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Original Research Article

Efficacy of ultrasound-guided subacromial bursa steroid injection for treating shoulder pain in post-stroke hemiparetic patients

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Abstract

Purpose: *To assess the efficacy of ultrasound-guided subacromial bursa (SAB) steroid injection for treating hemiplegic shoulder pain (HSP) after stroke (CS), as well as its impact on joint mobility, and inflammatory mediators.*
Methods: *Seventy-two (72) patients with CS-related HSP were divided into two groups: study and control groups. The study group received ultrasound-guided SAB injection of triamcinolone acetonide in addition to conventional treatment, while control group received only conventional rehabilitation. Both groups received 4 weeks of treatment and were assessed using pain visual analogue scale (VAS) and passive range of motion (PROM) indices before treatment and at 1, 4, and 12 weeks after treatment. Additionally, the Fugl-Meyer motor function (FMA-U) scale score, activities of daily living (ADL) score, modified Barthel index (MBI), serum IL-1β, IL-6, nitric oxide (NO) levels, and incidence of adverse reactions were assessed before and after 4 weeks of treatment.*
Results: *The study group had a significantly higher total efficacy/effectiveness (86.11 %) compared to control group (53.89 %). Both groups showed initial decreases and subsequent increases in VAS and PROM from week 1 to week 12 after treatment. However, the study group had significantly lower VAS scores, angle of forward flexion, abduction, and external rotation at all time points compared to control group ($p < 0.05$). At week 4, the study group had significantly higher FMA-U, ADL, and MBI scores, as well as significantly lower IL-1β, IL-6, and NO levels when compared to control group ($p < 0.05$).*
Conclusion: *Ultrasound-guided SAB steroid injection improves the efficacy of HSP after CS, improves joint mobility, and reduces serum levels of IL-1β, IL-6, and NO. Further large-sample studies with increased sample sizes and longer investigation periods are needed to validate these findings.*

Keywords: *Ultrasound, Subacromial bursa steroid injection, Stroke, Hemiplegic shoulder pain, Efficacy*

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INTRODUCTION

Cerebral stroke (CS) hemiplegic shoulder pain (HSP) refers to local sharp pain in the affected shoulder joint during rest and passive or active movement after a stroke. The pain typically radiates from the shoulder to the elbow and hand and worsens with shoulder joint external rotation and abduction, significantly affecting sleep

quality, upper limb function, and rehabilitation training outcomes [1,2]. Currently, active comprehensive treatments including exercise therapy, physical therapy, occupational therapy, traditional therapy, and medication therapy are the mainstay for treating HSP after CS and have achieved certain therapeutic effects. However, some patients still have difficulty relieving intense pain and improving joint mobility through conventional analgesics and physical therapy, and this limits their clinical application [3,4].

With the widespread application of minimally-invasive visual ultrasound in rehabilitation medicine, ultrasound-guided subacromial bursa (SAB) steroid injection has become an area of interest in clinical treatment of HSP after CS. This technique enables precise localization of the SAB target under ultrasound imaging guidance and the injection of steroid drugs that effectively relieved synovial inflammation within the joint to reduce pain and improve joint mobility [5]. Previous studies have reported the efficacy of pulsed radiofrequency treatment of the suprascapular nerve in patients with HSP after CS [6]. However, there is limited research on the efficacy of ultrasound-guided steroid injection therapy for HSP patients and its impact on inflammatory factors.

This study aimed to investigate the efficacy of ultrasound-guided SAB steroid injection therapy in HSP patients after CS and the impact on joint mobility and serum levels of interleukin-1β (IL-1β), interleukin-6 (IL-6), and nitric oxide (NO).

METHODS

Patients

A total of 72 patients with CS-associated HSP admitted to the Qionghai Hospital of Traditional Chinese Medicine, Qionghai between January 2020 and June 2022 were included in this study. The patients were randomly assigned to study group and control group with 36 patients in each group. The study group had 19 males and 17 females, a mean HSP duration of 13.92 ± 2.74 days, 16 cases of left hemiplegia, 20 cases of right hemiplegia, 22 cases of cerebral infarction, and 14 cases of cerebral hemorrhage in the CS type. The control group had a mean age of 54.31 ± 5.65 years, 20 males, and 16 females, a mean HSP duration of 13.88 ± 2.63 days, 18 cases of left hemiplegia, 18 cases of right hemiplegia, 21 cases of cerebral infarction and 15 cases of cerebral hemorrhage in the CS type. This study was approved by the hospital's ethics committee (approval no. QHH-IRB- 011-20230708). This study was conducted in compliance with guidelines of the Declaration of Helsinki [7].

