

The Clinical Results of Conservative Treatment of Frozen Shoulder Using Continuous Passive Motion

Hoe-Jeong Chung, Doo-Sup Kim[✉], Yeo-Seung Yoon, Dong-Woo Lee, Kyung-Jin Hong

Department of Orthopedic Surgery, Yonsei University Wonju College of Medicine, Wonju, Korea

Background: The purpose of this study is to administer conservative treatment in 30 patients diagnosed with idiopathic frozen shoulder, following the suggested frozen shoulder rehabilitation program and to assess the clinical outcome using a prospective study.

Methods: Thirty patients diagnosed with idiopathic frozen shoulder, treated with steroid hormone injection on the articular joint with an intra-articular steroid (triamcinolone 40 mg+lidocaine 4 ml) injection and started on stepwise shoulder extension exercise were chosen. The subjects were divided into two groups of 15 people each with one group undergoing rehabilitation with continuous passive motion (CPM) and the other group without it. Follow-ups were done before rehabilitation and at 4-week intervals with the 24th being the final week. At every follow-up, passive range of motion (ROM) was measured and surveys on pain and clinical score were administered.

Results: In the last follow-up, both groups showed statistically significant improvements in all evaluation criteria. However, no statistical difference in all values of the ROM and Constant score evaluation criteria was observed between the groups. Only in the last follow-up, group 1 had a visual analog scale (VAS) score of 2.4 ± 2.1 points, which was lower, with statistical significance, than the VAS score of group 2, which was 4.4 ± 3.1 points ($p < 0.001$).

Conclusions: Study using CPM in treatment of frozen shoulder has been inadequate, meaning that there is still room for improvement and need for more study on setting a more specific protocol and guidelines for this procedure.

(Clin Shoulder Elbow 2015;18(4):217-220)

Key Words: Bursitis; Continuous passive motion therapy; Rehabilitation

Introduction

Frozen shoulder is often seen in middle aged people over 40 years and is a common cause of night pain. While the etiology of this disease is uncertain, it is generally presented by a gradual decrease of both active and passive range of motion (ROM).^{1,2} Frozen shoulder is known to cause pain and restriction of motion of the shoulder joint, show positive results of treatment and usually heals by itself within 1 to 2 years being a self-limited disease.³ However, most patients do not receive proper treatment, with recovery taking more than 3 years. According to some reports full recovery cannot be reached in cases without proper treatment.⁴

The usefulness of continuous passive motion (CPM) has already been confirmed in knee joint situations,^{5,6} but its usefulness in shoulder joint is still in question.⁷ While the rehabilitation protocol for rotator cuff tear has been reported,^{7,8} that of primary frozen shoulder has not. Similar to how CPM has become a basic procedure in knee joint situations, we believe that CPM can play a major role in rehabilitation of the shoulder joint through more research on the effectiveness of CPM on various shoulder diseases. Therefore, this prospective research was conducted on subjects with frozen shoulder who were divided into two groups, with one group undergoing rehabilitation with CPM and the other group without it to evaluate the clinical results and effectiveness of CPM.

Received May 31, 2015. **Revised** August 7, 2015. **Accepted** November 3, 2015.

[✉]**Correspondence to:** Doo-Sup Kim

Department of Orthopedic Surgery, Yonsei University Wonju College of Medicine, 20 Ilisan-ro, Wonju 26426, Korea

Tel: +82-33-741-1360, **Fax:** +82-33-746-7326, **E-mail:** dskim1974@yonsei.ac.kr

Financial support: None. **Conflict of interests:** None.

Methods

Subject of the Research

The research was conducted from March 2012 to February 2013, after being approved by the Yonsei University Wonju College of Medicine's Institutional Review Board. The subjects were 30 patients diagnosed with idiopathic frozen shoulder. Inclusion criteria were treatment with steroid hormone injection on the articular joint with an intra-articular steroid (triamcinolone 40 mg+lidocaine 4 ml) injection and follow-up by a step by step systematic shoulder ROM exercise. In addition, for patients aged over 45 but under 64 the additional inclusion criteria were forward elevation under 120 degrees, external rotation of 30 degrees or internal rotation under L3 with the arms attached to the body, decreased range of both active and passive exercise, no muscle loss compared to non-affected side muscle strength and plane X-ray with no osseous lesions inside or around the joint. Exclusion criteria for the choice of subjects were past history of frozen shoulder surgery or disease (particularly diabetes and thyroid disease), associations with muscle weakness, radiologically confirmed osteoarthritis, and subjects of other studies. Patients with lesions such as rotator cuff tear, or impingement syndrome that could be detected on ultrasound or magnetic resonance imaging were also excluded. The use of analgesics was halted 2 weeks before the start of the research and during the clinical trials of this research as well. This research was only conducted after obtaining informed consents from all subjects. All of the patients involved in this research participated in the 6-month long treatment and follow-up.

