

Extracorporeal Shock Wave Therapy versus Local Corticosteroid Injection and Platelet-Rich Plasma in The Treatment of Supraspinatus Tendinopathy

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ABSTRACT

Background: A chronic degenerative musculoskeletal condition known as tendinopathy is widespread in both the general public and sportsmen. The most typical therapies used to facilitate tendon repair and regeneration are extracorporeal shockwave therapy (ESWT), platelet-rich plasma (PRP), and local corticosteroid injection.

Objective: The aim of the current study was to evaluate the efficacy of ESWT to corticosteroid and PRP injections in the treatment of supraspinatus tendonitis.

Patients and methods: A total of 60 subjects suffering from supraspinatus tendinopathy were recruited and divided into 3 groups: 20 patients who received platelet-rich plasma (PRP) injections, 20 patients who received local corticosteroid injection, and 20 patients who received ESWT using radial ESWT.

Results: In the PRP group results showed a statistically significant improvement in visual analogue scale (VAS), tendon thickness, tear size, and American Shoulder and Elbow Surgeons patient self-report section (ASES-p). The VAS, US examination, and ASES-p all indicated statistically significant improvements after corticosteroid injection. The VAS, US test, and ASES-p all revealed statistically significant improvements in the ESWT group.

Conclusion: In comparison to steroid injection and ESWT, PRP therapy offers an extra favorable short-term benefit for the treatment of supraspinatus tendinopathy. ESWT is also a simple, effective, and noninvasive alternative for the treatment of supraspinatus tendinopathy. Two months following therapy, local corticosteroid injections reduced discomfort and increased functional abilities.

Keywords: Supraspinatus tendinopathy, Shockwave therapy, Steroid injection, Platelet-rich plasma.

INTRODUCTION

Supraspinatus tendinopathy is a common source of shoulder discomfort, and is a debilitating disorder that is particularly prevalent after middle age ^(1,2). Resistive overuse is a predisposing factor ⁽³⁾.

Most frequently as a result of recurrent stressors and overloading during sports or occupational activities, the supraspinatus tendon is implicated, damaged, and degenerates ⁽⁴⁾.

Sometimes wear and tear results in supraspinatus tendinitis, which is commonly associated with subacromial bursitis. There may be partial tears or complete tears ⁽⁵⁾. Numerous conservative therapies exist, however there is little data to support their effectiveness ⁽⁶⁾.

One-impulse acoustic waves known as shock waves are produced by electromagnetic, electrohydraulic, or piezoelectric sources. Extracorporeal shock wave treatment (ESWT) has been successfully utilized to treat enthesopathies over the past 20 years ⁽⁷⁾.

ESWT's impact on plantar fasciitis, epicondylitis, jumper's knee, and supraspinatus tendinopathy has all been studied in clinical trials ⁽⁸⁻¹¹⁾.

When subacromial corticosteroid injections are utilized in the treatment of rotator cuff tendinopathies, corticosteroid injection in supraspinatus tendinopathy revealed clinical benefits in pain reduction and range of motion ⁽¹²⁾. This is because of their ability to reduce inflammation and the immune system. They disrupt the inflammatory and immunological cascade on a

number of levels by acting directly on nuclear steroid receptors. By doing this, they decrease vascular permeability, inhibit inflammatory cell accumulation, phagocytosis, neutrophil production, metalloprotease, and metalloprotease activator, as well as prevent the synthesis and release of several inflammatory mediators like prostaglandin and leukotrienes, which reduces erythema, swelling, heat, and joint tenderness and increases relative viscosity ⁽¹³⁾.

PRP, which is used to treat supraspinatus tendinopathy, is an autologous concentration of platelets derived by whole blood centrifugation under particular conditions. The activation of growth factors such as PDGFs alpha, beta, TGFs beta 1 and beta 2, VEGF, and EGF, which can play a role in tendon healing ⁽¹⁵⁾, is the result of the anti-inflammatory that is related to the chemotactic activity towards the cells of inflammation.

