Comparison of Clinical and Ultrasound Imaging Outcomes Between Corticosteroid and Hypertonic Dextrose Injections for Chronic Supraspinatus Tendinopathy

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Background: Both corticosteroids and hypertonic dextrose injections are commonly used for chronic supraspinatus tendinopathy.

Purpose: To compare the supraspinatus echogenicity and clinical effects of echo-guided hypertonic dextrose versus corticosteroid injection for treating chronic supraspinatus tendinopathy.

Study Design: Cohort study; Level of evidence, 3.

Methods: The authors performed a secondary data analysis of a previous clinical trial including patients who received normal saline versus hypertonic dextrose injection; patients who received corticosteroid injection were recruited between August 2017 and July 2021. Baseline patient data were matched among these 3 groups at a 1:1:1 ratio. At baseline and 2, 6, and 12 weeks after the intervention, the authors compared morphological changes (supraspinatus thickness and echogenicity) and clinical parameters (visual analog scale [VAS] for pain, Shoulder Pain and Disability Index [SPADI], and range of motion [ROM]). Analysis of variance was used to compare mean changes from baseline among the groups.

Results: A total of 75 patients (25 in each group) were included. At 2-week follow-up, both the dextrose and the steroid groups exhibited improvement in VAS scores (mean difference [MD] from baseline: –2.0 in dextrose group; –3.3 in steroid group (P < .001)), SPADI scores (MD from baseline: –10.6 in dextrose group; –24.6 in steroid group (P < .001)), and flexion ROM (MD from baseline: 13.6° in dextrose group; 21.1° in steroid group) (P = .001). At 6 weeks after injection, the hypertonic dextrose group exhibited more favorable echogenic improvement in supraspinatus tendon morphology compared with the other 2 groups (P < .001). However, the steroid group showed significantly more improvement in clinical parameters compared with the other 2 groups at both week 6 (MD from baseline: VAS, –3.2; SPADI, –26.6; flexion ROM, 21.5°) and week 12 (MD from baseline: VAS, –2.5; SPADI, –20.4; flexion ROM, 15.2°) (P < .001 for all).

Conclusion: Hypertonic dextrose injection improved supraspinatus echogenicity after 6 weeks but provided short-term symptomatic relief in the patients with chronic supraspinatus tendinopathy when compared with corticosteroid or saline injections. Steroid injection exerted a more favorable clinical effect at weeks 6 and 12 but demonstrated a negative effect on the supraspinatus.

Keywords: corticosteroid; prolotherapy; rotator cuff; supraspinatus; tendinopathy; tendinosis; morphology

Rotator cuff tendinopathy is a common cause of shoulder dysfunction and pain that interferes with activities of daily living, work, and sports. Shoulder and upper limb pain is the second most common cause of chronic musculoskeletal pain.2 It most commonly affects the supraspinatus tendon because this tendon experiences a high level of stress during sports and activities of daily living. The supraspinatus tendon is involved during overhead exercises and plays a crucial role in rotator cuff function. However, the supraspinatus tendon can be easily damaged by repetitive impingement injuries, leading to chronic inflammation and subsequent cytokine-induced collagen fiber degradation.22

Current nonsurgical treatments for rotator cuff tendinopathy include nonsteroidal anti-inflammatory agents, exercise therapy, and corticosteroid injections.3 In recent years, prolotherapy has been considered an alternative treatment for patients with chronic rotator cuff tendinopathy.4 Prolotherapy is an injection-based therapy that exerts...
a regenerative effect on patients with chronic musculoskeletal pain. Hypertonic dextrose is one of the most commonly used prolotherapy agents and is considered to induce cell proliferation, thus strengthening and healing the tendon. The injection of hypertonic dextrose is assumed to result in an osmotic gradient and cause the influx of growth factors and inflammatory cells, thus initiating the healing cascade of the injured site. In a previous study, we reported that 20% hypertonic dextrose injection could relieve pain within 2 weeks of injection compared with sham control. However, the effect of hypertonic dextrose injection was not sustained. In addition, although the effects of hypertonic dextrose are attributable to structural improvement, we did not observe morphological changes in our previous study. In contrast to hypertonic dextrose prolotherapy, glucocorticoid injection might damage the tendon by causing potential excitotoxicity. Although Cole et al compared the effect of hypertonic dextrose with that of corticosteroid injection on chronic supraspinatus tendinopathy, their study reported limited information regarding morphological changes after the intervention. Therefore, we wanted to investigate the morphological changes in the supraspinatus tendon through ultrasound imaging after the injection.

