Combined Effect of End Range Mobilization (ERM) and Mobilization with Movement (MWM) Techniques on Range Of Motion and Disability in Frozen Shoulder Patients: A Randomized Clinical Trial

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Abstract

The purpose of the study was to find out the combined effect of end range mobilization and mobilization with movement in patients with frozen shoulder. A total of 30 patients (male =16; female=14) were selected as subjects and they were further divided into 3 groups respectively (Group A=ERM; Group B=MWM; Group C=ERM+MWM). Each group comprising of 10 subjects (Group A & B male=6, female=4; Group C male= 4, female= 6). The results of the present study suggest that there was an improvement in the mean values of Range of Motion (both active & passive) and Shoulder Pain Disability Index scores after treatment in all the 3 groups. But it was found that an improvement was statistically significant more in the group C than the group A & B respectively. It was concluded that the combination manual therapy (ERM+MWM) should be incorporated in the treatment protocol of frozen shoulder patients to achieve better gain in the ROM & SPADI scores.

Keywords: ERM, MWM, Frozen Shoulder, ROM, Disability

Introduction

Frozen shoulder syndrome is a condition of uncertain etiology characterized by a progressive loss of both active and passive shoulder motion *(Yang et al, 2007)*. It occurs in the general population with an incidence of approximately 2% and of these 20 to 30% develop the condition bilaterally *(Binder et al, 1984)*. The condition is characterized by an insidious and progressive loss of active and passive mobility in the glenohumeral joint due to joint contracture *(Vermeulen et al, 2000)*. It is more common in females, age between 40-60 years *(Khan et al, 2009)* and in the non-dominant arm. Pain and stiffness noted in these patients was not due to arthritis, but rather, was due to soft tissue pathology of the periarticular structures. There is slow onset of pain felt near the insertion of deltoid, inability to sleep on the affected side, painful and restricted elevation and external rotation, with a normal radiological appearance *(Bunker, 1997)*. The loss of passive range of external rotation has remained pivotal to the diagnosis of frozen shoulder. *Kelly et al (2009)* described the classification system identifying primary frozen shoulder as idiopathic and secondary shoulder as posttraumatic and proposed the classification where primary frozen shoulder and idiopathic adhesive capsulitis are considered identical and not associated with a systemic condition or history of injury. Capsule and synovium thickness greater than 4 mm is a specific and sensitive criterion for diagnosis of frozen shoulder *(Emig et al, 1995)*. The complete loss of external rotation is the most important factor in differential diagnosis. To regain the normal extensibility of the shoulder capsule, passive stretching of the shoulder capsule in all planes of motion by means of end-range mobilization techniques (EMTs) has been recommended but data to support the use of these treatments are lacking *(Yang et al, 2007)*. *Vermulen et al (2000)* showed effective result of End Range Mobilization after 3 months of treatment. There are an increasing number of reports that showed clinically beneficial effects of Mulligan's mobilization-with-movement (MWM) treatment technique *(Mulligan, 2000)*. The most frequent reported effect is that of an immediate and substantial pain reduction accompanied by improved function. Mulligan showed effective results in patients treated with frozen shoulder *(Mulligan, 1992)*. The purpose of the study was to find out the combined effect of end range mobilization and mobilization with movement in patients with frozen shoulder.

Materials & Methods

The 30 patients of frozen shoulder both male and female in the age range of 40 to 60 years were selected as subjects after obtaining their consent based on inclusion and exclusion criteria of the study. The subjects were further divided into three groups: Group-A (n=10), Group-B (n =10) and Group C (n=10). Both the group A (ERM) and group B (MWM) was further comprising of six male and four female subjects each respectively. Group C (ERM+MWM) comprises of four male and six female subjects.

