Pain Ther (2024) 13:241–249
https://doi.org/10.1007/s40122-024-00578-6

ORIGINAL RESEARCH

Association of Range of Motion Deficit and Recurrence of Pain After Treatment of Adhesive Capsulitis

Jung Hwan Lee · Jun Ho Lee · Min Cheol Chang

Received: November 1, 2023 / Accepted: January 15, 2024 / Published online: February 5, 2024

ABSTRACT

Introduction: We evaluated the factors influencing the duration of significant pain reduction after conservative management for adhesive capsulitis (AC).

Methods: Follow-up for 6–8 months was performed with 141 patients with AC who experienced significant pain reduction after treatment. Clinical and demographic factors, numeric rating scale (NRS) scores, and shoulder range of motion (ROM) were collected and assessed pretreatment (T0), at 5 weeks post-treatment (T1), and at 6–8 months post-treatment (T2). Patients were divided into successful (n = 96) and unsuccessful (n = 45) NRS groups according to the degree of pain reduction at T2. We assessed post-treatment NRS and ROM improvement scores within each group and compared these parameters between the two groups.

Results: Significant NRS and ROM improvements were achieved in all patients who participated in our study. The unsuccessful NRS group demonstrated a lack of significant improvement in abduction at T1 and T2. All T1 and shoulder ROM measurements among the unsuccessful NRS group were significantly smaller than those among the successful NRS group.

Conclusions: Failure to achieve a significant improvement in abduction angle after conservative management of AC was significantly associated with pain recurrence.

Keywords: Bursitis; Shoulder; Range of motion; Articular; Pain; Prognosis; Joint capsule release; Injections; Intraarticular; Thyroid diseases

J. H. Lee
Namdarun Rehabilitation Clinic, 112-11, Seongbok 1-ro, Suji-gu, Yongin, Gyeonggi-Do, South Korea

J. H. Lee
Department of Neurosurgery, Kyung Hee University Medical Center, 23 Kyung Hee Daero, Dongdaemun Gu, Seoul 02447, South Korea

M. C. Chang (✉)
Department of Physical Medicine and Rehabilitation, College of Medicine, Yeungnam University, 317-1, Daemyungdong, Namku, Daegu 705-717, Republic of Korea
e-mail: wheel633@gmail.com

Key Summary Points

We investigated the parameters that might determine the longevity of significant pain reduction maintenance after conservative management for adhesive capsulitis (AC).

The patients who experienced symptom recurrence 6 to 8 months after completing the 5 weeks of scheduled treatment for the initial pain relief showed significantly lower improvement in range of motion (ROM), especially in the abduction angle.

This study demonstrated that the patients with thyroid disease were significantly related to unsuccessful pain control maintenance 6-8 months after treatment.

Failure to significantly improve shoulder ROM, especially abduction angle, after conservative treatment was significantly associated with pain recurrence 6–8 months after treatment in patients with AC.

INTRODUCTION

Adhesive capsulitis (AC) is one of the most common disorders affecting the glenohumeral joint. The main clinical manifestations of AC, pain and limited range of motion (ROM), are caused by the thickening of the glenohumeral and coracohumeral ligaments, capsular adhesion, glenohumeral joint contracture, and subsequent reduction of the glenohumeral joint volume [1, 2]. Histologically, this capsular contracture is characterized by fibroblast proliferation and patchy depositions of type III collagen, synovial thickening, and loss of axillary recess with the absence of inflammatory infiltrates [3, 4].

Treatment modalities, including physical therapy, manual therapy, ROM exercise, and intraarticular injection, have been implemented for pain control and restricted ROM improvement. While a large portion of patients with AC may achieve significant pain control and ROM improvement, there are clinical failures despite various conservative treatments. In a study that included a comprehensive survey of shoulder specialists, 22.5% of the respondents said that > 10% of the patients with AC did not respond to conservative treatment [5]. Even patients who have achieved significant pain control sometimes develop persistent or residual ROM restrictions. Moreover, the recurrences of the symptoms after the initial clinical success have been reported by most patients. These untoward phenomena have brought up crucial doubts or controversy about conditions that might be related to (or lead to) these recurrences of pain after initial control among shoulder specialists. Steroid injection was one of the popularly used conservative treatment methods. These recurrences also necessitate repeated steroid injections, increasing the probability that side effects related to steroids will occur [6].