The aim of the current study was to evaluate the efficacy of ESWT to corticosteroid and PRP injections in the treatment of supraspinatus tendonitis.

PATIENTS AND METHODS

A randomized controlled clinical trial was conducted at Benha University Hospitals. A total of 60 patients suffering from supraspinatus tendinopathy were recruited and divided into 3 groups: 20 patients who received platelet-rich plasma (PRP) injections, 20 patients who received local corticosteroid injection, and 20 patients who received ESWT using radial ESWT.

The inclusion criteria were: The patient has not responded to pharmacological treatment (one course of the standard dose of prescribed analgesic or non-steroidal anti-inflammatory drugs) for at least three weeks. The patient has not responded to a standard course of non-pharmacological and non-surgical conservative treatment. The patient is willing to take part in the research and show up for all planned follow-up appointments. The patient has a free passive range of motion and at least 90 degrees of active abduction in the shoulder that is afflicted.

The exclusion criteria were: The patient had prior shoulder surgery, infections or tumors, there are malignant tumors on the patient, no matter where they are, pregnancy, neurological diseases that may lead to shoulder pain, and coagulation diseases.

All patients were confirmed to have supraspinatus tendinopathy diagnosed according to a history of lateral elbow discomfort and functional activities like grasping or moving heavy things make symptoms worse, musculoskeletal examination of the shoulder to exclude other causes of shoulder pain,

clinical tests and Ultrasound changes as, tendon thickening and focal areas of hypoechogenicity. All the patients in the study groups underwent a physical exam, a lab analysis, and a history taking.

Supraspinatus muscle diagnostic tests: A crucial finding was the presence of discomfort and weakness, especially in cases of rotator cuff issues. The difference between genuine weakness and pain-related weakness was made. a patient with rotator cuff weakness brought on by discomfort while the arm was in the arc of impingement and subacromial bursitis.

Ultrasonic evaluation: First, in the comparable standard scans, the humeral head, glenoid, coracoid process, acromion, and clavicular bone should be recognized as bony landmarks. Transverse and longitudinal scans of the supraspinatus, subscapularis, infraspinatus, and teres minor muscles in the biceps tendon groove, and Basic US assessment of the shoulder included scanning the subacromial-subdeltoid (SASD) bursa, the posterior glenohumeral recess, the glenoid labrum, and the glenohumeral and acromioclavicular joint longitudinally⁽¹⁶⁾.

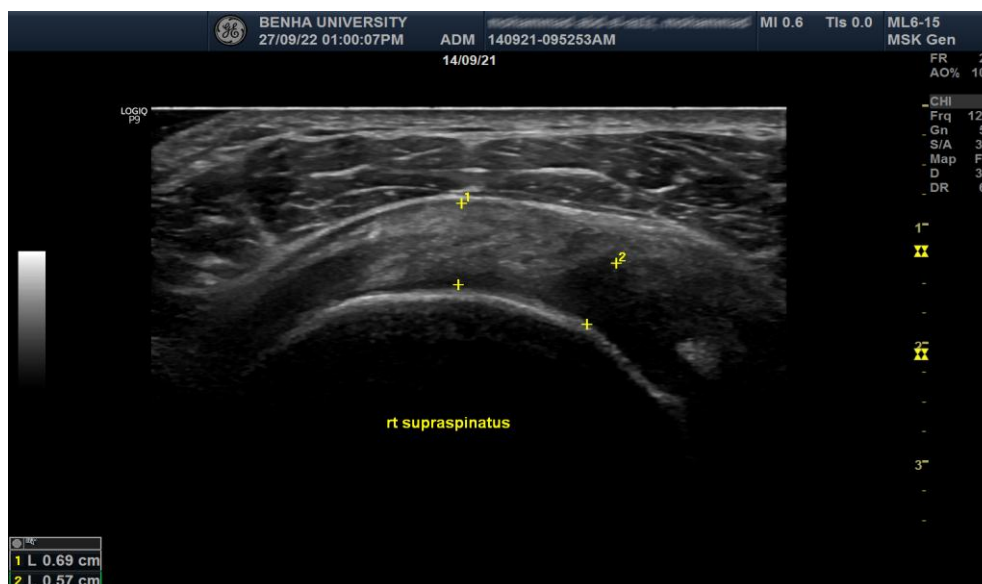


Figure (1): Greyscale transverse view showing supraspinatus tendon thickness (6.9mm) and partial thickness tear size (5.7).

