



The course and clinical impact of articular magnetic resonance imaging findings 6 months after shoulder manipulation under ultrasound-guided cervical nerve root block for frozen shoulder

Tomohiro Saito, MD ^{a,*}, Hideharu Sugimoto, MD, PhD ^b, Hideyuki Sasanuma, MD, PhD ^a, Yuki Iijima, MD, PhD ^a, Yuji Kanaya, MD ^a, Takashi Fukushima, MD ^a, Hideaki Watanabe, MD, PhD ^c, Ichiro Kikkawa, MD, PhD ^c, Katsushi Takeshita, MD, PhD ^b

^a Department of Orthopaedic Surgery, Jichi Medical University, Tochigi, Japan

^b Department of Radiology, Jichi Medical University, Tochigi, Japan

^c Jichi Children's Medical Center, Tochigi, Japan

ARTICLE INFO

Keywords:

Frozen shoulder
manipulation
MRI findings
bone bruise
capsular tear
labral tear

Level of evidence: Level IV, Case series,
Treatment study

Background: In our previous study, iatrogenic capsular tears, bone bruises of the humeral head, and labral tears were detected on magnetic resonance imaging (MRI) performed 1 week after manipulation following ultrasound-guided cervical nerve root block in patients with frozen shoulder 6 months after manipulation.

Methods: We studied 25 patients with frozen shoulder. MRI was performed before, 1 week after, and 6 months after manipulation. On the basis of the course of MRI findings over a period of 6 months, the patients were divided into 2 groups: those with MRI findings of bone bruises, capsular tears, and/or labral tears (19 patients) and those with no MRI findings (6 patients). The clinical outcomes of the 2 groups at 6 months after manipulation were compared using the Wilcoxon matched-pairs test, the Mann-Whitney test, and the Fisher exact probability test for statistical analysis.

Results: At 1 week after manipulation, 96% of patients had capsular tears, 40% had bone bruises, and 20% had labral tears; these percentages had decreased at 6 months after manipulation to 4%, 20%, and 8%, respectively. No significant differences in clinical outcomes were noted between patients with residual MRI findings 6 months after manipulation and those without any MRI findings.

Conclusion: Most of the iatrogenic capsular tears, bone bruises, and labral tears detected 1 week after manipulation had disappeared 6 months later. Residual MRI findings 6 months after manipulation had no significant correlation with clinical symptoms.

© 2018 Published by Elsevier Inc. on behalf of American Shoulder and Elbow Surgeons. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Frozen shoulder is a very common condition that is characterized by pain and restriction of motion, with a reported prevalence of 2% to 5%.³ There are many conservative treatment options for frozen shoulder, including medications, physiotherapy, and intra-articular steroid injection.³ However, in some patients, the condition is refractory to conservative treatment. If a patient with frozen shoulder is unresponsive to conservative therapy, more invasive treatment may be recommended, including manipulation under general anesthesia¹⁰ or arthroscopic capsular release.^{2,4}

Frozen shoulder has recently been treated via shoulder manipulation under ultrasound-guided cervical nerve root block in an

outpatient setting, with good short-term clinical results reported.^{1,8} The procedure does not require general anesthesia and hospitalization. However, there are concerns about complications after manipulation under ultrasound-guided cervical nerve root block, and a previous study reporting magnetic resonance imaging (MRI) findings at 1 week after manipulation showed that 97% of patients had capsular tears, 50% had bone bruises of the humeral head, and 13% had labral tears⁹; this study recommended a follow-up investigation to determine whether these MRI findings affected the clinical outcomes.

The purpose of this study was to investigate (1) whether capsular tears, bone bruises, and labral tears that appeared as a consequence of manipulation under ultrasound-guided cervical nerve root block were still present 6 months after manipulation and (2) whether there was a relationship between the residual MRI findings at 6 months after manipulation and the clinical outcomes. We hypothesized that most of the capsular tears, bone bruises, and

This study was approved by the Jichi Medical University Institutional Review Board (protocol A14-02).

