Shockwave therapy versus local steroid injection in chronic supraspinatus tendinopathy

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Received 4 April 2018
Accepted 30 September 2018

Egyptian Rheumatology & Rehabilitation
2019, 46:141–147

Objective
To evaluate the efficacy of shockwave therapy versus ultrasound-guided steroid injection in the treatment of chronic supraspinatus tendinopathy.
Patients and methods
This study was carried out on 30 patients with calcific and noncalcific supraspinatus tendinopathy for more than 3 months. A clinical assessment was performed for all patients including pain scoring by the visual analog scale and full shoulder examination at the start of the study and 6 weeks later. Shoulder ultrasound was performed at the start of the study. Fifteen patients received four sessions of radial shockwave therapy (Intelect Radial Shockwave, UK) 3 bar pressure, 2000 pulses, 20 Hz. Fifteen patients received a single ultrasound-guided subacromial steroid injection (1 ml triamcinolone 40 mg and 1 ml lidocaine).
Results
Both groups showed a statistically significant improvement in pain relief (visual analog scale) and clinical examination: tenderness, shoulder range of motion, and muscle power. There was no statistically significant difference between both groups.
Conclusion
Radial shockwave therapy has no additional benefit over ultrasound-guided steroid injection in the short term in patients with chronic supraspinatus tendinopathy.

Keywords:
chronic supraspinatus tendinopathy, local steroid injection, shockwave therapy

Egypt Rheumatol Rehabil 46:141–147

1110-161X

Introduction

Supraspinatus tendinopathy is the most commonly diagnosed condition that caused shoulder pain. The supraspinatus tendon is the most affected tendon (80%), followed by the infraspinatus tendon (15%) and the subscapularis tendon (5%) [1]. Chronic supraspinatus tendinopathy is a common disabling condition [2]. Chronic supraspinatus tendinopathy is more prevalent between the third and the fifth decades, and more common in women [3]. Several authors attribute shoulder complaints to repetitive work, hand overhead activities, and high psychosocial demands [4].

Many theories have been proposed suggesting that supraspinatus tendinopathy has a multifactorial etiology as a result of extrinsic factors leading to narrowing of the subacromial space with compression of the bursal side of the tendons as anatomic variants of the acromion, subacromial spurring or osteophytes, and intrinsic factors, mainly avascularity [5]. The intrinsic factors are the primary cause [6].

Calcific supraspinatus tendinitis is an enthesopathy caused by inflammation around calcium hydroxyapatite crystal deposits usually localized in the supraspinatus tendon and near its insertion in the humerus. The reported prevalence of asymptomatic calcifications in the rotator cuff tendons is 2.7–20%. The disease progression has four phases [7]: the precalcific phase, where there is asymptomatic metaplasia of the tendinous tissue into fibrocartilage, the formative phase, where there are calcium deposits in the tendon, and it is either asymptomatic or caused only mild pain, the resorptive phase, which is the most painful phase, where there is cell-mediated calcium resorption by macrophages and multinucleated giant cells, and the last phase is the repair and healing phase, where there is still some residual pain and stiffness. Noncalcific tendinopathy is considered the precalcific phase by some authors [8].

Pain is the main symptom that is caused by increasing intratendon pressure, with vascular proliferation occurring during resorption of calcifications. Also, increasing the tendon volume leads to its compression by the coracoacromial arch, resulting in

shoulder impingement syndrome, whose effects are functional loss and disability. By increasing calcification, a partial tendon rupture occurs, whereas complete rupture of the tendon is rare [9]. Clinical features also include pain triggering loss of muscular strength, decreased range of motion, and shoulder disability with localized pain in the deltoid region, which increases after overhead activities [8]. The resulting limitation of function affects activities of daily life and sleep, leading to anxiety and distress [10].

Radiography examination shows calcium deposits that are not connected to the bone. Also, MRI and musculoskeletal ultrasound show the calcifications and tendon status, and exclude other rotator cuff disorders [9].

Treatment is usually conservative, including oral and local NSAIDs and physical therapy. In chronic severe cases, subacromial corticosteroid injections, extracorporeal shockwave therapy (ESWT), ultrasonic-guided needling, and lavage are used. Surgical intervention is the last line of treatment in severely resistant cases [3].