Inclusion criteria

Patients who met the diagnostic criteria for CS [8], first onset of disease, unilateral limb paralysis within 6 months, severe shoulder joint pain on the affected side, diagnosis of shoulder joint cavity injection therapy indication by musculoskeletal ultrasound, and provided informed consent.

Exclusion criteria

History of surgery on the affected shoulder joint, concomitant cervical spine disease, diabetes, thyroid disease, or other conditions that may cause shoulder joint changes, injection site infection, history of allergy to steroids or local anesthetics.

Treatments

Control group received conventional comprehensive rehabilitation treatment which includes; comprehensive training for the hemiplegic limbs (including muscle strength training, hand support, weight transfer, and joint relaxation training, with each training session lasting approximately 45 min), physical therapy (interferential electrotherapy applied to the affected shoulder of the hemiplegic side of patients with CS after HSP by placing the electrodes before and after the affected area for 20 min each time), occupational therapy (including sanding board treatment and grip training, lasting 20 min each), oral painkillers (pain relief treatment was given based on the soft tissue lesion condition of patients with CS after HSP. All comprehensive rehabilitation treatments were administered five times a week for a total of four weeks. Patients in the study group received SAB injection of dexamethasone under ultrasound guidance. The method involves using the portable color Doppler ultrasonic diagnostic instrument M-Turbo with a linear array probe of 15 MHz. Patients were positioned with their affected shoulder joints in internal rotation. After routine disinfection of the injection site, the ultrasound probe was placed under the shoulder acromion to identify the subacromial bursa and a needle was inserted into the bursa and monitored. An intermittent injection of 2 mL of normal saline was performed to identify the expansion of the hypoechoic area on the ultrasound surface to confirm a successful puncture. After the fluid was extracted, 20 mg dexamethasone in 2 % lidocaine was injected. Then the needle was removed and the injection

site was disinfected and bandaged. Patients were instructed to maintain local skin cleanliness and dryness and functional positioning for 24 h after treatment.

Efficacy criteria

Efficacy was classified as significant improvement (disappearance of shoulder pain symptoms in patients with hemiplegic shoulder pain (HSP) after comprehensive treatment, with unrestricted range of motion and ability to perform activities of daily living independently), effective (significant improvement in the above symptoms, with mild dependence on daily activities and unrestricted range of motion in the shoulder joint), ineffective (failure to achieve the above standards) [9].

Total effective rate = significant improvement rate + effective rate.

Pain response level

The degree of shoulder joint pain in the hemiplegic side of patients with HSP before treatment, as well as after the 1st, 4th, and 12th week of treatment, was evaluated using the visual analogue scale (VAS) [10]. The VAS scores ranged from 0 to 10, with higher scores indicating more severe pain in patients with HSP after treatment.

Shoulder joint mobility

Passive range of motion (PROM) indices which include shoulder joint passive forward flexion, abduction, and external rotation were measured using a goniometer before treatment and after 1, 4, and 12 weeks of treatment, to evaluate the shoulder joint mobility of patients with HSP on the hemiplegic side in both groups [11]. The shoulder joint forward flexion and abduction range of motion ranged from 0° to 180°, and external rotation ranged from 0° to 60°.

Upper limb motor function and activities of daily living

Fugl-Meyer motor assessment (FMA) [12], activities of daily living (ADL) [13], and modified Barthel index (MBI) [14] were used to evaluate changes in upper limb motor function and activities of daily living in both groups before and after 4 weeks of treatment. The FMA-related upper limb reflex activity, coordinated movement of flexor and extensor muscles, and wrist stability, have a total score of 66 points. A higher score indicated better upper limb motor function on the hemiplegic side. The ADL and MBI scores have a total score of 100 points.

Determination of serum IL-1β, IL-6, and NO levels

Before treatment and after 4 weeks of treatment, 5 mL of fasting elbow venous blood was collected from all patients with CS-induced HSP, centrifuged, and stored at -20 °C. Enzyme-linked immunosorbent kit (Shenzhen Jingmei Bioengineering Co., Ltd.) strictly operated by designated personnel was used to determine serum IL-1β, IL-6, and NO levels.

Safety evaluation

The occurrence of adverse events such as elevated blood sugar, joint swelling, osteoporosis, endocrine disorders, delayed skin whitening, and muscle atrophy was recorded during treatment.

Statistical analysis

Data analysis was conducted using SPSS 22.0 statistical software (IBM, Armonk, NY, USA). Metric data, such as PROM indices before and after treatment were expressed as mean ± standard deviation (SD). Independent t-test was used to compare statistical differences while comparisons at different time points were done with analysis of variance. Count data such as clinical efficacy was expressed as numbers and percentages and analyzed using the chi-square test. $P < 0.05$ was considered statistically significant.

