ORIGINAL RESEARCH ORİJİNAL ARAŞTIRMA

DOI: 10.31609/jpmrs.2023-97168

Comparison of the Effectiveness of the Ultrasound-Guided Subacromial, Acromioclavicular with Subacromial Injection and Suprascapular Nerve Block in Patients with Shoulder Subacromial Impingement Syndrome: A Randomized Controlled, Single Blind, Clinical Trial

Omuz Subakromiyal Sıkışma Sendromlu Hastalarda Ultrason Eşliğinde Yapılan Subakromiyal, Akromiyoklavikular ile Subakromiyal Enjeksiyon ve Supraskapular Sinir Bloğunun Etkinliğinin Karşılaştırılması: Randomize Kontrollü, Tek Kör, Klinik Çalışma

Burcu METİN ÖKMEN[a,b], Korgün ÖKMEN[c]

[a]Department of Physical Medicine and Rehabilitation, University of Health Sciences Bursa Yüksek İhtisas Training and Research Hospital, Bursa, Türkiye

[b]Private Physician, Bursa, Türkiye

[c]Department of Anesthesiology and Reanimation, University of Health Sciences Bursa Yüksek İhtisas Training and Research Hospital, Bursa, Türkiye

This study was approved by the Ethical Committee of University of Health Sciences, Bursa Yuksek Ihtisas Training and Research Hospital (2016/15-02).

ABSTRACT Objective: The main interventional therapeutic techniques of subacromial impingement syndrome (SIS) are subacromial (SA) injection and suprascapular nerve block (SSNB). Also, acromioclavicular joint (ACJ) pathologies may be a common etiological factor with SIS and should be considered in treatment management. This study aimed to investigate the efficacy of SA injection, ACJ and SA injection (ACJ+SA), and SSNB in the treatment of SIS. **Material and Methods:** This prospective, randomized, controlled trial included 90 patients with chronic shoulder pain associated with SIS. The patients were divided into three groups: Group SA (n=30) receiving ultrasound (US)-guided SA injection, Group SA+ACJ (n=30) receiving US-guided SA+ACJ injection, and Group SSNB (n=30) receiving US-guided SSNB. Follow-up parameters were visual analogue scale (VAS), Shoulder Pain and Disability Index (SPADI) and Short Form-12 (SF-12) scores measured before treatment and at the posttreatment 2nd week, 4th, 12th and 24th week. **Results:** In SA+ACJ and SSNB groups, VAS and SPADI scores were found to be statistically significantly lower than before treatment at all measurement times after treatment ($p<0.001$). The decrease in both measurement scores did not continue at the 24th week follow-up of Group SA ($p>0.05$). The SF-12 scores of all three groups were significantly higher than the baseline at all measurement times ($p<0.001$). **Conclusion:** The findings of this study suggest that SA, SA+ACJ injection and SSNB application have positive effects on pain, function and quality of life in patients with SIS in the short term, while only SA+ACJ injection and SSNB maintain their effectiveness in long-term follow-ups.

Keywords: Shoulder pain; subacromial impingement syndrome; suprascapular nerve block; subacromial injection; acromioclavicular joint

ÖZET Amaç: Subakromiyal sıkışma sendromunun [subacromial impingement syndrome (SIS)] ana girişimsel tedavi teknikleri, subakromiyal (SA) enjeksiyonu ve supraskapular sinir bloğudur [suprascapular nerve block (SSNB)]. Ayrıca akromiyoklavikular eklem [acromioclavicular joint (ACJ)] patolojileri SIS ile ortak bir etiyolojik faktör olabilir ve tedavi yönetiminde dikkate alınmalıdır. Bu çalışmada, SIS tedavisinde SA enjeksiyonu, ACJ ve SA enjeksiyonu (ACJ+SA) ve SSNB'nin etkinliğinin araştırılması amaçlandı. **Gereç ve Yöntemler:** Bu prospektif, randomize, kontrollü çalışma, SIS ile ilişkili kronik omuz ağrısı olan 90 hastayı içermektedir. Hastalar 3 gruba; Grup SA (n=30) ultrason (US) eşliğinde SA enjeksiyonu, Grup SA+ACJ (n=30) US eşliğinde SA+ACJ enjeksiyonu ve Grup SSNB (n=30) US eşliğinde SSNB enjeksiyonu yapılan gruplar olarak ayrıldı. İzlem parametreleri, tedavi öncesi ve tedavi sonrası 2, 4, 12 ve 24. haftalarda ölçülen görsel analog skala [visual analogue scale (VAS)], Omuz Ağrısı ve Disabilite İndeksi [Shoulder Pain and Disability Index (SPADI)] ve Kısa Form-12 [Short Form-12 (SF-12)] skorlarıydı. **Bulgular:** SA+ACJ ve SSNB gruplarında tedavi sonrası tüm ölçüm zamanlarında VAS ve SPADI skorları tedavi öncesine göre istatistiksel olarak anlamlı derecede düşük bulundu ($p<0,001$). Grup SA'nın 24. hafta takiplerinde her iki ölçüm skorlarında düşüş devam etmedi ($p>0,05$). Her üç grubun SF-12 puanları tüm ölçüm zamanlarında başlangıca göre anlamlı olarak yüksek bulundu ($p<0,001$). **Sonuç:** Bu çalışmanın bulguları, SA, SA+ACJ enjeksiyonu ve SSNB uygulamasının SIS tanılı hastalarda kısa dönemde ağrı, fonksiyon ve yaşam kalitesi üzerine olumlu etkilerinin olduğunu, uzun dönem takiplerde ise sadece SA+ACJ enjeksiyonu ve SSNB etkinliğini koruduğunu düşündürmektedir.

