**Name of Journal:** *World Journal of Orthopedics*

**Manuscript NO:** 39184

**Manuscript Type:** ORIGINAL ARTICLE

***Randomized Clinical Trial***

**Corticosteroid injection alone *vs* additional physiotherapy treatment in early stage frozen shoulders**

Kraal T *et al.* Dutch frozen shoulder trial, a randomized controlled trial

Tim Kraal, Inger Sierevelt, Derek van Deurzen, Michel van den Bekerom, Lijkele Beimers

**Tim Kraal, Inger Sierevelt, Lijkele Beimers,** Department of Orthopedic Surgery, Slotervaart Center of Orthopedic Research and Education, Amsterdam 1066 EC, The Netherlands

**Derek van Deurzen, Michel van den Bekerom,** Department of Orthopedic Surgery, Shoulder and Elbow Unit, OLVG Hospital, Amsterdam 1091 AC, The Netherlands

**ORCID number:** Tim Kraal (0000-0003-4377-6901); Inger Sierevelt (0000-0003-0924-9358); Derek van Deurzen (0000-0002-6948-183X); Michel van den Bekerom (0000-0002-1184-0529); Lijkele Beimers (0000-0001-8856-1061).

**Author contributions:** Kraal T is the initiator of this study and wrote the study protocol and a large part of this manuscript; Sierevelt I is involved as a clinical epidemiologist and research coordinator; Sierevelt I is responsible for the statistical analysis and correct presentation of the results; van Deurzen D and van den Bekerom M both included patients at their center, and were both responsible for follow up at this location; Beimers L is responsible for inclusions at the other center and responsible as supervisor for the protocol and progress of the study; all authors were involved in the writing and revising of this manuscript.

**Institutional review board statement:** Approval for a prospective randomized clinical trial (D-FROST; Dutch frozen shoulder study) was obtained by the MC Slotervaart Hospital Medical Ethics Committee (NL47325.048.13).

**Clinical trial registration statement:** The trial was registered in the Dutch Trial Register (NTR4587).

**Conflict-of-interest statement:** All authors declare that they have no conflict of interest to declare.

**CONSORT 2010 statement:** The authors have read the CONSORT 2010 Statement, and the manuscript was prepared and revised according to the CONSORT 2010 Statement.

**Open-Access:** This article is an open-access article which was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

**Manuscript source:** Unsolicited manuscript

**Correspondence to:** **Lijkele Beimers, MD, PhD, Staff Physician, Orthopedic Surgeon,** Department of Orthopedic Surgery, Slotervaart Center of Orthopedic Research and Education, MC Slotervaart, Louwesweg 6, Amsterdam 1066 EC, The Netherlands. lijkele.beimers@slz.nl

**Telephone:** +31-20-5125116

**Received:** April 7, 2018

**Peer-review started:** April 7, 2018

**First decision:** June 14, 2018

**Revised:** July 1, 2018

**Accepted:** August 2, 2018

**Article in press:**

**Published online:**

**Abstract**

***AIM***

To investigate the additional value of physiotherapy after a corticosteroid injection in stage one or two idiopathic frozen shoulders (FSs).

***METHODS***

A two center, randomized controlled trial was done. Patients with a painful early stage idiopathic FS were eligible for inclusion. After written consent patients were randomly allocated into two groups. All patients received an ultrasound guided intra-articular corticosteroid injection. One group underwent additional physiotherapy treatment (PT) and the other group did not (non-PT). The primary outcome measure was the Shoulder Pain and Disability Index (SPADI). Secondary outcomes were pain (numeric pain rating scale), range of motion (ROM), quality of life (RAND-36 score), and patient satisfaction. Follow up was scheduled after 6, 12 and 26 wk.

***RESULTS***

Twenty-one patients were included, 11 patients in the non-PT and 10 in the PT group, with a mean age of 52 years. Both treatment groups showed a significant improvement at 26 wk for SPADI score (non-PT: *P* = 0.05, PT: *P* = 0.03). At 6 wk follow up, median SPADI score was significant decreased in the PT-group (14 IQR: 6-38) *vs* the non PT-group (63 IQR: 45-76) (*P* = 0.01). Pain decreased significantly in both groups but no differences were observed between both treatment groups at any time point, except for night pain at 6 wk in favor of the PT group (*P* = 0.02). Significant differences in all three ROM directions were observed after 6 wk in favor of the PT group (*P* ≤ 0.02 for all directions). A significant greater improvement in abduction (*P* = 0.03) and external rotation (*P* = 0.04) was also present in favor of the PT-group after 12 wk. RAND-36 scores showed no significant differences in health related quality of life at all follow up moments. At 26 wk, both groups did not differ significantly with respect to any of the outcome parameters. No complications were reported in both groups.

***CONCLUSION***

Additional physiotherapy after corticosteroid injection improves ROM and functional limitations in early stage FS s up to the first three months.

**Key words:** Frozen shoulder; Adhesive capsulitis; Physiotherapy; Corticosteroid

**© The Author(s) 2018.** Published by Baishideng Publishing Group Inc. All rights reserved.

**Core tip:** Corticosteroids and physiotherapy are the most widely used treatment modalities in frozen shoulders (FSs). However, the role of physiotherapy, especially in early FSs, is controversial. Corticosteroid injection with additional physiotherapy leads to better Shoulder Pain and Disability Index scores and range of motion up to three months compared to corticosteroid injection alone. Although a trend was recognized in favor of the physiotherapy group, both groups did not differ significantly with respect to any of the outcome parameters at final follow up after 26 wk.

