Comparison of glenohumeral and subacromial steroid injection in primary frozen shoulder: a prospective, randomized short-term comparison study

Joo Han Oh, MD, PhD\textsuperscript{a}, Chung Hee Oh, MD\textsuperscript{b,\ast}, Jung-Ah Choi, MD, PhD\textsuperscript{c}, Sae Hoon Kim, MD\textsuperscript{d}, June Hyuk Kim, MD\textsuperscript{e}, Jong Pil Yoon, MD\textsuperscript{f}

\textsuperscript{a}Department of Orthopaedic Surgery, Seoul National University Bundang Hospital, Seongnam-si, Gyeonggi-do, South Korea
\textsuperscript{b}Department of Orthopaedic Surgery, S-Seoul Hospital, Suwon-si, Gyeonggi-do, South Korea
\textsuperscript{c}Department of Radiology, Seoul National University Bundang Hospital, Seongnam-si, Gyeonggi-do, South Korea
\textsuperscript{d}Department of Orthopaedic Surgery, Seoul National University Hospital, Seoul, South Korea
\textsuperscript{e}Department of Orthopaedic Oncology Clinic, National Cancer Center, Goyang-si, Gyeonggi-do, South Korea
\textsuperscript{f}Department of Orthopaedic Surgery, Kyungpook National University Hospital, Daegu, South Korea

\textbf{Background:} Glenohumeral (GH) joint steroid injection is one of the most well-known treatments for frozen shoulder. However, the low accuracy of GH joint injections and the improvement of symptoms after subacromial (SA) steroid injections led us to design a study that compares the efficacy of a steroid injection for primary frozen shoulder according to the injection site.

\textbf{Materials and methods:} Patients with primary frozen shoulder were randomly divided into 2 groups according to the location of the injection: a GH group of 37 for the glenohumeral joint and an SA group of 34 for the subacromial space. Injections were completed using ultrasonographic guidance. Evaluations using a visual analog scale (VAS) for pain, the Constant score, and passive range of motion (ROM) were completed at 3, 6, and 12 weeks after the injection.

\textbf{Results:} The GH group showed lower pain VAS at 3 weeks, but no statistical difference was found between the 2 groups at 6 and 12 weeks. Improvement in pain was evident at every follow-up visit compared with the preinjection evaluation. There was no significant difference between the 2 groups with respect to the Constant score or ROM at serial follow-up.

\textbf{Conclusions:} The GH steroid injection was not superior to a SA injection for patients with primary frozen shoulder even though injection at the GH joint led to earlier pain relief compared with the SA injection. SA steroid injection along with a GH injection is an alternative modality, and the treatment should be individualized and tailored appropriately.

This work was performed at Seoul National University College of Medicine, Seoul National University Bundang Hospital. The Investigational Review Board (IRB No. B-0607/035-023) approved the human protocol for this investigation. All investigations were conducted in conformity with ethical principles of research, and research expenses were approved by the IRB.

*Reprint requests: Chung Hee Oh, MD, Department of Orthopaedic Surgery, S-Seoul Hospital, 154-1 Metan-dong, Younhtong-gu, Suwon-si, Gyeonggi-do 443-800, Korea.
E-mail address: choh08@nate.com (C.H. Oh).

1058-2746/2011 Journal of Shoulder and Elbow Surgery Board of Trustees.
Frozen shoulder is one of the most well-known causes of shoulder pain and disability. Codman first described “frozen shoulder” in 1934, and Neviser first used the term “adhesive capsulitis” and described the synovial changes of the glenohumeral (GH) joint in 1945. There have been many efforts to identify the pathophysiology and find the best treatment for this condition. Bunker and Anthony revealed that the pathologic process of frozen shoulder includes active fibroblastic proliferation, and Uhthoff and Boileau also focused on the contracture of the anterior capsular structures as the main pathologic process.