Treatment Protocol: The subjects of Group-A underwent End range mobilization *(Hengeveld & Banks, 2005)* for flexion, abduction, external rotation & internal rotation along with conventional physiotherapy programme for 2days/week for 3 weeks, session of 30 minutes total duration. Three sets of 10 to 15 repetitions with 1 minute rest in between of intensive mobilization techniques, varying the plane of elevation or varying the degree of rotation in the end-range position, were applied during these techniques *(Yang et al, 2007)*. The subjects of Group B were given Mobilization with movement *(Mulligan, 2006)* along with conventional physiotherapy programme for 2days/week for 3 weeks, session of 30 minutes total duration. While performing all these techniques, the glide was sustained during slow active shoulder movements to the end of the pain-free range and released after return to the starting position. Three sets of 10 repetitions were applied, with 1 minute between sets.

The subjects of Group C were given combination of ERM+MWM as described above in Group A and Group B respectively. All the three groups were given conventional physiotherapy *(Kumar et al, 2012)* comprising of posterior capsular stretching in cross-body reach position using the opposite arm done by the subjects in all the groups. Duration- Each stretch was performed 5 times per day in a minute for total of approximately 15 minutes per day & basic pendular exercises (three times daily for 2-3 minutes). The scores of range of motion (both active & passive) & SPADI (Shoulder Pain and Disability Index) of each subject of Group-A, Group-B & Group – C were recorded before and after 3-weeks. The data was analyzed using statistical computer software 'SPSS16 free trial version'. The mean, standard deviation & one way ANOVA- test was used for between group comparisons of ROM and SPADI. Post HOC analysis- Tukey's test was used for significant interactions between groups and to find which group is better. The results were found to be significant at $p< 0.05$.

Results & Discussion

The mean age and BMI of the subjects of Group –A, Group-B & Group C were 48.60±5.37 years, 50.40±5.85 years & 47.90±4.35 years; 25.10±1.524 Kg/m^2, 25.10±3.446 Kg/m^2 & 25.70±1.160 Kg/m^2 respectively. It was found that the difference in the mean values of age and BMI in all the three groups were not statistical significant.

Table 1. Comparison of Age & BMI

	Group-A	Group-B	Group-C	p-value
Age (years)	48.60±5.37	50.40 ±5.85	47.90 ±4.35	0.55
BMI (Kg/m^2)	25.10±1.52	25.10 ±3.446	25.70 ±1.160	0.795

*significant p<0.05

Table 2 shows the difference in mean of pre SPADI among three groups was not statistically significant. But the difference in mean of post SPADI among three groups were statistically significant.

Table 2 Mean, standard deviation and p value of Pre-Post SPADI among Group A , Group B and Group C.

	Pre SPADI			Post SPADI		
	Mean ±SD	F	P	Mean ±SD	F	P
Group A	72.07 ±5.52	0.43	0.64	45.46 ±3.52	12.10	0.00
Group B	72.77 ±3.85			44.07 ±3.36		
Group C	70.60 ±6.00			36.53 ±5.78		

Table 3 shows the comparison of scores of active ROM in terms of flexion, abduction, external rotation & internal rotation respectively among Group-A, Group-B & Group-C before and after 3 weeks. It was found that before the start of 3 weeks treatment programme to the subjects of three groups, there existed no statistical difference in the scores of active ROM. However after 3 weeks statistically significant difference in the scores of active ROM in all the groups but a greater improvement was observed in Group-C as compared to Groups- A & B respectively.

Table 3: Mean, standard deviation and p value of Pre-Post Active ROM comparison among Group A, Group B and Group C.

Movements		PRE-ROM			POST-ROM		
		A	B	C	A	B	C
Flexion	Mean ±SD	100.60±6.93	98.80±7.17	99.30±7.60	102.30±6.71	102.90±6.93	110.60±7.01
	F value		0.16			4.51	
	P value		0.84			0.02	
Abduction	Mean ±SD	98.40±5.40	98.50±6.02	96.50±6.78	101.80±5.51	101.20±6.05	109.50±8.68
	F value		0.34			4.51	
	P value		0.71			0.02	
External rotation	Mean ±SD	19.20±3.67	21.80±2.78	21.00±1.49	23.60±4.16	29.70±5.16	32.40±3.92
	F value		2.26			10.25	
	P value		0.12			0	
Internal rotation	Mean ±SD	27.30±6.80	31.20±7.16	34.90±7.52	29.90±6.59	31.70±4.11	39.40±9.09
	F value		2.81			5.34	
	P value		0.07			0.01	

Table 4 Mean, standard deviation and p value of Pre-Post Passive ROM among Group A, Group B and Group C.

