Effectiveness of Sustained Stretching of the Inferior Capsule in the Management of a Frozen Shoulder

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Abstract

Background Physiotherapy treatment of frozen shoulder is varied, but most lack specific focus on the underlying disorder, which is the adhered shoulder capsule. Although positive effects were found after physiotherapy, the recurrence and prolonged disability of a frozen shoulder are major factors to focus on to provide the appropriate treatment.

Questions/purposes We wished to study the effectiveness of a shoulder countertraction apparatus on ROM, pain, and function in patients with a frozen shoulder and compare their results with those of control subjects who received conventional physiotherapy.

Each author certifies that he or she, or a member of his or her immediate family, has no funding or commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

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Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

This work was performed in the Physiotherapy Outpatient Department of St John's Medical College & Hospital, Bangalore, KA, India.

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Methods A total of 100 participants were randomly assigned to an experimental group and a control group, with each group having 50 participants. The control group received physiotherapy and the experimental group received countertraction and physiotherapy. The total treatment time was 20 minutes a day for 5 days per week for 2 weeks. The outcome measures used were goniometer measurements, VAS, and the Oxford Shoulder Score.

Results Improvements were seen in the scores for shoulder flexion ($94.1^\circ \pm 19.79^\circ$ at baseline increased to $161.9^\circ \pm 13.05^\circ$ after intervention), abduction ROM ($90.4^\circ \pm 21.18^\circ$ at baseline increased to $154.8^\circ \pm 13.21^\circ$ after intervention), and pain (8.00 ± 0.78 at baseline decreased to 3.48 ± 0.71 after intervention) in the experimental group. Sixty percent of the participants ($n = 30$) were improved to the fourth stage of satisfactory joint function according to the Oxford Shoulder Score in the experimental group compared with 18% ($n = 9$) in the control group ($p < 0.001$).

Conclusions Incorporating shoulder countertraction along with physiotherapy improves shoulder function compared with physiotherapy alone for the treatment of a frozen shoulder. Additional studies are needed focusing on this concept to increase the generalizability of the countertraction apparatus in various groups.

Level of Evidence Level II, prospective comparative study. See the Instructions for Authors for a complete description of levels of evidence.

Introduction

Frozen shoulder, or adhesive capsulitis, is a condition of uncertain etiology characterized by substantial restriction of active and passive shoulder movement and occurring in the

absence of a known shoulder intrinsic disorder [26]. Frozen shoulder affects approximately 2% to 5% of the general population and 10% to 15% of the population with diabetes. It often is considered a self-limiting condition [13, 28], but there are studies showing a considerable number of untreated patients with long-term disability and pain [4, 6, 18, 38]. It affects people in their fourth to sixth decade of life, and more often women and especially patients with diabetes are more prone to get adhesive capsulitis [9]. The predominant features of this condition are pain and restricted motion or stiffness in the shoulder. Studies have been done on the relationship between shoulder ROM and function [32, 33, 37]. The results showed that people with loss of shoulder ROM have difficulty in completing their activities of daily living [32, 33, 37]. Overall, the condition affects work, leisure, and general quality of life [14]. Despite the relatively low percentages of the general population affected by idiopathic loss of shoulder ROM, the long-term limitations experienced by these patients suggest that greater understanding of the condition and more effective intervention approaches are needed [31]. One of the major current treatment options available for frozen shoulder is physiotherapy [17] through the use of modalities such as application of moist heat or cold, ROM and strengthening exercises, stretches and manual therapy, along with providing patient education and a home exercise program [9, 18, 21, 30, 37]. Results of studies regarding the relationship between shoulder ROM and functional status of the patients support an impairment-based rehabilitation approach because the impairment measures were substantially associated with functional activity status [1, 5, 10].

Joint mobilization techniques such as traction and glide are used to stretch the adhered capsule and improve the physiologic accessory movements. Traction involves distraction of one articular surface perpendicular to the other and gliding involves translational movement of one articular surface parallel to the other [11, 29]. These techniques are considered capable of stretching the particular connective tissues that may limit joint motion without impingement, resulting in an improvement of the limited ROM and reduction in pain.