The technique of PRP injection in group 1:

Obtain 20 ml of whole blood into tubes containing 10% sodium citrate. Except for a brief shake to combine the anticoagulant with the blood before platelet separation, never freeze the blood. Using the first "soft" spin, centrifuge the blood for 10 minutes at 3500 RPM to separate it into three layers: an upper layer of plasma, a middle layer of buffy coat, and a lower layer of red blood cells. Using a sterile pipette, transfer the platelet-containing supernatant plasma into a different sterile tube (devoid of anticoagulant). To obtain a platelet concentrate, centrifuge sterile tubes at a faster speed during the second spin (a hard spin) at 4000 rpm for 7 minutes.

Platelet-poor plasma (PPP) makes up the top 2/3 and the lower 1/3 of the mixture. Platelet pellets develop near the tube's bottom. PRP is now ready. Remove PPP and gently shake the tube to suspend the platelet pellets in a minimum amount of plasma (4-5 mL).

The needle is directed IP into the body of the SSP and into the tear using a lateral approach and a transducer in transverse view. The injection is carried out using a fenestration method with the bevel down to properly distribute the PRP. Avoid unduly traumatizing the intact tissue at any costs. The patient may be seated or laying on his or her side with one hand on the back. The SSP tendon itself should contain the needle's tip.

