

Body Mass Index Is Related to the Recovery After Intra-articular Injection of Triamcinolone Acetonide for the Treatment of Frozen Shoulder: Case Series Study

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Research article

Keywords: Frozen shoulder, triamcinolone acetonide, body mass index

Posted Date: June 15th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-592935/v1>

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Abstract

Background: Patients with frozen shoulder tend to respond differently to the intra-articular injection of triamcinolone acetonide. The purpose of the present study was to evaluate the clinical effect of glenohumeral injection with triamcinolone acetonide for frozen shoulder and determine the factors related to extent of range of motion (ROM) recovery.

Methods: A cohort of patients who underwent intra-articular glenohumeral injection of triamcinolone acetonide under diagnosis of primary frozen shoulder was reviewed. The primary outcome variable of interest was the range of changes in each aspect of ROM at six weeks after injection. The relationship between improvement and unresponsiveness to intra-articular injection for the treatment of frozen shoulder with various factors were evaluated. The analyzed factors were as follows: age, sex, body mass index (BMI), initial ROM before injection, symptom duration, hand dominance, smoking history, and the existence of underlying disease including diabetes mellitus, hypertension, coronary disease, thyroid disease and hypercholesterolemia.

Results: A total of 305 patients were reviewed. There were significant improvements in all aspects of ROM at six weeks after injection. The forward flexion ($\rho=-0.346$, $p<0.001$) and external rotation ($\rho=-0.204$, $p=0.040$) showed a negative correlation with BMI. Multivariate analysis revealed that BMI is the sole factor related to recovery of forward flexion ($p=0.032$) and external rotation ($p=0.007$) at six weeks post-injection.

Conclusion: Intra-articular injection of triamcinolone acetonide is an effective method for improving ROM in patients with frozen shoulder. Increased BMI showed adverse effects on ROM recovery.

Background

Pathophysiologic process of inflammation leading to fibrosis on the glenohumeral joint is known to be the main pathology of idiopathic frozen shoulder.(1, 2) Among various conservative treatments for frozen shoulder, intra-articular corticosteroid injection has remained one of the verified methods commonly used in clinical practice. By reducing synovial inflammation, which leads to a decrease in pain perception, this promotes range of motion (ROM) recovery in frozen shoulder.(3) Combining intra-articular injection with passive and active exercises accelerates recovery during the early stages of treatment for frozen shoulder.(4)

However, despite the certified effect of intra-articular injection on frozen shoulder, patients tend to respond differently to the injection of triamcinolone acetonide. Some patients recover their ROM dramatically without much effort with exercises or rehabilitation after injection, while some show little difference in ROM even after rehabilitation, with no definite evidence of complications. So far, various studies have revealed the risk factors or conditions associated with the etiology of primary frozen shoulder, including diabetes mellitus, thyroid disease,(5) cardiac or pulmonary problems.(5) However, to our

best knowledge, there is little in the literature directly evaluating factors associated with post-injection status in frozen shoulders.

The purpose of this study was to identify whether there is improvement in ROM within six weeks after triamcinolone acetonide injection and determine the factors related to the extent of ROM recovery after intra-articular injection of triamcinolone acetonide in patients with primary frozen shoulder. The authors hypothesized that there will be an overall increase in ROM after injection and the presence of factors that are known to be closely related to the etiology of frozen shoulder may also affect the outcome of the intra-articular injection of triamcinolone acetonide.

Methods

Patient selection

This study was approved by our hospital's Institutional Review Board. From July 2015 to May 2020, we reviewed 534 patients under the diagnosis of unilateral frozen shoulder and received intra-articular injection of triamcinolone acetonide. We defined frozen shoulder based on previous studies as forward flexion less than 100° (maximal 150°; forward flexion is glenohumeral motion without scapulohumeral rhythm), external rotation under 45° (maximal 90°) in 0° of horizontal abduction, or internal rotation at a level lower than the third lumbar spine (L3) (maximal T7 level).^(6, 7)

For enrollment, we selected patients who underwent both plain radiograph and magnetic resonance imaging to detect reliable imaging indicators of frozen shoulder such as thickening of the capsule in the rotator interval, thickening of the coracohumeral ligament and obliteration of the fat triangle under the coracoid process.⁽⁸⁾ Also, detection of combined shoulder lesions that could cause restriction in shoulder motion or decreased ROM was made. Patients with concomitant shoulder lesions, including rotator cuff tear, labral tear, or arthritis, and those with a history of previous shoulder surgery or fracture were not included in the analysis.