With this regard, this analysis seeks the parameters that might determine the longevity of significant pain reduction maintenance after conservative management for AC.

METHODS

Patients

Baseline information, including age, gender, main lesion side (left or right), presence of diabetes mellitus, thyroid disease, rotator cuff disease, numeric rating scale (NRS), and shoulder ROM, were retrospectively collected between January 2022 and May 2022 from the selected 141 patients who were diagnosed with AC, obtained significant pain reduction (50% or more reduction compared with pretreatment) after 5 weeks of conservative treatments and could be followed up at 6–8 months after completion of the treatment. The diagnosis of AC was determined by painful and limited ROM of the shoulder joint for at least 1 month [7]. Limited shoulder ROM was described as a 25% or more reduction in ROM in abduction, flexion, and external rotation measured by a

goniometer for the diagnosis of AC [2]. This study did not include the data of patients with traumatic shoulder conditions affecting shoulder ROM, inflammatory joint disease, full-thickness rotator cuff tendon tear using ultrasonography, or history of surgery [8]. This study was approved by the Investigational Review Board (IRB) of Wooridul Spine Hospital (2022-03-WSH-002), which waived the requirement for written informed consent owing to the retrospective nature of the study. The Helsinki Declaration was adhered to in this study.

Treatment

The treatment lasted 5 weeks. Passive ROM exercise, with physical therapies, including heat and electrical therapy, was performed for 30 min twice weekly. Each patient was taught to perform active ROM exercise with ten repetitions thrice daily.[2]

The intraarticular injection was administered while the patient was in supine position, with the arm adducted and internally rotated. First, the skin was anesthetized with lidocaine, and then a 21-gauge spinal needle, 2.5–3 inches long, was directed into the shoulder joint space via an anterior approach under fluoroscopic guidance. Approximately 1 cc of contrast was injected to confirm the proper location of the needle inside the joint, followed by an injection of 40 mg triamcinolone (1 cc) and 0.5% lidocaine (5 cc) [9] (Fig. 1). The repeated intraarticular injections were administered at 1 to 2-week intervals under C-arm fluoroscopy until a conceivable pain reduction was achieved [9, 10].

Clinical Evaluation

Pain score was calculated using NRS, ranging from 0 (no pain) to 10 (worst possible pain) based on the degree of pain experienced in the previous week.

Passive ROM was measured with a goniometer while the patient was sitting upright on a chair. Abduction, flexion, and external rotation angle were measured, with the patients asked to relax as much as possible and the examiner pressing down on the clavicle and scapula using one hand to eliminate scapular movement during ROM measurement. For flexion and abduction angle measurement, the examiner moved the patient's arm in sagittal and coronal planes from arm adduction posture with the elbow joint extended [10, 11]. The external rotation angle was measured with the shoulder fully adducted, 90° elbow flexion, and neutral position of the forearm. Internal rotation angle could not be measured with a goniometer because most patients could not accomplish a 90° abduction, which is mandatory for an accurate internal rotation angle measurement [12].

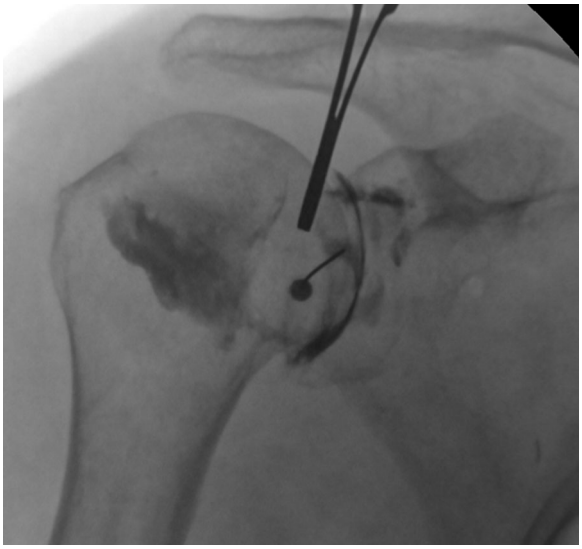

Fig. 1 Contrast spreading and needle position during glenohumeral intraarticular injection under fluoroscopic guidance

NRS and passive ROM were assessed at pretreatment (baseline, T0), at the end of 5 weeks of the treatment sessions (T1), and 6–8 months after the completion of treatment (T2).