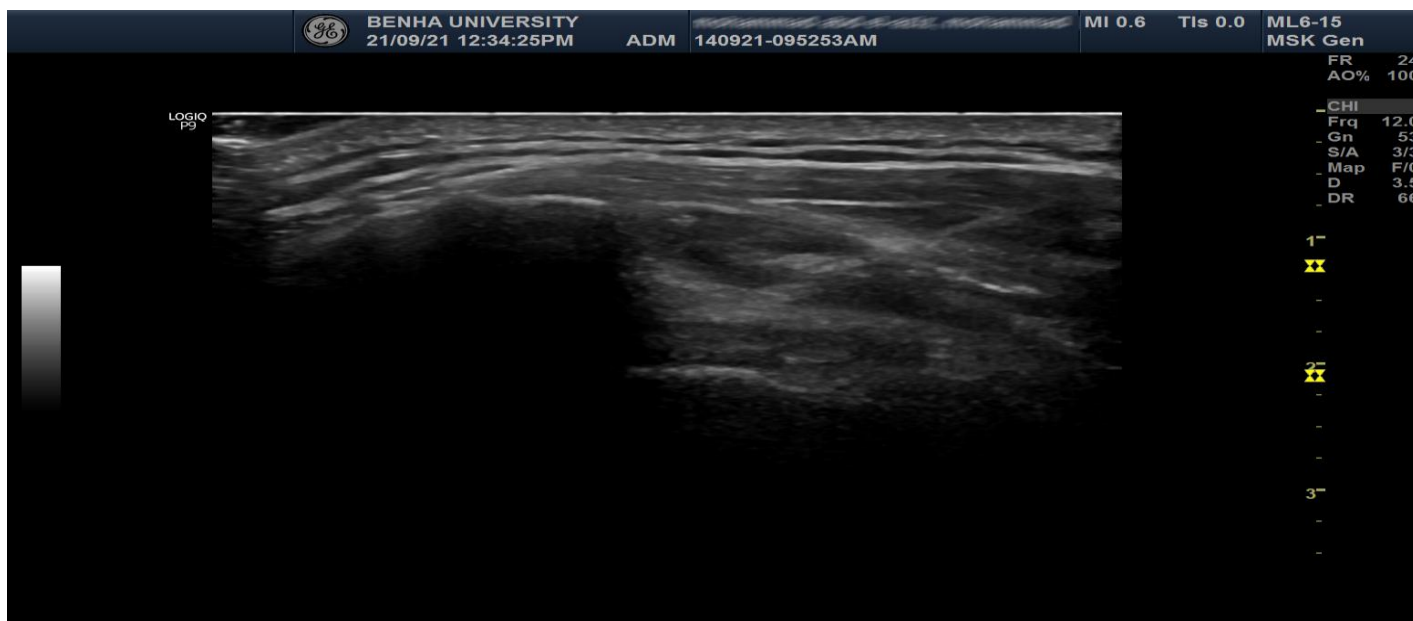


Figure (2): Greyscale transverse view showing needle inserted in supraspinatus tendon before injection.

Group 2: A total of 20 patients who received corticosteroid injections for the treatment of supraspinatus tendinopathy. 1 ml of Triamcinolone Acetonide (40 mg/1ml of Epirolefan vial was injected in the subacromial–subdeltoid bursa under ultrasound guidance for once.

Group 3: A total 20 patients received ESWT shock wave treatment once a week for six sessions. The patient's forearm was neutral and their elbow was bent 90 degrees while they sat on the bed. Over the uncomfortable region, the ESWT device's head was positioned in a 90 degree tangential position. Both the patient and the operator wore safety earmuffs to protect themselves from the device's deafening loudness. Iodine solution was used to clean the application area, and gel material was added to heighten the concussion. Clinical and ultrasonographic evaluations of the patients were performed at baseline, as well as 4, 8, and 12 weeks after the end of the therapy. 500 shock wave pulses fired in succession at a repetition rate of 5 pulses per second were utilized first, followed by 1800 shock wave pulses fired in succession at a repetition rate of 12 pulses per second.

Outcome measures:

1. Visual Analogue Scale (VAS): to assess the pain severity, we ask patients to rate the pain they experienced from 1 to 10 and to be recorded. VAS zero scores are the least pain, while the VAS 10.0 points to the worst pain. The VAS score will be directed by patient self-reported⁽⁸⁾.

2. ASES-p Asking the patient about the ability to perform daily activities using questionnaires ASES-p, which is widely used in functional assessment of shoulder pathologies.

The 11 components that make up the ASES-p scale are broken down into 10 things for function and 1 item for pain. The pain item assesses the current degree of pain using a 10-cm VAS, with 0 representing no pain at all

and 10 being the worst possible level of pain. The 10 function items assess a person's capacity to carry out certain activities of daily living and are scored on a Likert scale with a range of 0 to 3.

Ethical approval:

This study was ethically approved by the Institutional Review Board of the Faculty of Medicine, Benha University (Approval code: MS15/3/2019). Written informed consent was obtained from all participants. This study was executed according to the code of ethics of the World Medical Association (Declaration of Helsinki) for studies on humans.

Statistical analysis

STATA/SE version 11.2 for Windows (STATA Corporation, College Station, Texas) was used to perform the statistical analysis. For numerical data, mean, Standard Deviation (SD), and range were used to summarize the data, while for categorical data, frequency and percentage were used. The Chi-square test (X^2) and Fisher Exact Test (FET) were used to compare categorical data between the study groups. To find differences in means between two and more than two groups, the independent Student's t-test and One-Way Analysis of Variance (ANOVA, F) were employed, respectively. To find differences between pairings, post-hock testing use the Bonferroni technique were performed. The effects of the different treatments were compared before and 60 days after treatment using the paired t-test and the McNemar test, as appropriate. The threshold for statistical significance was P 0.05.