* Corresponding author: Tomohiro Saito, MD, Department of Orthopaedics, Jichi Medical University, 3311-1 Yakushiji, Shimotuke, Tochigi 329-0498, Japan.

E-mail address: tr-saitou@kkf.biglobe.ne.jp (T. Saito).

<https://doi.org/10.1016/j.jses.2018.11.001>

2468-6026/© 2018 Published by Elsevier Inc. on behalf of American Shoulder and Elbow Surgeons. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

labral tears detected 1 week after manipulation would have resolved 6 months after manipulation and that residual MRI findings at 6 months would not correlate with clinical outcomes.

Materials and methods

This retrospective study included 25 patients with frozen shoulder who underwent manipulation under ultrasound-guided cervical nerve root block between September 2013 and March 2016 in a single-surgeon academic setting. The included patients had frozen shoulder that had not responded to at least 3 months of conservative therapy; had shoulder pain with limited active and passive shoulder range of motion (ROM) in at least 3 directions (forward flexion [FF] $\leq 100^\circ$, external rotation at 0° of shoulder abduction [ER] $\leq 10^\circ$, and internal rotation [IR] $\leq L5$); and had undergone MRI before, 1 week after, and 6 months after manipulation under ultrasound-guided cervical nerve root block. Patients with a history of rotator cuff tear, osteoarthritis, calcifying tendinitis, or shoulder fracture were excluded. The study received ethical approval from the institutional review board. Informed written consent was obtained from all patients at final follow-up.

Outcome measures

We assessed shoulder motion pain using the Numeric Rating Scale (NRS). An experienced physical therapist blindly assessed active and passive ROM (including FF and ER) with a goniometer. The hand-behind-the-back method was used to measure IR as the spinal level that the patient's thumb could reach. We assessed IR ROM by assigning the number 1 to the first thoracic vertebra, with sequential numbering of the vertebrae through the fifth lumbar vertebra (17); IR to the sacrum was defined as 18; and IR to the buttock was defined as 19. We also investigated shoulder function based on the American Shoulder and Elbow Surgeons (ASES) Shoulder Scoring System.⁶ Pain, active ROM, and ASES scores were assessed before manipulation under ultrasound-guided cervical nerve root block and 6 months after manipulation.

Treatment procedures

The cervical nerve roots (C5–C6) were identified using ultrasonographic examination; then, injection of 10 mL of 0.75% ropivacaine, 10 mL of normal saline solution, and 10 mL of 1% lidocaine was performed around them. Manipulation was first performed by moving the shoulder into 90° of abduction with gradual ER. After 90° of abduction and 90° of ER were obtained, the arm was maximally abducted until the patient's upper arm touched his or her ear. Progression to maximum adduction was then performed, followed by IR while in maximum adduction. Progression to maximum ER with the arm at the patient's side was followed by progression to maximum ER with the patient's arm at 45° of abduction. Finally, IR was performed until the vertebral height that could be reached by the dominant thumb was equal to that of the nondominant thumb. All patients underwent the same rehabilitation program at least once a week starting the next day, which comprised shoulder ROM exercises and muscle stretching around the shoulder under the supervision of a physical therapist for 3 months.^{8,9}

MRI examination

A 3-T unit (Skyra; Siemens Medical Systems, Erlangen, Germany) was used to perform MRI examinations before, 1 week after, and 6 months after manipulation. As Miller et al⁷ reported that bone bruises associated with the medial collateral ligament of the knee began and generally resolved over a period of 2 to 4 months, we

chose 6 months for the final evaluation. All MRI examinations were evaluated by 1 board-certified radiologist with 30 years of experience in musculoskeletal radiology. The radiologist was blinded to the nature of the study and time since manipulation. A "bone bruise" was defined as a high-intensity area in the humeral head on coronal T2-weighted fat-saturated images. Capsular tears were assessed on coronal T2-weighted fat-saturated images, whereas labral tears were assessed on sagittal T2-weighted fat-saturated images. On the basis of MRI performed 6 months after manipulation, the patients were divided into 2 groups: those with bone bruises, capsular tears, and/or anterior and/or posterior labral tears visible on MRI and those with normal MRI findings. The clinical outcomes of the 2 groups at 6 months after manipulation were evaluated and compared.