In order to avoid including patients with inflammatory stage, of which the limitation is primarily caused by the subjective pain without actual pathological change of the intra-articular capsule itself, we have confined the cohort to the patients with at least 3 months of symptom duration before the injection. Also, patients with previous shoulder injection history were not included on the analysis. However, patients with other attempts including oral medications or physiotherapy prior to the injection were not excluded.

To reduce the risk of complications following an increase in blood glucose level after the injection of triamcinolone acetonide, injections were allowed in diabetic patients with controlled diabetes ($HbA1c < 7$) under the same medication for the past three months. Other underlying systemic conditions known to affect shoulder ROM or be associated with etiology of frozen shoulder such as thyroid diseases, hyperlipidemia, and hypertension were not considered as contraindications for intra-articular injection of triamcinolone acetonide. These conditions were considered to be underlying conditions when the patient

was under treatment or management after diagnostic confirmation. After excluding 229 patients, 305 patients with primary frozen shoulder were enrolled and evaluated.

Injection technique

All injections were performed after sterilization of the injection site. A high-resolution transducer (12 MHz linear array) was utilized for needle guidance. A 21-gauge needle on syringe containing 40 mg of triamcinolone acetonide mixed with 1 mL of lidocaine (2%) was prepared. The procedure was performed with the patients sitting on a chair with a neutral position of the shoulder and elbow flexed 90°. The needle was inserted anteriorly at the level of coracoid process aiming medially to the humeral head. As soon as the needle made contact with the humeral head, the needle was tilted away from the head and advanced into the articular cavity. The location of the needle within the joint was confirmed by ultrasound.

Post-injection rehabilitation

The same standardized rehabilitation protocols were applied to every patient from the day after injection. The patients were required to follow the home-based instruction daily without additional clinic-based physiotherapy. Pendulum circumduction and self-stretching passive motion exercise in every plane were recommended for six weeks after injection. Pulley exercise was recommended for advanced forward flexion; isometric exercise was also recommended. No limit was imposed on use of the shoulder to the extent tolerated. Periodic supervision for compliance of rehabilitation was made every two weeks.

Assessment

The passive ROM was checked twice before and after the injection. For the measurement, forward flexion and external rotation were evaluated with a goniometer when patients were in a supine position, excluding scapulohumeral motion. Internal rotation, which was measured in the sedentary position, was evaluated by the vertebral level reached by the tip of the thumb; internal rotation up to the level of the sacrum was designated as a zero point, and one point was added for each additional level upward. At six weeks post-injection, ROM was evaluated in the same manner.

Then, we also sought to determine what factors were correlated with improvement or unresponsiveness to the intra-articular injection for the treatment of frozen shoulder. The analyzed factors were as follows: age, sex, body mass index (BMI), initial ROM before injection, symptom duration, hand dominance, smoking history, and the existence of underlying disease including diabetes mellitus, hypertension, coronary disease, thyroid disease and hypercholesterolemia. All data were collected and evaluated by a clinical researcher who was blinded to the study assignments.

Statistical Methods

The primary outcome variable of interest was the range of changes in each aspect of ROM at six weeks after injection. A paired *t* test was used to compare the differences in ROM before and after injection for

enrolled patients. Pearson’s correlation coefficient (ρ) was performed to determine the relationship between ROM improvement and evaluated factors. Multivariate analysis using logistic regression analysis was performed to identify significant factors related to responsiveness and irresponsiveness of ROM to injection of triamcinolone acetonide. The amount of ROM improvement at six weeks post-injection was determined using dependent variables and independent variables, including the other factors mentioned above. The level of significance was set at $p < 0.05$. Statistical analysis was performed using the SPSS software version 18.0 (SPSS Inc., Chicago, IL, USA).

Results

Patient demographics are listed in Table 1. There were significant improvements in all aspects of ROM at six weeks after injection (Table 2).