The effectiveness of these treatment approaches were reported in a Cochrane review [12], which included approximately 32 studies, of which 28 were randomized controlled trials. The conclusion of the review was that although exercises and mobilization are effective for frozen shoulder, there is no evidence that physiotherapy alone is beneficial. Each of the studies had variability in methods. In addition, the quality of the study was poor, making the task of finding the effective treatment strategy more difficult [12].

Although there are several treatment options for a frozen shoulder involving medical and physiotherapy management, the effectiveness of such treatments is lacking. With

a view of the above-mentioned gaps in the focus of management for frozen shoulder and positive evidence of capsular stretching and mobilization on the frozen shoulder, a novel approach is needed for treatment of frozen shoulder. In the current study, we focused on a noninvasive mobilization strategy incorporating the traction component of the shoulder by an external countertraction device to create an inferior capsular stretch.

Our aim was to compare the effectiveness of inferior capsular stretching by a shoulder countertraction apparatus with conventional physiotherapy, assessing patients with a frozen shoulder based on ROM, pain, and shoulder function.

Patients and Methods

A prospective randomized trial was performed in the Physiotherapy Outpatient Department of St. John's Medical College and Hospital. Ethical committee approval was obtained before the beginning of the study. The sample size was determined by statistical power calculations. To detect a clinically meaningful difference in shoulder ROM of 25°, assuming a SD of 35°, 50 patients were required in each group to achieve 80% power at $\alpha = 0.05$. Therefore, a total of 100 participants who met all inclusion criteria were included in the study from February 2013 to June 2013. The inclusion criteria were: (1) restriction of shoulder movements; (2) shoulder pain at night that often disturbed sleep; (3) guarded shoulder movements; (4) difficulty in reaching behind the back; (5) reduced arm swing with walking; (6) rounded shoulders and stooped posture; and (7) ability to complete questionnaires. Exclusion criteria were: (1) recent joint infection or surgery (less than 6 months); (2) history of shoulder subluxation, dislocation, or ligamentous injury; (3) shoulder arthroplasty; (4) shoulder impingement syndrome; (5) trigger points in the upper trapezius; and (6) recent trauma. Clinical and radiologic examinations were done on the affected shoulder by experienced orthopaedic surgeons (MJS, GS, KZ) to confirm the diagnosis and for referral of participants for the trial.

Informed consent was obtained from the participants who were randomly assigned to the experimental group or the control group, with each group having 50 participants (Fig. 1) based on a sealed-envelope system obtained from computer-generated permuted randomization with a block size of two. After collecting the baseline data, the appropriate group assignment of the participants was done by a junior physiotherapist (LL). The control group received regular physiotherapy with moist heat before mobilization [30], then mobilization of eight to 12 repetitions in four sets to improve flexion and abduction ranges, and an electrotherapy modality (ultrasound or shortwave diathermy) for

Fig. 1 The flow chart shows the progress of participants included in our study.

pain reduction [15, 18, 22] with total treatment time of approximately 20 minutes per day for 5 days per week for 2 weeks. Patients also received a home program involving gentle shoulder ROM and function exercises (10 repetitions three times per day).

The experimental group received the same treatment with the addition of weighted shoulder countertraction during shoulder mobilization. The shoulder countertraction apparatus constitutes two overhead pulleys on a wall-fixed L-shaped steel frame (2.5 feet in length) with free weights of approximately 2 to 3 kg fixed at one end of the rope (3 m in length) passing through the pulleys while the other free end of the rope is connected to the distal end of the subject's affected upper limb which is covered with a cuff and medium-sized bandage (similar to the application of a crepe bandage for skin traction) just above the elbow. The ends of the rope are connected with an S hook. The patient is positioned comfortably to sit upright in a chair with a back rest, directly below the pulleys (Fig. 2). Weight is added based on the body weight cutoff of 60 kg. If the patient weighs more than the cutoff value (≥ 60 kg), 3 kg was set as the distracted load, whereas if the patient weighs less than the cutoff value (< 60 kg), 2 kg was set as the distracted load. Initially moist