Kraal T, Sierevelt I, van Deurzen D, van den Bekerom M, Beimers L. Corticosteroid injection alone *vs* additional physiotherapy treatment in early stage frozen shoulders. *World J Orthop* 2018; In press

**INTRODUCTION**

Frozen shoulder (FS), is a common cause of shoulder pain and disability, affecting approximately 2% to 4% of the general population[1-3]. The peak incidence of FS is between the fifth and sixth decade, slightly more frequently occurring in women than in men. The pathophysiology of FS is poorly understood[4]. The generally accepted theory comprises an inflammatory cascade causing contracture of the anterosuperior capsule, the rotator interval and the coracohumeral ligaments of the shoulder joint. These events lead to the typical loss of passive external rotation seen in FS[2]. Although there are histopathological similarities with Dupuytren’s disease, a FS follows a different natural course[5]. Historically, FS is considered to be self-limiting with three different stages; the freezing, frozen and thawing stages[6,7]. However, clear distinction between separate stages is difficult without clear cut off criteria, and a continuing spectrum is more appropriate. Functional recovery mainly takes place within one to three years[8,9]. However, the remaining pain and restriction in range of motion (ROM) of the shoulder joint can persist even at long term[10-12].

There is no widely agreed consensus about the most optimal treatment regimen for FS. Systematic reviews point to a large gap in evidence for treatment strategies for FS[13-15].Currently, there seems to be a trend towards more invasive treatments like manipulation under anesthesia and particularly arthroscopic capsular release[16]. However, there is insufficient evidence to recommend these treatment modalities[13]. Less invasive treatment options are intra-articular corticosteroid injections and physiotherapy. These are the most widely used treatment modalities in FS, in both primary and secondary healthcare settings[2,17,18]. Corticosteroid injections demonstrated a positive effect on shoulder pain and ROM, at least at the short term[19,20]. However, the role of physiotherapy in the treatment of FS is more uncertain[14,21,22]. Supervised neglect, consisting of supportive therapy and exercises within pain limits, has been advocated as an appropriate treatment for FS[23]. In a systematic review, Blanchard *et al*[24] hypothesized a potential beneficial effect of combining corticosteroid injections with physiotherapy. Conclusive evidence to support this is lacking, which warrants further trials. The objective of this randomized controlled trial was therefore to investigate the additional value of physiotherapy treatment (PT) after an intra-articular corticosteroid injection in the management of early stage idiopathic FSs. It is hypothesized that additional physiotherapy is superior to corticosteroid injection alone with respect to ROM and shoulder function.

**MATERIALS AND METHODS**

Approval for a prospective randomized clinical trial (D-FROST; Dutch frozen shoulder study) was obtained by the MC Slotervaart Hospital Medical Ethics Committee (NL47325.048.13). The trial was registered in the Dutch Trial Register (NTR4587). The study was undertaken in accordance with the declaration of Helsinki. Patients were recruited between February 2014 and December 2015 in two participating hospitals in Amsterdam. Patients were eligible for participation if they exhibited clinical signs of a FS, being pain and stiffness of the involved shoulder without preliminary trauma persisting for more than three months. The required level of pain was a minimum score of six out of ten on a numeric pain scale. Restriction of the passive ROM of the shoulder joint of more than 30° in external rotation and a second direction (*i.e.*, abduction and/or forward flexion) when compared to the unaffected contralateral side was required for inclusion. Conventional radiographs of the shoulder joint and ultrasound studies were used to rule out osteoarthritis and rotator cuff ruptures. Exclusion criteria were: corticosteroid injection in the shoulder joint region in the previous 6 wk; previous surgery to the shoulder; systemic inflammatory disease; neurological disorder with impairment of the upper limb, and the use of anti-coagulation therapy in therapeutic dosage. With these selection criteria, it is intended to select a clearly defined population of patients with early stage (stage one or two) idiopathic FSs. Patients were informed both in word and with an information leaflet. Informed consent was obtained from all included patients.

***Randomization and interventions***

Patients were randomly assigned in two groups. The intervention group undergoing a PT program (PT-group), or the control group without physiotherapy (non-PT). Patients were allocated to one of the study groups using an online website. Randomization was stratified by the participating hospital and performed in variable blocks using computer generated randomization software. Participating orthopaedic surgeons who assessed patient eligibility had no access to the randomization software, hereby securing allocation concealment. Within two weeks after inclusion, patients in both study groups received an ultrasound guided glenohumeral joint injection of 1 mL kenacort 40 mg in 4 mL lidocaine 1%, administered by an experienced radiologist. Both groups were informed about the possible self-limiting nature of FS, and got counseling about optional analgesics as acetaminophen, nonsteroidal anti-inflammatory drugs (NSAIDs) or tramadol if needed. The non-PT group did not receive PT. Advice was given to try to use the affected arm in daily life activities within their pain limits. Patients in the PT group were referred to a participating physiotherapy clinic. All participating physiotherapists treated the referred study patients according to a standardized protocol, twice a week with a maximum duration of three months. This physiotherapy protocol was composed after a thorough literature review by the participating shoulder surgeons in accordance with two experienced shoulder treating physiotherapists. The aim of the PT was to increase ROM of the shoulder, decrease pain, and restore the function of the shoulder for daily activities. Tissue irritability of the shoulder joint was taken into account to guide the intensity of the treatment[25]. Passive mobilization techniques were used, except for Maitland grade five mobilizations[26]. Attention was paid to scapulothoracic movement with the purpose to improve the scapulohumeral kinematics. Also, active and auto-assisted stretching techniques were part of the physiotherapy program. If there was an increase in pain lasting for more than four hours after the PT session, the next session had to be less intense. Hot packs, icing and massage techniques to reduce pain were allowed. Transcutaneous electrical nerve stimulation (TENS), pulsed electromagnetic field (PEMF), infrared, dry needling and medical taping were not allowed due to the lack of evidence of these treatment modalities in the treatment of FS[27].