Statistical analysis

Statistical analyses were performed using commercial software (SPSS for Windows, version 20.0; IBM, Armonk, NY, USA). As the Shapiro-Wilk test did not follow the normal distribution, we used nonparametric statistics.

The Wilcoxon matched-pairs test was performed to analyze the ASES shoulder scores and shoulder ROM before and 6 months after manipulation. The Mann-Whitney test was used to compare the 2 groups regarding age, duration of symptoms before manipulation, NRS score, ROM (FF, ER, and IR), and ASES score at 6 months. The Fisher exact probability test was used to compare the 2 groups regarding patient sex. Significance was defined as $P < .05$. All values are presented as mean \pm standard deviation.

Results

The study comprised 25 patients, 9 male and 16 female patients, with a mean age of 57.6 ± 10.3 years (range, 36–73 years). The mean duration of symptoms before manipulation was 8.9 ± 4.9 months (range, 5–24 months). The respective ROM values before manipulation and 6 months after manipulation were $81^\circ \pm 14^\circ$ and $140^\circ \pm 27^\circ$ for FF ($P < .001$), $-2^\circ \pm 8^\circ$ and $41^\circ \pm 21^\circ$ for ER ($P < .001$), and the sacrum and T12 for IR ($P < .001$); all aspects of ROM were significantly improved at 6 months after manipulation compared with before manipulation. The NRS score significantly decreased from 5.76 ± 2.67 before manipulation to 1.84 ± 1.89 at 6 months after manipulation ($P < .001$). The ASES score significantly improved from 33.8 ± 17.3 before manipulation to 80.8 ± 16.6 at 6 months after manipulation ($P < .001$).

At 1 week after manipulation, 96% of cases (24 of 25) had capsular tears, 40% (10 of 25) had bone bruises, and 20% (5 of 25) had labral tears; these percentages were decreased at 6 months after manipulation to 4% (1 of 25), 20% (5 of 25), and 8% (2 of 25), respectively (Figs. 1–3). No significant differences in clinical symptoms were noted between patients with residual MRI findings at 6 months after manipulation and those with normal MRI findings (Table 1).

Discussion

Loew et al⁵ reported on the intra-articular lesions seen in primary frozen shoulder after manipulation. They concluded that even though manipulation under general anesthesia is effective in terms of joint mobilization, the method can cause iatrogenic intra-articular damage. The intra-articular MRI findings at 1 week after manipulation have been reported.⁹ There have been no studies describing the clinical course of intra-articular findings after manipulation for frozen shoulder, and the clinical impact of residual MRI findings at 6 months after manipulation was still unclear.