Table I. Demographics of the enrolled patients

Age, years, mean (range)	57.55 (52–73)
Sex, male/female, n	122/183
Average follow-up, period, weeks	7.54
Average body mass index (BMI), kg/m ²	23.2
- BMI > 25, n	- 41
Smoking population, n	24
Comorbidity, n	
Diabetes mellitus	51
Hypertension	71
Coronary disease	18
Thyroid disease	25
Hypercholesterolemia	67
Initial range of motion	
Forward flexion	106.1
External rotation	25.2
Internal rotation*	2.4
* Internal rotation measured base on the levels of vertebrae. The vertebral level was numbered serially as follows: 0 for any level below the sacral region and 1 additional point for each level higher than the sacrum.	

Table 2
Pre- and post-injection range of motion

	Range of motion before injection	Range of motion after injection	<i>p</i> value
Forward Flexion	106.1	137.1	.024
External Rotation	25.2	55.4	.012
Internal Rotation*	2.4	10.8	.015
* Internal rotation measured base on the levels of vertebrae. The vertebral level was numbered serially as follows: 0 for any level below the sacral region and 1 additional point for each level higher than the sacrum.			

The improvement range of forward flexion showed a negative correlation with BMI ($\rho=-0.346$, $p < 0.001$). In the case of external rotation, a negative correlation was observed with BMI ($\rho=-0.204$, $p = 0.040$). However, internal rotation did not show any correlation with the evaluated factors.

Multivariate analysis revealed the main factor related to recovery of forward flexion ($p = .032$) and external rotation ($p = .007$) at post-injection six weeks was BMI (Tables 3 and 4). However, regression did not reveal any significant differences between internal rotation with respect to the listed factors. (Table 5)

Table 3
Multivariate analysis showing variables affecting recovery of forward flexion after the intraarticular injection of triamcinolone acetonide.

Characteristic	p-value	Beta
Age	.288	.034
Sex	.327	.626
Body Mass Index	.032	-.182
Initial Range of Motion	.111	.05
- Flexion	.346	.022
- External Rotation	.274	.114
- Internal Rotation		
Duration of symptom before injection	.390	.132
Dominant hand	.155	.587
Smoking	.547	-.697
Diabetes mellitus	.601	-.366
Hypertension	.921	-.069
Coronary disease	.613	-.732
Thyroid disease	.072	.144
Hypercholesterolemia	.787	.180

Table 4
 Multivariate analysis showing variables affecting recovery of
 external rotation after the intraarticular injection of
 triamcinolone acetonide.

Characteristic	p-value	Beta
Age	.310	- .076
Sex	.629	.039
Body Mass Index	.007	- .203
Initial Range of Motion	.174	- .038
- Flexion	.548	.545
- External Rotation	.272	.218
- Internal Rotation		
Duration of symptom before injection	.807	.019
Dominant hand	.156	.174
Smoking	.367	.068
Diabetes mellitus	.286	- .081
Hypertension	.298	- .080
Coronary disease	.718	.027
Thyroid disease	.407	- .602
Hypercholesterolemia	.366	- .068

Table 5
Multivariate analysis showing variables affecting recovery of
internal rotation after the intraarticular injection of
triamcinolone acetonide.

Characteristic	p-value	Beta
Age	.542	– .514
Sex	.157	.476
Body Mass Index	.067	– .549
Initial Range of Motion	.144	.565
- Flexion	.957	– .141
- External Rotation	.375	.328
- Internal Rotation		
Duration of symptom before injection	.242	– .547
Dominant hand	.214	.175
Smoking	.398	– .241
Diabetes mellitus	.617	.226
Hypertension	.581	.384
Coronary disease	.224	.141
Thyroid disease	.487	– .219
Hypercholesterolemia	.175	.547

The existence of diabetes mellitus or thyroid diseases, which were known to be related to the etiology of frozen shoulder, did not actually affect the recovery of ROM after injection. No patient reported symptoms or signs suggestive of acute infection after injection.

Discussion

This study revealed significant improvement in ROM within six weeks after the intra-articular injection of triamcinolone acetonide in patients with frozen shoulder. It was noted that BMI affected the result of intra-articular injection of corticosteroid and was the sole factor that actually affected the recovery of both forward flexion and external rotation after injection. Increased BMI showed an inverse relationship on ROM recovery after injection, meaning higher BMI levels typically were associated with a lower range of recovery.

Among many factors that are associated with etiology and prognosis of frozen shoulder, diabetes mellitus is probably one of the most frequently mentioned factors among various conditions or diseases.