***Outcome parameters and follow up***

Main outcome parameter of this study was the Shoulder Pain and Disability Index (SPADI) at 26 wk follow up, consisting of 13 questions divided in two domains (pain and disability). Item responses were rated on a eleven-point scale (0-10) leading to a score between 0 (best) and 100 (worst)[28]. The SPADI has been translated and validated in Dutch[29,30].Pain on average last week, and pain at night were scored on a ten point numeric pain rating scale (NPRS). Health related quality of life was assessed using the RAND-36[31,32]. Passive ROM was measured in standing position with the use of a goniometer. External rotation was measured in the horizontal plane, with the elbow at the side. Abduction was measured in the frontal plane and anteflexion in the sagittal plane. Patient satisfaction about their change in pain and function was assessed on a five point Likert-scale (“worse’’, ‘‘unchanged’’, ‘‘unsatisfactory improved’’, ‘‘satisfactory improved’’ and ‘‘good to very good improved”)[33]. Repeated corticosteroid injections were allowed after 6 wk if the level of pain had not dropped by at least 50%. Follow up was scheduled after 6, 12 and 26 wk.

***Statistical analysis***

Statistical analysis was performed by use of SPSS statistical package software (version 22.0; Armonk, NY: IBM Corp) according to the intention to treat principle. Statistical review was performed by a clinical epidemiologist. Due to small sample sizes and skewed distributions, analyses were performed non-parametrically. Patient’s demographics and baseline characteristics were described and compared between groups according to their distributions. Continuous and ordinal data are presented as medians with interquartile ranges (IQR) and differences between the treatment groups were assessed by use of Mann Whitney *U* (MWU) tests. Wilcoxon Signed Ranks tests were performed to assess change from baseline at 26 wk. *χ*2 tests were performed in case of categorical variables. A *P*-value < 0.05 was considered statistically significant.

**RESULTS**

***Patient population***

A total of 21 patients were included with 11 patients in the non-PT and 10 in the PT group (Table 1). All patients had conventional radiographs of the shoulder without abnormalities. At baseline, external rotation was limited in both patient groups with a median external rotation measuring 5 degrees for all patients (IQR: 0-20). Median NPRS on average last week was 8 (IQR: 7-8.5). In both groups two patients were disabled to work because of the FS symptoms. Two patients in both groups had received a previous corticosteroid injection more than three months prior to inclusion. After 26 wk, ROM measurements were available of 81% of the patients. Questionnaires were completed by 15 out of 21 patients (71%).An intra-articular corticosteroid injection was repeated after 12 wk in two patients in both groups. No complications or adverse events were reported in both groups.

***Clinical and functional outcome***

The median total SPADI scores for all patients at baseline was 81 (IQR: 58-87), which confirmed the severe pain and disabilities of a FS in the early stages. Both treatment groups showed a significant improvement at the primary endpoint of 26 wk for SPADI scores (non-PT: *P* = 0.05, PT: *P* = 0.03). At 6 wk follow up, median SPADI scores had decreased to 63 (IQR: 45-76) in the non-PT group and 14 (IQR: 6-38) in the PT group. This difference was significant (*P* = 0.01) and exceeded the minimal clinical important difference (range 8-13) of the SPADI[34], but this difference had disappeared after 26 wk (*P* = 0.23). At final follow up median SPADI scores were 24 (IQR: 12-19) in the non-PT and 10 (IQR: 2-28) in the PT group (Figure 1 and Table 2). Passive ROM increased significantly compared to baseline in both groups (*P* < 0.03 for all comparisons). Significant differences in all three ROM directions were observed after 6 wk in favor of the PT group (*P* ≤ 0.02 for all comparisons). At final follow up, all ROM measurements were still in favor of the PT-group, however not significant (Table 3).

Both NPRS items “night pain” and “average pain last week” showed significant decreases at 26 wk follow up for both groups (*P* < 0.03 for all comparisons). However, significant differences between both treatment groups were not observed at any time point except for night pain at 6 wk in favor of the PT group (*P* = 0.02, Table 4). Results of the RAND-36 showed no significant differences between both groups regarding health related quality of life at all follow up moments. A slightly higher satisfaction score was reported by the PT group compared to the non-PT group at 6 wk follow up (*P* = 0.02). At all other follow up moments, the degree of satisfaction was comparable between the two treatment groups (Table 4).

**DISCUSSION**

The aim of this trial was to investigate whether physiotherapy is of additional value after an intra-articular corticosteroid injection into the shoulder joint in the treatment of patients with a FS in stage one or two. At final follow up after 26 wk, no clinical or functional differences were observed between both groups, with or without additional PT. However, total SPADI scores, ROM measurements and NPRS for pain at night were significantly superior in the physiotherapy group at 6 wk. The most considerable differences between the groups were observed for the ROM, in favor of the PT group until 12 wk of follow up. This could imply that PT after an intra-articular corticosteroid injection is of additional clinical value in the treatment of FS. The result of physiotherapy is an improved shoulder function, with less limitation in the rehabilitation process of patients with FS up to the first three months after a corticosteroid injection in the shoulder joint.