Anahtar Kelimeler: Omuz ağrısı; subakromiyal sıkışma sendromu; supraskapular sinir bloğu; subakromiyal enjeksiyon; akromiyoklavikular eklem

Correspondence: Burcu METİN ÖKMEN
Department of Physical Medicine and Rehabilitation, University of Health Sciences Bursa Yüksek İhtisas Training and Research Hospital, Bursa, Türkiye
E-mail: burcumetinokmen@gmail.com

Peer review under responsibility of Journal of Physical Medicine and Rehabilitation Science.

Received: 31 Mar 2023 ***Received in revised form:*** 28 Aug 2023 ***Accepted:*** 28 Aug 2023 ***Available online:*** 11 Sep 2023

1307-7384 / Copyright © 2023 Turkey Association of Physical Medicine and Rehabilitation Specialist Physicians. Production and hosting by Türkiye Klinikleri.
This is an open access article under the CC BY-NC-ND license (https://creativecommons.org/licenses/by-nc-nd/4.0/).

ARTICLE IN PRESS

Shoulder pain is a common cause of musculoskeletal pain and has different etiologies. Muscle, bone structure, or connective tissue pathologies can cause shoulder pain. One of the most common pathologies of shoulder pain, the subacromial impingement syndrome (SIS) may involve many conditions like rotator cuff disorders, tendinitis, and tears. On the pathophysiological level, it can have various functional, degenerative, and mechanical causes.[1,2] This syndrome often becomes chronic, limiting patients' activities and requiring lifestyle changes. Numerous factors like the structural condition of the acromion and the weakness of the rotator cuff muscles can reduce the subacromial (SA) space where the muscle tendons are located, triggering the development of SIS.[3] The mechanical stress that is involved in SIS may also cause inflammation and tissue damage in the supraspinatus, biceps and rotator cuff tendons, and the rotator cuff.

Lack of treatment or inadequate treatment may cause stimulation and sensitization of mechanoreceptors and free nerve endings by tissue damage, leading the syndrome to become chronic.[3] Often, conservative treatment is preferred initially. Nonsteroidal anti-inflammatory drugs, physical therapy and other analgesic regimens are the primary choices.[4] Among interventional methods, corticosteroids (CS) are one of the primary options in injection therapy since they have a strong anti-inflammatory effect, and they act quickly. The main interventional therapeutic techniques are SA injection and suprascapular nerve block (SSNB). Some previous studies have tried to reveal their efficacy on shoulder pain.[1,3,5] The efficacy of SA injection and SSNB on shoulder pain has been investigated in different studies in the literature.[1,3,5] There are many opinions about the mechanism of action of SA injections. The possible therapeutic mechanisms include reduction of muscle spasm, anti-inflammatory effect, the effect of tissue metabolism.[6] The SSNB is another treatment option used in shoulder pain. The suprascapular nerve (SSN) originating from the ventral rami of C5 and C6 has both motor and sensory properties. This nerve, which carries sensory impulses to 70% of the shoulder joint, also has sensory branches encompassing the acromioclavicular joint (ACJ).[7,8] Regional nerve block achieved by SSNB may be effective through different mechanisms in addition to the effects of CS used in the management of pain. These mechanisms include reducing nociceptive input, blocking nociceptive fibers in peripheral, spinal, or cranial nerves, blocking afferent nerve fibers accompanying autonomic nerves, and suppressing abnormal reflex mechanisms.[6]

ACJ, one of the four joints that make up the shoulder joint complex, connects the scapula to the clavicle and serves as the main joint connecting the upper limb to the trunk.[7] The incidence of ACJ arthritis in asymptomatic cases is reported to be 75%.[9] Research has highlighted those acromioclavicular pathologies may be a common etiological factor with SIS and they should be taken into consideration in treatment management.[8]

The hypothesis of this study was that the ACJ injection co-administered with the SA injection would increase the treatment efficacy. Therefore, we investigated the follow-up results of patients undergoing SA injection, SA and ACJ injection, or SSNB over a period of 6 months.