RESULTS

Table 1 summarizes the demographic and clinical characteristics of the studied groups. With relation to DM, there was a significant statistical difference between the tested groups (P=0.002).

Table (1): Characteristics of the two research groups' patients.

Variable		PRP (no.=20)	C.S. injection (no.=20)	ESWT (no.=20)	P-value	P1	P2	P3
Age (years)	Mean ±SD	47.15±6.39	44.45±4.84	44.35±4.08	0.07	0.14	0.11	0.94
	Range	37-60	37-52	39-53				
Sex	Female (%)	16 (80%)	15 (75%)	15 (75%)	1.00	100	1.00	1.00
	Male (%)	4 (20%)	5 (25%)	5 (25%)				
BMI (kg/m ²)	Mean ±SD	23.54±2.03	23.40±1.68	22.98±1.55	0.58	0.81	0.33	0.41
	Range	19.14-26.57	19-25.71	20-26				
Disease duration (months)	Mean ±SD	8.55±2.30	7.35±3.10	8.2±2.09	0.31	0.17	0.62	0.31
	Range	5-12	3-12	4-10				
DM	No (%)	12 (60%)	20 (100%)	11 (55%)	0.002	0.003	0.75	0.001
	Yes (%)	8 (40%)	0 (0.0%)	9 (45%)				
ESR (mm/hr)	Mean ±SD	17.85±4.42	19.1±4.61	21.95±5.46	0.41	0.70	0.22	0.34
CRP (mg/L)	Negative (%)	16 (80%)	11 (55%)	14 (70%)	0.23	0.18	0.46	0.33
	Positive (%)	4 (20%)	9 (45%)	6 (30%)				

P1: between PRP & C.S. injection, P2: between PRP & ESWT, P3: between C.S. injection & ESWT. PRP= Platelet rich plasma, C.S.= Corticosteroid injection, ESWT= Extracorporeal shock wave therapy, BMI= Body Mass Index, DM= Diabetes Mellitus, ESR= Erythrocyte Sedimentation Rate, CRP= C-reactive protein.

Table 2 shows that in PRP there was a substantial statistical difference between before and after 60 days regarding VAS, tendon thickness, tear size and ASES-p. However, there was no statistically significant difference in bursitis by US exam between the tested groups.

Table (2): Comparison between clinical findings of patients before and 60 days after treatment with PRP.

PRP (no.=20)		Mean ±SD (Range)		Rate of change (%)	Test	P-value
		Before	After 60 days			
VAS	Mean ±SD	8.65±0.87	2.1±1.25	75.40±15.33 50-100	t= 18.63	<0.001
	Range	7-10	0-4			
US exam.	Bursitis Yes (%)	6 (30%)	3 (15%)	50	X ² = 3.00	0.08
	Tendon thickness	6.89±0.78 5.7-8.6	5.9±0.68 4.5-7.2	14.38±3.96 8.95-23.73	t= 14.66	<0.001
	Tear size	5.47±0.57 4.5-6.4	4.1±0.57 3-5.2	25.01±7.45 10.53-36.17	t= 14.07	<0.001
ASES-p	Pain	9.25±5.91 1-21	40.25±5.49 35-50	723.16±1024.75 66.67-3900	t= 16.04	<0.001
	Function	26.58±5.47 16.66-35	44.41±3.80 36.66-50	72.08±26.59 42.86-130.07	t= 33.75	<0.001
	Total	35.83±8.92 17.66-54.33	84.66±6.36 75-98.33	151.34±67.79 62.58-343.54	t= 22.87	<0.001

Table 3 shows that in corticosteroids injection there was a substantial statistical difference between before the procedure and 60 days after the procedure regarding VAS, US exam and ASES-p.

Table (3): Comparison between clinical findings of patients before and 60 days after treatment with C.S. injection.