RESULTS

Clinical efficacy

The overall response rate of HSP patients after CS in study group was 86.11 %, which was significantly higher than 53.89 % in control group ($p < 0.05$).

Degree of pain response before and after treatment

There was an initial decrease followed by a persistent increase in VAS score from 1 to 12 weeks after treatment in both groups. There was no significant difference in VAS scores of the two groups ($p > 0.05$) and VAS scores in study group were significantly lower than control group at every time point ($F_{time} = 66.153$, $F_{group\ between} = 14.521$, $F_{Time\ x\ Between\text{-}group} = 7.088$, $p < 0.05$). See Figure 1.

Table 1: Clinical efficacy in patients with HSP after CS (n = 36)

Group	Markedly effective	Effective	Invalid	Overall response rate
Study	14(38.89)	17(47.22)	5(13.89)	31(86.11)
Control	10(27.78)	13(36.11)	13(36.11)	23(53.89)
x^2				4.741
P-value				0.029

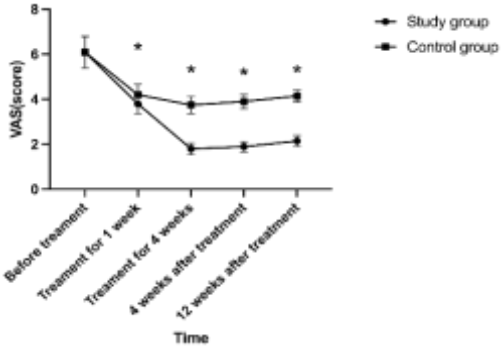

Figure 1: Comparison of VAS scores before and after treatment

Passive range of motion (PROM) indices of the two groups

There were no significant differences in PROM indices such as forward flexion angle, abduction angle, and external rotation angle between the two groups of patients ($p > 0.05$). There was an initial decrease followed by a persistent increase in PROM indices from 1 to 12 weeks after treatment in both groups. Forward flexion angle ($F_{time} = 3.021$, $F_{group\ interval} = 10.087$, $F_{Time \times intergroup} = 50.904$, $p < 0.05$), abduction angle ($F_{time} = 1.623$, $F_{group\ intergroup} = 6.101$, $F_{Time \times intergroup} = 56.179$, $p < 0.05$) and external rotation angle ($F_{time} = 0.975$, $F_{group\ intergroup} = 2.712$, $F_{Time \times Between\text{-}group} = 72.801$, $p < 0.05$) in study group were significantly lower than control group at every time point. The results are shown in Figure 2, Figure 3 and Figure 3**.**

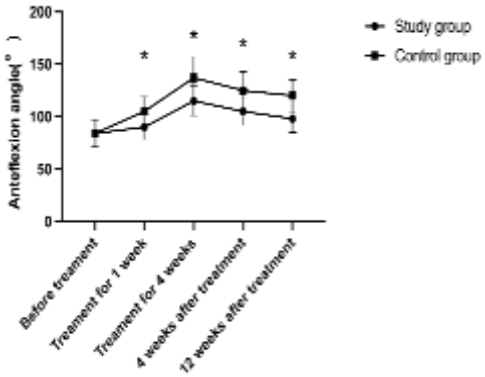

Figure 2: Comparison of flexion angle before and after treatment.

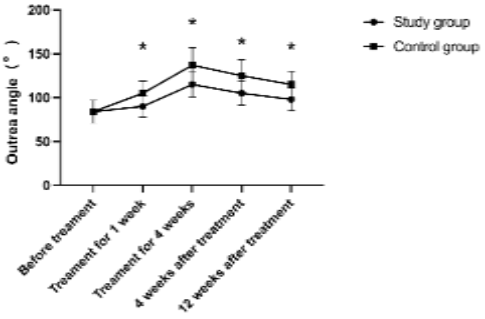

Figure 3: Comparison of abduction angle before and after treatment.