For the treatment of frozen shoulder, different authors reported several techniques with favorable outcomes, including medical treatment, physical therapy and exercises, intra-articular steroid injection, hydraulic distension, blockade of the suprascapular nerve, manipulation under anesthesia, arthroscopic release, and skillful neglect.

Steroid injection into the GH joint, accompanied by therapeutic shoulder exercises, is one of the most well-known approaches, regardless of the etiology for the frozen shoulder. However, a low accuracy of injection into the GH joint without radiologic guidance, relative ease of access into the subacromial (SA) space, improvement of frozen shoulder symptoms after a SA steroid injection in certain patients, few reports discussing the effects of SA pathology on frozen shoulder, and the effect of steroid injections into the SA space raise questions regarding the etiology of the disease entity and how we should approach this peculiar shoulder disorder.

The current study compared the clinical efficacy of steroid injection in patients with primary frozen shoulder using a prospective randomized comparison model according to the location of the injection (GH joint vs SA space). The purpose was to evaluate postinjection pain and function using shoulder range of motion (ROM) and Constant scores. Our hypothesis was that clinical outcomes of GH steroid injections would be better than SA injections in patients with primary frozen shoulder.

Materials and methods

This was a prospective randomized comparison study of steroid injection into the GH joint or SA space in primary frozen shoulder, combined with stretching exercises and nonsteroidal anti-inflammatory drug (NSAID) supplementation.

Between January 2007 and August 2008, we recruited 102 patients with shoulder pain and a limitation of both active and passive motion in at least 2 directions (abduction and forward flexion <100°, external rotation <20°, or internal rotation <L3). Patients were examined with plain radiographs (true anteroposterior, 30° caudal tilt, and axial view) and ultrasonography (USG) to detect the secondary cause of the frozen shoulder, such as a rotator cuff tear, calcific tendinitis, or osteoarthritis. The study excluded 4 patients with a full-thickness rotator cuff tear, 7 with a partial-thickness rotator cuff tear, 10 with calcific tendinitis, 1 with osteoarthritis of the shoulder, and 1 with a greater tuberosity fracture of the humeral head. An additional 8 patients did not want to participate in the study (5 were inconvenienced by the follow-up interview, and 3 did not respond to our request for a reason). The remaining 71 patients with primary frozen shoulder were included (Fig. 1), and written informed consent was obtained from all participants. All included patients had undergone conservative management, including medication and physiotherapy, for at least 6 weeks before inclusion in this study but had no improvement in their symptoms.

Treatment procedure

Randomization was done according to an automatic generated randomization list. Patients were divided into 2 groups by the site of the steroid injection: GH joint (GH group), which comprised 37 patients, or the SA space (SA group). For injection into the shoulder joint, we used the posterior approach. For the SA space, a lateral approach was used. One musculoskeletal radiologist (J.A.C.) performed diagnostic USG (iU22 scanner, Philips Healthcare, Bothell, WA, USA) and USG-guided injections.

A mixture of 1 mL triamcinolone (40 mg), 4 mL of 2% lidocaine, and 4 mL of normal saline was injected, and all patients in both groups were prescribed NSAIDs and analgesics for pain control. Patients were also given a self-exercise program consisting of gentle active-assistive or passive forward flexion, abduction, external rotation, adduction, and sleeper’s stretch exercises; these were repeated 10 times slowly and held for 5 to 10 seconds at a frequency of 3 to 5 times daily. Patients were instructed to stretch the shoulder gently against the limits of tolerance and to avoid strengthening exercises until shoulder pain subsided.

If at any time during the study a patient was unable to continue the treatment protocol, he or she was dropped from the study and managed with other treatments. In the GH group, one suprascapular nerve block was given at 3 weeks and one additional hyaluronic acid injection was given after the index injection as a result of continued severe pain. In the SA group, 2 patients required suprascapular nerve block at 3 weeks and 1 patient was given an additional hyaluronic acid injection at 6 weeks after the index injection as a result of continued severe pain.