MATERIAL AND METHODS

This prospective randomized controlled single-blind clinical trial, patients aged 18-65 years with shoulder pain for more than 3 months and diagnosed with SIS were included. At the diagnosis, the patient's clinical history was taken and physical examination was performed. Inspection and palpation of the shoulder, active and passive range of motion, instability of the glenohumeral joint, and scapular dyskinesia were evaluated in the physical examination. Muscle strength test was done by comparing opposite side. The Hawkins test (detection of internal rotation pain in the arm during 90° flexion) and the Neer test (detection of anterior elevation pain at 90° and above) were used as provocative tests. Shoulder magnetic resonance imaging (MRI) was also used in the diagnosis of the SIS. MRI findings associated with SIS included pathologies such as SA bursitis, supraspinatus tendonitis, partial rupture of the rotator cuff tendons. Previous shoulder operation; presence of central nervous system pathologies or rheumatologi-

ARTICLE IN PRESS

cal disease and polyneuropathy; cervical radiculopathy; physical therapy in the last 6 months; administering an injection therapy for shoulder pain determined as exclusion criteria. Physical therapy applications were defined as exclusion criteria as they may change the effectiveness of injection treatments and cause confusion in the results.

Ethical Committee of University of Health Sciences, Bursa Yuksek Ihtisas Training and Research Hospital (2016/15-02). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Using a random number table, the patients were divided into 3 groups namely Group SA (n=30) receiving ultrasound (US)-guided SA injection, Group SA+ACJ (n=30) receiving US-guided SA+ACJ injection, and Group SSNB (n=30) receiving US-guided SSNB (Figure 1). All injections and blocks were performed by the same researcher.

INTERVENTIONS

Treatment protocols: All interventions were performed using an 8-18 MHz linear US probe following the proper site cleaning while the patients were in the sitting position.

SSNB: The transducer was placed parallel to the scapula in the supraspinous fossa and then, moved laterally to display the supraspinatus muscle and the underlying bone fossa. SSN was visualized at the suprascapular notch. The needle was directed from the medial to the lateral with the in-plane technique. A mixture of 10 mL of 0.25% bupivacaine and 40 mg of methylprednisolone was injected.[10]

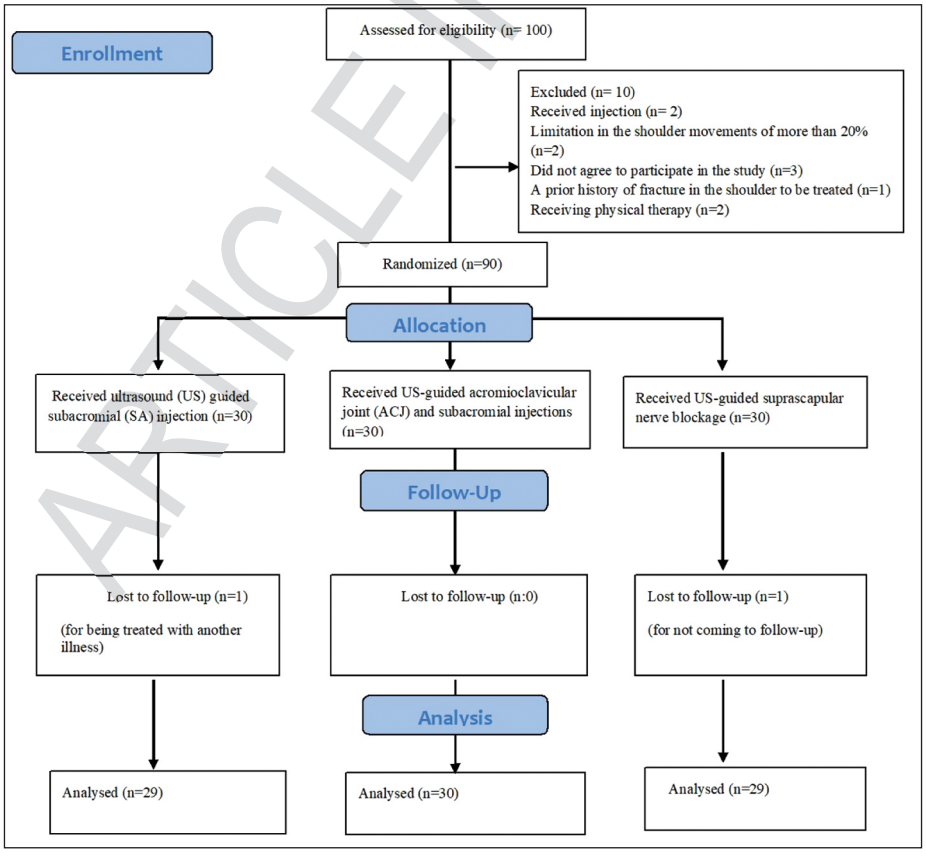

FIGURE 1: Flow chart of the study.

ARTICLE IN PRESS

SA injection: The SA injection was performed using the lateral, in-plane approach, with 5 mL bupivacaine at 0.25% concentration containing 40 mg methylprednisolone. In the SA+ACJ group, 5 mL of 0.25% bupivacaine containing 20 mg of methylprednisolone was applied to the SA region using a lateral approach under US guidance.