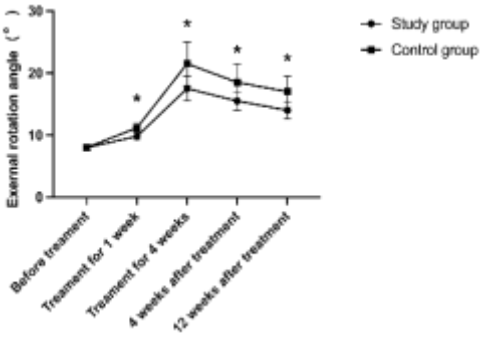

Figure 4: Comparison of external rotation angle before and after treatment

Upper limb motor function and activities of daily living

There was no significant difference in FMA-U score, ADL score, and MBI score between the two groups ($p > 0.05$). However, FMA-U score, ADL score, and MBI score before treatment were significantly lower after 4 weeks of treatment. Also, FMA-U score, ADL score, and MBI score in the study group were significantly higher than in the control group ($p < 0.05$). See **Table 2.**

Serum levels of IL-1β, IL-6, and NO before and after treatment

There was no significant difference in serum levels of IL-1β, IL-6, and NO in both groups ($p > 0.05$). However, levels of IL-1β, IL-6, and NO levels in both groups were significantly lower after 4 weeks of treatment. Also, study group had significantly lower levels of IL-1β, IL-6 than control group ($p < 0.05$) (Figures 8 to 10).

Table 2: Comparison of FMA-U scores, ADL scores and MBI scores before and after treatment

Parameter	Study group	Control group	*P*-value
FMA-U scores			
Before treatment	18.50±3.02	18.45±3.00	0.998
Treatment for 4 weeks	38.50±6.42	30.14±5.43	<0.001
ADL scores			
Before treatment	40.50±5.10	40.40±3.00	0.996
Treatment for 4 weeks	60.18±5.43	50.22±5.23	<0.001
MBI scores			
Before treatment	40.15±6.70	41.41±6.60	0.995
Treatment for 4 weeks	75.44±10.98	60.43±7.81	<0.001

Table 3: Comparison of IL-1β levels, IL-6 levels and NO levels before and after treatment

Inflammatory indicator	Study group	Control group	*P*-value
IL-1β(ng/L)			
Before treatment	68.80±9.60	68.90±9.50	0.987
Treatment for 4 weeks	32.50±4.56	40.40±5.60	<0.001
IL-6(ng/L)			
Before treatment	90.40±15.50	90.67±14.40	0.990
Treatment for 4 weeks	40.33±5.50	51.30±7.68	<0.001
NO(μmol/L)			
Before treatment	45.80±7.80	45.90±7.60	0.994
Treatment for 4 weeks	75.70±9.64	50.10±8.45	<0.001

Treatment safety

None of the patients with HSP after CS developed osteoporosis, endocrine disorders, or muscle atrophy during treatment in either group. There were 2 cases of elevated blood glucose, 1 case of joint swelling, and 2 cases of delayed skin blanching in study group; 2 cases of joint swelling and 1 case of delayed skin blanching in control group. The incidence of treatment-emergent adverse events in HSP patients following CS was 13.89 % in study group, which was not significantly different from the corresponding value of 8.33 % in control group (Fisher $p = 0.710$).

DISCUSSION

Hemiplegic shoulder pain (HSP) is a medical condition caused by local muscle spasms, adhesive capsulitis, and suprascapular neuropathy leading to severe shoulder pain and significantly affecting upper limb function, daily life, and rehabilitation training [15]. In the past, clinical practice often relied on taking analgesics to relieve shoulder pain in HSP patients after cerebral stroke, but some patients still had unsatisfactory therapeutic effects due to adverse reactions caused by long-term use of analgesics [16]. Suprascapular bursa (SAB) is a large bursa located under the shoulder peak on the surface of the supraspinatus tendon, and not connected to the shoulder joint cavity. It is a common injection site for HSP treatment around the shoulder joint [17]. This study investigates the therapeutic effect of SAB corticosteroid injection under ultrasound guidance on HSP patients after cerebral stroke, as well as its impact on joint mobility and serum IL-1β, IL-6, and NO levels.

The results of the study showed that total effective rate of treatment in HSP patients after CS in study group was significantly higher than control group. Furthermore, VAS score in study group was significantly lower than control group from 1st to 12th week after treatment. Passive range of motion (PROM) indices such as forward flexion angle, abduction angle, and external rotation angle were significantly lower in study group than control group at all time points. These results indicated that ultrasound-guided SAB corticosteroid injection therapy improved the clinical efficacy of CS after HSP, effectively alleviated the degree of pain reaction in patients, and improved joint mobility. Suprascapular bursa (SAB) has a good lubricating effect on shoulder joint, which effectively reduces frictional damage during movement. There are a large number of free nerve endings and pain receptors that cross each other internally with the shoulder joint cavity and the long head of the biceps tendon sheath, further causing shoulder joint activity disorders [18].