**Keywords:** Frozen shoulder; glenohumeral; subacromial; steroid
Demographics

The GH group consisted of 37 patients, 17 men (46%) and 20 women (54%), who were a mean age of 55.7 years (range, 42-74 years). The mean duration of symptoms was 6.2 months (range, 1.5-16 months). Five patients reported a history of diabetes mellitus (DM) with the use of medication.

The SA group consisted of 34 patients, 15 men (44%) and 19 women (56%), who were a mean age of 58.3 years (range, 42-76 years). The mean duration of symptoms was 6.9 months (range, 2-12 months). Six patients reported a history of DM with the use of medication.

The 2 groups did not differ significantly in sex, age, symptom duration, or DM prevalence. Patient demographics are summarized in Table I.

Outcome measurements

All data (preinjection and 3, 6, and 12 weeks after injection) were prospectively collected by a clinical researcher who was blinded to the current study. The initial evaluation included the recording of a detailed medical history and a history of the shoulder problem. Pain score using a visual analog scale (VAS) and the Constant score for subjective function were evaluated at each follow-up period.

Student t test for age and symptom duration was performed using the Student t test for sex distribution. Improvement in each period between the groups and the differences between preinjection and each follow-up period were analyzed between the groups using the Student t tests. Additional Bonferroni corrections were used to adjust for multiple comparisons.

Table I  Demographic data of patients

<table>
<thead>
<tr>
<th>Variable</th>
<th>GH group</th>
<th>SA group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients, No.</td>
<td>37</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>Age, years</td>
<td>55.7 ± 8.0</td>
<td>58.3 ± 7.3</td>
<td>.15</td>
</tr>
<tr>
<td>(42-74)</td>
<td>(42-76)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>17</td>
<td>15</td>
<td>.87</td>
</tr>
<tr>
<td>Female</td>
<td>20</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Symptom duration, mon</td>
<td></td>
<td></td>
<td>.39</td>
</tr>
<tr>
<td>≤ 6 months</td>
<td>22</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>7 to 12 months</td>
<td>13</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>&gt;12 months</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Diabetes mellitus history</td>
<td>5</td>
<td>6</td>
<td>.63</td>
</tr>
</tbody>
</table>

GH, glenohumeral joint; SA, subacromial space.

* Continuous data are presented as the mean ± standard deviation (range).
† Calculated using independent samples t test.
‡ Calculated using χ² test.
Results

The preinjection pain VAS were not statistically different between the 2 groups, and pain VAS exhibited continuous improvements throughout the follow-up period in both groups. Marked pain improvement was measured at 3 weeks after injection in both groups; however, pain VAS were significantly lower in the GH group (3.0 ± 2.0) compared with the SA group (4.2 ± 1.9) at this point (P = .023, Fig. 2). However, there were no statistical differences in pain VAS at 6 weeks or 12 weeks after injection in either group. Differences in pain VAS between preinjection and at each follow-up period, which represented the amount of improvement from the initial pain at each follow-up period, were not different in either group (Table II).

Constant scores were similar for both groups before injection and also continuously improved throughout the follow-up period in both groups. There was no significant difference between the 2 groups at any of the follow-up evaluations (Fig. 3).

For passive ROM, all ROM, including abduction (Fig. 4), external rotation at the side (Fig. 5), and internal rotation at the back (Fig. 6), increased over time for both groups, and no statistical differences were found between the 2 groups for all 3 ROM evaluations at any of the follow-up assessments.

Mild adverse effects were reported in 1 patient from each group, including dizziness and a feeling of warmth just after the USG-guided injection. No other serious side effects were reported. The serum glucose level changed from 146 ± 50 mg/dL at the preinjection sampling to 181 ± 80 mg/dL at 3 weeks after the injection in the GH group and from 144 ± 27 to 153 ± 34 mg/dL in the SA group.