Movements		PRE-ROM			POST-ROM		
		A	B	C	A	B	C
Flexion	Mean ±SD	100.90±6.59	98.90±7.37	99.80±7.74	108.20±4.46	108.80±5.18	114.60±5.58
	F value		0.19			4.8	
	P value		0.82			0.01	
Abduction	Mean ±SD	103.40±7.09	105.50±7.50	99.90±7.66	106.50±6.11	106.60±7.53	114.40±6.73
	F value		1.45			4.41	
	P value		0.25			0.02	
External rotation	Mean ±SD	22.70±3.88	27.10±4.77	26.10±5.25	24.80±3.64	28.40±4.37	
	F value		2.43			10.63	
	P value		0.1			0	
Internal rotation	Mean ±SD	34.50±6.31	40.60±7.58	33.60±8.15	37.30±6.30	40.80±7.54	47.10±1.19
	F value		2.95			7.54	
	P value			0.06		0	

Table 4 shows the comparison of scores of passive ROM in terms of flexion, abduction, external rotation & internal rotation respectively among Group-A, Group-B & Group-C before and after 3 weeks. It was found that before the start of 3 weeks treatment programme to the subjects of three groups there was no statistical difference in the scores of passive ROM. However after 3 weeks statistical significant differences in the scores of passive ROM in all the groups were recorded but a greater improvement was observed in Group-C as compared to Groups- A & B respectively. According to Tukey's, multiple comparisons, it was revealed that there is no significant difference found among Group A, Group B and Group C in terms of pre active & passive ROM respectively.

Post Hoc Analysis for Active Flexion ROM: There exists no significant difference, when Group A was compared with Group B (p value= 0.979), but there was significant difference observed in Group C compared with Group A (p value= 0.031) and Group and Group B compared with Group C (p value=0.048) in terms of post active flexion ROM.

Post Hoc Analysis for Active Abduction ROM: There exists no significant difference, when Group A was compared with Group B (p value=0.979), but there was significant difference, when Group C was compared with Group A (p value= 0.048) and Group B was compared with Group C (p value=0.031) in terms of post active abduction ROM.

Post Hoc Analysis for Active External Rotation ROM: There exists no significant difference in Group B when compared with group C (p value=0.377), but there was a significant difference in Group A compared with Group B (p value=0.013) and Group C compared with Group A (p value= 0.000) in terms of post active external ROM.

Post Hoc Analysis for Active Internal Rotation ROM: There exists no significant difference in Group A compared with Group B (p value=0.830), but there was a significant difference, when Group C compared with Group A (p value= 0.013) and Group B compared with Group C (p value=0.049) in terms of post active external ROM.

Post Hoc Analysis for Passive Flexion ROM: There exists no significant difference in Group A compared with Group B (p value=0.963), but there was a significant difference, when Group A compared with Group C (p value= 0.024) and Group B compared with Group C (p value=0.043) in terms of passive flexion ROM.

Post Hoc Analysis for Passive Abduction ROM: There exists no significant difference in Group A compared with Group B (p value=0.999), but there was a significant difference, when Group C compared with Group A (p value= 0.039) and Group C compared with Group B (p value=0.042) in terms of passive abduction ROM.

Post Hoc Analysis for Passive External Rotation ROM: There exists no significant difference in Group A when compared with Group B (p value=0.226), but there was a significant difference, when Group C compared with Group A (p value= 0.000) and Group B compared with Group C (p value=0.021) in terms of passive External Rotation ROM.