An initial good improvement is frequently reported in studies using corticosteroid injection for FS[22,35]. The beneficial value of additional physiotherapy was also reported by Carette *et al*[21]. In his clinical trial, corticosteroid injection followed by physiotherapy provided a faster recovery of shoulder function compared to injection alone, or placebo injection combined with physiotherapy. Ryans *et al*[22] conducted a RCT comparing four treatment strategies for FS. The authors concluded that corticosteroids were effective for pain relief and shoulder disability at short term, and physiotherapy was effective in restoring external rotation. In both studies the differences were most distinct at early follow up, at 6 and 12 wk, but not significant after more than three months. This is quite similar to our findings. A reason for this might be the self-limiting natural course of the disease. Still, the beneficial effect of physiotherapy at short term can be of clinical relevant value in case the duration of symptoms and disabilities is shortened with this strategy.

On the contrary, other studies do not support the use of physiotherapy in the treatment of FS[23,24]. In a systematic review, Blanchard *et al*[24] found inferior results of PT compared to corticosteroid injection. Some even consider physiotherapy inappropriate during early (painful) stage of FS[2,36]. A possible explanation for inferior results from physiotherapy in the treatment of FS is inadequacy to take in to account the tissue irritability level. Irritability is a term to reflect the tissue’s ability to handle physical stress, presumably related to the extent of inflammatory activity. Tissue irritability can be categorized in three levels, based on patient reported pain, pain at end ROM, and the difference between active and passive ROM[25]. PT intensity can vary in length of treatment, frequency of sessions, intensity of mobilization techniques and types of exercises. Intensive physiotherapy at an early stage of FS without taking in to account the tissue irritability level can potentially worsen the symptoms of FS. For example, Diercks *et al*[23] reported a negative effect of PT including passive stretching and manual mobilization, compared to supportive therapy within pain limits. However, no corticosteroid injections were used in the trial of Diercks *et al*[23]. Intra-articular corticosteroids have an anti-inflammatory effect, which is likely to attenuate tissue irritability[37]. Our concept is that to optimize treatment of early stage FS, PT intensity should be guided by tissue irritability level. Moreover, PT is preferably started after an intra-articular corticosteroid injection.

In this prospective RCT, the study population was clearly defined according to strict criteria to include patients with an idiopathic FS in stage one or two with symptoms lasting at least three months. The corticosteroid injections were administered under ultrasound guidance by experienced radiologists. Rehabilitation was performed according to a uniform physiotherapy protocol and carried out by specialized shoulder physiotherapists. The ROM measurements were assessed by the treating orthopedic surgeon. Although not blinded for the allocated intervention, these measurements were done consistently and by an experienced surgeon.

The major limitation of this study is the relatively small number of included patients. The results of this trial should therefore be interpreted with caution. A sample size of 41 subjects per group with a power of 90%, alpha 0.05 and a 10% drop out rate was calculated at the beginning of the study. This was based on the primary outcome parameter SPADI with a minimal clinical important difference of 13 and a standard deviation of 17. Unfortunately, it turned out impossible to include this number of patients within a reasonable period of time. This was being attributed by two factors. The costs for physiotherapy were supported by Slotervaart Center of Orthopedic Research and Education (SCORE), however, this was only available for a limited number of patients. Three separate research grant applications for funding of the trial were declined. Secondly, there was an unexpected amount of unwillingness to participate among eligible patients. We tried to increase the number of inclusions by attracting attention for the trial in several ways. Printed posters were exposed in the waiting rooms of the Orthopaedic Department, an article about the trial was published in the local hospital journal and an information letter was sent to more than 200 general practitioners in the catchment area. However, even with these small numbers a positive effect of physiotherapy was observed up to three months follow up. It is possible that more significant differences between both treatment groups could have been found with a larger number of included patients.

A control group without corticosteroid injection was not made available in the study design to monitor the true natural course of the condition, because of our assumption that this could raise more difficulties persuading patients to participate in the trial. Study patient compliance to physiotherapy sessions was not recorded. However, a high compliance rate was expected as the provided PT was free of charge. We are not aware of any patient crossing over, *i.e.*, starting physiotherapy at their own initiative if assigned to the non-PT group. A possible explanation for inferior SPADI scores and ROM measurements at 6 wk in the non-PT group could be the confounding role of diabetes in two patients in this group. A prolonged refractory course of a FS can be expected with diabetes[38,39]. However, the results from additional analysis with exclusion of these two patients with diabetes did not change the conclusions.

That being said, it is important to note that there is no clear understanding of the exact mechanism responsible for the natural course of FSs, with its improvement over time for most patients. We do agree that an important aspect of treatment is advice and education of patients, with attention for the patients perspective regarding their expectations and their experiences of a FS.

With the results of this trial and the current literature, we suggest to offer patients additional PT after an intra-articular corticosteroid injection in the treatment of an early stage FS. The SPADI scores, ROM and pain at night scores are significantly better in the PT group *vs* the non-PT group at 6 wk. With time, the positive effect of PT had faded out. At final follow up at 26 wk there were no significant differences between patients in both groups. Additional PT can improve shoulder function and shorten the duration of functional limitations during the recovery of early stage FS patients up to the first three months.