The use of subacromial corticosteroid injections is still one of the most common procedures for the treatment of shoulder pain. Corticosteroids exert anti-inflammatory and anti-nociceptive effects. Corticosteroid injections vary in type and doses; long-acting corticosteroids are used most commonly for the treatment of shoulder pain. The most commonly used is triamcinolone acetonide, with a dose range of 20 or 40 mg. Steroid injection in the subacromial bursa guided by ultrasound leads to more pain relief, improvement in disability, and increasing active range of motion than Non US guided injections [11]. Subacromial corticosteroid injection is less invasive, easy to perform, leads to fewer adverse effects, is not costly, and easily available. Its short-term effects include clinical improvement such as pain relief, remissions, increased range of motion, and also radiological improvement [3].

ESWT is used in the treatment of chronic enthesopathies such as epicondylitis, plantar fasciitis by heel spur, and chronic rotator cuff tendinitis. The effects are stimulation of tissue healing, destruction of calcifications and reactive vascularization, and pain relief [1]. There is evidence of the intermediate-term effects of ESWT such as pain relief and improved shoulder function for chronic calcific rotator cuff tendinopathy more than noncalcific rotator cuff tendinopathy [12]. There are two types of ESWT: radial and focused shockwave therapy. Shockwave therapy is classified into low-energy and high-energy shockwave therapy according to the energy flux density. High-energy shockwave therapy is better in improving shoulder function and pain relief in chronic calcific supraspinatus tendinopathy. The advantages of ESWT are good clinical results, wide applicability, the fact that it is relatively inexpensive, and absence of severe side effects or long-term complications, but it is more time consuming as multiple sessions are needed to achieve these effects [13].

Patients and methods

Our study included 30 patients with supraspinatus tendinopathy for more than 3 months. Supraspinatus tendinopathy was diagnosed clinically and confirmed by musculoskeletal ultrasonography.

Exclusion criteria were traumatic shoulder injuries, previous shoulder surgery or shoulder instability, osteoarthritis of the glenohumeral and acromioclavicular joints, bone infections, cervical radiculopathy, diabetes mellitus, rheumatological diseases as rheumatoid arthritis and gouty arthritis, coagulation diseases, patients on anticoagulant therapy, pregnancy, epilepsy, pacemaker, and skin infection overlying the injection site.

Informed consent was obtained from all patients.

All patients underwent a full assessment of history and clinical assessment, especially visual analog scale (VAS), muscle wasting, tenderness score, range of motion, muscle power, and special tests of the shoulder including empty cant test, full can test, subscapularis lift-off test, Hawkins–Kennedy test, Neer's test, external rotation test, and tests for shoulder instability.

Scanning technique

High-resolution ultrasound was used with a 10–12 MHz linear transducer (LOGIQ 5 pro series; GE Medical Systems, USA; Memphis city, Tennessee state).

The examination was performed for the supraspinatus tendon with the patient sitting in front of the sonographer, with the shoulder in the modified crass position. The tendon was scanned by longitudinal and transverse views. An injection was administered in the same position in the subacromial bursa.

Statistical analysis

Statistical calculations and analysis were carried out, with calculation of the mean, SD, Student's t test, paired t test, χ^2, linear correlation coefficient and analysis of variance

tests, using the statistical package for the social science (IBM SPSS, IBM, Armonk, New York, USA), version 17. The qualitative data were presented as number and percentages, whereas quantitative data were presented as mean, SDs, and ranges when a parametric distribution was present. An unpaired Student's *t* test was used to compare between two groups in terms of quantitative data. A paired *t* test was used to compare between related samples. χ^2 and Fisher's exact tests were used to compare two groups in terms of qualitative data. The linear correlation coefficient was used for the detection of correlation between two quantitative variables in one group. The analysis of variance test was used for comparison among different time-points in the same group in terms of quantitative data. A correlation study for relationships of different variables was carried out using the Pearson correlation coefficient (*r*). *P* value was considered significant as follows: *P* value more than 0.05, nonsignificant; *P* value less than 0.05, significant; *P* value less than 0.01, highly significant.

Results

This study included 30 patients diagnosed with supraspinatus tendinopathy. They were divided into two groups: group I received a single subacromial ultrasound-guided steroid injection and group II received radial shockwave therapy. Their demographic data are shown in Table 1.