Post Hoc Analysis for Passive Internal Rotation ROM: There exists no significant difference in Group A when compared with Group B (p value=0.371), but there was a significant difference, when Group C compared with Group A (p value= 0.002) and Group B compared with Group C (p value=0.052), in terms of passive Internal Rotation ROM.

Post Hoc Analysis for SPADI: According to Tukey's, multiple comparisons, it was revealed that there is no significant difference found among Group A, Group B and Group C in terms of pre SPADI. However there exists no significant difference in Group A when compared with Group B (p value=0.760), but there was a significant difference, when Group C compared with Group A (p value= 0.000) and Group B compared with Group C (p value=0.002), in terms of Post SPADI.

Discussion

The results of the present study indicated that subjects in all the three groups had shown significant improvements in the flexion, abduction, external and internal rotation ranges of motion respectively and there is decrease in shoulder disability as measured by SPADI. However, comparison among three groups, reveal that there is minimal improvement in end range mobilization group in terms of range of motion and shoulder disability, mobilization with movement group and combined intervention group. So, alternative hypothesis is accepted.

Comparing the effectiveness of the above treatment strategies in subjects with unilateral frozen shoulder, Group C (ERM+MWM) was observed to be more effective in increasing mobility and functional ability (Tables 3, 4). These results support the findings of previous studies *(Yang et al, 2007; Mulligan, 2003; Vermeulen et al, 2006; Teys et al, 2008; Kachingwe et al, 2008; Kumar et al, 2012)* showing improvement after mobilization in a frozen shoulder.

To regain the normal extensibility of the shoulder capsule and tight soft tissues, passive stretching of the shoulder capsule and soft tissues by means of mobilization techniques has been recommended, but limited data supporting the use of these techniques are available *(Vermeulen et al, 2000; Diercks and Stevens, 2004)*. Mobilization techniques improve the normal extensibility of the shoulder capsule and stretch the tightened soft tissues to induce beneficial effects *(Yang et al, 2007)*. The results of the present study support this promise and indicate that the most beneficial effects can be achieved with combination of ERM and MWM rather than separate one.

The three groups had equal number of subjects and there were no significant differences with respect to their gender distribution, age which could have altered the results of the study (Table 1).

Bialosky et al (2009) suggested that manual therapy (MT) is effective in the treatment of musculoskeletal pain. They proposed the mechanism accounts for the complex interactions of both the peripheral and central nervous system which comprise the pain experience. Specific joint mobilization techniques are believed to selectively stress certain parts of the joint capsule *(Terry, 1991)*. Joint mobilization techniques are assumed to induce neurophysiologic effect which is based upon the stimulation of the peripheral mechanoreceptors and inhibition of nociceptors *(Mangus et al, 2002)*. The biomechanical effect manifests itself when forces are directed towards resistance but within the limit of subjects tolerance. The mechanical changes may include breaking up adhesions, realigning of collagen or increasing fiber glide when specific movement stress the specific part of the capsular tissue *(Donatelli and Wooden, 2004)*. Mobilization techniques are supposed to increase or maintain joint mobility by inducing rheological changes in synovial fluid, cartilage matrix and increased synovial turnover time *(Noel et al, 2000)*.

Maitland's mobilization mainly consists of rhythmic oscillatory movements which stimulate the type-2 dynamic mechanoreceptors and by this way can inhibit the type-4 nociceptive receptors and also has an effect on circulatory perfusion. Mobilization has an effect on fluid flow as blood flow in the vessels supplying the nerve fibres and synovial fluid flow surrounding the avascular articular cartilage. Mobilization causes a reversal of the ischemia, oedema, and inflammation cycle and reduces joint effusion and relieves pain by reducing the pressure over the nerve endings *(Maitland, 1983)*.