Discussion

The current prospective, randomized comparison study revealed that steroid injection into the GH joint or SA space, followed by stretching exercises and NSAID supplementation, decreased pain and improved function, including ROM and Constant scores, for primary frozen shoulder. We failed to prove our hypothesis that the clinical outcomes of USG-guided steroid injection into the GH joint would be better than injection into the SA space in patients with primary frozen shoulder.

There are numerous reports that a single GH joint steroid injection is effective for lessening shoulder pain and disability in patients with frozen shoulder and that GH steroid injection is considered to be a well-known and accepted treatment for frozen shoulder. The concept of synovial inflammation for the pathophysiology of frozen shoulder, the joint capsule can be the main pathology, and intra-articular steroid injection can be justified for its treatment. In a clinical setting, however, we find that GH steroid injections are not always effective for primary frozen shoulder. The inaccuracy of joint injections is likely a major reason for this, because several authors have reported a low accuracy of GH injections without image guidance, reporting a 26.8% accuracy for the anterior approach. Second, we usually diagnose frozen shoulder as “idiopathic and primary” after the exclusion of other possible secondary causes. One of the most common secondary causes of frozen shoulder is a rotator cuff disorder, including rotator cuff tendinopathy and partial-thickness tears. In the present study, we used USG to detect secondary causes of frozen shoulder and performed USG-guided steroid injection to improve accuracy. We were able to exclude definite and quite visible secondary causes, such as calcification and partial rotator cuff tears. However, it is not always easy to demonstrate rotator cuff tendinopathy or tendinitis without magnetic resonance imaging, even with a modern USG equipment, although inflammation and contracture around the rotator interval (the extra-articular component) can be detected by Doppler USG or dynamic high-resolution USG.

![Figure 2](Image 323x571 to 550x726)

**Figure 2** Pain evaluations using visual analog scale (VAS) were improved after patients received an injection in the glenohumeral (GH) joint or in the subacromial (SA) space. There was a significant statistical difference between the patients in 2 groups at 3 weeks after injection (*P = .023*). The error bars show the standard error of the mean.

<table>
<thead>
<tr>
<th>Table II</th>
<th>Pain visual analog scale score differences compared with initial evaluation *</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAS difference</td>
<td>GH group</td>
</tr>
<tr>
<td>Preinjection score vs</td>
<td></td>
</tr>
<tr>
<td>3 weeks</td>
<td>−3.3 ± 1.8</td>
</tr>
<tr>
<td>6 weeks</td>
<td>−3.8 ± 2.6</td>
</tr>
<tr>
<td>12 weeks</td>
<td>−4.5 ± 2.5</td>
</tr>
</tbody>
</table>

GH, glenohumeral joint; SA, subacromial space; VAS, visual analog scale.

* Continuous data are presented as the mean ± standard deviation.

† Not adjusted for multiple comparisons.

‡ Adjusted by Bonferroni correction.
The 3 stages of frozen shoulder are pain, stiffness, and recovery. However, most patients show overlapping symptoms, such as painful stiffness; thus, frozen shoulder is believed to be a spectrum of disease, from inflammation to contracture. Interestingly, the age distribution of frozen shoulder and rotator cuff disorders are similar, and the initial location and primary pathology of frozen shoulder is the rotator interval or coracohumeral ligament, which are extra-articular. Considering these facts, we believe that many stiff shoulders originate in the SA space, even though this hypothesis cannot be demonstrated using current imaging techniques. We aimed to prove this hypothesis with a homogenous group of patients with primary frozen shoulder using USG to exclude secondary frozen shoulder and to provide a higher injection accuracy.