Patients in both groups were assessed for pain by the VAS before intervention and at follow-up after 6 weeks. Both groups showed a statistically significant difference at follow-up compared with the baseline, but there was no significant difference between both groups, as shown in Table 2.

Patients in both groups were assessed clinically including muscle wasting, tenderness score, shoulder range of motion, and muscle power before intervention and at follow-up after 6 weeks. No statistically significant

Table 1 Demographic data of the patients

Demographic data	Group I (steroid injection) [*n* (%)]	Group II (shockwave) [*n* (%)]	χ^2 test	
			t/χ^2	*P* value
Sex				
Male	3 (20)	3 (20)	0	1 (NS)
Female	12 (80)	12 (80)		
Age				
Range	33–60	32–57	0.604	0.551 (NS)
Mean±SD	44.933±7.526	43.267±7.583		
Duration				
Range	4–12	4–12	–0.874	0.39 (NS)
Mean±SD	6.400±2.063	7.267±3.240		
Affected shoulder				
Right	7 (46.67)	10 (66.67)	1.222	0.269 (NS)
Left	8 (53.33)	5 (33.33)		
Handedness				
Right	13 (86.67)	13 (86.67)	0	1 (NS)
Left	2 (13.33)	2 (13.33)		
Dominant/nondominant shoulder affection				
Dominant	8 (53.33)	10 (66.67)	0.139	0.709 (NS)
Nondominant	7 (46.67)	5 (33.33)		

Table 2 Visual analog scale before intervention and at follow-up in both groups

VAS	Groups		*t* test	
	Steroid injection	Shockwave therapy	*t*	*P* value
Before				
Range	5–9	5–9	–0.632	0.532 (NS)
Mean±SD	6.6±1.121	6.867±1.187		
Follow-up				
Range	0–3	0–4	–0.656	0.517 (NS)
Mean±SD	1.467±0.915	1.733±1.28		
Difference				
Mean±SD	5.133±0.743	5.133±1.06		
P value	<0.001*	<0.001*		

VAS, visual analog scale. *highly significant

Table 3 Comparison between the two groups before intervention and at follow-up in terms of muscle wasting

Muscle wasting	Groups [*n* (%)]		χ^2	
	Steroid injection	Shockwave therapy	χ^2	*P* value
Before				
Negative	13 (86.67)	14 (93.33)	0.37	0.543
Positive	2 (13.33)	1 (6.67)		
Follow-up				
Negative	14 (93.33)	14 (93.33)	0	1
Positive	1 (6.67)	1 (6.67)		
P value	0.543	1		

Table 4 Comparison between the two groups before intervention and at follow-up in terms of the tenderness score

Tenderness score	Groups		*t* test	
	Steroid injection	Shockwave therapy	*t*	*P* value
Before				
Range	1–3	1–3	0	1
Mean±SD	2.067±0.458	2.067±0.704		
Follow-up				
Range	0–2	0–2	0	1
Mean±SD	0.867±0.64	0.867±0.743		
Differences				
Mean±SD	1.2±0.561	1.2±0.561		
P value	<0.001*	<0.001*		

*highly significant.

difference was found in both groups in muscle wasting at follow-up or between both groups. A statistically significant difference in the tenderness score was found in both groups at follow-up in terms of the tenderness score, muscle power, and range of motion in most of the directions, with no statistical significance between both groups, as shown in Tables 3–6.

On musculoskeletal ultrasound, group I included two patients with calcific supraspinatus tendinopathy, 13 patients with noncalcific tendinopathy, nine patients with subacromial subdeltoid bursitis, and three patients with associated bicipital tendinopathy. Group II included two patients with calcific supraspinatus tendinopathy, 13 patients with noncalcific tendinopathy, six patients with subacromial subdeltoid bursitis, and three patients with associated bicipital tendinopathy (Figs 1 and 2).

There was no statistically significant difference between calcific and noncalcific supraspinatus tendinopathy, except that patients with calcific tendinopathy had more limited range of motion than noncalcific patients.

There was a strong statistically significant correlation between VAS and the tenderness score at follow-up in both groups. There was a moderate statistically significant correlation between VAS and range of motion: abduction, adduction, flexion, and external rotation in abduction at follow-up in both groups. There was a strong statistically significant negative correlation between the duration of symptoms and the range of motion in the steroid injection group. There was a moderate statistically significant negative correlation between the tenderness score and the range of motion in the shockwave group.