The objectives of this study were to investigate the clinical effects and echogenicity outcomes after ultrasound-guided hypertonic dextrose or corticosteroid injection among patients with chronic supraspinatus tendinopathy. We hypothesized that hypertonic dextrose injection can improve the outcomes of chronic supraspinatus tendinopathy with fewer clinical effects of pain relief than steroid injection.

METHODS

Study Design and Participants

This retrospective case-control study was performed using data from a previous randomized controlled study to compare the clinical effects of normal saline with those of hypertonic dextrose. Injections for the corticosteroid injection group were administered using the same protocol as follows: (1) age >20 years, (2) chronic shoulder pain for >6 months, and (3) having an ultrasound finding of chronic degenerative supraspinatus tendinopathy. The exclusion criteria of this study were as follows: (1) previous surgery of the affected shoulder; (2) receipt of hyaluronic acid injection, platelet-rich plasma injection, or any type of injection or shockwave therapy in the shoulder joint within the previous 3 months; and (3) a neurological disease causing weakness on the affected side and impairing cognitive function and the ability to complete the questionnaire. Our study protocol received ethics committee approval, and all procedures involving human participants followed the ethical standards of the institutional committee and the principles of the Declaration of Helsinki. All the patients provided written informed consent before undergoing baseline assessments.

The study participants were classified into 3 groups based on the type of injection they received: (1) normal saline (control group), (2) 20% hypertonic dextrose (dextrose group), and (3) triamcinolone acetonide 40 mg (steroid group). These groups were matched at a 1:1:1 ratio by propensity-score matching with the following baseline characteristics: age; body mass index (BMI); symptom duration; affected side; presence of diabetes, trauma, and thyroid disorders; analgesic medication use (eg, acetaminophen or nonsteroidal anti-inflammatory drugs; regular use for >7 days); and physical therapy. A flowchart of the patient inclusion process is shown in Figure 1.

Intervention

The participants in the control group were injected with 5 mL of normal saline by using a 23-gauge needle under ultrasound guidance for supraspinatus tendinopathy. In the dextrose group, the injection was administered under ultrasound guidance. We used ultrasonography to locate the target site for treating chronic supraspinatus tendinopathy. Hypertonic dextrose was injected under aseptic conditions by using a 23-gauge needle; 5 mL of 20% hypertonic dextrose prolotherapy (DPT) solution was injected into the insertion site of the supraspinatus tendon in 1 session. In the steroid injection group, participants were injected with 40-mg triamcinolone acetonide and 2 mL of lidocaine combined. Echo-guided injection with a 23-gauge needle was conducted in the supraspinatus tendon sheath (near the

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insertion site of the greater tubercle of the humerus) among all the groups. All these interventions were performed by 2 clinical physicians (Y.-W.C., and S.-W.H.) with more than 10 years of experience in musculoskeletal ultrasound.

Outcome Assessment

All evaluations were performed at baseline and 2, 6, and 12 weeks after the intervention. Variables considered in the outcome assessment included morphological, clinical, and range-of-motion (ROM) parameters.

**Morphological Parameters.** The morphological quantification of sonographic echogenicity was performed by plotting a grayscale region-of-interest (ROI) histogram of the supraspinatus tendon. The histogram revealed the gray-level distribution of pixels in an ROI, which demonstrated the density of the tendon. It was taken as a tool for detecting the hypoechogenic appearance of supraspinatus tendinopathy, and the histogram value could be used as an alternative sonographic indicator of rotator cuff partial-thickness tear or tendinopathy. We selected the injection site at the supraspinatus tendon, which was the site of the ultrasound landmark, as the ROI and compared it with a selected area (0.5 cm) in the middle of the deltoid muscle, directly above the supraspinatus tendon. The echogenicity ratio was calculated as the mean grayscale value of the supraspinatus ROI as a reference to the deltoid muscle ROI (Figure 2).

We also evaluated the maximum thickness of the supraspinatus tendon as determined through ultrasound by using

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**Figure 1.** Flow diagram of the study.