Mobilization with intense capsular stretching causes tissue remodeling refers to a physical rearrangement of the connective tissue extracellular matrix (fibers, crosslinks, and ground substance) and collagenous tissues respond to increased tensile loading by increasing the synthesis of collagen and other extracellular components *(Mueller and Maluf, 2002)*.

Lin et al (2008) had found the reduction in GH joint stiffness and increase in passive abduction range of motion, immediately after end-range mobilization of the shoulder joint that is consistent with the findings obtained in the present study (Table 4). The use of intensive mobilization techniques may help to decrease the risk of further stiffness or joint contracture progression in patients with adhesive capsulitis.

The result of the present study (Table 3, 4) are consistent with the finding obtained in the study conducted by *Wadsworth et al (1986)* demonstrated that, passive oscillatory movements are effective to reduce pain and increase in all the motions (except medial rotation in the control group) significantly in the frozen shoulder patients because of neuromodulation effect on the mechanoreceptors within the joints *(Barak, 1985).*

Many authors and clinicians advocated joint mobilization for pain reduction and improved ROM *(Vermeulen et al, 2000; Vermeulen et al, 2006). Johnson et al (2007)* who found significant improvement in external rotation motion in patients with frozen shoulder after performing posterior glide mobilizations sustained for 1 minute at end range of abduction and external rotation by promoting elongation of shortened fibrotic soft tissues. These findings support the results obtained in the present study (Table 3, 4).

Vermeulen et al (2000) demonstrated that, with End range mobilization techniques (EMTs) there is increases in joint capacity and glenohumeral mobility after 3 months of treatment. He reported significant improvement in active and passive motion, pain and joint volume & the results coincide with the present study (Table 3, 4).

The findings obtained by *Teys et al (2008)* using the Mulligan's mobilization with movement(MWM) in the plane of scapula in the restricted shoulder results in significant improved ROM and Pressure pain threshold (PPT) are consistent with the findings obtained in the present study (Table 3, 4). Improved ROM by Mulligan's movement with mobilization is attributed to the mechanisms underlying it as described by *Wright et al (1995),* that the mechanism responsible for MWM treatment effects may feasibly involve changes in the joint, muscle, pain and motor control systems as it produce an immediate relief in pain and improve ROM respectively.

Vicenzino et al (2007) reports espousing clinically beneficial effects of Mulligan's mobilization-with-movement (MWM) treatment techniques by substantial pain reduction accompanied by improved function in shoulder disorders by reducing positional faults at joints (subluxations). The evidence from the pain science studies that have attempted to characterize the hypoalgesic effect has indicated that it may be non-opoid in nature as well as exhibiting features that are complex and widely distributed to other systems, such as the motor and sympathetic nervous systems.

Kachingwe et al (2008) found, there was significant increase in active ROM and decrease in pain, in patients with Shoulder dysfunction by using MWM techniques as described by *Mulligan (1999).* Passive movement produced by manual techniques resulted in pain reduction through activation of mechanoreceptors inhibiting nociceptive stimuli through the gate-control mechanism or through facilitation of synovial fluid nutrition *(Threlkeld, 1992)*. An additional explanation given that why MWM was better in decreasing pain and improving function is that, MWM technique has the additional benefit which may engage additional proprioceptive tissues, such as the golgi tendon organs activated by tendon stretch and restored the normal glenohumeral arthrokinematics and resulted in capsular stretching *(Kachingwe et al, 2008)*.

In the post hoc analysis, using Tukey's method it was found that, both End range mobilization and Movement with mobilization techniques increases both active and passive ROM and reduces disability significantly in 20 Frozen shoulder patients after 3 weeks intervention, but the more statistical significant result was found with combined intervention of ERM and MWM techniques in both active and passive ROM and SPADI scores in 10 frozen shoulder patients after 3 weeks intervention.

Conclusion

It was concluded that the combination manual therapy (ERM+MWM) should be incorporated in the treatment protocol of frozen shoulder patients to achieve better gain in the ROM & SPADI scores.

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