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Physiotherapy Section

Is Position Induced Movement Re-education Helpful on Early Functional Recovery in Acute Adhesive Capsulitis? A Randomised Controlled Trial

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ABSTRACT

Introduction: Adhesive Capsulitis (AC) is a common musculoskeletal disorder of shoulder caused by inflammation and adhesion formation in the capsule and periarticular structures. The increased nociception from the shoulder can suppress the movement perception and related functions of shoulder and upper limb. Active range of motion of shoulder may be more painful and limited due to pain, spasm and stiffness. Positioning of shoulder joint in end ranges may activate the mechanoreceptors of muscles, tendon, ligaments, joint capsule which may reduce the nociception and increase the movement perception.

Aim: To compare the effect of Position Induced Movement Re-education (PIMR) combined with Low Level Laser Therapy (LLLT) over active free shoulder exercises with LLLT and Grade-I Maitland Mobilisation adjunct with moist heat therapy in the management of acute adhesive capsulitis of shoulder.

Materials and Methods: A total of 30 subjects diagnosed with stage I AC were randomly allocated in three groups. Group A received PIMR and LLLT, Group B received Codman's pendular exercises along with LLLT and Group C received Grade I Maitland Mobilisation and moist heat therapy for five days a week for two consecutive weeks. The pre and post-intervention scores of shoulder joint range of motion and shoulder pain disability index were obtained and analysed.

Results: A statistically significant difference was seen in the shoulder pain and disability index score and shoulder range of motions among three groups with the p-value less than 0.05. The patients treated with position induced movement re-education combined with LLLT showed better improvement in shoulder disability and range of motion scores when mean differences were compared with other two groups using Mann-Whitney U test (for SPADI score) and One-way ANOVA (shoulder range of motions).

Conclusion: Position induced movement therapy along with LLLT is effective in reducing pain, improving range of motion and disability in stage I AC.

Keywords: Frozen shoulder, Mobilisation, Shoulder exercises, Shoulder pain

INTRODUCTION

Adhesive capsulitis of shoulder is highly prevalent (2-5%) among general public especially in adults and it has been estimated that there is a high incidence rate among female compared to male [1, 2]. The causes for the occurrence of acute pain in the patients with AC of shoulder are primarily the inflammation and resultant adhesion formation in the joint capsule and related periarticular structures [3]. Apart from this, several other factors like myofascial trigger points, diabetes mellitus, and sedentary lifestyle or lack of exercise, stress also perpetuate the symptoms of AC [4-6].

The clinical manifestations of AC are classified under three stages i.e., stage of inflammation, adhesion and freezing [2,3,7]. In fact, the inflammatory stage is the most pain provoking stage which may lead to further negative consequences of one's functional movements of shoulder [2,3,8]. Importantly, the patients who are not adequately treated for inflammation reduction and adhesion breakdown at the early stage can progress to the stage of freezing [9]. Treatment for inflammation and adhesion are essential to reduce acute pain, spasm and related shoulder dysfunction [8,9].

The superimposed nociception from the shoulder joint structures may aggravate the pain perception at the primary sensory cortex level [10]. As a result of increased pain perception, the protective muscle spasm in the shoulder muscles appears. Further, it reduces the muscle's ability to relax in its full length during the active shoulder movements [11,12]. Continuation of this scenario for a week or more will lead to inhibition of mechanoreceptive perception at the secondary sensory cortex. Weak shoulder muscles are the result of decreased movement and superimposed pain perception in acute adhesive capsulitis of shoulder [2,13].

Traditionally, the non-steroidal anti-inflammatory medications are commonly prescribed by physicians to reduce pain severity [2,14]. The patients may end up in severe stiffness and altered movement pattern of shoulder due to lack of shoulder mobility exercises or/and late-reference to physical therapies. [2,3,15]. Based on these reasons LLLT has been used to reduce inflammation [16,17], and joint mobilisation and pain free pendular exercises are used to improve the joint range of motion in the physical therapy practice [18,19].