Patients were divided into successful (n = 96) and unsuccessful (n = 45) groups according to the degree of pain reduction at the T2 timepoint. Pain reduction of $\geq$ 50% compared to the initial pain was considered successful. We compared the clinical and demographic data of the two groups at the T0 and T1 to identify the related factor that might affect the significant pain reduction maintenance at the T2 timepoint.

Statistical Analysis

Statistical analysis was performed using the SPSS Version 14.0 statistical package (SPSS Inc., Chicago, IL, USA). The paired *t* test was used to evaluate the significance of NRS reduction and ROM improvement at the T1 and T2 compared to the T0 in the total population and the successful and unsuccessful pain reduction groups. The proportions of gender, main lesion side, number of injections, and association of diabetes, thyroid disease, and rotator cuff disease were compared between the successful and unsuccessful groups using the Chi-square test. Comparison of age, pain duration, and NRS and shoulder ROM at the T1 and T2 between the successful and unsuccessful groups were conducted with the student *t* test. $p < 0.05$ was considered to be statistically significant.

RESULTS

NRS and Shoulder ROM at T0, T1, and T2 in the Total Population, the Successful NRS Group, and the Unsuccessful NRS Group

Significant NRS reduction and increased ROMs for flexion, abduction, and external rotation were achieved in all patients who participated in our study at the T1 and T2 compared to the T0 timepoint. Similarly, in the successful group, significant NRS reduction and increase in ROMs for flexion, abduction, and external rotation were observed at T1 and T2 compared to T0 ($p < 0.001$). However, NRS for the unsuccessful group at the T2 timepoint showed a lack of significant difference from the T0, while NRS at T1 was significantly reduced from the T0 ($p < 0.001$). For the ROM of the shoulder, it was observed that the abduction angle, unlikely for the flexion ($p < 0.001$ at T1 & T2) and external rotation angle ($p < 0.001$ at T1 & $p = 0.033$ at the T2), lacked significant improvement both at the T1 and T2 timepoints compared to the T0 (Table 1).

Demographic Data, NRS, and Shoulder ROM at the T0, T1, and T2 and Between the Successful NRS and the Unsuccessful NRS Group

No significant difference was observed in age, pain duration, proportion in gender, main side of the lesion, number of injections, and association of diabetes mellitus and rotator cuff disease using ultrasonography. However, the unsuccessful NRS group prevailed with thyroid disease in a significantly higher proportion than the successful NRS group ($p = 0.004$).

The baseline NRS and every shoulder ROMs at the T0 timepoint were not significantly different between the groups. The NRS at the T1 timepoint also lacked a significant difference between the groups, but the unsuccessful group showed significantly higher NRS than the successful group at the T2 timepoint. Every shoulder ROMs of the unsuccessful NRS group were significantly smaller and restricted than the successful group at the T1 and T2 timepoints ($p < 0.001$) (Table 2).

DISCUSSION

Treatments of patients with AC aim at both pain reduction and shoulder ROM improvement. The patients who experienced symptom recurrence 6 to 8 months after completing the 5 weeks of scheduled treatment for the initial pain relief showed significantly lower improvement in ROM, especially in the abduction angle. This has suggested that significant improvement of ROM, especially in abduction angle, might be a crucial target of the treatment for the sake of pain control and could be a determining factor to warrant the pain reduction effect maintenance.

Previous studies have reported the clinical implication of significant shoulder ROM recovery. Adding hydro-dilatation to intraarticular steroid injection to facilitate shoulder ROM restoration produced the clinical benefits of more efficient pain control [13–16]. These improvements of ROM acquired by hydro-distension helped to maintain the pain reduction successfully for up to 24 weeks for the patients

Table 1 Comparison of NRS and shoulder ROM at T0, T1, and T2 in total population, successful NRS group, and unsuccessful NRS group