ACJ injection: the probe was placed on the joint in the coronal plane. Using the out-of plane technique, 2 mL of a 0.25% concentration of bupivacaine and 20 mg of methylprednisolone solution was injected into the joint (Figure 2). All patients received only one injection therapy session. Physical therapy and rehabilitation or non-steroidal inflammatory drug therapy was not arranged.

OUTCOME MEASURES

Primary outcome measures: visual analogue scale (VAS) scores measured before treatment and at the 2nd week, 4th, 12th and 24th week after treatment.

Secondary outcome measures: Shoulder Pain and Disability Index (SPADI) scores, Short Form-12 (SF-12) scores measured before treatment, and at the 2nd week and 4th, 12th and 24th week after treatment and complications.

SPADI: The SPADI score consists of 2 parts that assess pain and disability. In the 1st part [Shoulder Pain Index (SPI)] shoulder pain is questioned and consists of 5 questions. The pain felt by the patient in the previous week is measured by VAS. In the 2nd part (Shoulder Disability Index) it evaluates the degree of shoulder movements and includes 8 questions. The degree of difficulty in the patient's shoulder movements in the previous week is also measured by VAS. SPADI with a total of 13 questions has a total score of 130, with 130 points indicating maximum disease. The validity of SPADI has been demonstrated.[11]

SF-12: It consists of 2 parts, physical (SF-12-PCS) and mental (SF-12-MCS) assessment and 12 items. The total score is evaluated out of 100. A score of zero indicates the lowest level of health, and a score of 100 indicates the highest level of health.[12]

The patients were followed up and questioned by the evaluator, who was blind to the type of injection administered to the patient. During the treatment and follow-up of 90 patients, one patient was observed to receive treatment for another disease and one patient did not come to follow-ups. Therefore, statistical analyses were performed with 29 patients in Group SA, 30 patients in Group SA+ACJ, and 29 patients in Group SSNB (Figure 1).

STATISTICAL ANALYSIS

Data analysis was performed using IBM SPSS 23.0 (Armonk, NY, USA). statistical software package. Data were analyzed using descriptive statistical methods (frequency, percentage, mean, standard deviation, median, minimum-maximum) as well as the comparison of qualitative data chi-square (c^2) test was used. Compliance with the normal distribution of data was assessed by Kolmogorov-Smirnov and the Shapiro-

ARTICLE IN PRESS

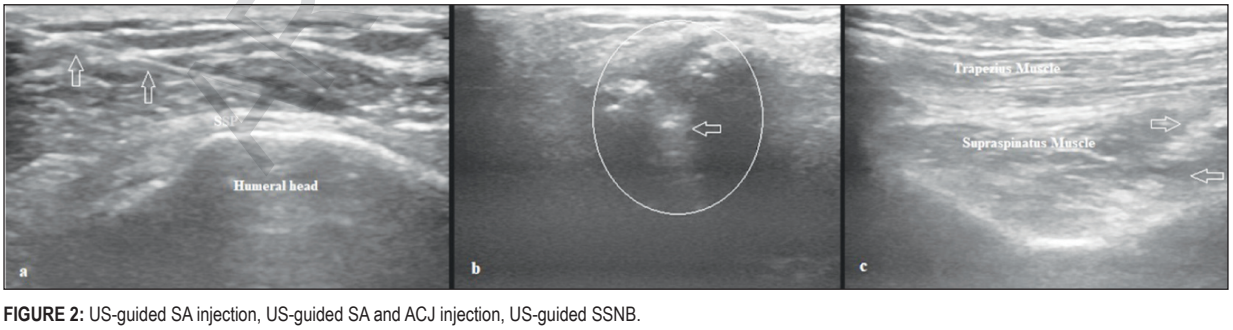

FIGURE 2: US-guided SA injection, US-guided SA and ACJ injection, US-guided SSNB.

a: SA injection; US-guided in-plane approach to the subdeltoid-SA bursa along the short axis of the SSP, White arrow: needle.

b: ACJ injection; US-guided out-of-plane approaches to the coronal section of the AC joint; White circle, White arrow: needle tip.

c: SSNB; During the transverse scan of the scapular spine, the SSN displayed in the suprascapular notch was blocked with a needle directed from the medial to the lateral using the in-plane technique. White arrow: needle.

US: Ultrasound; SA: Subacromial; ACJ: Acromioclavicular joint; SSNB: Suprascapular nerve block; SSP: Supraspinatus tendon; SSN: Suprascapular nerve.

Wilk test (it was found that the data are not normally distributed). The Kruskal-Wallis H test was used for intergroup comparisons whereas the comparisons between the measurement times (intragroup comparison) were performed using the Friedman test.

POWER ANALYSIS

According to the results of previous studies, the post-injection 6th-week VAS scores were found to be 2.65±1.17 in the patients used injection.[13] The primary outcome measure of this study was a one point reduction in the post-injection 6th-week VAS scores. To obtain a study power of 85% (α=0.05), 30 patients from each group for the required sample size a total of 90 patients were assessed.