Active range of motion is more painful due to the increased nociception and protective muscle spasm in early stage AC [2,3]. So, patients may face difficulty to perform the complete range of active movements of shoulder at the early stage [1-3]. Thus, it is essential for the clinicians to achieve the shoulder joint full range of motion by lengthening the soft tissue structures using passive positioning of joint instead of active range of movement exercises, where the patient may experience aggravation of pain [20].

Mobilisation or other manual therapies have been considered as a general approach to manage the AC but the literature does not provide a conclusive evidence particularly to treat the acute stage AC [21,22]. Treatment of movement components (muscles, tendon, capsule, ligaments) by passive positioning along with sensory components (pain) can reduce the pain as well as re-educate the movements [20,23]. Thus, positioning of joints at the end ranges may be more

beneficial to achieve the optimal length of soft tissue structures and induce movement re-education in patient with acute stage AC.

Position induced movement re-education: A Newly proposed exercise program in which the joints are positioned in the functional pattern specifically at the end ranges with help of therapist or patients themselves to re-educate the movement perception where the existence of superimposed pain perception inhibits the movement function. The passive positioning of joints in functional movement pattern may produce sustained stretching of muscles, tendons, joint capsule and other periarticular structures which lead to activation of neuromuscular spindle, golgi tendon organs and other mechanoreceptors [23].

The proprioceptive and mechanoreceptive inputs from the joint structures may keep the somatosensory and motor cortex neurons active and it can inhibit the relay of nociception to primary sensory cortex [10,23,24]. Furthermore, the sustained tendon stretching caused by positioning may relax the muscles by Golgi tendon stimulation induced reflex relaxation and alpha motor regulation by higher neurons [10,20,23]. This technique may be more feasible for patients who are unable to perform the complete range of movements actively and to avoid pain perception and improving the range of motion.

Based on this physiological background we proposed a hypothesis that the application of position induced movement re-education combined with LLLT may be more beneficial to suppress the nociception and induce muscle relaxation in the acute stage shoulder AC. Past literature provides evidence for the therapeutic effectiveness of LLLT [16,17], active free exercises [18,19] and other mobilisation [21] techniques in the management of different stages of AC of shoulder. Our current study was conducted to evaluate the role of PIMR and Codman's pendular exercises with the combination of LLLT in the management of pain and movement dysfunction in the acute stage AC.

MATERIALS AND METHODS

Study Design

A single blind randomised controlled study and the study protocol was approved by Institutional Ethics Committee (Ref: NIPT/IEC/Min/2015-16/dated 09-03-2016). This study was conducted at the Department of Physiotherapy, Justice K S Hegde charitable hospital, Mangaluru, India, during the period between March 2016 and February 2017.

Participant Selection

The preliminary medical examination was done by an Orthopaedic physician and the patients who were diagnosed with acute stage AC of shoulder referred to Physical therapy Department were taken. Patients participation screening was performed by an independent physiotherapist based on the inclusion and exclusion criteria. Complaints of acute pain with less than three months, radiographic evidence for AC, age between 30 to 60 years irrespective gender and reduction of shoulder joint movements were considered for the inclusion [2,4].

Patients with history of trauma to shoulder, shoulder dislocation, cervical radiculopathy, fibromyalgia, hemiplegic shoulder, rheumatoid arthritis and shoulder pain for more than three months were excluded. The eligible participants were informed about the nature of study and possible therapeutic benefits of treatments. The patients who were willing to produce a written informed consent were included in this study.

Randomisation, Allocation and Blinding

The random number generation (computer generated), allocation ratio (1:1:1) was carried out by statistician. Participant's allocation in any one of the three groups was informed through phone call to the principal investigator by the research supervisor to perform the respective intervention. The outcome assessor was blinded to the random allocation and offered treatments to individual participants throughout the study period.

Interventions Procedures

All 30 patients of acute stage AC were equally allocated in three groups (10 each) and treated with respective group interventions. The participants in Group-A received PIMR and LLLT, Group-B participants received Codman's pendular exercises and LLLT, and Group-C was allocated for Maitland Mobilisation and moist heat therapy.