**Figure 2.** (A) The region-of-interest (ROI) histogram of the midportion of the supraspinatus tendon was measured. (B) The ROI of the deltoid muscle above the supraspinatus tendon was measured to calculate the ratio of the histogram (for eliminating the bias of the ultrasound setting).
We calculated the average of 3 measurements of supraspinatus tendon thickness for each image from 2 ultrasound images. Subsequently, the values of these 2 images were averaged for data analysis. All the ultrasound measurements were performed by a single physiatrist (Y.-H.L.) (ie, physical medicine and rehabilitation physician), who was blinded to group allocation of the participant.

**Clinical Parameters.** In terms of the clinical outcomes, we obtained the Shoulder Pain and Disability Index (SPADI) score for the shoulder with chronic supraspinatus tendinopathy to evaluate its function and pain level. The SPADI consists of 5 pain and 8 disability items measured and calculated as the mean of the corresponding items on a scale of 0 to 10, with the highest score indicating severe pain and disability. In this study, the total outcome score used for statistical analysis was calculated as the sum of the pain and disability subscales. An 8-point change in the SPADI score was considered the minimal clinically meaningful difference for the patients with shoulder pain. Shoulder pain was also evaluated using a visual analog scale (VAS) score ranging from 0 (no pain) to 10 (tremendous pain). A minimum decrease of 1.3 points in the VAS score or a 25% reduction in pain was considered the minimal clinically meaningful difference in pain intensity. The patients reported their pain levels during rest and during the movement of the shoulder joint in all directions. The highest pain score during movements was included for further analysis.

**ROM Parameters.** We evaluated active ROM of the shoulder (ie, forward flexion, abduction, internal rotation, and external rotation) using an electrical goniometer. To measure forward flexion, the patient was asked to sit in the upright position without any trunk movement. The arm was actively moved in the forward flexion position in the sagittal plane with full elbow extension, and the palm was moved down based on the participant’s tolerated ROM. The goniometer was placed along the shaft of the humerus perpendicular to the plane of motion (Figure 3A).

Active shoulder abduction was measured with full elbow extension, leading with the thumb to ensure consistent rotation with scapular motion. The arm was actively moved in the forward flexion position in the sagittal plane with full elbow extension, and the palm was moved down based on the participant’s tolerated ROM. The goniometer was placed along the shaft of the humerus perpendicular to the plane of motion (Figure 3A).
the shaft of the humerus perpendicular to the plane of motion (Figure 3B).

To measure active internal rotation, the participant was asked to remain in the prone position with the tested arm supported on the table in 90° of abduction, the forearm flexed to 90°, and the wrist in a neutral position. A small pillow or rolled towel was directly placed under the arm to ensure neutral horizontal positioning and provide stabilization. The participant was instructed to internally rotate their arm while maintaining the 90° abducted position and preventing compensatory movements. Once the active end range was achieved, the goniometer was placed on the distal forearm just proximal to the wrist for recording the measurement angle (Figure 3C).

To measure external rotation, the participant was asked to remain in the supine position with the tested arm being supported on the table with 90° of abduction, the elbow flexed to 90°, and the wrist in a neutral position. A small pillow or rolled towel was placed under the humerus to ensure neutral horizontal positioning. The participant was asked to externally rotate his or her arm back to the end-tolerated range without discomfort. Once the active end range was achieved, the goniometer was placed on the distal forearm just proximal to the wrist for recording the measurement (Figure 3D).

All ROM measurements were performed by a physiatrist (Y.-H.L.) who was blinded to group allocation. The minimal detectable change of 90% CIs for the intrarater analysis indicated a change of ≥8° for forward flexion, 4° for abduction, 8° for internal rotation, and 9° for external rotation.15,16 The patients were asked to slowly move their shoulders until they reached an angle at which pain was intolerable; the motion was performed 3 times to record the median value of the angle.

Sample Size Estimation

G*Power 3.1 was used to estimate the sample size required for repeated-measures analysis of variance (ANOVA) between factors in the study. An effect size of 0.4, an alpha value of .05, 3 groups, and 4 measurements (VAS, SPADI, shoulder flexion, and supraspinatus thickness) were included in this analysis. We determined that a minimum sample size of 66 (22 for each group) was required to examine differences between the study groups. Considering the probability of patients being lost to follow-up, we enrolled 75 patients in our study to ensure adequate statistical power with an anticipated value of 0.95.