RESULTS

The statistical analysis of the study included 88 patients, 29 in the SA, 30 in the SA+ACJ, and 29 in the SSNB group. There was no statistically significant difference between the three groups in terms of age, gender, affected side, and duration of symptoms (Table 1). Pre-treatment VAS, SF-12 scores and SPADI values did not statistically significantly differ between the groups (p>0.05) (Table 2, Table 3).

In all groups, the VAS scores measured at the 2nd week and the 4th and 12th weeks after treatment were found to be statistically significantly lower compared to the pre-treatment values (p<0.001) (Table 2). There was no statistically significant difference between pre-treatment and 24th week VAS scores only in the Group SA (p>0.05) whereas 24th week VAS scores of the SA+ACJ and SSNB groups were found to be statistically significantly lower than pre-treatment values (p<0.001). Similarly, the SPADI scores measured at the 2nd week and the 4th and 12th weeks after treatment were found to be statistically significantly lower compared to the pre-treatment in all groups (p<0.001) (Table 3).

There was no statistically significant difference between pre-treatment and 24th week SPADI scores of the Group SA (p>0.05) whereas 24th week SPADI scores of the SA+ACJ and SSNB groups were found to be statistically significantly lower than pre-treatment values (p<0.001) (Table 3). The comparison of SPADI and VAS scores in terms of measurement

TABLE 1: Demographic characteristics of the patients.

		SA (n=29)	SA+ACJ (n=30)	SSNB (n=29)	*p
Age (year)		51.5±9.55	52.47±8.55	52.14±7.96	0.962
Gender	Female (n/%)	17 (58.6)	17 (56.7)	17 (58.6)	0.985
	Male (n/%)	12 (41.4)	13 (43.3)	12 (41.4)	
Affected site	Left (n/%)	9 (31.0)	10 (33.3)	11 (37.9)	0.853
	Right (n/%)	20 (69.0)	20 (66.7)	18 (62.1)	
Symptom duration (week)		24.86±18.90	20.40±19.60	23.38±18.05	0.652

*p value of less than 0.05 was considered statistically significant. Comparison between groups (one-way analysis of variance); SA: Subacromial; ACJ: Acromioclavicular joint; SSNB: Suprascapular nerve block.

TABLE 2: VAS between groups and within groups.

VAS	SA (n=29)	SA+ACJ (n=30)	SSNB (n=29)	*p
PRT	63 (21-85)	64 (19-83)	63 (18-80)	0.995
PST 2nd week	25 (8-40)	23 (10-38)	26 (5-36)	0.998
4th week	13 (0-61)	15.5 (5-63)	17 (10-58)	0.740
12th week	20 (8-40)	21.5 (5-35)	23 (5-41)	0.824
24th week	30 (8-63)	22 (8-40)	21.4 (8-41)	**<0.001¥**
p**	<0.001	<0.001	<0.001	
Difference	PRT between PST 2nd week, 4th week and 12th week	PRT between others	PRT between others	

*Comparison between groups (Kruskal-Wallis H); ¥Group SA between others; **Comparison within groups (Friedman); p value of less than 0.05 was considered statistically significant; VAS: Visual analog scale; SA: Subacromial; ACJ: Acromioclavicular joint; SSNB: Suprascapular nerve block; PRT: Pre-treatment; PST: Posttreatment.

ARTICLE IN PRESS

TABLO 3: Comparison of SDI and SPI between groups and within groups.

	SA (n=29)		SA+ACJ (n=30)		SSNB (n=29)		*p	*p
	SPI	SDI	SPI	SDI	SPI	SDI	SPI	SDI
PRT	39 (15-48)	47 (28-71)	37.5 (19-50)	45.5 (26-73)	39.8 (18-47)	44 (24-77)	0.958	0.965
PST								
2nd week	11 (0-35)	12 (0-47)	11.5 (0-39)	11 (5-46)	13 (3-37)	13 (2-48)	0.887	0.932
4th week	8 (0-41)	7 (1-52)	10 (1-43)	11 (3-51)	11 (3-41)	9 (0-53)	0.781	0.821
12th week	12 (0-38)	13 (0-47)	13.5 (2-39)	14 (2-45)	11.5 (3-39)	12.5 (1-49)	0.724	0.351
24th week	27 (0-48)	31 (4-64)	14 (3-39)	14.2 (2-47)	12.7 (3-38)	13.8 (3-46)	**<0.001¥**	**<0.001¥**
p**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**		
Difference	PRT between PST 2nd, 4th and 12th week	PRT between others	PRT between others	PRT between others	PRT between others	PRT between others		

*Comparison between groups (Kruskal-Wallis H); ¥Group SA between others; **Comparison within groups (Friedman); p value of less than 0.05 was considered statistically significant; SDI: Shoulder Disability Index; SPI: Shoulder Pain Index; SA: Subacromial; ACJ: Acromioclavicular joint; SSNB: Suprascapular nerve block; PRT: Pre-treatment; PST: Post-treatment.

times revealed that the scores measured at the 24th week were statistically significantly higher in Group SA ($p<0.001$) (Table 2, Table 3) (Figure 3). When compared with pre-treatment values, SF-12 scores were observed to be statistically significantly higher in all groups at all measurement times (Table 4).