Limb hemiplegia in CS after HSP patients destroys the activity and stability of the affected side shoulder joint and muscle tears or weakness in the shoulder girdle leads to imbalanced biological and mechanical characteristics of the shoulder joint, resulting in functional disorders and intense pain. In some patients, there may even be obvious resting pain and decreased joint

activity in all directions [19]. Triamcinolone is a long-acting and potent anti-inflammatory and anti-allergic corticosteroid hormone drug that regulates cytokine and immune cell levels in the body, reduces acute inflammatory symptoms, and exerts a good anti-inflammatory and analgesic effect on muscle injuries and bone and joint diseases [20]. Ultrasound-guided pre-SAB injection of triamcinolone treatment effectively reduced capillary permeability, and inhibits local inflammatory reactions and exudation by corticosteroids, thereby reducing pain, improving efficacy, and improving joint mobility.

Visual analogue scale (VAS) and passive range of motion (PROM) indices showed an initial decrease followed by a persistent increase from 1st to 12th week after treatment in both groups. The reason for this may be that comprehensive rehabilitation treatment including oral analgesics or triamcinolone was effective in pain relief and joint mobility improvement during the treatment period. Some patients may still experience mild pain and a slight decrease in PROM indices after treatment, but the overall pain response was significantly lower after treatment and joint mobility was significantly better after treatment. This means that both groups have good treatment effects.

Fugl-Meyer motor (FMA), activities of daily living (ADL), and modified Barthel index (MBI) scores were significantly higher in study group after 4 weeks of treatment. This suggests that ultrasound-guided SAB steroid injection therapy improved upper limb motor function and daily activity ability in patients with CS-induced HSP, which is beneficial for promoting patients' recovery.

Ultrasound-guided SAB injection of triamcinolone acetonide improved the intra-articular tissue environment of the patient's shoulder joint, increased the joint cavity volume, and expanded the adhesion of intra-articular tissues. This led to an increase in shoulder joint range of motion in patients with CS-induced HSP, thus effectively promoting the recovery of their upper limb movement range and daily living abilities [21]. Ultrasound displays the muscle, SAB, tendon structures, and pathological tissue changes and adhesions around the shoulder joint in a real-time, dynamic, and clear manner. Hou *et al* [22] found that ultrasound-guided SAB injection improved the accuracy of needle insertion, and avoided the possibility of blindly injecting drugs into patients' motor pathways to effectively achieved precise treatment. This is consistent with the findings of this study which revealed that ultrasound-guided SAB steroid injection therapy improved motor function and daily activity ability of patients with CS-induced HSP.

The findings also showed levels of IL-1β, IL-6, and NO in study group were significantly lower than those in control group after 4 weeks of treatment. This suggests that ultrasound-guided SAB steroid injection therapy inhibited the release of inflammatory cytokines in patients with CS-induced HSP and improved the degree of inflammation. It was found that SAB located between the shoulder peak and rotator cuff tendon is prone to friction (during shoulder joint movement) and inflammation.

Non-specific stimuli caused by CS-induced HSP activate synovial cells, leading to a rapid increase in the levels of inflammatory cytokines such as IL-1β and IL-6, which are closely related to shoulder joint stiffness [23]. Nitric oxide (NO) is an arthritis inflammatory mediator that inhibits the proliferation of chondrocytes and destroys cartilage tissue. High concentration of NO promotes necrosis of soft tissues in joints and plays an important role in pathological progression of bone and joint diseases [24].

Ultrasound-guided SAB injection of triamcinolone acetonide effectively exerts a prolonged anti-inflammatory response in patients with CS-induced HSP. The reason may be related to the fact that ultrasound-guided SAB injection of triamcinolone acetonide inhibits the expression of serum IL-1β, IL-6, and NO, exerting a highly effective and long-lasting anti-inflammatory effect. Furthermore, the incidence of adverse events during treatment period was not statistically significant in both groups. This revealed that ultrasound-guided SAB steroid injection therapy for CS-induced HSP increases the effectiveness of treatment without increasing risk of serious adverse events.

Limitations of this study

The limitations of this study include the relatively small sample size, which may lead to sampling bias and a relatively short investigation time.

CONCLUSION

Ultrasound-guided SAB steroid injection therapy improves therapeutic efficacy in HSP patients after CS, reduces serum IL-1β, IL-6, and NO levels, and improves joint mobility safety.

Further in-depth studies with increased sample sizes and longer investigation periods are needed to validate these findings.

DECLARATIONS

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Ethical approval

This study was approved by the Ethics Committee of Qionghai Hospital of Traditional Chinese Medicine, Qionghai, China (approval no. QHH-IRB- 011-20230708).

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflict of Interest

No conflict of interest associated with this work.

Contribution of Authors

The authors declare that this work was done by the authors named in this article and all liabilities pertaining to claims relating to the content of this article will be borne by them. Sunbin Chen and Shibin Lin contributed equally.

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