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Magnetic resonance imaging and short-term clinical results of severe frozen shoulder treated with manipulation under ultrasound-guided cervical nerve root block

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Background: We evaluated the magnetic resonance (MR) imaging findings and short-term clinical outcomes of severe idiopathic frozen shoulder treated with manipulation under ultrasound-guided cervical nerve root block (MUC).

Methods: The subjects were 30 patients (average age, 55.2 years; 12 men, 18 women) with severe frozen shoulder. Severe idiopathic frozen shoulder was defined as follows: a range of motion (ROM) of $\leq 100^{\circ}$ in forward flexion, $\leq 10^{\circ}$ in external rotation, and at or below the fifth lumbar vertebral level in internal rotation. Before the manipulation, all patients had continued global ROM loss for at least 6 months. Before and after manipulation, they underwent MR imaging. MR images and clinical results were evaluated 1 month after the procedure.

Results: In terms of the capsule tear pattern, MR imaging showed 14 midsubstance tears and 15 humeral avulsions of glenohumeral ligament–like lesions. An anterior labrum tear occurred in 4 shoulders, whereas 15 shoulders showed a bone bruise in the posterosuperior and anteromedial portions of the humeral head despite no humeral shaft fracture. There were significant improvements in the ROM, Constant-Murley score, American Shoulder and Elbow Surgeons score, and Numeric Rating Scale score from before treatment to 1 month after the procedure.

Conclusion: MR imaging of patients with severe frozen shoulder after MUC showed 29 capsule tears, 4 labrum tears, and 15 bone bruises of the humeral head. Approximately 50% of patients are likely to experience bone bruising after MUC. Long-term follow-up of these patients should be performed carefully.

Level of evidence: Level IV, Case Series, Treatment Study.

Keywords: Frozen shoulder; manipulation; capsule tear; bone bruise; magnetic resonance imaging

Frozen shoulder is a major orthopedic condition characterized by a limited range of motion (ROM) of the glenohumeral joint and shoulder pain. This condition was first described by Codman in 1934.[5] Frozen shoulder affects an

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estimated 2% to 5% of the total population.[3,10] Reeves et al[20] studied the natural history of frozen shoulder and described the presence of 3 phases of the condition: initial freezing, marked by an insidious onset of pain; frozen, involving pain and limited ROM of the shoulder; and thawing, with gradual symptom resolution.

Although the pathologic process has been described as inflammatory thickening of the articular capsule[21-23] or the development of intra-articular or extra-articular synovial inflammation,[13] no causes have been identified.

Treatment of frozen shoulder is controversial. Although conservative treatments are generally preferred, invasive treatments may be used in cases of protracted pain or no improvement in the limited ROM. Arthroscopic capsulectomy[12] or closed manipulation under general anesthesia is reportedly associated with good clinical outcomes.[6,24] However, closed manipulation involves shoulder joint stress induced in a blind manner and has been associated with complications including humeral shaft fracture, glenoid fracture, rotator cuff injury, and brachial plexus injury.[1,2,15,16]

Cervical nerve root blockade is a good option for anesthesia or analgesia of the shoulder.[17] Vasovagal symptoms and sympathetic blockade as major complications of this block reportedly occur in 1% to 2% of patients.[19] Recent advancements in ultrasonographic imaging equipment have enabled the visualization of muscles, bone, and nerves, facilitating ultrasound-guided nerve blockade.[18,27] The use of ultrasound for guidance of cervical nerve blocks is reportedly safer and more effective than electrical nerve stimulation.[11] Since 2013, we have performed shoulder joint manipulation under ultrasound-guided cervical nerve root blockade (MUC) on an outpatient basis. Patients can visualize their shoulder manipulation during this procedure, unlike during general anesthesia. This procedure can be performed quickly on an outpatient basis and may consequently contribute to health care cost reductions. However, no reports are available on the clinical outcomes of this procedure or the changes and complications that can occur in the shoulder joint.

The purpose of this study was to evaluate the short-term clinical outcomes of shoulder joint MUC in patients with severe frozen shoulder and to describe the magnetic resonance (MR) imaging findings of changes in the shoulder joint.

Materials and methods

This was a retrospective case-control study. Of 34 patients (35 shoulders) with severe idiopathic shoulder who underwent MUC in our hospital from September 2013 to January 2015, 30 patients (30 shoulders) with MR images of the shoulder joint obtained both before and after the procedure and who were followed up for at least 6 months after the procedure were included in the study. The mean age of the patients was 55.2 (range, 38-71) years (12 men, 18 women). Patients were diagnosed with severe idiopathic frozen shoulder if they had limited ROM in all directions ($\leq$100° in forward flexion [FF], $\leq$10° in external rotation at the side [ER], and at or below the fifth lumbar vertebral level in internal rotation [IR]) and did not respond to a combination of intra-articular steroid injections and physical therapy for at least 6 months. The mean time from shoulder pain onset to the procedure was 9.1 (range, 6-24) months.

The definition of idiopathic frozen shoulder was as follows: age of $\geq$35 years, shoulder pain associated with a ROM deficit (>10° loss of FF and ER) on the affected side, and loss of more than 2 spinal levels in IR compared with the unaffected side.

The exclusion criteria were as follows: complete rotator cuff tear, shoulder osteoarthritis, calcified tendinitis, history of shoulder joint fracture, history of shoulder joint surgery, long head biceps tendon injury, diabetic stiff shoulder, possible diabetes with a National Glycohemoglobin Standardization Program hemoglobin A_{1c} value of $\geq$6.5% or a Japan Diabetes Society value of $\geq$6.1%, cervical radiculopathy, brachial plexus injury, dementia, schizophrenia, depression, panic disorder, and generalized anxiety disorder.

The inclusion criteria for undergoing MUC were as follows: absence of infections, tumors, hematomas, and severe cervical deformities as shown by anteroposterior and lateral cervical spine radiographs as well as the availability of another person to drive the patient home after the procedure.

Surgical procedure

All procedures were performed by a single surgeon (S.H.). With the patients in the supine position, the cervical nerve roots (C5/C6) between the anterior and middle scalene muscles were identified using an ultrasound scanner (Noblus; Hitachi ALOKA Medical, Tokyo, Japan) and a body surface probe, then injected with 10 mL of anapeine, 10 mL of normal saline, and 10 mL of 1% lidocaine. The patients were assessed for immediate procedural complications. All unexpected symptoms or signs were evaluated and documented by the procedural physician. The patients were then placed in a waiting area for observation and reassessed in 30 minutes by an experienced procedural nurse or technologist. Manipulation was started after the absence of pain around the shoulder joint at 90° passive FF and maximum abduction was confirmed. First, manipulation was performed by alternating between anterior elevation and ER. This procedure was repeated gently until the same ROM was obtained in both FF and ER on the nondominant side. Next, ER and IR were performed at 90° abduction. IR and ER were then performed at 90° anterior elevation, followed by adduction. The second and third techniques were completed after obtaining >80% ROM on the nondominant side. Finally, IR was performed until the dominant thumb touched the nondominant thumb at the same vertebral height with the patients in the standing position.

After the MUC was completed, the glenohumeral joint was identified using the posterior approach by ultrasonography, and 2 mL of 1% lidocaine plus 40 mg of triamcinolone was injected into the joint to prevent postprocedural pain. After the procedure, the patients underwent noncontrast radiography to check for fractures.

Postoperative treatment

All patients underwent a standard rehabilitation protocol including shoulder passive and active ROM exercises and stretching of the