Position Induced Movement Re-education with Low Level Laser Therapy (In Group-A)

The patients in this group were initially treated with LLLT with necessary precautionary measures using the Class B single diode infra-red laser (Medical Italia,). The hand held probe was placed over the painful sites of shoulder joint capsule and laser beam was applied for two to three minute in a site [16,17]. The same procedure was followed to treat the different areas of joint capsule (anterior, posterior, inferior and superior) separately. The procedure and treatment parameters of LLLT were summarised in the [Table/Fig-1].

Parameters	Doses
Wavelength	904 nm
Power supply	230 watts
Power density	0.1 Joule
Irradiation time	two to three minute
Method of application	Direct contact
Frequency of treatment	five days/week×two weeks

[Table/Fig-1]: Treatment parameters of low level laser therapy.

Position Induced Movement Re-education

It is a method of passive positioning of limb with the combination of different movements to achieve optimal rotation of articulating surfaces and improve the range of motion. The following shoulder joint's movement components were selected for PIMR to treat the patients who were diagnosed with acute shoulder pain and movement dysfunctions [Table/Fig-2].

Component I: Patients in supine, the shoulder joint was passively moved towards the 90° abduction and placed externally rotated with elbow in 90° flexion and later shoulder was placed in internal rotated position [Table/Fig-2a,b].

Component II: In supine position the patients shoulder was moved towards the abduction, external rotation (same as in component I) and the patients palm was placed under the patient's head. Later with slightly abducted shoulder the patient's dorsum of the hand was placed under the patient's buttock or lower back [Table/Fig-2c,d].

Component III: The patients were positioned in prone lying, shoulder at 90° abduction and elbow of 90° flexion. First shoulder was placed in external rotated position and later it was placed in internal rotated position [Table/Fig-2e,f].

Each position was kept for two to three minutes and repeated for two to three times in a single session of treatment. And the patients were instructed to carry out these movement patterns as a home care program to maintain the rotational movements and muscle length. Both LLLT and PIMR were given five days in a week for two consecutive weeks.

Codman's Pendular Exercises with Low Level Laser Therapy (In Group B)

Initially LLLT was applied around the shoulder joint to reduce the inflammation and pain [Table/Fig-1]. After the laser therapy the patients were instructed to perform the Codman's pendular exercises with the supervision of treating therapist [25,26]. Prior to the exercises the pendular exercise was demonstrated to patients

[Table/Fig-2]: Description of position induced movement re-education (PIMR) technique used in acute adhesive capsulitis; a) Shoulder abduction, external rotation and elbow flexion; b) Shoulder abduction, internal rotation and elbow flexion; c) Shoulder abduction with external rotation, elbow flexion and head over the palm; d) Shoulder abduction with internal rotation, elbow flexion and hand under the trunk; e) Shoulder abduction, elbow flexion and palm placed over the mattress; f) Shoulder abduction with internal rotation, darsum of hand placed over the mattress.

Outcome Measures

Primary outcome: The intensity of shoulder pain and functional disability was assessed with Shoulder Pain and Disability Index (SPADI) subjective questionnaire, which has good internal consistency (Cronbach alpha=0.96) to assess the pain and related functional limitations [30]. English, Kannada and Malayalam version of SPADI tool was used based on patients language preference. SPADI has five items for assessing pain severity and eight items for disability assessment, and each item's score ranges from 0–10, where 0 indicates no pain or difficulty and 10 indicates severe pain or disability. The sum of scores of 13 items were divided by 13 and multiplied by 100 to obtain the total SPADI score range from 0–100 (0=no pain and no disability, 100=severe pain and disability).

Secondary outcome: The shoulder joint's range of motions was measured using hand held universal goniometer which is a valid and reliable (Inter-rater reliability; rho=0.64–0.69) quantitative tool for the measurement of joint range of motions [31]. The procedure for shoulder joint's range of movements were summarised in [Table/Fig-3]. The scores of outcomes were assessed at baseline prior to interventions and two weeks post intervention.