As corticosteroid therapy can lead to an increase in blood glucose levels and diabetic patients are vulnerable to complications following an increase in glucose levels, physicians tend to limit corticosteroid usage. Still, a corticosteroid injection is not considered as an absolute contraindication among diabetic patients, and is used in diabetic patients due to the fact that the injection is still effective for decreasing pain perception and accelerating functional recovery in the early post-injection period.(3) Contrary to the expectation that the result of injection would be inferior among diabetic patients, diabetes itself did not actually affect the results and there were no cases with injection-related complications. We concluded that triamcinolone acetonide is a safe injection modality among diabetic patients with frozen shoulder under this condition, which is a well-controlled blood glucose level. Further, as long as diabetes is under control, the existence of the disease itself did not actually affect the efficacy of injection. According to Kim et al, the different doses of triamcinolone acetonide did not actually show long-term differences for the treatment of frozen shoulder except the short-term glucose level increase with higher dose among diabetic patients.(9)

Numerous studies have reported a relationship between abnormalities in serum lipid profiles and the incidence of frozen shoulder. The level of serum cholesterol or triglyceride was higher among patients with adhesive capsulitis and hypercholesterolemia showed a prevalence of 17% among frozen shoulders. (10) (11) Park et al. reported that hypercholesterolemia and inflammatory lipoproteinemia have significant associations with primary adhesive capsulitis.(12) They proposed that higher levels of inflammatory lipoproteins in shoulder stiffness may induce inflammatory changes that are involved in adhesive capsulitis. However, existence of hypercholesterolemia itself did not significantly affect the ROM recovery after injection in this study. Similar to the enrolled diabetic patients, patients who have revealed themselves as hyperlipidemic were aware of the existing condition and under the medication in this particular study. Regarding the results shown with diabetic mellitus and hyperlipidemia, which are known to be associated with etiology of frozen shoulder, we concluded that triamcinolone acetonide injection is available and effective for the treatment of frozen shoulder as long as these conditions are under control.

Obesity is a condition that is commonly involved with various systemic diseases and due to a high incidence of obesity, it is not unexpected that there will be more obese patients with frozen shoulder occurring in the future. Unlike diabetes, there are not many studies that have hypothesized and demonstrated that obesity also plays a role in the pathogenesis of frozen shoulder. According to the cohort study by Kingston et al., more than 50% of the enrolled patients were classified as either overweight or obese among the analyzed 2190 patients who were diagnosed as adhesive capsulitis.(13) A prospective comparison study by Lin et al. has revealed that normal weight patients ($BMI < 25 \text{ kg/m}^2$) showed better Constant scores after corticosteroid injection for adhesive capsulitis when compared to overweight patients. These results were consistent with our study that showed being overweight affected the result of the injection. The result of this study has clinical implications due to the fact that average BMI around the world continues to increase and morbid obesity increases the risk of complications in many aspects. Specifically, obesity is also related to worse outcomes and higher risk of a revision surgery

via shoulder arthroplasty.(14, 15) Understanding the effect of BMI on corticosteroid injection can help guide discussions about expectations with patients regarding the recovery of frozen shoulder. Our results clearly suggest that being overweight is disadvantageous for the recovery from frozen shoulder and also providing this information to the patients may lead to voluntary weight loss in order to maximize the benefits of corticosteroid injections.

Some possible explanations can be suggested why BMI was associated with outcomes of corticosteroid injection in frozen shoulders. First, increased BMI is associated not only with increased chronic musculoskeletal pain, but also with increased chronic pain in general.(16–18) Persistent pain among obese patients may have reduced the effect of the injection and subsequent rehabilitation. This makes sense, as obesity, which is associated with decreased physical activity and having a larger and heavier arm, might have led to poor compliance of post-injection rehabilitation. Second, as shown in various joint problems, a more intense inflammatory reaction is known to happen in obese populations.(19–21) Even though the shoulder joint is not a weight-bearing joint, aggravated inflammation within the joint might hamper the injection result on a frozen shoulder.

The limitations in internal rotation also showed improvement after injection, but unlike forward flexion or external rotation, its recovery was not affected by any evaluated factors. In fact, different from the other motions, the deficit of internal rotation is not only caused by posterior capsule, which exists within the joint space, but also by adaptation from tightness of posterior musculotendinous tissue, including infraspinatus and teres minor.(22–25) There have been many controversies regarding the contribution of posterior capsule pathology on internal rotation deficit leading to necessity of extended surgical release of the posterior capsule.(7, 26, 27) Considering the dominating extra-articular factors, it can be explained that recovery of internal rotation could be less dependent on the effect of intra-articular injection when compared to the result of forward flexion and external rotation, and thus was not affected by the evaluation method.