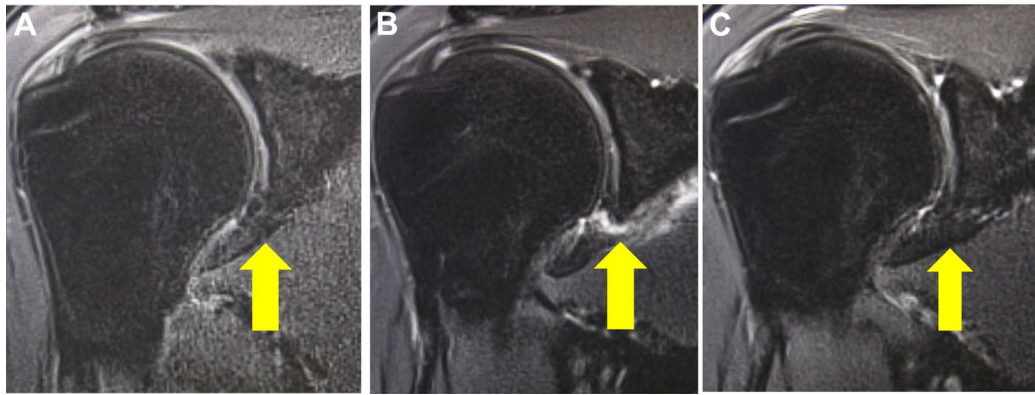


Figure 1 Magnetic resonance images showing the course of a capsular tear after shoulder manipulation for frozen shoulder in a 66-year-old male patient. All images are coronal T2-weighted fat-suppressed images. The arrows indicate the joint capsule. (A) Capsular thickening was present before the manipulation. (B) A capsular tear was observed 1 week after the manipulation. (C) At 6 months after the manipulation, the capsular tear had disappeared.

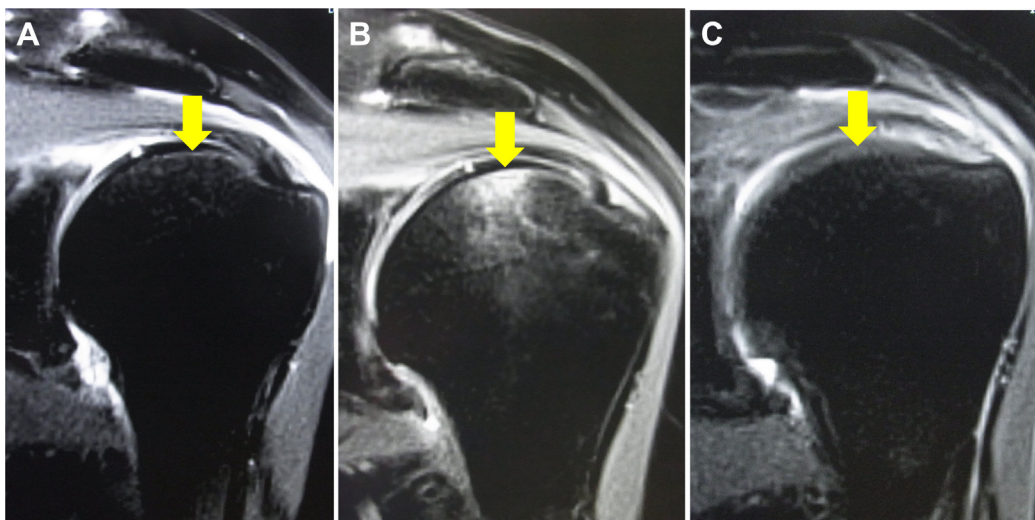


Figure 2 Magnetic resonance images showing the course of a bone bruise after shoulder manipulation for frozen shoulder in a 65-year-old female patient. All images are coronal T2-weighted fat-suppressed images. The arrows indicate the humeral head. (A) A normal humeral head was present before the manipulation. (B) A bone bruise was observed 1 week after the manipulation. (C) At 6 months after the manipulation, the bone bruise had disappeared.