Statistical Analysis

The measurement data with normal distribution are expressed as mean (range), and the mean values among the 3 groups were compared using ANOVA. Categorical variables were compared among the 3 groups by using the chi-square test. The measurement and grade data with nonnormal distribution are expressed as the median (interquartile range) and compared using the independent-samples Kruskal-Wallis test among the 3 groups. When the continuous variables accorded with the normal distribution and homogeneity of variance assumptions, we conducted ANOVA to analyze differences in changes in these outcome measures among the 3 groups. When the variables did not meet the requirements of the parameter test, the independent-samples Kruskal-Wallis test was used. Statistical analysis was conducted at the 95% confidence level. A P value <.05 was considered to indicate a statistically significant difference. All statistical analyses were performed using SPSS software Version 25 (IBM Corp).

RESULTS

After the selection process, 75 patients were recruited in this study (25 patients per group). Table 1 lists the baseline characteristics of the study population. The 3 groups were well matched for basic characteristics and variables; namely, age, sex, BMI, affected side, symptom duration, analgesic medication use, and physical therapy. No significant differences in the baseline patient variables or outcome measures were observed among the 3 groups.

Table 2 presents the findings between baseline and 2 weeks after the intervention. At the 2-week follow-up, changes in the outcome measures of ultrasound morphology, VAS scores, and SPADI scores differed among the 3 groups. The change in mean echogenicity was significantly different in the dextrose and steroid groups compared with the saline group (P = .025). However, no significant differences in the supraspinatus tendon thickness and echogenicity ratio were noted among 3 groups. In terms of clinical parameters, both the dextrose and steroid groups had significantly more improvement in VAS scores (P < .001), SPADI scores (P < .001), and flexion ROM compared with the saline group (P = .001).

Table 3 presents the findings between baseline and 6-week follow-up. There were differences in echogenicity and clinical parameters among the 3 groups. Significantly more changes in echotexture were seen in the dextrose group than in the other 2 groups (P < .001). However, the steroid group exhibited significantly more improvement in VAS scores, SPADI scores, and ROM measurements compared with the saline and dextrose groups (P < .001 for all).

Table 4 presents the findings between baseline and 12 weeks after the interventions. There were differences in echogenicity and clinical parameters among the 3 groups. The supraspinatus tendon thickness (P = .001), mean echogenicity (P < .001), and echogenicity ratio (P < .001) were more significantly improved in the dextrose group than in the saline group. In contrast, the steroid group demonstrated a significantly decreased supraspinatus tendon thickness, mean echogenicity, and echogenicity ratio compared with the saline group. In terms of clinical parameters, the steroid group exhibited significantly more improvement in VAS scores (P < .001), SPADI scores (P < .001), and shoulder ROM measurements (P < .001) compared with the other 2 groups.

DISCUSSION

Ultrasound-guided hypertonic dextrose injection exerted a positive effect on morphological changes in the
supraspinatus tendon 6 weeks after injection ($P = .024$ in supraspinatus thickness, $P = .003$ in mean echogenicity, and $P < .001$ in echogenicity ratio), and this improvement was maintained until 12 weeks after hypertonic dextrose injection ($P < .001$). In contrast, the patients who received steroid injection demonstrated poor echotexture parameters at week 12 after the injection ($P < .001$). In terms of the clinical parameters, hypertonic dextrose injection was able to relieve pain and improve SPADI scores up to week 2 after the injection ($P < .001$); however, the effect of hypertonic dextrose injection on clinical scores was not sustained at weeks 6 and 12 postinjection. Compared with the hypertonic dextrose group, the steroid injection group demonstrated more significant improvement in VAS and SPADI scores at week 2 ($P < .001$); moreover, this effect persisted until weeks 6 and 12. These findings indicate that hypertonic dextrose relieves pain and improves shoulder function for a short period and leads to structural changes in the supraspinatus tendon after week 6. In contrast, steroid injection provides more effective pain relief but exerts a negative effect on the supraspinatus tendon echotexture.