According to our literature search, only one study explored SA steroid injections for frozen shoulder. Rizk et al. reported a randomized trial comparing 4 groups: intra-articular methylprednisolone and lidocaine injection, intrabursal methylprednisolone and lidocaine injection, intra-articular lidocaine injection, and intrabursal lidocaine injection. In their study, 40 mg of methylprednisolone was injected weekly for 3 weeks. There was no significant difference in outcomes between intrabursal injections and intra-articular injections. The injection of steroids with lidocaine had no advantage over lidocaine alone in restoring shoulder motion; however, partial, transient pain

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**Figure 3**  Constant scores improved after patients received an injection in the glenohumeral (GH) joint or in the subacromial (SA) space. There were no significant statistical differences between the 2 groups at serial follow-up assessments. The error bars show the standard error of the mean.

**Figure 4**  Abduction improved after patients received an injection in the glenohumeral (GH) joint or in the subacromial (SA) space. There were no significant statistical differences between the 2 groups at serial follow-up assessments. The error bars show the standard error of the mean.

**Figure 5**  External rotation improved after patients received an injection in the glenohumeral (GH) joint or in the subacromial (SA) space. There were no significant statistical differences between the 2 groups at serial follow-up assessments. The error bars show the standard error of the mean.

**Figure 6**  Internal rotation improved after patients received an injection in the glenohumeral (GH) joint or in the subacromial (SA) space. There were no significant statistical differences between the 2 groups at serial follow-up assessments. The error bars show the standard error of the mean.
relief occurred in two-thirds of the steroid-treated patients. Our study demonstrated that USG-guided steroid injection treatment for primary frozen shoulder decreased pain and improved function, and there were no significant differences in outcomes between the GH joint and the SA space injection.

This study has several limitations: First, more patients and longer-term follow-up are necessary to prove our hypothesis. A sample size of 71 patients is relatively small to claim strong statistical power, and further research with a larger number of patients is necessary. Patients in our study experienced a high degree of improvement in pain, ROM, and function after 12 weeks, and there were no differences in outcomes between the groups at every follow-up interval. We believe that 3 months of follow-up may be enough to compare the short-term treatment effects, as other reports have done.16,31

Second, we did not include a control group receiving other treatment modalities, such as physiotherapy with medication only or a placebo injection to eliminate the possibility that a placebo effect was responsible for the improvements.

Third, USG is limited in its ability to detect intra-articular (eg, superior labrum anteroposterior lesion) and minimal rotator cuff (eg, tendinopathy) pathologies. The result is that some patients included in the present study may not have had truly idiopathic primary frozen shoulders. We tried to diagnose and treat patients as we would in an actual clinical setting.

Finally, what authors measured as pain VAS was a general perception of overall pain during 24 hours at each follow-up interview. We did not separate pain into nocturnal pain and pain with motion that could be relieved by a GH injection or a SA injection, respectively. We thought it was hard to separate these kinds of pain because patients usually feel pain in a mixed nature, such as motion pain during sleep.

Conclusions

Our prospective, randomized, comparative, short-term follow-up study suggested that steroid injections into the GH joint or SA space, followed by stretching exercises and NSAID supplementation, decreases pain and improves function, including ROM and Constant scores, in patients (mean symptom duration, 6.5 months) with primary frozen shoulder. We failed to prove our hypothesis that clinical outcomes of USG-guided steroid injection into the GH joint would be better than those of a SA injection in patients with frozen shoulder, even though the GH group experienced earlier pain relief. Considering the relative lower accuracy of blind injections into the GH joint, SA steroid injections along with intra-articular injections are an alternative treatment for frozen shoulder in outpatient clinics. Further studies should focus on the etiology and pathophysiology of frozen shoulder, and the treatment of frozen shoulder should be individualized and tailored appropriately to patients’ needs and conditions.

Acknowledgments

The authors thank Hye Ran Kim and Shang Mi Shim for their assistance with data collection.

Disclaimer

This research was supported by Grant 06-2007-023 from SK Chemicals, Korea Co. Ltd. research fund. There was no potential benefit to the company from this article. No product of the company was mentioned. The authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

References