**ARTICLE HIGHLIGHTS**

***Research background***

Frozen shoulder (FS) is a common cause of shoulder pain and disability. A contracted capsule with a decreased capsular volume leads to a typical loss of passive external rotation seen in FS. Physiotherapy and corticosteroid injections are the most widely used treatment modalities in FS, in both primary and secondary healthcare settings.

***Research motivation***

Corticosteroid injections demonstrated a positive effect on shoulder pain and range of motion (ROM), at least at the short term. However, the role of physiotherapy in the treatment of FS is more uncertain. For example, supervised neglect, consisting of supportive therapy and exercises within pain limits, has also been advocated as an appropriate treatment for FS.

***Research objectives***

The objective of this randomized controlled trial was therefore to investigate the additional value of physiotherapy treatment (PT) after an intra-articular corticosteroid injection in the management of early stage idiopathic FSs. It is hypothesized that additional physiotherapy is superior to corticosteroid injection alone with respect to ROM and shoulder function.

***Research methods***

A two center prospective randomized controlled trial was undertaken. Patients with a painful early stage idiopathic FS were eligible for inclusion. After written consent patients were randomly allocated into two groups. All patients received an ultrasound guided intra-articular corticosteroid injection. One group underwent additional PT and the other group did not (non-PT). The primary outcome measure was the SPADI. Secondary outcomes were pain (NPRS), ROM, quality of life (RAND-36 score), and patient satisfaction. Follow up was scheduled after 6, 12 and 26 wk.

***Research results***

Twenty-one patients were included, 11 patients in the non-PT and 10 in the PT group. Both treatment groups showed a significant improvement at 26 wk for SPADI score. At 6 wk follow up, median SPADI score was significant decreased in the PT-group (14 IQR: 6-38) *vs* the non PT-group (63 IQR: 45-76) (*P* = 0.01). Significant differences in all three ROM directions were observed after 6 wk in favor of the PT group (*P* ≤ 0.02 for all directions). At 26 wk, both groups did not differ significantly with respect to any of the outcome parameters. No complications were reported in both groups.

***Research conclusions***

Intra-articular corticosteroid infiltration is effective in the treatment of FS. Additional PT can improve shoulder function and shorten the duration of functional limitations during the recovery of early stage FS patients up to the first three months. The physiotherapy intensity should be guided on tissue irritability. Future research should focus on the different populations other than idiopathic FSs like post-operative or post-traumatic FSs. Furthermore, a small subset of patients is not satisfactory treated with conservative treatment as an injection and physiotherapy. It would be very interesting to investigate if these patients with a prolonged and refractory course of the disease could be identified at an early time point.

***Research perspectives***

It would be very interesting to investigate if these patients with a prolonged and refractory course of the disease could be identified at an early time point.

**REFERENCES**

1 **Tasto JP**, Elias DW. Adhesive capsulitis. *Sports Med Arthrosc Rev* 2007; **15**: 216-221 [PMID: 18004221 DOI: 10.1097/JSA.0b013e3181595c22]

2 **Robinson CM**, Seah KT, Chee YH, Hindle P, Murray IR. Frozen shoulder. *J Bone Joint Surg Br* 2012; **94**: 1-9 [PMID: 22219239 DOI: 10.1302/0301-620X.94B1.27093]

3 **van der Windt DA**, Koes BW, de Jong BA, Bouter LM. Shoulder disorders in general practice: incidence, patient characteristics, and management. *Ann Rheum Dis* 1995; **54**: 959-964 [PMID: 8546527 DOI: 10.1136/ard.54.12.959]

4 **Pietrzak M**. Adhesive capsulitis: An age related symptom of metabolic syndrome and chronic low-grade inflammation? *Med Hypotheses* 2016; **88**: 12-17 [PMID: 26880627 DOI: 10.1016/j.mehy.2016.01.002]

5 **Bunker TD**, Anthony PP. The pathology of frozen shoulder. A Dupuytren-like disease. *J Bone Joint Surg Br* 1995; **77**: 677-683 [PMID: 7559688 DOI: 10.1302/0301-620X.77B5.7559688]

6 **Reeves B**. The natural history of the frozen shoulder syndrome. *Scand J Rheumatol* 1975; **4**: 193-196 [PMID: 1198072 DOI: 10.3109/03009747509165255]

7 **Jayson MI**. Frozen shoulder: adhesive capsulitis. *Br Med J* (Clin Res Ed) 1981; **283**: 1005-1006 [PMID: 6794738 DOI: 10.1136/bmj.283.6298.1005]

8 **Griggs SM**, Ahn A, Green A. Idiopathic adhesive capsulitis. A prospective functional outcome study of nonoperative treatment. *J Bone Joint Surg Am* 2000; **82-A**: 1398-1407 [PMID: 11057467 DOI: 10.2106/00004623-200010000-00005]

9 **Guyver PM**, Bruce DJ, Rees JL. Frozen shoulder - A stiff problem that requires a flexible approach. *Maturitas* 2014; **78**: 11-16 [PMID: 24636964 DOI: 10.1016/j.maturitas.2014.02.009]

10 **Binder AI**, Bulgen DY, Hazleman BL, Roberts S. Frozen shoulder: a long-term prospective study. *Ann Rheum Dis* 1984; **43**: 361-364 [PMID: 6742896 DOI: 10.1136/ard.43.3.361]