	Total population	*p*	Successful NRS group	*p*	Unsuccessful NRS group	*p*
NRS						
T0	7.27 ± 0.89		7.29 ± 0.93		7.22 ± 0.79	
T1	1.32 ± 0.71	< 0.001[a,b]	1.32 ± 0.7	< 0.001[a,b]	1.31 ± 0.73	< 0.001[a,b]
T2	3.21 ± 2.86	< 0.001[a,c]	1.33 ± 0.74	< 0.001[a,c]	7.22 ± 0.82	1.000[c]
Flexion						
T0	106.06 ± 21.49		105.26 ± 22.84		107.78 ± 18.39	
T1	152.23 ± 15.52	< 0.001[a,b]	156.67 ± 9.37	< 0.001[a,b]	142.78 ± 21.04	< 0.001[a,b]
T2	149.89 ± 21.68	< 0.001[a,c]	158.18 ± 10.57	< 0.001[a,c]	132.22 ± 28.03	< 0.001[a,c]
Abduction						
T0	69.36 ± 22.2		69.06 ± 24.54		70 ± 16.34	
T1	130.39 ± 36.95	< 0.001[a,b]	152.81 ± 11	< 0.001[a,b]	82.56 ± 25.42	0.067[b]
T2	127.48 ± 40.5	< 0.001[a,c]	153.13 ± 13.52	< 0.001[a,c]	72.78 ± 18.17	0.271[c]
External rotation						
T0	20.14 ± 7.93		20.05 ± 9.3		20.33 ± 3.6	
T1	49.72 ± 18.16	< 0.001[a,b]	59.01 ± 12.37	< 0.001[a,b]	29.89 ± 11.36	< 0.001[a,b]
T2	47.13 ± 19.79	< 0.001[a,c]	58.65 ± 11.95	< 0.001[a,c]	22.56 ± 5.5	0.033[a,c]

NRS numeric rating scale, *T0* at pretreatment, *T1* at the time of finishing 5 weeks treatment sessions, *T2* at 6–8 months after completion of treatment

[a] $p < 0.05$

[b] *p* score means statistical significance of paired *t* test between T0 and T1

[c] *p* score means statistical significance of paired *t* test between T0 and T2

who were refractory to physical therapy and intraarticular steroid injection [17]. The study demonstrated that distension arthrography successfully led to a lower rate of AC recurrence. The higher distension volume showed a more dose-dependent correlation with the lower recurrence rates independent of capsule rupture or steroid dosage [18]. These results have indicated that the more successful clinical benefits might not be restricted to merely anti-inflammatory or pain-reducing efficacy but are closely related to a more aggressive release of capsular stiffness, manifested as improving ROM limitation.

Limitation of shoulder ROM, especially during the passive abduction maneuver, might be correlated with the volume of the glenohumeral capsule and thus can be a good diagnostic indicator for shoulder AC using arthrography [10]. Capsular stiffness of the glenohumeral joint significantly correlates with the limitation of the shoulder ROM, especially toward the abduction and external rotation directions [8]. According to these studies, abduction or external rotation angle was more closely related to the capsular tightness or contracture, a primary characteristic of AC than the other shoulder ROM. Moreover, a clinical study comparing the pain score and ROM between the capsular preserved and capsular rupture groups, verified during the distension arthrography, reported that the capsular preserved group had a lower

Table 2 Demographic data, NRS, and shoulder ROM at T0, T1, and T2 and between successful NRS and unsuccessful NRS group

	Successful NRS group (*N* = 96)	**Unsuccessful NRS group (*N* = 45)**	***p***
Age	55.71 ± 10.39	52.73 ± 6.8	0.082
Gender			
Male	32	17	0.705
Female	64	28	
Main lesion side			
Right	48	27	0.283
Left	48	18	
Diabetes mellitus			
Absent	56	33	0.095
Present	40	12	
Thyroid disease			
Absent	90	34	0.004*
Present	6	11	
Rotator cuff disease			
Absent	29	15	0.702
Present	67	30	
Duration of pain (months)	5.03 ± 1.74	5.29 ± 1.18	0.369
Number of injections	2.79 ± 0.72	2.76 ± 0.71	0.965
NRS at T0	7.29 ± 0.93	7.22 ± 0.79	0.666
Flexion at T0	105.26 ± 22.84	107.78 ± 18.39	0.519
Abduction at T0	69.06 ± 24.54	70 ± 16.34	0.816
External rotation at T0	20.05 ± 9.3	20.33 ± 3.6	0.845
NRS at T1	1.32 ± 0.7	1.31 ± 0.73	0.927
Flexion at T1	156.67 ± 9.37	142.78 ± 21.04	< 0.001*
Abduction at T1	152.81 ± 11	82.56 ± 25.42	< 0.001*
External rotation at T1	59.01 ± 12.37	29.89 ± 11.36	< 0.001*
NRS at T2	1.33 ± 0.74	7.22 ± 0.82	< 0.001*
Flexion at T2	158.18 ± 10.57	132.22 ± 28.03	< 0.001*
Abduction at T2	153.13 ± 13.52	72.78 ± 18.17	< 0.001*