STATISTICAL ANALYSIS

The gender, hand dominance and side affected (Categorical data) were presented in frequencies, shoulder pain and disability index score (qualitative data) was presented in median and Interquartile Range (IQR) and shoulder range of motion (quantitative data) have presented in the form of mean and standard deviation. Shapiro test was used to test the outliers and homogeneity of data and one-way ANOVA (for shoulder range of motions analysis) and Mann-Whitney U test (for SPADI score analysis) were used to compare the treatment effects between the groups. SPSS version 21.0 was used to analyse the data and the p-value ≤0.05 for the 95% confidence interval and 5% alpha level was considered as statistical significance.

Shoulder motions/Patient position	Starting position	Position of Goniometer parts		
		Moveable arm	Fulcrum	Stationary arm
Flexion and extension/Supine	UL is parallel to trunk	Parallel to arm	1˝ below the AP (lateral shoulder)	Parallel to couch
Internal and external rotation/Supine	Elbow 90° flexion, Shoulder 45°-90° Abd.	Parallel to forearm	At level of OP of ulna	Parallel to couch
Abduction/Sitting	Seated on a stool, UL at the side of trunk	Parallel to the arm	1˝ below the AP (anterior shoulder)	Parallel to trunk

[Table/Fig-3]: Procedure for shoulder range of motion measurement using hand held goniometer.
AP= Acromian process, OP= Olecranon process, Abd.= Abduction, UL= Upper limb, "= Inch, °= Degree

by the therapist. The oscillatory pendular movements of shoulder were performed for two to three minutes in the forward–backward direction, side-to-side direction (two to three minutes) and circular pattern (two to three minutes). In a single session, these exercises were repeated twice and continued for five days in a week in two consecutive weeks [23,25,26].

Grade I Maitland Mobilisation with Moist Heat Application (In Group C)

Tolerable moist heat was applied using hydrocollateral moist pack for 10-15 minutes around the shoulder joint to induce the local relaxation and reduce the muscle spasm of affected shoulder of 10 patients [27]. Later, the patients were positioned in supine lying and downward pressure was applied over the anterior part of the shoulder to glide the head of humerus posteriorly [21,22,28,29]. Similarly, in prone position of the patients the palm of the therapist placed over the posterior aspect of the shoulder to push the head of humerus anteriorly [28,29]. Both anterior and posterior glide (Grade I- Maitland Mobilisation) was performed for 10 repetitions per session in a day. Mobilisation with moist heat therapy was continued for five consecutive days in a week for two weeks period.

RESULTS

Descriptive Statistical Results

There are 17 male and 13 females with mean age of 52.86 years (Range: 35-60 years) who were treated in this study and the mean age of patients distributed among three groups also belongs to similar age group. Further, the baseline results also showed that right side affected (n=17) patients were slightly more than the left side (n=13) affected patients. Among the 30 patients there were 11 patients diagnosed with diabetes mellitus and undergoing regular medications for the same. The mean score of SPADI among three groups indicates that the patients were affected by pain and disability with more than 60% SPADI score. Even the shoulder range of motions of affected side reduced from the normal ranges, which indicated that there is acute reduction in the shoulder movements. The post-intervention outcome scores at two weeks show improvement for all outcome measures when these scores were compared with respective baseline scores in all three groups [Table/Fig-4].