There was a highly statistically significant relation between muscle power at follow-up and VAS, the tenderness score, and range of motion except internal rotation in abduction at follow-up in both groups.

Discussion

Chronic supraspinatus tendinopathy is a common cause of shoulder pain. It occurs more with increased overhead activities. The most common symptoms are shoulder pain triggering muscle wasting, shoulder girdle muscle weakness, and limited active range of motion of the shoulder [14].

Supraspinatus tendinopathy is usually self-limiting, but can be severe and chronic; thus, it is usually managed by nonoperative treatment, resulting in good outcome. The most efficient treatment is still debatable and no standard treatment has been established as yet [15].

Treatment usually starts with rest, oral and topical NSAIDs, and physical therapy. In chronic cases, various treatments are used including a local corticosteroid injection in the subacromial bursa, ESWT, and ultrasound-guided needling and lavage. Surgical intervention is used in resistant severe cases [16].

Local corticosteroid injection is the most widely used treatment because of its anti-inflammatory and pain relief effects. It is low cost, easy to perform, and has a low risk of complications. It yields better outcomes when injected into the subacromial bursa under ultrasound guidance.

ESWT is an effective noninvasive technique, results in pain relief, and promotes tissue healing through improvement of neovascularization and reduction of local inflammation and resorption of calcifications. It is easy to perform, but painful, especially when the patient is in the hyperalgesic state, and expensive [14].

In our study, patients in both groups showed a statistically significant difference at follow-up in

Table 5 Comparison between the two groups before intervention and at follow-up in terms of range of motion

Range of motion	Groups		*t* test	
	Steroid injection	Shockwave therapy	*t*	*P* value
Abduction range				
Before				
Range	80–170	70–170	0.375	0.71
Mean±SD	151.333±30.441	146.667±37.353		
Follow-up				
Range	110–170	110–170	–0.091	0.928
Mean±SD	161.333±18.848	162±21.112		
P value	0.03*	0.052*		
Adduction range				
Before				
Range	20–50	10–50	1.065	0.296
Mean±SD	40.667±12.799	35.333±14.573		
Follow-up				
Range	30–50	30–50	–0.316	0.754
Mean±SD	47.333±5.936	48±5.606		
P value	0.019*	0.002*		
Flexion range				
Before				
Range	100–170	90–170	0.241	0.812
Mean±SD	158.667±20.307	156.667±24.976		
Follow-up				
Range	140–170	140–170	–0.226	0.823
Mean±SD	166.667±8.165	167.333±7.988		
P value	0.034*	0.076		
Extension range				
Before				
Range	40–60	20–60	1.133	0.267
Mean±SD	56±7.368	50.667±16.676		
Follow-up				
Range	50–60	40–60	0.316	0.754
Mean±SD	58±4.14	57.333±7.037		
P value	0.082	0.055		
Internal rotation in abduction				
Before				
Range	40–70	30–70	0.778	0.443
Mean±SD	66±8.281	62.667±14.376		
Follow-up				
Range	60–70	50–70	0.447	0.658
Mean±SD	69.333±2.582	68.667±5.164		
P value	0.055	0.07		
External rotation in abduction				
Before				
Range	30–100	20–100	0.085	0.933
Mean±SD	86.667±20.237	86±22.615		
Follow-up				
Range	60–100	80–100	–0.821	0.418
Mean±SD	95.333±11.255	98±5.606		
P value	0.017*	0.051*		

VAS, tenderness, range of motion, and muscle power, but there was no significant difference between both the groups. This is in agreement with the meta-analysis carried out by Arirachakaran *et al.* [15] that compared shockwave therapy, steroid injection, and other treatments, and found a statistically significant improvement in both groups at follow-up, But no significant difference on comparing both groups. Twenty percent of our patients (six patients) had associated bicipital tendinopathy. This is in agreement with the meta-analysis carried out by Redondo-Alonso *et al.* [16] that found a high association between bicipital tendinopathy and chronic supraspinatus tendinopathy. This association

Table 6 Comparison between the muscle power before intervention and at follow-up between the two groups

