flexion, extension, abduction, internal rotation, and extensional rotation muscle strength values, and significant improvements in shoulder functionality levels after treatment. These results showed that the effectiveness of the CP protocol applied in our study had compatible outcomes with the literature.

A study was stated that the factors increasing the compression on the anterior side of the acromion, especially between the anterior humeral head and the coracoacromial ligament, were due to increased load and calcification in this region. It was emphasized that this situation is important in the formation of the acromion type [23]. Among the acromion types, especially the type 3 form, the acromio-humeral joint space is narrower [24]. Other studies have reported that individuals with type 3 acromion have more SIS symptoms [21, 25]. In the literature, there are studies indicating that acromion type is effective in the occurrence of SIS [5-7]. We found studies examining the relationship between the occurrence of pathologies and acromion type. In particular, it was wondered if the acromion type changed the results in acromioplasty, bursectomy, or in other surgeries [26]. We think that calcifications in the acromion of individuals with type 3 acromion may affect shoulder ROM and proprioception by narrowing the acromio-humeral joint space. In our study, this may be the reason why the type 3 acromion group had less

improvement in shoulder flexion angle compared to the type 1 and type 2 groups. In addition, not only shoulder flexion but also shoulder abduction angle increased less in the type 3 group when compared to the type 1 group. In a study, it was stated that shoulder ROM is a determining parameter in improving shoulder proprioception [27]. In our study, we think that proprioception was affected in the same way, in parallel with the fact that the shoulder ROM values of the individuals in the type 3 group improved less than the other groups. This situation explains the fact that the deviation values in abduction joint position sensation after treatment in type 1 and type 2 groups were less than in type 3 groups.

Circi et al. [28] claimed that acromion type does not have an effect on treatment results in patients with SIS. In the same study, it was reported that acromion morphology had no effect on shoulder functionality. In our study, SPADI scores, which we used to evaluate shoulder functionality, showed no difference in the post-treatment change values in all acromion types, similar to that study.

### Limitations

The limitations of our study include the lack of distinction between the affected and dominant side, the inability to evaluate shoulder internal and external proprioception, and the lack of a long-term follow-up study.

### CONCLUSIONS

In our study, it was concluded that the CP protocol provided significant improvement in pain, ROM, joint position sense, shoulder muscle strength, and shoulder functionality in all acromion types. However, the type 3 acromion structure may be more handicapped in terms of improvements in ROM and proprioception than other acromion types.

**Conflict of Interest:** The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

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**Ethical Approval:** The approval of Non-Interventional Research Ethics Committee of Hasan Kalyoncu University with

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