Variables (n=30)	Group–A PIMR and LLLT (n=10)	Group-B CPE and LLLT (n=10)	Group-C MM and MHT (n=10)
Age (Years)	53 (6.61)	50.7 (6.34)	54.9 (5.38)
Gender (Male/Female)	4/6	7/3	6/4
Side affected (Right/Light)	5/5	8/2	4/6
Hand dominance (Right/Light)	9/1	8/2	8/2
SPADI (0-100%)			
Baseline	66.68 (5.52)	62.37 (9.09)	60.27 (4.25)
At two weeks	18.91 (2.78)	24.62 (4.89)	34.07 (3.40)
Shoulder flexion (0-180°)			
Baseline	111.90 (9.45)	117.30 (9.16)	118.40 (7.38)
At two weeks	151. 60 (4.88)	143.30 (8.98)	137. 10(3.31)
Shoulder extension (0-60°)			
Baseline	49.70 (7.40)	47.80 (4.56)	49.10 (5.02)
At two weeks	58.6 (3.27)	59.6 (2.83)	59 (3.52)
Shoulder Abduction (0-180°)			
Baseline	104.80 (8.65)	105.70 (9.33)	110.10 (8.50)
At two weeks	148.4 (5.77)	(143.9 (5.4)	140.3 (3.88)
Shoulder internal rotation (0-70°)			
Baseline	52.90 (4.38)	51.20 (4.44)	54.20 (3.73)
At two weeks	65.9 (2.76)	62.4 (4.4)	61.3 (1.63)
Shoulder external rotation (0-90°)			
Baseline	47.40 (2.41)	46.70 (1.82)	47.00 (3.36)
At two weeks	64.7 (3.77)	62.2 (3.67)	58.6 (3.06)

[Table/Fig-4]: Characteristics of participants among three groups.
PIMR= Position induced movement re-education, LLLT= Low level laser therapy, CPE= Codman's pendular exercises, MM= Maitland mobilisation, MMT= Moist heat therapy

Inter-Groups Comparison of Shoulder Pain and Disability

The Mann-Whitney U test results for shoulder pain and disability index scores have been shown in the [Table/Fig-5]. The comparison results of the group treated with LLLT and PIMR, and the group treated with moist heat and Maitland Mobilisation show mean difference of 21.68 ($p<0.05$). The results also indicate significant mean difference (mean=10.02, $p<0.05$) between the group treated with LLLT and PIMR and the group treated with LLLT and pendular exercises. The mean difference (11.56) between the pre-minus post-mean scores of Group B and C reveals statistical significance ($p<0.05$) in favour of Group B. The overall intergroup comparison results suggest that Group A is improved from pain and disability better than Group B and C [Table/Fig-5].

Group	Mean±SD	Median (IQR)	Difference	Mean rank	Z-value	p-value
A	47.77±4.83	48.46 (42.68-52.11)	10.02	14.05	-2.69	0.007
B	37.75±8.18	37.69 (29.8-45.72)		6.95		
A	47.77±4.83	48.46 (42.68-52.11)	21.68	15.5	-3.78	<0.001
C	26.19±3.15	26.54 (24.76-28.42)		5.5		
B	37.75±8.18	37.69 (29.8-45.72)	11.56	14.85	-3.29	0.001
C	26.19±3.15	26.54 (24.76-28.42)		6.15		

[Table/Fig-5]: Inter group comparison of SPADI score's difference using Mann-Whitney U test.
SD= Standard deviation, IQR= Interquartile range, SPADI= Shoulder pain and disability index

Comparison of Shoulder Range of Motion

The mean scores (Baseline–second week) of shoulder range of motion among three groups were analysed using One-way ANOVA to find out difference. The results of shoulder flexion ($F_{2,27}=9.32$), abduction ($F_{2,27}=4.56$), internal rotation ($F_{2,27}=10.35$) and external rotation ($F_{2,27}=11.87$) indicated significant difference ($p<0.05$). However, the p-value for inter group comparison of shoulder extension range of motions was $p=0.38$ ($F_{2,27}=1.01$) which indicate the absence of statistical significance among three groups. These results indicate that there is different level of improvement among three groups for the shoulder range of motion [Table/Fig-6].

Intergroup Multiple Comparison of Shoulder Range of Motion

The post-hoc test with bonferronic adjustment was used to identify the exact changes of shoulder range of motion between the groups. The results show that the shoulder range of motion in the Group A improved ($p<0.05$) better than group C except for the shoulder extension ($p>0.05$). Comparison between the Group A and B did not show any statistical significance ($p>0.05$) other than the shoulder flexion range of motion ($p=0.03$). The statistical comparison of shoulder internal and external rotation range of motion between Group B and C using post-hoc analysis have significant improvement ($p<0.05$). However, the other movements of shoulder have not shown any statistical significance with p-value more than 0.05 [Table/Fig-7].