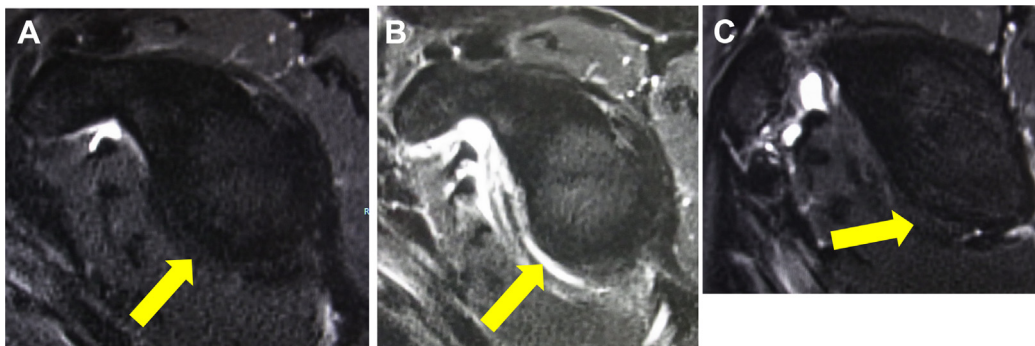


Figure 3 Magnetic resonance images showing the course of a labral tear after shoulder manipulation for frozen shoulder in a 66-year-old male patient. All images are sagittal T2-weighted fat-suppressed images. The arrows indicate the anterior labrum. (A) A normal anterior labrum was present before the manipulation. (B) An anteroinferior labral tear (Bankart lesion) was observed 1 week after the manipulation. (C) At 6 months after the manipulation, the Bankart lesion had disappeared.

To our knowledge, our study is the first to analyze the course of MRI findings (including capsular tears, bone bruises, and labral tears) in patients with frozen shoulder who have undergone manipulation and to record the presence or absence of these MRI findings at 6 months after manipulation. We showed that residual MRI findings at 6 months appear to have little correlation with clinical outcomes.

Bone bruises of humeral head

As humeral bone fractures after manipulation under general anesthesia have been reported,⁷ we performed the manipulation gently and carefully to avoid causing fracture. A previous study reported that 50% of patients had bone bruises of the humeral head

Table 1
Relationship between presence of residual MRI findings at 6 months after MUC for frozen shoulder and clinical outcomes

	Patients with residual MRI findings at 6 mo after MUC (n = 6)	Patients with no residual MRI findings at 6 mo after MUC (n = 19)	P value
Age, yr	57 ± 11.7	57.8 ± 10.1	.98*
Male/female sex	4/2	5/14	.97 [†]
Duration of symptoms before MUC, mo	9.7 ± 4.8	8.7 ± 5.0	.54*
NRS score at 6 mo after MUC	1.2 ± 0.8	2.1 ± 2.1	.49*
FF at 6 mo after MUC, [°]	142.5 ± 36.2	138.9 ± 24.4	.44*
ER at 6 mo after MUC, [°]	38.3 ± 17.5	41.6 ± 22.9	.82*
IR at 6 mo after MUC	T12	T12	.77*
ASES score at 6 mo after MUC	83.6 ± 6.4	79.9 ± 21.1	.70*

MRI, magnetic resonance imaging; MUC, manipulation under cervical nerve root block; NRS, Numerical Rating Scale for pain in shoulder; FF, forward flexion; ER, external rotation; IR, internal rotation; ASES, American Shoulder and Elbow Surgeons.

* Mann-Whitney test.

[†] Fisher exact probability test.

at 1 week after manipulation,⁹ so we had concerns about the impact that this would have on the clinical outcomes. Miller et al⁷ reported that improvement of bone bruises in the knee took about 2 to 4 months. In our study, the bone bruises had disappeared in 90% of patients (9 of 10) at 6 months after manipulation. Although bone bruises generally cause pain, it is unclear why the bone bruises did not cause pain in our patients; it may have been because the shoulder is a non-weight-bearing joint and the degree of bone bruise was low. One patient who still had bone bruising at 6 months after manipulation had a reasonable clinical outcome (ASES score of 75). This finding suggests that it is unnecessary to treat bone bruises appearing 1 week after manipulation.

Labral tears

Although we were concerned about anterior or posterior shoulder dislocation or apprehension, none of the patients who had a labral tear experienced shoulder dislocation or other symptoms. One patient with a residual anterior labral tear 6 months after manipulation had a good clinical outcome (ASES score of 90), whereas another patient with a residual anterior labral tear at 6 months had a reasonable outcome (ASES score of 76.7). It is unclear why the labral tear did not cause any dislocation or apprehension. However, labral tears after manipulation did not affect clinical outcomes at 6 months after manipulation.