Method of the Research

Anatomic shoulder CPM machine (Centura; Kinetec, Tournes, France) was used in the rehabilitation process; the goniometer for measuring ROM. Research was conducted on 30 patients who signed the informed consent form for this research and were divided into 2 groups of 15 people each through random sampling. Group 1 underwent rehabilitation using CPM, and group 2 received conservative treatment. The performing method for group 1 was forward raising exercise performed before the extension exercise, then external rotation exercise with arms attached to the body, and, last, external and internal rotation exercise with arms rotated to 90°. Scapular elevation, abduction or forward flexion was started above 30° and increased to tolerance level. Rotation was set at tolerance level. To avoid impingement, external rotation should be at 30° before scapular elevation, abduction or forward flexion is beyond 90°.

The above described program was performed for one hour per day, three times a week, for 6 months. The protocol for the early discontinuation of the rehabilitation program before 6 months included situations where a patient complained about a pain or gained full ROM. The principle of group 2 was self-

treatment after undergoing passive-stretching education in the physical therapy department. The program started with forward elevation exercise, external rotation, and exercise using a pulley. Internal rotation and adduction were added depending on the improvement of the ROM.

All patients were evaluated before the rehabilitation program was started and follow-ups were done every 4 weeks after it began. The subjects' passive ROMs were measured and a survey on their pain and clinical score was administered during the final follow-up. Pain was graded using a visual analog scale (VAS) of 0 to 10 with 10 being severe pain and 0 being no pain. For evaluation of the clinical score, Constant score was used and was measured before the program and at the final follow up. Forward elevation, external rotation on neutral state, and internal rotation at abduction were measured in 10 degrees, summed up, and then divided by the ROM of the normal side to determine the ratio. The statistical review performed for this research was the independent t-test using the IBM SPSS ver. 20.0 (IBM Co., Armonk, NY, USA) statistics program.

Results

In the last follow-up, both groups showed statistically significant improvements in all evaluation criteria. Clinical results for group 1 are shown in Table 1 and those for group 2 are shown in Table 2.

All values of the ROM and Constant score evaluation criteria between the groups showed no statistical difference. Only in the last follow-up, group 1 had a VAS score of 2.4 ± 2.1 points, which was lower with statistical significance compared with the VAS score of group 2, which was 4.4 ± 3.1 points ($p < 0.001$).

Discussion

CPM is a part of the basic equipment of rehabilitation in the field of Orthopedics. It was first introduced in a study conducted by Salter et al.⁹⁾ where CPM was found to be more effective and resulted in greater improvement-proven in restoration of articular ligament compared to a fixation method in an animal study. Thus, CPM was further applied to many human orthopedic diseases. As studies such as the one by Denis et al.¹⁰⁾ began recommending CPM for patients who underwent artificial knee replacement, application of CPM to lower extremities became a common method for use in orthopedic patients. However, clinical practice of CPM treatment on upper extremities was barely utilized due to the upper extremities requiring a much larger number of exercise axes than the lower extremities.

Even when part of the upper extremities, application of CPM was found to be suitable for cases of idiopathic frozen shoulder because the main problem of idiopathic frozen shoulder is limitation of ROM with pain and idiopathic frozen shoulder