DISCUSSION

Adhesive capsulitis of shoulder is more prevalent among adult population [1,2], and primarily manifest diffused pain and movement restriction in the shoulder, which constraint the patients to carry out their routine activities [1-3]. The patients may experience difficulty to perform active shoulder joint's range of movements in the early stages of AC due to fear of movement performance (Kinesiophobia). Further, excessive nociceptive information from shoulder may suppress the movement perception [10], which result in the formation of adhesions and subsequent freezing of shoulder movements [2,11-13]. Thus, current study was conducted to reduce pain (LLLT) and prevent movement restriction with the passive positioning (PIMR) of shoulder joints in the end ranges among the patients diagnosed of early stage AC.

In this study, our aim was to evaluate the effectiveness of PIMR combined with LLLT over Codman's pendular exercise combined with LLLT and Maitland Mobilisation combined with moist heat therapy. The comparison of statistical results among the three groups clearly suggest that the group treated with LLLT and PIMR is improved better than other two groups from shoulder pain, disability [Table/Fig-4] and range of motions [Table/Fig-5,6]. After the application of LLLT and active free pendular exercises in the second group, shows better result than the combined effects of Grade-I Maitland Mobilisation and moist heat therapy. These results indicate that application of LLLT is an important treatment tool to reduce the inflammation in order to promote tissue healing, pain relief and associated functional disabilities of shoulder.

The major interest of this study is to evaluate whether PIMR can produce better outcomes by stretching the soft tissues of shoulder joint and promoting the movement perception in the cortical level. This study results provide supportive evidence for our hypothesis because even though LLLT was applied in two groups the PIMR technique applied group shows good outcomes. A randomised control study of Ibrahim M et al., provides evidence for the

Shoulder range of motions	Groups	Pre–Post Mean±SD	95% CI for the difference		F-value	p-value
			Lower	Upper		
Flexion	A	39.70±11.42	31.52	47.87	9.32	0.001
	B	26.00±13.14	16.59	35.40		
	C	18.70±7.9	13.04	24.35		
Extension	A	8.90±5.44	5.00	12.79	1.01	0.38
	B	11.80±4.18	8.80	14.79		
	C	9.90±4.2	6.89	12.90		
Abduction	A	43.60±9.5	37.51	49.68	4.56	0.02
	B	38.20±9.4	31.47	44.92		
	C	30.20±11.75	21.79	38.60		
Internal rotation	A	13.00±3.29	10.63	15.36	10.35	<0.001
	B	11.20±1.87	9.85	12.54		
	C	7.10±3.47	4.61	9.58		
External rotation	A	17.30±2.62	15.42	19.17	11.87	<0.001
	B	15.50±3.5	12.99	18.00		
	C	11.60±1.5	10.52	12.67		

[Table/Fig-6]: Comparison of shoulder range of motion using One-way ANOVA.
ANOVA= Analysis of variance, CI= Confidence interval, SD= Standard deviation

Shoulder range of motion (sROM)	Mean±SD of Pre–Post mean scores				Difference	95% CI for dif.		p-value
	I-Group		J-Group		I-J	Lower	Upper	
Flexion	A	39.70±11.42	B	26.00±13.14	13.70	1.09	26.30	0.03
	A	39.70±11.42	C	18.70±7.9	21.00	8.39	33.60	0.001
	B	26.00±13.14	C	18.70±7.9	7.30	5.30	19.90	0.45
Extension	A	8.90±5.44	B	11.80±4.18	-2.90	-2.40	8.20	0.52
	A	8.90±5.44	C	9.90±4.2	-1.00	-4.30	6.30	0.12
	B	11.80±4.18	C	9.90±4.2	1.90	3.40	7.20	0.326
Abduction	A	43.60±9.5	B	38.20±9.4	5.40	5.99	16.79	0.71
	A	43.60±9.5	C	30.20±11.75	13.40	2.00	24.79	0.01
	B	38.20±9.4	C	30.20±11.75	8.00	3.39	19.39	0.25
Internal rotation	A	13.00±3.29	B	11.20±1.87	1.80	1.59	5.19	0.56
	A	13.00±3.29	C	7.10±3.47	5.90	2.50	9.29	<0.001
	B	11.20±1.87	C	7.10±3.47	4.10	0.70	7.49	0.01
External rotation	A	17.30±2.62	B	15.50±3.5	-1.80	1.25	4.85	0.43
	A	17.30±2.62	C	11.60±1.5	-5.70	2.64	8.75	<0.001
	B	15.50±3.5	C	11.60±1.5	-3.90	0.84	6.95	0.01