Table 2 continued

	Successful NRS group ($N = 96$)	Unsuccessful NRS group ($N = 45$)	p
External rotation at T2	58.65 ± 11.95	22.56 ± 5.5	< 0.001*

NRS numeric rating scale, *ROM* range of motion, *T0* at pretreatment, *T1* at the time of finishing 5 weeks treatment sessions, *T2* at 6–8 months after completion of treatment
*$p < 0.05$

pain score and a greater ROM improvement during the abduction [19]. This meant that improving the abduction ROM might be a crucial factor for the effective release of AC than the other ROMs. This was consistent with the present results, which showed that the main characteristic of the unsuccessful pain reduction group was a failure to acquire a significant shoulder abduction angle after the treatment.

Despite some controversies, diabetes was generally associated with the clinical recurrence or poor prognosis of AC [20]. Although some controversies are still prevailing. While one prospective study reported equivocal successful functional outcomes in patients with or without diabetes after arthrography distension [21], the other study found higher recurrence rates for those comorbid with diabetes [18]. Our study showed no correlation between diabetes and the recurrence of pain.

Thyroid diseases, including hypo- and hyperthyroidism, have been reported to be associated with AC [22]. They were considered to be a risk factor for the clinical severity and prognostic factor of the treatment [23, 24]. This study demonstrated that the patients with thyroid disease were significantly related to unsuccessful pain control maintenance 6–-8 months after treatment.

This study had several limitations; first, this study was retrospective design, only patients who could be followed up 6–8 months after the treatment were included. However, follow-up for longer than 6 months was not needed. Six months was long enough to identify patients in whom pain would recur and demonstrate that recurrence significantly correlates with failure to achieve sufficient shoulder ROM at 5 weeks post-treatment. A prospective study that identifies patients initially achieving successful pain reduction and assesses correlation between shoulder ROM at treatment completion and pain score change during the full follow-up period may provide further clinically beneficial results. Second, only pain scores and ROM were evaluated, and functional assessment was not conducted, which might have hindered the proper identification of the true prognostic factor for pain reduction maintenance in more diverse aspects of AC.

CONCLUSIONS

In conclusion, failure to significantly improve shoulder ROM, especially abduction angle, after conservative treatment was significantly associated with pain recurrence 6–8 months after treatment in patients with AC.

ACKNOWLEDGEMENTS

We thank the participants of the study.

Medical Writing/Editorial Assistance English language editing service was provided by Editage (www.editage.com). The funding for this service was provided by Yeungnam University.

Author Contributions. All authors contributed to the study conception, design, material preparation, data collection, data analysis, drift of manuscript. All authors read and approved the final manuscript.

Funding. This journal's Rapid Service Fee and Open Access Fee were supported by the National Research Foundation (NRF) of Korea and funded by the Korean government (MSIT, Grant number: 00219725).

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

Declarations

Conflict of interest. The authors report no conflicts of interest in this work.

Ethical Approval. This study was approved by the Investigational Review Board (IRB) of Wooridul Spine Hospital (2022-03-WSH-002), which waived the requirement for written informed consent owing to the retrospective nature of the study. The Helsinki Declaration was adhered to in this study.