11 **Shaffer B**, Tibone JE, Kerlan RK. Frozen shoulder. A long-term follow-up. *J Bone Joint Surg Am* 1992; **74**: 738-746 [PMID: 1624489 DOI: 10.2106/00004623-199274050-00013]

12 **Hand C**, Clipsham K, Rees JL, Carr AJ. Long-term outcome of frozen shoulder. *J Shoulder Elbow Surg* 2008; **17**: 231-236 [PMID: 17993282 DOI: 10.1016/j.jse.2007.05.009]

13 **Rangan A**, Hanchard N, McDaid C. What is the most effective treatment for frozen shoulder? *BMJ* 2016; **354**: i4162 [PMID: 27554676 DOI: 10.1136/bmj.i4162]

14 **Maund E**, Craig D, Suekarran S, Neilson A, Wright K, Brealey S, Dennis L, Goodchild L, Hanchard N, Rangan A, Richardson G, Robertson J, McDaid C. Management of frozen shoulder: a systematic review and cost-effectiveness analysis. *Health Technol Assess* 2012; **16**: 1-264 [PMID: 22405512 DOI: 10.3310/hta16110]

15 **Lewis J**. Frozen shoulder contracture syndrome - Aetiology, diagnosis and management. *Man Ther* 2015; **20**: 2-9 [PMID: 25107826 DOI: 10.1016/j.math.2014.07.006]

16 **Mun SW**, Baek CH. Clinical efficacy of hydrodistention with joint manipulation under interscalene block compared with intra-articular corticosteroid injection for frozen shoulder: a prospective randomized controlled study. *J Shoulder Elbow Surg* 2016; **25**: 1937-1943 [PMID: 27771263 DOI: 10.1016/j.jse.2016.09.021]

17 **van der Windt DA**, Koes BW, Devillé W, Boeke AJ, de Jong BA, Bouter LM. Effectiveness of corticosteroid injections versus physiotherapy for treatment of painful stiff shoulder in primary care: randomised trial. *BMJ* 1998; **317**: 1292-1296 [PMID: 9804720 DOI: 10.1136/bmj.317.7168.1292]

18 **Winters JC**, Sobel JS, Groenier KH, Arendzen HJ, Meyboom-de Jong B. Comparison of physiotherapy, manipulation, and corticosteroid injection for treating shoulder complaints in general practice: randomised, single blind study. *BMJ* 1997; **314**: 1320-1325 [PMID: 9158469 DOI: 10.1136/bmj.314.7090.1320]

19 **Shah N**, Lewis M. Shoulder adhesive capsulitis: systematic review of randomised trials using multiple corticosteroid injections. *Br J Gen Pract* 2007; **57**: 662-667 [PMID: 17688763]

20 **Song A**, Higgins LD, Newman J, Jain NB. Glenohumeral corticosteroid injections in adhesive capsulitis: a systematic search and review. *PM R* 2014; **6**: 1143-1156 [PMID: 24998406 DOI: 10.1016/j.pmrj.2014.06.015]

21 **Carette S**, Moffet H, Tardif J, Bessette L, Morin F, Frémont P, Bykerk V, Thorne C, Bell M, Bensen W, Blanchette C. Intraarticular corticosteroids, supervised physiotherapy, or a combination of the two in the treatment of adhesive capsulitis of the shoulder: a placebo-controlled trial. *Arthritis Rheum* 2003; **48**: 829-838 [PMID: 12632439 DOI: 10.1002/art.10954]

22 **Ryans I**, Montgomery A, Galway R, Kernohan WG, McKane R. A randomized controlled trial of intra-articular triamcinolone and/or physiotherapy in shoulder capsulitis. *Rheumatology* (Oxford) 2005; **44**: 529-535 [PMID: 15657070 DOI: 10.1093/rheumatology/keh535]

23 **Diercks RL**, Stevens M. Gentle thawing of the frozen shoulder: a prospective study of supervised neglect versus intensive physical therapy in seventy-seven patients with frozen shoulder syndrome followed up for two years. *J Shoulder Elbow Surg* 2004; **13**: 499-502 [PMID: 15383804 DOI: 10.1016/j.jse.2004.03.002]

24 **Blanchard V**, Barr S, Cerisola FL. The effectiveness of corticosteroid injections compared with physiotherapeutic interventions for adhesive capsulitis: a systematic review. *Physiotherapy* 2010; **96**: 95-107 [PMID: 20420956 DOI: 10.1016/j.physio.2009.09.003]

25 **Kelley MJ**, Shaffer MA, Kuhn JE, Michener LA, Seitz AL, Uhl TL, Godges JJ, McClure PW. Shoulder pain and mobility deficits: adhesive capsulitis. *J Orthop Sports Phys Ther* 2013; **43**: A1-31 [PMID: 23636125 DOI: 10.2519/jospt.2013.0302]

26 **Vermeulen HM**, Rozing PM, Obermann WR, le Cessie S, Vliet Vlieland TP. Comparison of high-grade and low-grade mobilization techniques in the management of adhesive capsulitis of the shoulder: randomized controlled trial. *Phys Ther* 2006; **86**: 355-368 [PMID: 16506872]

27 **Green S**, Buchbinder R, Hetrick S. Physiotherapy interventions for shoulder pain. *Cochrane Database Syst Rev* 2003; : CD004258 [PMID: 12804509 DOI: 10.1002/14651858.CD004258]