Table 1. Clinical Results according to the Follow-up Period in the CPM Group

Period of CPM	VAS	Constant score	Forward elevation (°)	External rotation (°)	Internal rotation (°)	Average ROM (compare with non-affected side, %)
Initial	7.9 ± 3.0	58.6 ± 4.2	95.6 ± 14.1	45.6 ± 14.9	46.0 ± 14.7	46.8 ± 12.7
4 weeks	4.4 ± 2.7	63.8 ± 15.5	111.3 ± 15.6	51.6 ± 13.6	48.0 ± 13.8	56.1 ± 22.4
8 weeks	3.8 ± 1.2	68.7 ± 15.7	120.0 ± 15.6	55.6 ± 13.7	51.3 ± 14.8	62.6 ± 22.4
12 weeks	2.4 ± 1.5	71.4 ± 17.0	121.0 ± 20.2	61.6 ± 15.8	60.1 ± 14.4	69.5 ± 15.0
16 weeks	2.4 ± 2.1	75.8 ± 17.7	129.3 ± 22.3	68.3 ± 16.9	60.6 ± 17.5	76.5 ± 16.7
20 weeks	1.9 ± 1.7	79.8 ± 3.4	136.0 ± 13.8	71.0 ± 14.7	68.0 ± 15.9	82.0 ± 12.5
24 weeks (final)	0.8 ± 0.8	80.8 ± 14.7	147.3 ± 14.9	72.1 ± 13.3	68.9 ± 14.0	85.1 ± 11.9

Values are presented as mean ± standard deviation.

CPM: continuous passive motion, VAS: visual analog scale, ROM: range of motion.

Table 2. Clinical Results according to the Follow Up-Period in the Control (Non-CPM) Group

Period of non-CPM	VAS	Constant score	Forward elevation (°)	External rotation (°)	Internal rotation (°)	Average ROM (compare with non-affected side, %)
Initial	8.1 ± 3.0	59.4 ± 14.3	106.6 ± 14.5	44.6 ± 13.9	45.0 ± 13.7	46.5 ± 11.9
4 weeks	6.8 ± 2.9	68.8 ± 15.2	111.3 ± 15.4	49.6 ± 13.9	51.3 ± 13.5	51.2 ± 12.3
8 weeks	6.1 ± 2.1	68.0 ± 14.8	119.6 ± 15.4	55.3 ± 15.1	54.0 ± 13.8	59.0 ± 13.7
12 weeks	5.2 ± 2.9	70.4 ± 5.9	121.0 ± 20.1	57.3 ± 16.5	60.0 ± 16.5	69.2 ± 16.2
16 weeks	4.4 ± 3.1	73.8 ± 6.7	128.6 ± 21.5	61.0 ± 18.1	65.0 ± 17.7	74.3 ± 17.5
20 weeks	3.6 ± 3.8	80.1 ± 14.3	136.3 ± 21.8	65.3 ± 16.9	75.6 ± 13.7	79.8 ± 11.8
24 weeks (final)	3.2 ± 3.3	82.6 ± 21.2	142.0 ± 18.2	69.2 ± 15.3	76.4 ± 15.6	83.3 ± 15.0

Values are presented as mean ± standard deviation.

CPM: continuous passive motion, VAS: visual analog scale, ROM: range of motion.

is reversible with proper rehabilitative treatment. Despite such distinct characteristics of the disease, there are only a small number of clinical reviews reflecting the effects of CPM on shoulder sprain; the first clinical review applying CPM to frozen shoulder patients conducted by Dundar et al.¹¹⁾ illustrated an increase in ROM of shoulder but no significant improvement when compared to the conservative rehabilitative treatment. However this study had a major limitation of a short treatment period and follow-up term, respectively, being 4 weeks and 12 weeks. Such a short follow-up period can conceal the true impact of CPM as the healing process of idiopathic frozen shoulder is believed to be over two years. This study lengthened the time of treatment to six months and monthly follow-up to six months, attempting to clarify any significant differences in clinical results between treatment using CPM and conventional rehabilitation treatment.

In this study, performance of CPM showed the greatest improvement in the first four weeks of treatment in all evaluation values. In addition, constant improvements in not only ROM but also in clinical outcomes were observed during 24 weeks of treatment and follow-up. However, no statistically significant differences in all values and evaluation criteria, except the VAS score, were observed between the two groups.

When considering the ROM of the joint, all values of average ROM, Constant score, forward elevation, external rotation, internal rotation in group 1 and group 2 during the final follow-up did not show statistically significant differences showing results similar to those of other studies.¹⁰⁾ This is also thought to be related to the fact that CPM treatment of the shoulder joint is not clinically well applied yet due to the sheer amount of axes that need to be implemented.