DISCUSSION

The results of the present study demonstrated an improvement in pain and function in the 2nd, 4th, and 12th weeks follow-up of patients who received SSNB, ACJ+SA and SA injections; however, this improvement continued at the 24th week only in patients who received SSNB and ACJ+SA injection. Nonetheless, the quality of life of patients was observed to improve at 24th week follow-up in all groups.

Different treatment protocols may be utilized in chronic shoulder pain with different etiologies. Minimally invasive methods can be used for patients who do not benefit from conservative treatments (e.g. medical therapy, physical therapy, etc.), or in addition to conservative treatment.[14,15] Some studies have investigated the efficacy of SA injection and SSNB, which are frequently used minimally invasive methods, on the improvement of pain and functional status in shoulder pain.[2,8,13,16,17] However, only a small number of studies have evaluated the role of ACJ in SIS. Therefore, there is insufficient knowledge on this subject in the literature.

Different opinions have been reported about the efficacy of SA injection in studies where the combination of local anesthetic and CS is performed.[13,18,19]

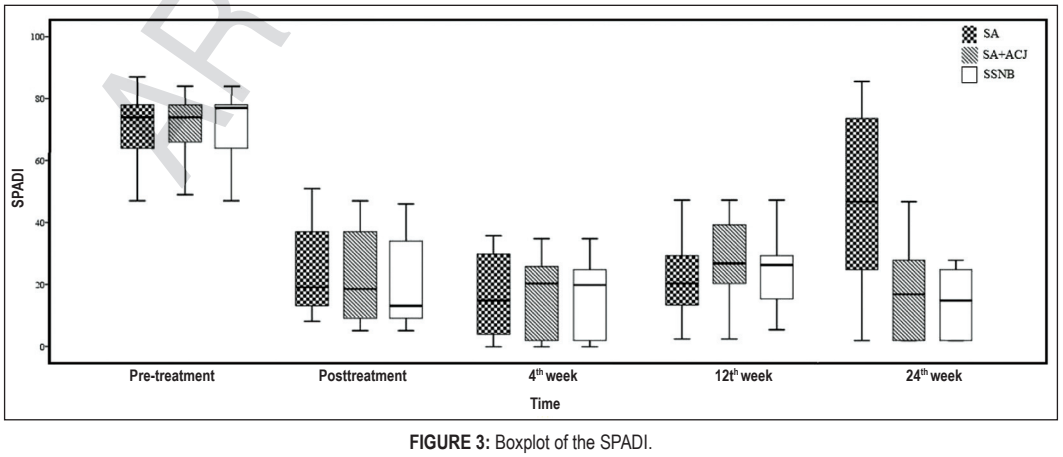

FIGURE 3: Boxplot of the SPADI.
SPADI: Shoulder Pain and Disability Index; SA: Subacromial; ACJ: Acromioclavicular joint; SSNB: Suprascapular nerve block.

ARTICLE IN PRESS

TABLE 4: SF-12 between groups and within groups.

SF-12	SA (n=29)	SA+ACJ (n=30)	SSNB (n=29)	p*
PCS				
PRT	33 (22.60-44.70)	34 (22.60-44.70)	34.3 (25.5-48.6)	0.995
PST				
2nd week	42.9 (32.7-49.10)	42.2 (25.5-49.10)	43.8 (25.5-49.10)	0.998
4th week	43 (22.6-49.10)	42.3 (33-48.6)	41.3 (25.5-48.6)	0.740
12th week	45.3 (32.7-48.3)	46.1 (25.5-48.6)	44.8 (25.5-48.6)	0.824
24th week	42.4 (32.7-48.6)	42.7 (25.5-49.1)	43 (32.7-49.1)	0.724
p**	**<0.001**	**<0.001**	**<0.001**	
Difference	PRT between PST 2nd week, 4th week and 12th week	PRT between others	PRT between others	
MCS				
PRT	35.7 (22.60-50.4)	34.6 (22.60-44.7)	34.9 (20.30-50.4)	0.905
PST				
2nd week	42.2 (39.6-48.20)	40 (29.6-48.20)	39.9 (33-43.3)	0.898
4th week	41.4 (26-43.6)	42.1 (26-43.6)	42 (35.9-43.6)	0.840
12th week	44.3 (39.1-43.3)	43 (26-44.4)	43.5 (33-43.3)	0.762
24th week	42.4 (39.6-48.2)	42.6 (40.5-44.9)	42 (33-41.4)	0.784
p**	**<0.001**	**<0.001**	**<0.001**	
Difference	PRT between others	PRT between others	PRT between others	

*Comparison between groups (Kruskal-Wallis H); **Comparison within groups (Friedman); p value of less than 0.05 was considered statistically significant; SF-12: Short Form-12; SA: Subacromial; ACJ: Acromioclavicular joint; SSNB: Suprascapular nerve block; PCS: Physical state assessment scale; PRT: Pre-treatment; PST: Posttreatment; MCS: Mental state assessment scale.