28 **Roach KE**, Budiman-Mak E, Songsiridej N, Lertratanakul Y. Development of a shoulder pain and disability index. *Arthritis Care Res* 1991; **4**: 143-149 [PMID: 11188601 DOI: 10.1002/art.1790040403]

29 **Elvers JWH**, Oostendorp RAB, Siervelt IN, van der Heijden KWAP. De Nederlandstalige Shoulder pain and Disability Index (SPADI-Dutch Version) bij patiënten na een subacromiale decompressie volgens Neer. *Ned Tijdschr voor Fysiother* 2003; **113**: 126-131

30 **Thoomes-de Graaf M**, Scholten-Peeters GG, Duijn E, Karel Y, Koes BW, Verhagen AP. The Dutch Shoulder Pain and Disability Index (SPADI): a reliability and validation study. *Qual Life Res* 2015; **24**: 1515-1519 [PMID: 25471288 DOI: 10.1007/s11136-014-0879-1]

31 **VanderZee KI**, Sanderman R, Heyink JW, de Haes H. Psychometric qualities of the RAND 36-Item Health Survey 1.0: a multidimensional measure of general health status. *Int J Behav Med* 1996; **3**: 104-122 [PMID: 16250758 DOI: 10.1207/s15327558ijbm0302\_2]

32 **Ware JE Jr**, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Med Care* 1992; **30**: 473-483 [PMID: 1593914 DOI: 10.1097/00005650-199206000-00002]

33 **ten Klooster PM**, Drossaers-Bakker KW, Taal E, van de Laar MA. Patient-perceived satisfactory improvement (PPSI): interpreting meaningful change in pain from the patient's perspective. *Pain* 2006; **121**: 151-157 [PMID: 16472915 DOI: 10.1016/j.pain.2005.12.021]

34 **Roy JS**, MacDermid JC, Woodhouse LJ. Measuring shoulder function: a systematic review of four questionnaires. *Arthritis Rheum* 2009; **61**: 623-632 [PMID: 19405008 DOI: 10.1002/art.24396]

35 **Griesser MJ**, Harris JD, Campbell JE, Jones GL. Adhesive capsulitis of the shoulder: a systematic review of the effectiveness of intra-articular corticosteroid injections. *J Bone Joint Surg Am* 2011; **93**: 1727-1733 [PMID: 21938377 DOI: 10.2106/JBJS.J.01275]

36 **Harris G**, Bou-Haidar P, Harris C. Adhesive capsulitis: review of imaging and treatment. *J Med Imaging Radiat Oncol* 2013; **57**: 633-643 [PMID: 24283550 DOI: 10.1111/1754-9485.12111]

37 **Roh YH**, Yi SR, Noh JH, Lee SY, Oh JH, Gong HS, Baek GH. Intra-articular corticosteroid injection in diabetic patients with adhesive capsulitis: a randomized controlled trial. *Knee Surg Sports Traumatol Arthrosc* 2012; **20**: 1947-1952 [PMID: 22113218 DOI: 10.1007/s00167-011-1776-6]

38 **White D**, Choi H, Peloquin C, Zhu Y, Zhang Y. Secular trend of adhesive capsulitis. *Arthritis Care Res (Hoboken)* 2011; **63**: 1571-1575 [PMID: 22034118 DOI: 10.1002/acr.20590]

39 **Wang K**, Ho V, Hunter-Smith DJ, Beh PS, Smith KM, Weber AB. Risk factors in idiopathic adhesive capsulitis: a case control study. *J Shoulder Elbow Surg* 2013; **22**: e24-e29 [PMID: 23352186 DOI: 10.1016/j.jse.2012.10.049]

**P-Reviewer:** Hernandez-Sanchez S, Mittal R, Peng B, Scibek J **S-Editor:** Ji FF **L-Editor: E-Editor:**

**Specialty type:** Gastroenterology and hepatology

**Country of origin:** TheNetherlands

**Peer-review report classification**

Grade A (Excellent): 0

Grade B (Very good): B, B

Grade C (Good): C

Grade D (Fair): 0

Grade E (Poor): 0

****

**Figure 1 Median total SPADI score compared between both groups (non-physiotherapy treatment and physiotherapy treatment).** Error bars represent inter quartile range. The asterisk marks statistical significance between both groups. SPADI: Shoulder Pain and Disability Index; PT: Physiotherapy treatment.

**Table 1 Demographics and patient characteristics**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Characteristic** | **Total** |  **Non-PT**  | **PT** | ***P*-value** |
| **No. of patients** | 21 | 11  | 10  |   |
| **Age** (yr) | 51.9 (SD 5.1) | 50.4 (SD 6.1) | 53.3 (SD 3.8) | 0.17 |
| **Gender *n* (%)** |   |   |   |   |
| Male | 9 (43) | 4 (36) | 5 (50) |   |
| Female | 12 (57) | 7 (64) | 5 (50) | 0.67 |
| **Stage of frozen shoulder *n* (%)** |   |   |   |   |
| Freezing (stage I) | 8 (38) | 6 (55) | 2 (20) |   |
| Frozen (stage II) | 13 (62) | 5 (45) | 8 (80) | 0.18 |
| **Duration of symptoms prior to intervention *n* (%)** |   |   |   |   |
| < 6 mo | 13 (62) | 9 (82) | 4 (40) |   |
| > 6 mo | 8 (38) | 2 (18) | 6 (60) | 0.08 |
| **Previous injection around the shoulder *n* (%)** | 11 (52) | 5 (45) | 6 (60) | 0.67 |
| **Previous** PT ***n* (%)** | 15 (71) | 7 (64) | 8 (80) | 0.64 |
| **Disabled to work related to shoulder *n* (%)** | 4 (19) | 2 (18) | 2 (20) | 1.00 |
| **Diabetes mellitus *n* (%)** | 2 (10) | 2 (18) | 0 (0) |   |

PT: Physiotherapy treatment.