REFERENCES

1. van der Stok J, Fitzsimons M, Queally JM, O'Donnell T. Does capsular distension and a short period of countertraction improve outcome following manipulation under anesthesia for the treatment of primary adhesive capsulitis of the glenohumeral joint? J Shoulder Elbow Surg. 2022;31:772–81.
2. El Naggar TEDM, Maaty AIE, Mohamed AE. Effectiveness of radial extracorporeal shock-wave therapy versus ultrasound-guided low-dose intra-articular steroid injection in improving shoulder pain, function, and range of motion in diabetic patients with shoulder adhesive capsulitis. J Shoulder Elbow Surg. 2020;29:1300–9.
3. Neviaser AS, Hannafin JA. Adhesive capsulitis: a review of current treatment. Am J Sports Med. 2010;38:2346–56.
4. Makki D, Al-Yaseen M, Almari F, et al. Shoulder hydrodilatation for primary, post-traumatic and post-operative adhesive capsulitis. Shoulder Elbow. 2021;13:649–55.
5. Cho CH, Lee YH, Kim DH, Lim YJ, Baek CS, Kim DH. Definition, diagnosis, treatment, and prognosis of frozen shoulder: a consensus survey of shoulder specialists. Clin Orthop Surg. 2020;12:60–7.
6. Lee JH, Lee SH, Song SH. Clinical effectiveness of botulinum toxin type B in the treatment of subacromial bursitis or shoulder impingement syndrome. Clin J Pain. 2011;27:523–8.
7. Kelley MJ, Shaffer MA, Kuhn JE, et al. Shoulder pain and mobility deficits: adhesive capsulitis. J Orthop Sports Phys Ther. 2013;43:A1-31.
8. Lee SY, Lee KJ, Kim W, Chung SG. Relationships between capsular stiffness and clinical features in adhesive capsulitis of the shoulder. PM R. 2015;7:1226–34.
9. Tucker A, Christina H, Saad A, Bicknell R. Analysis of the clinical outcome of arthrographic steroid injection for the treatment of adhesive capsulitis. Open Orthop J. 2017;11:804–9.
10. Hagiwara Y, Sugaya H, Takahashi N, et al. Effects of intra-articular steroid injection before pan-capsular release in patients with refractory frozen shoulder. Knee Surg Sports Traumatol Arthrosc. 2015;23:1536–41.
11. Joo YJ, Yoon SJ, Kim CW, et al. A comparison of the short-term effects of a botulinum toxin type a and triamcinolone acetate injection on adhesive capsulitis of the shoulder. Ann Rehabil Med. 2013;37:208–14.
12. Awan R, Smith J, Boon AJ. Measuring shoulder internal rotation range of motion: a comparison of 3 techniques. Arch Phys Med Rehabil. 2002;83:1229–34.

13. Jacobs LG, Barton MA, Wallace WA, Ferrousis J, Dunn NA, Bossingham DH. Intra-articular distension and steroids in the management of capsulitis of the shoulder. BMJ. 1991;302:1498–501.

14. Reza SS, Bijan F, Asghar HA, et al. Treatment of frozen shoulder: a double blind study comparing the impact of triamcinolone injection alone or in association with joint distention. Res J Pharm Biol Chem Sci. 2013;4:226–34.

15. Yoon JP, Chung SW, Kim JE, et al. Intra-articular injection, subacromial injection, and hydrodilatation for primary frozen shoulder: a randomized clinical trial. J Shoulder Elbow Surg. 2016;25: 376–83.

16. Catapano M, Mittal N, Adamich J, Kumbhare D, Sangha H. Hydrodilatation with corticosteroid for the treatment of adhesive capsulitis: a systematic review. PM R. 2018;10:623–35.

17. Rae GC, Clark J, Wright M, Chesterton P. The effectiveness of hydrodistension and physiotherapy following previously failed conservative management of frozen shoulder in a UK primary care centre. Musculoskeletal Care. 2020;18:37–45.

18. Nicholson JA, Slader B, Martindale A, Mckie S, Robinson CM. Distension arthrogram in the treatment of adhesive capsulitis has a low rate of repeat intervention. Bone Joint J. 2020;102-B:606–10.

19. Kim K, Lee KJ, Kim HC, Lee KJ, Kim DK, Chung SG. Capsule preservation improves short-term outcome of hydraulic distension in painful stiff shoulder. J Orthop Res. 2011;29:1688–94.

20. Dyer BP, Burton C, Rathod-Mistry T, Blagojevic-Bucknall M, van der Windt DA. Diabetes as a prognostic factor in frozen shoulder: a systematic review. Arch Rehabil Res Clin Transl. 2021;3: 100141.

21. Clement RG, Ray AG, Davidson C, Robinson CM, Perks FJ. Frozen shoulder: long-term outcome following arthrographic distension. Acta Orthop Belg. 2013;79:368–74.

22. Cucchi D, Marmotti A, De Giorgi S, et al. Risk factors for shoulder stiffness: current concepts. Joints. 2017;5:217–23.

23. Schiefer M, Teixeira PFS, Fontenelle C, et al. Prevalence of hypothyroidism in patients with frozen shoulder. J Shoulder Elbow Surg. 2017;26:49–55.

24. Vicenti G, Moretti L, De Giorgi S, et al. Thyroid and shoulder diseases: the bases of a linked channel. J Biol Regul Homeost Agents. 2016;30:867–70.