However, the VAS score showed great improvement in the CPM group compared to the control group starting from week 4 and a statistically significant result was recorded at the last follow-up. This result agrees with a research study conducted by Dundar et al.¹¹⁾ which reported that due to ongoing stretching exercise, the secondary neuron of the dorsal horn becomes desensitized, relieving the pain. However, in this study researchers may have found one of the factors that improved the pain in the CPM group. Patients tend to feel more discomfort during rehabilitation when undergoing conventional self-treatment making their compliance level low. However, this study found that CPM enables the patient to have higher expectations and higher levels of compliance with rehabilitation, having a more positive effect. This is a subjective approach and cannot be easily generalized

due to the small number of patients, but this could still be partially confirmed through repetitive follow-ups and observation of the rehabilitation procedure.

There are many limitations to this research. One of them is the fact that steroid injection is a factor that can improve pain to a certain extent for subjects in both group 1 and group 2. However, considering the fact that patients could perform ROM exercises more easily and the purpose of the study focused on the effects of CPM, the factor of steroid injections in this comparison study between CPM and conventional rehabilitation treatment (both conducted after steroid injections) was not thought to be a major problem. A second limitation is the VAS score. When measuring the VAS score, a certain time period such as while resting, during day time acting, or night time was not chosen. This means that the VAS score was taken during different situations for different subjects. In addition, VAS score itself is a subjective indicator adding to its disadvantages. The last limitation is the small sample size. Due to limitations of time and space availability a small sample size of 30 people were chosen while a larger sample size could have definitely led to clearer results.

Conclusion

It can be seen that using CPM in treatment of frozen shoulder is only effective to an extent. However, CPM treatment allows the patient have the main role in his or her own rehabilitation, resulting in satisfaction with their rehabilitation process even in situations where there is a lack of qualified professionals. In addition, study using CPM in treatment of idiopathic frozen shoulder has been inadequate, meaning that there is still room for improvement and need for more study on setting a more specific protocol and guidelines for this procedure.

References

1. Wong PL, Tan HC. A review on frozen shoulder. *Singapore Med J.* 2010;51(9):694-7.
2. Hsu JE, Anakwenze OA, Warrender WJ, Abboud JA. Current review of adhesive capsulitis. *J Shoulder Elbow Surg.* 2011; 20(3):502-14.
3. Park TS, Na JU, Kim SI, Kim TS. Arthroscopic management and manipulation of chronic idiopathic adhesive capsulitis of the shoulder. *J Korean Orthop Assoc.* 2001;36(4):367-71.
4. Shaffer B, Tibone JE, Kerlan RK. Frozen shoulder. A long-term follow-up. *J Bone Joint Surg Am.* 1992;74(5):738-46.
5. Lubiecki M, Carr A. Frozen shoulder: past, present, and future. *J Orthop Surg (Hong Kong).* 2007;15(1):1-3.
6. Uppal HS, Evans JP, Smith C. Frozen shoulder: a systematic review of therapeutic options. *World J Orthop.* 2015;6(2):263-8.
7. Raab MG, Rzeszutko D, O'Connor W, Greatting MD. Early results of continuous passive motion after rotator cuff repair: a prospective, randomized, blinded, controlled study. *Am J Orthop (Belle Mead NJ).* 1996;25(3):214-20.
8. Michael JW, König DP, Imhoff AB, et al. Efficiency of a post-operative treatment after rotator cuff repair with a continuous passive motion device (CPM). *Z Orthop Ihre Grenzgeb.* 2005; 143(4):438-45.
9. Salter RB, Hamilton HW, Wedge JH, et al. Clinical application of basic research on continuous passive motion for disorders and injuries of synovial joints: a preliminary report of a feasibility study. *J Orthop Res.* 1984;1(3):325-42.
10. Denis M, Moffet H, Caron F, Ouellet D, Paquet J, Nolet L. Effectiveness of continuous passive motion and conventional physical therapy after total knee arthroplasty: a randomized clinical trial. *Phys Ther.* 2006;86(2):174-85.
11. Dunder U, Toktas H, Cakir T, Evcik D, Kavuncu V. Continuous passive motion provides good pain control in patients with adhesive capsulitis. *Int J Rehabil Res.* 2009;32(3):193-8.