heat is applied and then the apparatus is fixed to the patient's affected hand for approximately 10 minutes, which provides the inferior capsular stretch on the applied shoulder. After the above steps, along with the distraction provided by the countertraction, mobilization of the glenohumeral joint is given manually using posteroanterior glides, followed by gentle rotatory passive ROM of the glenohumeral joint in internal and external rotation. Mobilization glides were done in grades of 1 to 4 [23, 24] depending on the restriction level based on the Maitland classification system. To improve the flexion range, the patient is seated facing opposite the hanging weights (Fig. 2), while to improve the abduction range, the patient is seated parallel to the hanging weights in such a way that the affected shoulder is away from the weights. The patient is permitted to have a rest period for approximately 3 minutes between the flexion and abduction mobilizations. The whole treatment session is approximately 20 minutes per day for 5 days a week for 2 weeks (Table 1). The therapist's position for the mobilizations was standing on the affected side of the patient, with the thenar eminence of the mobilizing hand closer to the joint line, at the greater tuberosity of the humerus to provide the glides. The non-mobilizing hand was holding the distal part of the humerus to

Fig. 2 Shoulder countertraction being applied to a patient is shown in this photograph.

provide appropriate distraction at the glenohumeral joint and to aid in performing rotatory passive ROM.

Treatment for both groups was performed by senior physiotherapists (AP, SP). The outcomes were recorded by an independent outcome assessment trained physiotherapist (DJ), who was not involved in the intervention procedures and also was unaware of participants' allocated groups. The outcome measures used were universal goniometry to measure shoulder flexion and abduction ROM [2] based on standard reference points of ROM measurement, VAS scores for pain [3], and the Oxford Shoulder Score to measure shoulder function [7, 8, 13, 37]. The Oxford Shoulder Score is a 12-item self-reported questionnaire which provides reliable, valid, and responsive data regarding the patient's perception of shoulder problems. Based on the outcome of the Oxford Shoulder Score (range, 0–49), patients can be categorized in four stages: Stage 1 (range, 0–19), indicative of severe shoulder arthritis; Stage 2 (range, 20–29), indicative of moderate to severe shoulder arthritis; Stage 3 (range, 30–39), indicative of mild to moderate shoulder arthritis; and Stage 4 (range, 40–49), indicative of satisfactory joint function. The outcomes were measured and calculated after the intervention period of 2 weeks and no participants dropped out of the study.

Descriptive statistics were reported using mean and 95% CI for continuous variables and number and percentages for

categorical variables. Independent t-test was used to compare the variables between the study groups at baseline. The chi-square test was used to find the associations between the Oxford Shoulder Function Score and study groups. Analysis of covariance was used to assess the effectiveness of intervention at the endpoint between the study groups adjusting for baseline and age as covariates. A p value less than 5% was considered statistically significant. The data were analyzed using SPSS Version 17 (SPSS Inc, Chicago, IL, USA).

Results

The mean age of the participants in the experimental group was younger when compared with the participants in the control group. Gender was distributed equally among both groups with 32 male (64%) and 18 female (36%) participants in the experimental group and 33 male (66%) and 17 female (34%) participants in the control group. Both groups achieved similar improvements in shoulder flexion ROM ($p = 0.36$) and abduction ROM ($p = 0.55$) (Table 2). Similarly, both groups had considerable pain reduction ($p < 0.0001$). However, the major improvement was seen in the Oxford Shoulder Score with 60% ($n = 30$) of patients in the experimental group showing improvement to the fourth stage of Oxford Shoulder Score for satisfactory joint function, when compared with the control group with only 18% ($n = 9$) improving to the fourth stage of the Oxford Shoulder Score ($p < 0.001$). A post hoc power analysis was done using nMaster Version 1 (Department of Biostatistics, Christian Medical College, Vellore, India), considering the difference in pain between the groups that we observed from this study and reduction in the percentage of shoulder function score between the study groups. The post hoc power analysis also showed that the study had adequate power ($> 90\%$). There were no adverse events or side effects reported by patients in either group, apart from the usual muscle soreness that usually presents after mobilization.