The findings of this study should be interpreted with some limitations. First, we were not able to account for all of the factors that can affect the recovery from frozen shoulder. For example, even though every patient was taught to undergo the same routine exercise during post-injection recovery with periodic assessment of compliance, the individual compliance for rehabilitation cannot be identical. As the post-injection rehabilitation was completely based on home exercise program with periodic supervision, careful monitoring may not be sufficient to ensure adherence. Also, even though we have limited the cohort with no history of previous injection, we were not able to verify all the specific treatments including physical therapy or self-motivated exercises prior to the injection. Second, the patient cohort was not large, which may have resulted in some contributing factors being overlooked. A larger sample size may have decreased the chance of type II error. Third, the change in ROM was used as the sole barometer in this evaluation. This study would have been more objective if additional clinical assessments, such as pain score, Constant score or ASES score, were utilized. Fourth, this study only showed correlations and cannot explain a cause-effect relationship between various factors and the recovery.

Conclusion

Intra-articular injection of triamcinolone acetonide is an effective method for improving ROM in patients with frozen shoulder. Increased BMI showed adverse effects on ROM recovery.

Abbreviations

ROM: range of motion

BMI: body mass index

Declarations

- Ethical approval and consent to participate: Written/documented consent approved and reviewed by the Institutional Review Board of Seoul St. Mary's Hospital, the Catholic University of Korea Study No. : KC17OESI0118
- Consent for publication: : The Author transfers the non-exclusive publication rights Availability of data and materials
- Availability of supporting data: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.
- Competing interests: The authors declare that they have no competing interests.
- Funding: not applicable
- Authors' contributions: H.J.L and Y.S.K. analyzed and interpreted the data. B.S.K. contributed to the acquisition of data. Y.S.K. and H.J.L. contributed to drafting the work and revising it critically for important intellectual content. H.J.L. contributed to the final approval of the version to be published. All authors agreed to be accountable for all aspects of the work to ensure that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.
- Acknowledgement: not applicable

References

1. Kim DH, Lee KH, Lho YM, Ha E, Hwang I, Song KS, et al. Characterization of a frozen shoulder model using immobilization in rats. *J Orthop Surg Res.* 2016;11(1):160.
2. Hand GC, Athanasou NA, Matthews T, Carr AJ. The pathology of frozen shoulder. *J Bone Joint Surg Br.* 2007;89(7):928–32.
3. Roh YH, Yi SR, Noh JH, Lee SY, Oh JH, Gong HS, et al. Intra-articular corticosteroid injection in diabetic patients with adhesive capsulitis: a randomized controlled trial. *Knee surgery, sports traumatology, arthroscopy: official journal of the ESSKA.* 2012;20(10):1947–52.