**Table 2 Shoulder Pain and Disability Index scores for pain, disability and total Shoulder Pain and Disability Index scores (medians with inter quartile range)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Non-PT | PT | *P*-value |
| SPADI pain  |  |  |  |  |
| Baseline (wk) |  | 82 (70-90) | 86 (46-92) | 0.68 |
| 6  |  | 71 (24-79) | 18 (9-43) | 0.09 |
| 12  |  | 48 (22-68) | 20 (9-57) | 0.17 |
| 26  |  | 14 (8-30) | 13 (4-32) | 0.94 |
| SPADI limitations  |  |  |  |  |
| Baseline (wk) |  | 81 (58-88) | 74 (28-84) | 0.42 |
| 6  |  | 69 (47-76) | 11 (4-36) | 0.01 |
| 12  |  | 38 (25-72) | 14 (5-58) | 0.15 |
| 26  |  | 10 (9-50) | 8 (1-25) | 0.35 |
| SPADI total  |  |  |  |  |
| Baseline (wk) |  | 80 (65-87) | 82 (35-86) | 0.54 |
| 6  |  | 63 (45-76) | 14 (6-38) | 0.01 |
| 12  |  | 42 (25-72) | 16 (7-58) | 0.17 |
| 26  |  | 14 (11-39) | 10 (2-28) | 0.44 |

SPADI: Shoulder Pain and Disability Index; PT: Physiotherapy treatment.

**Table 3 Range of motion measurements, medians (with inter quartile range)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Non-PT | PT | *P-*value |
| Abduction  |  |  |  |  |
| Baseline (wk) |  | 50 (40-60) | 50 (41-102) | 0.39 |
| 6  |  | 70 (43-90) | 100 (80-140) | 0.01 |
| 12  |  | 80 (65-98) | 100 (90-165) | 0.03 |
| 26 |  | 85 (80-149) | 130 (85-170) | 0.33 |
| Anteflexion  |  |  |  |  |
| Baseline (wk) |  | 70 (70-80) | 95 (48-120) | 0.25 |
| 6  |  | 90 (75-111) | 140 (105-165) | 0.02 |
| 12  |  | 90 (80-146) | 130 (115-155) | 0.06 |
| 26  |  | 100 (90-160) | 155 (110-170) | 0.17 |
| External rotation  |  |  |  |  |
| Baseline (wk) |  | 0 (0-5) | 8 (0-24) | 0.14 |
| 6  |  | 13 (5-26) | 40 (30-43) | 0.01 |
| 12  |  | 18 (8-29) | 40 (25-65) | 0.04 |
| 26  |  | 30 (13-44) | 50 (35-60) | 0.07 |

PT: Physiotherapy treatment.

**Table 4 Pain (numeric pain rating scale) scores, RAND-36 physical component scale and mental component scale**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Non-PT | PT | *P*-value |
| NPRS average last week |  |  |  |
| Baseline (wk) | 8 (7-9) | 8 (5-8) | 0.37 |
| 6  | 4 (2-8) | 2 (1-4) | 0.19 |
| 12 | 4 (2-7) | 1 (0.5-5) | 0.17 |
| 26  | 3 (1-4) | 2 (0-3) | 0.41 |
| NPRS night |  |  |  |
| Baseline (wk) | 8 (8-9) | 9 (7-9) | 0.94 |
| 6  | 4 (3-7) | 2 (0-3) | 0.02 |
| 12  | 5 (2-7) | 1 (0-6) | 0.11 |
| 26  | 2 (1-3) | 2 (0-3) | 0.48 |
| RAND-36 PCS |  |  |  |
| Baseline (wk) | 33 (31-40) | 39 (34-46) | 0.11 |
| 6  | 43 (35-46) | 47 (44-52) | 0.10 |
| 12  | 45 (43-50) | 47 (43-55) | 0.63 |
| 26  | 43 (35-56) | 40 (46-56) | 0.56 |
| RAND-36 MCS |  |  |  |
| Baseline (wk) | 47 (36-54) | 44 (35-54) | 0.94 |
| 6  | 49 (35-52) | 50 (42-56) | 0.33 |
| 12  | 43 (29-51) | 52 (40-55) | 0.20 |
| 26  | 52 (50-57) | 52 (35-57) | 0.56 |
| Satisfaction (wk) |  |  |  |
| 6 | 3 (2-3) | 4 (3-4) | 0.02 |
| 12  | 2 (0-4) | 3 (2-4) | 0.22 |
| 26  | 3 (3-4) | 3.5 (3-4) | 1.00 |

Satisfaction scores (worse’’, ‘‘unchanged’’, ‘‘unsatisfactory improved’’, ‘‘satisfactory improved’’ and ‘‘good to very good improved). Results reported as medians (with inter quartile range). NPRS: Numeric pain rating scale; PT: Physiotherapy treatment.