Discussion

Various physiotherapy techniques have been described for treatment of frozen shoulder, but some studies of these techniques did not have a complete management program [12, 15, 16]. Few of the studies focused on capsular tightness and functional outcomes when compared with pain and stiffness [14, 17, 18, 20]. From studies showing evidence of previous interventions such as manual therapy, stretching, and exercises for a frozen shoulder [21, 22, 32, 37], we focused on manually treating the affected shoulder by joint mobilization incorporating sustained capsular stretching. This was the basis for our method of using the

Table 1. Sequenced treatment protocol for experimental group undergoing mobilization with countertraction

Treatment sequence	Technique used	Frequency/sessions
Warmup	Application of moist heat over the shoulder	2 minutes (approximately) per session
Mobilization with countertraction (I): position 1	Posteroanterior glides (Grades 1 to 4) followed by rotatory passive ROM in internal & external rotation of glenohumeral joint to improve flexion range	4 to 5 glides followed by 4 to 5 rotatory passive ROM for 3 to 5 minutes (approximately) per session
Mobilization with countertraction (II): position 2	Posteroanterior glides (Grades 1 to 4) followed by rotatory passive ROM in internal & external rotation of glenohumeral joint to improve abduction range	4 to 5 glides followed by 4 to 5 rotatory passive ROM for 3 to 5 minutes (approximately) per session
Electrotherapy modality	Deep tissue effect (ultrasound/short wave diathermy)	5 minutes (approximately) per session
Home exercise program	1. Forward flexion of the shoulder, holding a stick (in sitting/standing positions) 2. Pendulum exercises (clockwise & counterclockwise) 3. Wall-climbing exercises while standing (facing forward & facing sideways) 4. Functional exercises involving transfer of objects from one hand to other at various directions around the body, towel behind the back with both hands alternatively, lifting and carrying objects, and other functional activities that involved use of affected shoulder.	10 repetitions each for 3 times per day

Table 2. Final results of patients in both groups

Study variables	Experimental group		Control group		p value*	p value†
	Mean ± SD	95% CI	Mean ± SD	95% CI		
Age‡ (years)	49.16 ± 6.09	47.5–50.9	53.22 ± 6.74	51.3–55.1	0.002	
Sex						
Male	32 (64%)		33 (66%)		0.83	
Female	18 (36%)		17 (34%)			
Shoulder flexion ROM‡						
Baseline	94.1 ± 19.79		99.4 ± 23.38		0.22	
End of study	161.9 ± 13.0	158.3–165.5	165.3 ± 10.99	162.3–168.3		0.36
Shoulder abduction ROM‡						
Baseline	90.4 ± 21.18		90.7 ± 22.13		0.94	
End of study	154.8 ± 13.21	151.1–158.5	153.5 ± 12.42	150.6–156.9		0.55
VAS (pain scores)‡						
Baseline	8.00 ± 0.78		7.96 ± 0.81		0.80	
End of study	3.48 ± 0.71	3.27–3.67	3.98 ± 0.74	3.71–4.19		< 0.0001
Oxford Shoulder Score (shoulder function)						
Baseline (Stage)						
1	49 (98%)		50 (100%)		1.00	
2	1 (2%)					
End of study (Stage)						
1	0 (0%)		28 (56%)			
2	20 (40%)		13 (26%)		< 0.001	
3	30 (60%)		9 (18%)			

* Comparing the variables across the study groups at baseline; † analysis of covariance was done to compare the end line values between the two study groups after adjusting for baseline values and age; ‡ mean ± SD.

countertraction apparatus for inferior capsular stretching during shoulder mobilization to evaluate its effect on ROM, pain, and function in a frozen shoulder. We also had a sequenced protocol of warmup by moist heat followed by mobilization along with countertraction which was followed by an electrotherapy modality and home exercise program involving gentle shoulder ROM exercises. A hypothesis behind our technique of using countertraction was the concept of axial distraction, which when provided to the shoulder, allows for a greater gain in mobility at the end range. This subsequently increases shoulder mobility [11, 23, 29, 34]. For continuous sustained axial traction, suspended weights by countertraction were used for the affected limb.