ARTICLE IN PRESS

While some of these studies reported that methylprednisolone treatment injected into the SA cavity did not affect pain and functional recovery during the 12-week follow-up period, 2 different studies concluded that SA injections were effective.[13,18] In one of these studies, Ogbeivor et al. reported that VAS and SPADI values were found to be significantly lower at the end of 12 weeks.[19] On the other hand, Sumanont et al. emphasized that although the CS injection on the shoulder region provided an acceptable reduction in pain and improvement in functional outcomes, the current literature in this area was insufficient.[2] In our study, consistent with the literature, we found that the efficacy of the injection decreased after the 12th week in the group that received only SA injection.

SSNB is another treatment option that can be used in the treatment of shoulder pain.[7,8] There are different pathologies in which the use of SSNB for analgesic purposes can be considered primarily. One of these is the pathologies that can develop due to the anatomical structure of the SSN. The SSN becomes susceptible to traction and compression in the area where it passes through the spinoglenoid notch and passes under the transverse suprascapular ligament adjacent to the supraspinatus fossa.[16] VAS and SPADI scoring systems were used as SSNB follow-up parameters demonstrating the effectiveness in different studies. In placebo-controlled studies on chronic shoulder pain, it was reported that SSNB and the mixture of local anesthetic and CS could reduce pain and provide functional improvement.[17] On the other hand, it was determined that SSNB could lead to better results compared to SA injection according to the results of studies comparing the effectiveness of SSNB and SA injection.[16] Different mechanisms have been identified for the effectiveness of SSNB. The first of these is the depletion of neurotransmitter substance P and nerve growth factor in the glenohumeral joint synovium and afferent C fibers after neural blockade of afferent C and A γ fibers due to local anesthetic drug.[20] Another factor contributing to pain relief may lead to wind down or decreased central sensitivity of nociceptive neurons in the dor-

sal horn due to decreased peripheral nociceptive input following the neural blockade.[20] As a result of the stretching of the shoulder joint capsule with movement, it can cause an increase in the nociceptive and mechanoreceptor input. This may increase central sensitization and existing muscle spasms, and additionally limit the active motion of the glenohumeral joint by impairing the synergy between muscle groups. It has been reported that the decrease in the sensory input as a result of SSNB may increase the active movement of the shoulder joint.[20,21] The results we found in our study were also compatible with the literature. We found improvements in pain, functions and quality of life in patients who received SSNB injection. Therefore, we think that both mechanisms can be effective in our patients.

The association between the ACJ and diseases causing shoulder pain has been addressed in different studies.[8,9] In the literature, we could not find a study that applied ACJ injection in SIS. To the best of our knowledge, ACJ injection was mostly used in the primary pathologies of ACJ and a mixture of 2 mL steroid and local anaesthetic was reported to reduce pain for up to 12 months.[9] In another study investigating ACJ pathology in patients with SIS, pulsed radiofrequency treatment applied to the SA and ACJ was reported to prolong pain and functional improvement for up to 6 months.[22] In this study, it was observed that all 3 interventional treatment approaches provided improvement in pain and function over 6 months compared to pre-treatment. On the other hand, in the 6th month follow-up results, statistically significantly more improvement was found in the SA+ACJ and SSNB applied groups compared to the SA injection group.

The frequent association of ACJ pathologies in patients with SIS may contribute to the interpretation of these results. We believe that the fact that the sensory area of the SSN involves ACJ and that provided innervation of only this joint with accessory branches may explain that it causes an effect similar to ACJ injection.[7] These results suggest that the association of ACJ pathologies with patients diagnosed with SIS may need to be considered.[8] Which method should be used for long-term efficacy can be determined by the clinical experience of the practitioners, several factors such as the root cause of shoulder pain, and more studies.

The limitation of this study may be the absence of a control group. In addition, due to the design of the study, it can be considered that it could not be done double-blindly due to the fact that SA+ACJ injection was applied from 2 sites in the group.

CONCLUSION

From the results of this study, it can be concluded that SSNB and ACJ+SA injections administered with steroid +LA are more effective in the pain and function among patients with SIS in the long term than only SA injection. We think that remembering the ACJ injection when the SA injection is planned will provide additional contributions to the patient's improvement.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