In terms of ultrasound morphological changes, our study findings revealed that hypertonic dextrose injection increased the thickness and echogenicity parameters of the supraspinatus tendon. In previous studies on the injection of hypertonic dextrose in the patellar and Achilles tendons, a ligament strengthening effect and a regenerative pattern on ultrasound were observed. Elucidating mechanisms

### TABLE 1
Patient and Clinical Characteristics at Baselinea

| Variable          | Saline, n = 25 | Dextrose, n = 25 | Steroid, n = 25 |
|-------------------|----------------|------------------|-----------------|
| **Age, y**        | 53.0 (38-81)   | 54.4 (40-72)     | 57.3 (37-81)    |
| **Sex, female/male** | 13/12         | 11/14            | 13/12           |
| **BMI, kg/m²**    | 24.1 (18.7-29.4) | 24.6 (22.0-30.3) | 25.4 (18.2-34.1) |
| **Medication for pain, yes/no** | 13/12 | 11/14 | 10/15 |
| **Physical therapy, yes/no** | 14/11 | 15/10 | 13/12 |
| **Affected side, left/right** | 10.5 (6-15) | 10.4 (6-16) | 9.5 (6-12) |

### TABLE 2
Changes in Cortical Excitability and Motor Function Between Baseline and 2 Weeksa

| Variable          | 2-Week Follow-up | Change From Baseline |
|-------------------|------------------|---------------------|
| **Morphology on ultrasound** |                  |                     |
| Supraspinatus thickness, mm | 6.7 (6.2 to 8.1) | 7.0 (4.1 to 8.2) | 6.6 (3.8 to 8.2) | -0.4 [-0.8 to 0] | 0.2 [-0.1 to 0.5] | -0.2 [-1.0 to 0.6] | .069 |
| Echogenicity, grey scale | 50.0 (37.1 to 67.3) | 50.2 (35.1 to 66.9) | 44.0 (33.8 to 52.1) | -0.2 [-2.5 to 2.2] | 2.8 [-1.9 to 6.6] | -2.2 [-6.3 to 2.6] | .025 |
| Echogenicity ratio | 1.99 (1.61 to 2.54) | 2.02 (1.43 to 2.48) | 1.84 (1.31 to 2.26) | 0.06 [-0.11 to 0.24] | 0.17 [-0.02 to 0.35] | -0.63 [-0.25 to 0.19] | .121 |
| **Clinical parameters** |                  |                     |
| Flexion | 151.2 (133.2-176.9) | 151.6 (131.9-169.4) | 151.3 (134.9-172.1) | -0.36 [-1.02 to 0.30] | -2.0 [-2.7 to -1.2] | -4.3 [-3.9 to -2.6] | <.001 |
| Abduction | 139.9 (128.9-173.1) | 141.5 (123.6-167.4) | 137.2 (129.9-172.3) | -5.6 [-10.4 to -0.8] | -10.6 [-16.0 to -5.2] | -24.6 [-29.8 to -19.3] | <.001 |
| IR | 44.8 (38.7-52.6) | 45.6 (35.3-55.4) | 43.6 (33.2-54.2) | -1.8 [-3.8 to 0] | 1.4 [0.3 to 2.7] | 9.0 [0.9 to 14.1] | <.001 |

### Notes:
- Data are presented as mean (range) or No. of patients. BMI, body mass index; ER, external rotation; IR, internal rotation; ROM, range of motion; SPADI, Shoulder Pain and Disability Index; VAS, visual analog scale.
- Data are reported as mean (range) or mean difference [95% CI]. Boldface $P$ values indicate a statistically significantly difference change from baseline among the 3 groups ($P < .05$, analysis of variance). ER, external rotation; IR, internal rotation; ROM, range of motion; SPADI, Shoulder Pain and Disability Index; VAS, visual analog scale.
underlying the changes observed 6 weeks after hypertonic dextrose injection can be difficult. Theoretically, in proliferative therapy, the injection of an irritant solution initiates the inflammatory process, which increases fibroblast proliferation and induces collagen tissue synthesis and tissue healing. Previous in vitro studies have reported that cells exposed to hypertonic dextrose exhibited decreased viability, DNA synthesis, and metabolic activities initially and resulted in disease recurrence and progression. Corticosteroid injection might lead to cellular apoptosis and alter collagen synthesis, thus weakening and rupturing the tendon, reducing the immunological response, and hampering the success of future surgical repairs by delaying or inhibiting healing.