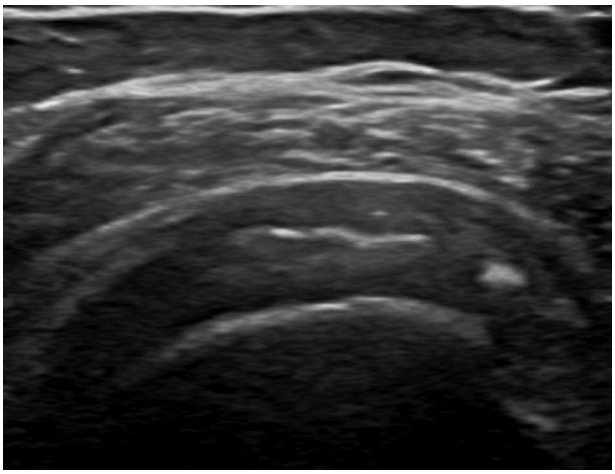
Muscle power	Groups [*n* (%)]		χ^2	
	Steroid injection	Shockwave therapy	χ^2	*P* value
Before				
G3–	5 (33.33)	5 (33.33)	0.952	0.621
G4–	6 (40)	8 (53.33)		
G4	4 (26.67)	2 (13.33)		
Follow-up				
G3–	3 (20)	2 (13.33)	2.925	0.711
G3	0	1 (6.67)		
G4–	1 (6.67)	0		
G4	1 (6.67)	2 (13.33)		
G4+	9 (60)	8 (53.33)		
G5	1 (6.67)	2 (13.33)		
P value	0.003*	0.001*		

*means highly significant

has been explained by the fact that both tendons are considered one of the main stabilizers of the glenohumeral joint by compressing the humeral head to the glenoid cavity. Also, the supraspinatus tendon plays a role in stabilizing the long head of biceps tendon by forming part of the long head of biceps tendon reflection pulley; thus, any damage of either one can affect the function of the other. Also, they reported that by increasing the chronicity of the supraspinatus tendinopathy, the overall biomechanics of the shoulder is affected; hence, the percentage of associated pathology of the long head of biceps is increased.

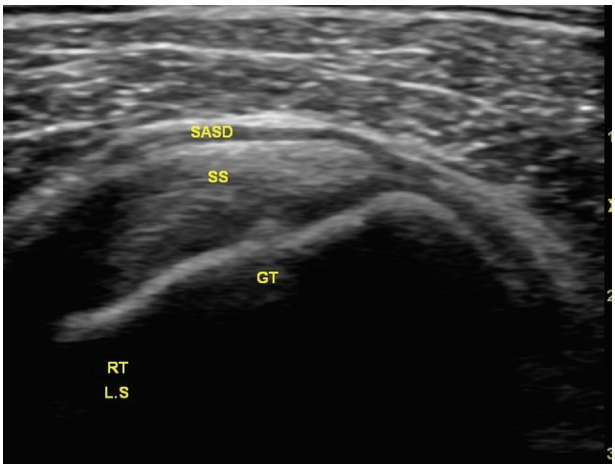
There was a strong statistically significant positive correlation between the VAS at the 6-week follow-up and the tenderness score at the 6-week follow-up in both groups. There was a moderate statistically significant negative correlation between the VAS at the 6-week follow-up and the range of motion in most of the directions, especially abduction, in both groups. There was a moderate statistically significant negative correlation between the tenderness score and range of motion in all directions at follow-up in group II. There was a strong statistically negative correlation between the duration of symptoms and the range of motion in most of the directions in group I. There was a highly statistically significant relation between muscle power at follow-up and VAS, tenderness score, and range of motion in most of the directions at follow-up in both groups.

Figure 1



A transverse and longitudinal section of supraspinatus tendon with calcific supraspinatus tendinopathy.

Figure 2



A transverse and longitudinal section of supraspinatus tendon with noncalcific supraspinatus tendinopathy.

Conclusion and recommendations

(1) There was a statistically significant improvement in both treatment groups at follow-up in VAS, tenderness, active range of motion, and muscle power, but no significant difference was found between both groups.
(2) Radial shockwave therapy has no additional beneficial short-term effect over steroid injection in the treatment of chronic calcific and noncalcific supraspinatus tendinopathy.

We recommend that similar studies be carried out with large sample sizes, long-term effects should be tested by increasing the follow-up duration, and musculoskeletal ultrasound should be used in long-term follow-up for the assessment of radiological improvement.

Financial support and sponsorship
Nil.

Conflicts of interest
None declared.

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