[Table/Fig-7]: Bonferonnic multiple comparison of shoulder range of motion between the groups.
CI=Confidence interval, SD=Standard deviation

importance of introducing the static progressive stretch device to improve the clinical outcomes in AC [20]. Our study focussed on the stretching of the shoulder joint's soft tissues by PIMR and Ibrahim M et al., study intention was also to improve soft tissue length using static progressive stretch device [20]. So, comparison of these two studies indicates that any form of static soft tissue stretching may beneficial to improve the clinical outcomes in the patients with AC.

Prior studies have documented the importance and clinical effectiveness of LLLT in the early stage AC management [17-19]. Especially Ip D et al., study on AC has concluded that application of LLLT can reduce the pain severity in patients with painful AC [32]. Likewise, our study added a clinical view point about the importance of application of LLLT prior to PIMR treatment to promote the early recovery and prevention of further musculoskeletal complications caused by adhesion formation.

This study provides evidence for the additional benefits of PIMR and the role of PIMR can be studied further in some other acute painful conditions where no contraindications like rupture of soft tissues and fracture and/or dislocation are evidenced. In similar sense, this technique may not be feasible to apply on those cases where he/she need a rest to the injured part and traumatic conditions etc.

The effectiveness of active free exercises was evidenced in the past especially once the patients get relief from the acute pain [22,28,29]. This study shows that introduction of pendular exercises after the application of LLLT even at the early stage AC have benefited the patients to improve their shoulder movement performance. This result reveals that the pendular exercise can be administrated along with other pain relieving treatment [20,27].

The Grade-I Maitland Mobilisation thought to be effective method to relieve pain and pain free movements while treating articular deficits of musculoskeletal origin [21,22,28,29]. However, a recent systematic review of Jain TK et al., have recommended that joint mobilisation may be good intervention tool for improving pain, range of motion in stage 2 and stage 3 AC [19]. In our study, Grade-I Maitland mobilisation after the application of moist heat therapy have not evidenced better improvement than other two groups. Therefore, results from the patients of mobilisation group are consistent with the systematic review of Jain TK et al., [19].

Studies in past supported the idea of applying deep or superficial heating modalities to reduce pain and associated functional

disabilities in patients with shoulder pain [20,27]. It is also an interesting area to study the role of moist heat (superficial heating) and other deep heating modalities with the combination of Maitland mobilisation in acute AC. This may provide important clinical message regarding the appropriate selection of heating modalities which can be applied prior to mobilisation techniques in patients with AC. Further, the definite role of Maitland Mobilisation can be identified by conducting a study on Maitland Mobilisation with and without moist heat application in acute stage AC.

LIMITATION

This study was intend to evaluate the role of PIMR combined with other therapeutic modalities, in that sense we have not used PIMR in the mobilisation group to find out the combined effects of these two techniques. Because of the smaller sample size we had certain limitation to strongly impose the clinical implications of PIMR, so further experimentation with larger sample size is recommended to find out the conclusive statistical evidences.

CONCLUSION

The combination of position induced movement re-education and LLLT found to be more effective than active pendular exercises with LLLT and Grade-I Maitland Mobilisation with moist heat therapy. At the early stage of AC, application of PIMR and/or active free pendular exercises along with LLLT may be more beneficial to prevent further adhesion formation and spreading of inflammatory reactions. PIMR is a safe, cost-effective method of treatment and easy for the patient to perform anywhere.

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