Corticosteroids injection (no.=20)		Before		After 60 days		Rate of change (%)	Test	P- value
		Mean ± SD	Range	Mean ± SD	Range			
VAS	Mean (±SD)	8.35±0.67	7-9	1.3±0.92	0-3	84.54±10.46 66.66-100	t=31.57	<0.001
	Range							
US exam.	Bursitis Yes (%)	20 (100%)		5 (25%)		75	X ² =15	0.0001
	Tendon thickness	4.94±0.82	3.8-6.2	4.89±0.79	3.7-6	1.05±1.4 0.0-3.7	t=3.24	0.004
ASES- p	Pain	8.25±3.35	5-15	43.5±4.62	35-50	510±234.86 200-900	t=31.57	<0.001
	Function	28.83±1.80	26-31	47.42±1.75	43.33-50	64.84±7.58 53.43-75.13	t=58.2	<0.001
	Total	37.08±4.02	31-44.33	90.77±5.67	80.33-100	146.89±24.78 103.02-191.29	t=43.85	<0.001

Table 4 shows that in ESWT there was a substantial statistical difference between before and after 60 days regarding VAS, US exam and ASES-p. However, there was no statistically significant difference in the prevalence of bursitis between the US test conducted before and after 60 days.

Table (4): Comparison between clinical findings of patients before and 60 days after treatment with ESWT.

ESWT (no.=20)		Before		After 60 days		Rate of change (%)	Test	P-value
		Mean ±SD	Range	Mean ±SD	Range			
VAS	Mean (±SD) Range	8.65±0.93	7-10	1.85±1.35	0-4	78.55±16.37 50-100	t=19.72	<0.001
US exam.	Bursitis Yes (%)	5 (25%)		4 (20%)		---	X ² =1.00	0.32
	Tendon thickness	7.17±0.53	6.5-8.2	6.05±0.44	5.3-6.9	15.56±3.25 6.06-22.06	t=19.36	<0.001
	Tear size	4.41±1.32	2.7-6.5	4.25±1.20	2.7-6	3.13±4.86 0-15.38	t=2.65	0.01
ASES-p	Pain	6.75±4.67	0-15	40.75±6.74	30-50	485.42±264.22 133.33-900	t=19.72	<0.001
	Function	25.83±7.01	16-39.33	43.33±4.26	35-50	79.96±50.10 2.78-158.66	t=8.81	<0.001
	Total	32.58±10.45	16-51	84.08±9.44	65-100	187.04±98.77 41.30-400	t=14.96	<0.001

DISCUSSION

The mean aim of the current study was to determine the effectiveness of ESWT in the treatment of supraspinatus tendinitis compared to corticosteroid and PRP injections. The total improvement in the corticosteroid injection group was 90.77 (SD 5.67) and in the ESWT group was 84.08 (SD 9.44) with a statistically significant improvement in the corticosteroid injection than ESWT group which disagree with the results in the study done by ESWT **Zamzam et al.** (17), who, in the course of treating 30 patients with calcified and non-calcified supraspinatus tendinopathy for more than 3 months, compared the effectiveness of ESWT and ultrasound-guided steroid injection. There was no statistically significant difference between the two groups in the management of chronic supraspinatus tendinopathy, although they did find statistically significant improvements in pain alleviation and clinical examination measures.

It is consistent with the study conducted by **Arirachakaran et al.** (18) comparing shockwave therapy, steroid injection, and other treatments indicated a statistically significant improvement in both groups at follow-up but no statistically significant difference when comparing the two groups.

In the current study, the PRP group was a highly statistically significant change in VAS before and after 60 days, US examination, pain, and function improvement which agrees with the study of **Scarpone et al.** (19) 20 shoulders (19 patients) included and received a single injection of PRP. After a follow-up of one year, patients showed improvement regarding VAS score, Functional exercise tests, MRI findings, and patient satisfaction.

In our study, VAS of pain showed a significant improvement from a mean of 8.65 pre-injection into a mean of 2.1 post injection after 60 days with an improvement ratio of 75.40 (P-value<0.001). Our findings were consistent with those of **Unlu et al.** (20),

who demonstrated that PRP injections surrounding torn or tendon had favorable clinical effects on reducing patients' subjective pain levels with great tolerance.