ARTICLE IN PRESS

REFERENCES

1. van der Sande R, Rinkel WD, Gebremariam L, et al. Subacromial impingement syndrome: effectiveness of pharmaceutical interventions-nonsteroidal anti-inflammatory drugs, corticosteroid, or other injections: a systematic review. Arch Phys Med Rehabil. 2013;94:961-76. PMID: 23246416.
2. Sumanont S, Boonard M, Peradhammanon E, et al. Comparative outcomes of combined corticosteroid with low volume compared to high volume of local anesthetic in subacromial injection for impingement syndrome: systematic review and meta-analysis of RCTs. Eur J Orthop Surg Traumatol. 2018;28:397-407. PMID: 29027006.
3. Yilmaz E. A prospective, comparative study of subacromial corticosteroid injection and subacromial corticosteroid injection plus suprascapular nerve block in patients with shoulder impingement syndrome. Arch Orthop Trauma Surg. 2021;141:733-41. PMID: 32356170.
4. Ökmen BM, Ökmen K. Comparison of photobiomodulation therapy and suprascapular nerve-pulsed radiofrequency in chronic shoulder pain: a randomized controlled, single-blind, clinical trial. Lasers Med Sci. 2017;32:1719-26. PMID: 28547075.
5. Sabeti-Aschraf M, Ochsner A, Schueller-Weidekamm C, et al. The infiltration of the AC joint performed by one specialist: ultrasound versus palpation a prospective randomized pilot study. Eur J Radiol. 2010;75:e37-40. PMID: 19647964.
6. Neustadt DH. Local corticosteroid injection therapy in soft tissue rheumatic conditions of the hand and wrist. Arthritis Rheum. 1991;34:923-6. PMID: 2059240.
7. Borbas P, Eid K, Ek ET, et al. Innervation of the acromioclavicular joint by the suprascapular nerve. Shoulder Elbow. 2020;12:178-83. PMID: 32565919; PMCID: PMC7285973.
8. Gürbüz H, Unalan H, Sarisaltik H, et al. The role of acromioclavicular arthritis in impingement syndromes. Yonsei Med J. 1998;39:97-102. PMID: 9587248.
9. Park KD, Kim TK, Lee J, et al. Palpation versus ultrasound-guided acromioclavicular joint intra-articular corticosteroid injections: a retrospective comparative clinical study. Pain Physician. 2015;18:333-41. Erratum in: Pain Physician. 2015;18:517. PMID: 26218936.
10. Harmon D, Hearty C. Ultrasound-guided suprascapular nerve block technique. Pain Physician. 2007;10:743-6. PMID: 17987095.
11. MacDermid JC, Solomon P, Prkachin K. The Shoulder Pain and Disability Index demonstrates factor, construct and longitudinal validity. BMC Musculoskelet Disord. 2006;7:12. PMID: 16472394; PMCID: PMC1382226.
12. Hurst NP, Ruta DA, Kind P. Comparison of the MOS short form-12 (SF12) health status questionnaire with the SF36 in patients with rheumatoid arthritis. Br J Rheumatol. 1998;37:862-9. PMID: 9734677.
13. Dogu B, Yucel SD, Sag SY, et al. Blind or ultrasound-guided corticosteroid injections and short-term response in subacromial impingement syndrome: a randomized, double-blind, prospective study. Am J Phys Med Rehabil. 2012;91:658-65. PMID: 22561385.
14. Dong W, Goost H, Lin XB, et al. Treatments for shoulder impingement syndrome: a PRISMA systematic review and network meta-analysis. Medicine (Baltimore). 2015;94:e510. Erratum in: Medicine (Baltimore). 2016;95:e96d5. PMID: 25761173; PMCID: PMC4602475.
15. Koester MC, George MS, Kuhn JE. Shoulder impingement syndrome. Am J Med. 2005;118:452-5. PMID: 15866244.
16. Coory JA, Parr AF, Wilkinson MP, et al. Efficacy of suprascapular nerve block compared with subacromial injection: a randomized controlled trial in patients with rotator cuff tears. J Shoulder Elbow Surg. 2019;28:430-6. PMID: 30651194.
17. Kamal K, Dahiya N, Singh R, et al. Comparative study of anatomical landmark-guided versus ultrasound-guided suprascapular nerve block in chronic shoulder pain. Saudi J Anaesth. 2018;12:22-7. PMID: 29416452; PMCID: PMC5789501.
18. McInerney JJ, Dias J, Durham S, et al. Randomised controlled trial of single, subacromial injection of methylprednisolone in patients with persistent, post-traumatic impingment of the shoulder. Emerg Med J. 2003;20:218-21. PMID: 12748132; PMCID: PMC1726117.
19. Ogbeivor C, Bandaru S, Milton C. A comparison of the effectiveness of lateral versus posterior approach to shoulder injection in patients with subacromial impingement syndrome: A pragmatic randomized controlled trial. Musculoskeletal Care. 2019;17:257-68. PMID: 31373430.
20. Lewis RN. The use of combined suprascapular and circumflex (articular branches) nerve blocks in the management of chronic arthritis of the shoulder joint. Eur J Anaesthesiol. 1999;16:37-41. PMID: 10084099.
21. Shanahan EM, Ahern M, Smith M, et al. Suprascapular nerve block (using bupivacaine and methylprednisolone acetate) in chronic shoulder pain. Ann Rheum Dis. 2003;62:400-6. PMID: 12695149; PMCID: PMC1754520.
22. Ökmen K, Ökmen B. Comparison the effectiveness of corticosteroid and pulsed radiofrequency in chronic shoulder pain. J Clin Anal Med. 2018;9(1):87-91. https://ia601603.us.archive.org/9/items/comparison-the-effectiveness-of-corticosteroid-and-pulsed-radiofrequency-in-chronic-shoulder-pain/JCAM-5511.pdf

ARTICLE IN PRESS