Capsular tears

We found no significant difference in clinical outcomes between patients with capsular tears at 6 months after manipulation and those without capsular tears; this finding indicates that clinicians do not need to treat residual capsular tears present at 6 months after manipulation.

Study limitations

This study had some limitations. These include the small number of patients and the short duration of follow-up. Further study with a large number of patients and longer follow-up is needed to confirm our results.

Conclusion

Most of the capsular tears, bone bruises, and labral tears detected at 1 week after manipulation under ultrasound-guided cervical nerve root block had disappeared at 6 months. Residual MRI findings at 6 months appear to have little to no correlation with clinical outcomes.

Acknowledgments

We thank Libby Cone, MD, MA, from Edanz Group Japan (www.edanzediting.com/ac) for editing a draft of this manuscript.

Disclaimer

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

- Ando A, Hamada J, Hagiwara Y, Sekiguchi T, Koide M, Itoi E. Short-term clinical results of manipulation under ultrasound guided brachial plexus block in patients with idiopathic frozen shoulder and diabetic secondary frozen shoulder. *Open Orthop J* 2018;12:99–104. <https://doi.org/10.2174/1874325001812010099>.
- Gallacher S, Beazley JC, Evans J, Anaspure R, Silver D, Redfern A, et al. A randomized controlled trial of arthroscopic capsular release versus hydro-dilatation in the treatment of primary frozen shoulder. *J Shoulder Elbow Surg* 2018;27:1401–6. <https://doi.org/10.1016/j.jse.2018.04.002>.
- Hsu JE, Anakwenze OA, Warrender WJ, Abboud JA. Current review of adhesive capsulitis. *J Shoulder Elbow Surg* 2011;20:502–14. <https://doi.org/10.1016/j.jse.2010.08.023>.
- Kanbe K. Clinical outcome of arthroscopic capsular release for frozen shoulder: essential technical points in 255 patients. *J Orthop Surg Res* 2018;13:56. <https://doi.org/10.1186/s13018-018-0758-5>.
- Loew M, Heichel TO, Lehner B. Intraarticular lesions in primary frozen shoulder after manipulation under general anesthesia. *J Shoulder Elbow Surg* 2005;14:16–21. <https://doi.org/10.1016/j.jse.2004.04.004>.
- Michener LA, McClure PW, Sennett BJ. American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form, patient self-report section: reliability, validity, and responsiveness. *J Shoulder Elbow Surg* 2002;11:587–94. <https://doi.org/10.1067/mse.2002.127096>.
- Miller MD, Osborne JR, Gordon WT, Hinkin DT, Brinker MR. The natural history of bone bruises. A prospective study of magnetic resonance imaging-detected trabecular microfractures in patients with isolated medial collateral ligament injuries. *Am J Sports Med* 1998;26:15–9.
- Saito T, Sasanuma H, Iijima Y, Kanaya Y, Saito T, Watanabe H, et al. Short-term clinical results of frozen shoulder treated with shoulder manipulation under ultrasound-guided cervical nerve root block at outpatient setting: a case series. *J Orthop Sci* 2017;22:275–80. <https://doi.org/10.1016/j.jos.2016.11.007>.
- Sasanuma H, Sugimoto H, Kanaya Y, Iijima Y, Saito T, Saito T, et al. Magnetic resonance imaging and short-term clinical results of severe frozen shoulder treated with manipulation under ultrasound-guided cervical nerve root block. *J Shoulder Elbow Surg* 2016;25:e13–20. <https://doi.org/10.1016/j.jse.2015.06.019>.
- Woods DA, Longanathan K. Recurrence of frozen shoulder after manipulation under anesthetic (MUA): the results of repeating the MUA. *Bone Joint J* 2017;99-B:812–7. <https://doi.org/10.1302/0301-620X.99B6.BJJ-2016-1133.R1>.