As regards corticosteroid injection, there was a substantial statistically high difference between before and after 60 days regarding VAS, US examination, pain, and function improvement agree with **Zamzam et al.** (17). They discovered a statistically significant difference in VAS, soreness, range of motion, and muscular strength during follow-up compared to the baseline.

In the current study, in ESWT group there was a high statistically significant difference between before and after 60 days regarding VAS, US examination, pain, and function improvement which coincides with, in a clinical trial with 30 patients, **Santamato et al.** (21) contrasted 3 treatment sessions of F-ESWT with the same protocol plus 10 supervised sessions of isokinetic exercise. Participants in the F-ESWT + exercise group experienced considerably less discomfort and a higher improvement in function and muscular endurance than those in the F-ESWT group at the two-month follow-up. In comparison to F-ESWT alone, the combined group was thought to be better in the short to medium term.

In 22 patients, **Carlisi et al.** (22) contrasted F-ESWT alone with F-ESWT combined with supervised eccentric training of the shoulder abductor muscles. There were no statistically significant differences between the groups at the 9-week follow-up, although there was a considerable reduction in pain and an improvement in upper limb function in both groups.

In a clinical trial with 142 participants, **Kvalvaag et al.** (23) compared R-ESWT and supervised exercise for 12 weeks with sham R-ESWT and exercise. Participants in both groups reported reduced shoulder discomfort and increased shoulder function at 24 and 52 weeks, but there were no differences

between the groups. The R-ESWT + exercise group exhibited a larger improvement in pain and function after 24 weeks, but no difference was identified at 52 weeks, according to a pre-specified subgroup analysis of individuals with calcification in the rotator cuff.

The current findings agreed with those of a previous study that examined the impact of ESWT in individuals with non-calcific supraspinatus tendinopathy. After receiving ESWT therapy, they reported a considerable reduction in shoulder discomfort and an increase in functional capacity⁽²⁴⁾.

In research by **Chen et al.**⁽²⁵⁾, it was compared to conventional therapy alone to see how ESWT, eccentric exercise, and conventional therapy affected patients with non-calcific rotator cuff tendinopathy. Their findings suggested that shock wave therapy added to combination therapy produced better results and had a substantial impact on the treatment of non-calcific rotator cuff tendinopathy.

Furthermore, our findings supported a study by **Chou et al.**⁽²⁶⁾, which examined the clinical outcomes of using ESWT for patients with refractory tendinitis or partial tears of the rotator cuff tendon in the athletic and non-athletic groups. They discovered that ESWT was highly effective in both groups and had a similar level of satisfaction in both cases.

As previously stated, ESWT is described as a series of single sonic pulses with high peak pressure (10-100 MPa, 100-1000 bar) and a brief (10 ms) duration that are delivered to the affected region by a suitable generator with an energy density in the range of 0.003-0.89 mJ/mm²⁽²⁷⁻²⁸⁾.

Although the exact mechanism of action of shock waves is unknown, it has been hypothesized that ESWT may impact topical pain components by overexciting the axon. Then, by eliminating unmyelinated sensory fibers, a reflexive analgesic effect is produced and pain is decreased. Nitric oxide (NO) generation generated by ESWT may be crucial in reducing inflammation, according to a number of recent studies⁽²⁹⁾. Additionally, it has been found that direct healing stimulation and neovascularization promotion also occur^(27,30).

CONCLUSION

In comparison to steroid injection and ESWT, PRP therapy shows extra positive short-term benefits for the treatment of supraspinatus tendinopathy. ESWT is also a simple, effective, and noninvasive alternative for the treatment of supraspinatus tendinopathy. Two months following therapy, local corticosteroid injections reduced discomfort and increased functional abilities.

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Competing interests: Nil.

All authors have read and approved this work, and they all meet the authorship criteria.

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