Our study has some limitations. First is the use of comparatively less reliability of measurement tools. However, we overcame this to an extent by having only one rater measure the outcomes for both groups. Second, we did not have a true control (no treatment) to determine the natural course of the disease, as it is unethical to not provide treatment. Third, we do not have followup of the patients, as this study involves the initial stage of research on using countertraction to find its primary outcome. Fourth, we could not show in detail with advanced measurement tools the rationale behind the effect of countertraction on capsular stretching. In future research, the biomechanical rationale behind the effect of countertraction would be studied with appropriate tools. Fifth, the stage of the frozen shoulder was not taken into account in the outcomes. This was overcome as the patients with various stages of frozen shoulder recruited for the study were homogeneously distributed across both groups.

The Oxford Shoulder Score was used to measure shoulder function as it has only 12 items, is easy for participants to complete, and the items met our focus parameters of functional improvement when compared with other shoulder function scales. Our study had more male participants, possibly because of socioeconomic reasons, as our region is more favorable for increased healthcare access for males. Although there were no side effects reported during the trial, precautions should be taken during application and use of the countertraction device on patients. Careful monitoring of a patient's physical and mental condition should be done along with prior counseling regarding the nature and use of the device in improving the patient's affected shoulder.

We observed an improvement in shoulder ROM of flexion and abduction in the experimental and control groups. This improvement was seen in other studies as well [19, 27], which reported improvement in shoulder motion for shoulder dysfunctions after joint mobilization techniques. The end range mobilization along with movement of the shoulder provided better improvement in shoulder mobility as

reported by Yang et al. [38]. The mobilization procedure we used was done with the shoulder in a functional position and the glides were given at end range [23–25]. Other studies also showed positive outcomes in glenohumeral joint mobility after passive mobilization of the shoulder in individuals with a frozen shoulder [19, 25, 35–37].

Pain reduction was seen in patients in our experimental and control groups. This decrease in pain levels has been reported by others who observed reduced pain levels after joint mobilization techniques. Hjelm et al. [17] reported that insufficient length of the anteroinferior capsule might be a critical mechanical factor for shoulder pain. Therefore, for the painful shoulder in the case of a frozen shoulder, the capsule (most often inferior part) gets adhered and causes capsular insufficiency [5, 10, 34]. This length can be restored through specific mobilization techniques directed at the appropriate capsule, which was the basis of our use of countertraction to have an effect on the capsule.

We observed a considerable level of improvement in shoulder function in the experimental group which received countertraction after regular physiotherapy. This improvement in shoulder function also was reported by Düzgün et al. [10] and Jewell et al. [18], who described an improvement in functional status for patients with adhesive capsulitis. A positive association also was seen between the improvement in shoulder function and our experimental group which underwent countertraction. This shows that mobilization with the countertraction apparatus had a positive effect on improvement of shoulder function. The difference in function observed in the experimental group can be attributed to three assumptions: (1) the position of mobilization was in the functional position; (2) the use of countertraction, might have had a positive psychological affect on the participants; and (3) other soft tissues such as the fascia or ligaments have an influence on functional improvement. Improvements seen in the function scores of patients who received countertraction show that ROM and pain are not the only factors that determine the functional ability of patients with a frozen shoulder. In addition, a functional outcome rather than pain or ROM is what an affected individual is concerned with and wants to improve to perform his or her daily activities, therefore it should be considered a priority.

Our method of mobilization along with use of a countertraction apparatus had a beneficial effect of improving shoulder function in patients with a frozen shoulder, when compared with mobilization alone. The beneficial effects seen with this countertraction apparatus provide a new treatment approach for a frozen shoulder. The easy usability of this apparatus will allow more physiotherapists to incorporate the device in their practice for treatment of their patients with frozen shoulder. However, additional studies are needed focusing on this concept, with more detailed

study parameters and measurement tools, to increase the generalization of the countertraction apparatus.

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