4. Carette S, Moffet H, Tardif J, Bessette L, Morin F, Fremont P, et al. Intraarticular corticosteroids, supervised physiotherapy, or a combination of the two in the treatment of adhesive capsulitis of the shoulder: a placebo-controlled trial. *Arthritis rheumatism*. 2003;48(3):829–38.
5. Manske RC, Prohaska D. Diagnosis and management of adhesive capsulitis. *Curr Rev Musculoskelet Med*. 2008;1(3–4):180–9.
6. Kim YS, Lee HJ, Park I, Im JH, Park KS, Lee SB. Are delayed operations effective for patients with rotator cuff tears and concomitant stiffness? An analysis of immediate versus delayed surgery on outcomes. *Arthroscopy: the journal of arthroscopic related surgery : official publication of the Arthroscopy Association of North America the International Arthroscopy Association*. 2015;31(2):197–204.
7. Kim YS, Lee HJ, Park IJ. Clinical outcomes do not support arthroscopic posterior capsular release in addition to anterior release for shoulder stiffness: a randomized controlled study. *Am J Sports Med*. 2014;42(5):1143–9.
8. Mengiardi B, Pfirrmann CW, Gerber C, Hodler J, Zanetti M. Frozen shoulder: MR arthrographic findings. *Radiology*. 2004;233(2):486–92.
9. Kim YS, Lee HJ, Lee DH, Choi KY. Comparison of high- and low-dose intra-articular triamcinolone acetate injection for treatment of primary shoulder stiffness: a prospective randomized trial. *J Shoulder Elbow Surg*. 2017;26(2):209–15.
10. Bunker TD, Esler CN. Frozen shoulder and lipids. *The Journal of bone joint surgery British volume*. 1995;77(5):684–6.
11. Hand C, Clipsham K, Rees JL, Carr AJ. Long-term outcome of frozen shoulder. *J Shoulder Elbow Surg*. 2008;17(2):231–6.
12. Sung CM, Jung TS, Park HB. Are serum lipids involved in primary frozen shoulder? A case-control study. *The Journal of bone joint surgery American volume*. 2014;96(21):1828–33.
13. Kingston K, Curry EJ, Galvin JW, Li X. Shoulder adhesive capsulitis: epidemiology and predictors of surgery. *J Shoulder Elbow Surg*. 2018;27(8):1437–43.
14. Singh JA, Sperling JW, Cofield RH. Risk factors for revision surgery after humeral head replacement: 1,431 shoulders over 3 decades. *J Shoulder Elbow Surg*. 2012;21(8):1039–44.
15. Wagner ER, Houdek MT, Schleck C, Harmsen WS, Sanchez-Sotelo J, Cofield R, et al. Increasing Body Mass Index Is Associated with Worse Outcomes After Shoulder Arthroplasty. *The Journal of bone joint surgery American volume*. 2017;99(11):929–37.
16. Vincent HK, Adams MC, Vincent KR, Hurley RW. Musculoskeletal pain, fear avoidance behaviors, and functional decline in obesity: potential interventions to manage pain and maintain function. *Reg Anesth Pain Med*. 2013;38(6):481–91.
17. Yoo JJ, Cho NH, Lim SH, Kim HA. Relationships between body mass index, fat mass, muscle mass, and musculoskeletal pain in community residents. *Arthritis Rheumatol*. 2014;66(12):3511–20.
18. Heim N, Snijder MB, Deeg DJ, Seidell JC, Visser M. Obesity in older adults is associated with an increased prevalence and incidence of pain. *Obesity (Silver Spring)*. 2008;16(11):2510–7.

19. Love TJ, Zhu Y, Zhang Y, Wall-Burns L, Ogdie A, Gelfand JM, et al. Obesity and the risk of psoriatic arthritis: a population-based study. *Ann Rheum Dis*. 2012;71(8):1273–7.
20. Bakirci S, Dabague J, Eder L, McGonagle D, Aydin SZ. The role of obesity on inflammation and damage in spondyloarthritis: a systematic literature review on body mass index and imaging. *Clin Exp Rheumatol*. 2020;38(1):144–8.
21. Urban H, Little CB. The role of fat and inflammation in the pathogenesis and management of osteoarthritis. *Rheumatology*. 2018;57(suppl_4):iv10–21.
22. Bailey LB, Shanley E, Hawkins R, Beattie PF, Fritz S, Kwartowitz D, et al. Mechanisms of Shoulder Range of Motion Deficits in Asymptomatic Baseball Players. *Am J Sports Med*. 2015;43(11):2783–93.
23. Poser A, Casonato O. Posterior glenohumeral stiffness: capsular or muscular problem? A case report. *Man Ther*. 2008;13(2):165–70.
24. Tyler TF, Nicholas SJ, Roy T, Gleim GW. Quantification of posterior capsule tightness and motion loss in patients with shoulder impingement. *Am J Sports Med*. 2000;28(5):668–73.
25. Yamauchi T, Hasegawa S, Nakamura M, Nishishita S, Yanase K, Fujita K, et al. Effects of two stretching methods on shoulder range of motion and muscle stiffness in baseball players with posterior shoulder tightness: a randomized controlled trial. *J Shoulder Elbow Surg*. 2016;25(9):1395–403.
26. Chen J, Chen S, Li Y, Hua Y, Li H. Is the extended release of the inferior glenohumeral ligament necessary for frozen shoulder? *Arthroscopy: the journal of arthroscopic related surgery : official publication of the Arthroscopy Association of North America the International Arthroscopy Association*. 2010;26(4):529–35.
27. Nicholson GP. Arthroscopic capsular release for stiff shoulders: effect of etiology on outcomes. *Arthroscopy: the journal of arthroscopic related surgery : official publication of the Arthroscopy Association of North America the International Arthroscopy Association*. 2003;19(1):40–9.