Hypertonic dextrose injection was able to provide short-term pain relief in the patients with chronic supraspinatus tendinopathy through an undefined mechanism. We hypothesize that sensorineural modulation would be involved in pain relief in patients with chronic supraspinatus tendinopathy. The transient receptor potential vanilloid-1 (TRPV1) cation channel is a capsaicin-sensitive receptor that can elicit neuropathic pain by transmitting pain signals. A previous study reported that a hyperosmotic agent exerted an analgesic effect through inhibiting extracellular matrix molecules and granulation tissue production. However, few studies have indicated that subacromial corticosteroid injection for rotator cuff tendinopathy adversely affected tendon integrity and resulted in disease recurrence and progression. Hypertonic dextrose injection was able to provide short-term pain relief in the patients with chronic supraspinatus tendinopathy.
In recent years, prolotherapy has been widely used and proposed as an alternative treatment to steroid injection. Studies have compared the effects of prolotherapy with those of steroid. Nasiri et al.\(^5\) reported that in terms of VAS and SPADI scores, prolotherapy was not inferior to corticosteroid injection in patients with rotator cuff-related shoulder pain, with the effect lasting up to 12 weeks after the intervention. Our study demonstrated that when compared with a corticosteroid injection, prolotherapy could not significantly relieve pain and disability in the patients with chronic supraspinatus tendinopathy. This finding is compatible with that of a recent study that reported that compared with prolotherapy, steroid injection resulted in better pain relief, function, and quality of life for the patients with rotator cuff lesions.\(^6\) In a meta-analysis investigating the effects of dextrose prolotherapy on tendinopathy, the authors reported that compared with steroid injection, prolotherapy resulted in slightly better pain control in the short term but inferior pain control in the immediate and long term. In addition, prolotherapy was not superior to steroids at any time point in terms of activity improvement.\(^6\)

These conflicting findings and heterogeneous clinical effects of prolotherapy may be attributable to the higher diversity of the prolotherapy technique among different studies. The optimal intervention protocol for prolotherapy is still not well-established, and this may lead to different effects in patients with chronic supraspinatus tendinopathy. In our study, a single echo-guided injection of hypertonic dextrose was not observed to be superior to that of steroids in terms of alleviating clinical symptoms. Although hypertonic dextrose injection contributed to structural improvement on ultrasound images, no clinical improvements were found. We surmise that the clinical influence of hypertonic injection was based on the TRPV1 mechanism, and the changes in tendon echogenicity parameters were not enough to effect clinical improvement. A comparison between multiple injections and 1 injection of hypertonic dextrose is required to determine the optimal dosage of hypertonic dextrose injection for achieving the most favorable clinical and structural benefits for patients with chronic supraspinatus tendinopathy.

**Limitations**

The limitations of this study need to be addressed. First, to investigate the effect of hypertonic dextrose injection on the patients with chronic supraspinatus tendinopathy, we administered a single injection specific to the supraspinatus tendon. This method is different from the typical rotator cuff prolotherapy injection technique in which injections are administered at multiple sites in multiple sessions. This may explain the difference in clinical efficacy observed between our study and previous studies reporting that prolotherapy is not inferior to steroid injection. Second, an objective functional assessment is lacking. Although we used the SPADI questionnaire, an objective assessment tool for shoulder strength and movement was not used. Additional studies investigating the strength or kinesiology of the shoulder after hypertonic dextrose injection are warranted. Third, although we tried to exclude concomitant shoulder problems such as fracture or arthroplasty, other kinds of shoulder diseases, such as arthritis, labral tears, acromial morphology problems, bursitis, and tendinopathy of other tendons, were difficult to totally exclude. Fourth, the durations of the baseline variables of smoking and diabetes were not recorded. The influence of these factors could not be assessed in a short follow-up period. Besides, the long-term clinical impact and structural changes on the supraspinatus tendon caused by tears could not be presented in this study. Last, we assessed structural changes after injection by using ultrasound, not magnetic resonance imaging (MRI). Although we standardized the ultrasound assessment protocol and quantitative evaluation, the bias introduced by the obtained image and data acquisition is inevitable. Moreover, ultrasound can only present the gross structural changes and is limited to histological changes of the supraspinatus tendon. Definite changes observed in the tenocyte and histology should be confirmed through MRI or a tendon biopsy study.

**CONCLUSION**

Corticosteroid injection provided a better clinical effect at weeks 6 and 12, but a negative effect for supraspinatus ultrasound image outcomes was observed in this study. Hypertonic dextrose injection was able to improve the supraspinatus ultrasound image outcomes after 6 weeks, but it only provided short-term (2 weeks) pain relief in patients with chronic supraspinatus tendinopathy.

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