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Randomized Clinical Trial for Efficacy of Mobilization with Movement versus End-Range Mobilization Techniques in the Treatment of Adhesive Capsulitis of Shoulder Joint

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The objective of this study is to compare the efficacy between mobilization with movement (MWM) and end-range mobilization techniques (EMTs) in the management of adhesive capsulitis. Eighteen and twenty-two patients from MWM and EMT groups, respectively, who returned after two-week follow-up were evaluated. This was a randomized, evaluator-blind, parallel comparison study. Active and passive range of motion (ROM) for flexion, internal and external rotation, abduction and pain scale were assessed regularly by the same physical therapist. Pain reduction was observed in most of the patients. The proportion of patients with the same or worse condition after one month of follow-up was not significantly different for all measures between groups, although the MWM group had a slightly smaller percentage than EMT group in internal rotation (1/18 vs 6/22, p=0.105). After one-month follow-up the MWM patients also had a significantly better improvement in external rotation, $p<0.05$. MWM was proved to be at least equally effective in the treatment of adhesive capsulitis compared to EMTs. Further studies are needed to investigate the efficacy of MWM and the duration of its effect. (J Rehab Med Assoc ROC 2003; 31(4): 187 - 197)

Key words: frozen shoulder, adhesive capsulitis, mobilization techniques, shoulder, clinical trial

INTRODUCTION

Frozen shoulder is characterized by painful restriction of shoulder motion. Its etiology and pathogenesis remain controversial. Several treatments have been investigated, including local or oral steroids, manipulation under anaesthesia (MUA), arthroscopic or hydraulic distension, stellate ganglion block, physiotherapy, surgical release, suprascapular nerve block, and radiotherapy. The responses to any particular treatment vary from patient to patient.[1-8] In a randomized study, Bulgen et al. have enrolled 42 patients into four treatment arms: intraarticular steroids, mobilizations, ice therapy and no

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treatment. Little long-term advantage was observed in any of the treatment regimens but steroid injections appeared to improve pain and range of movement in the early stages.[1] The disagreement about treatment effect of various treatment options in the literature is consistent with our clinical observations.

According to the Cyriax classification,[9] there are four types of shoulder problem. The first one is inert structure injury, including capsular pattern and non-capsular pattern. A capsular pattern indicates arthritis or capsule inflammation leading to fibrosis, then to thickening of the fibrous capsule, adhesion formation, and finally to loss of the normal capsular elasticity. The non-capsular pattern includes both acute and chronic subacromion bursitis, subcoracoid bursitis, acromioclavicular joint sprain, coracoid and trapezoid ligament sprain, and instability of the shoulder. The second type of shoulder condition is contractile structures disorders, among which tendonitis is the most common diagnosis. The third type is vascular disorder with subclavian steal syndrome as the major complaint. The fourth type is neurological problem, which might result from a lesion of nerve roots C_2-C_4, or neuritis of the accessory nerve.[10]

Although Cyriax suggested that capsular stretching could be performed when an acute adhesive capsulitis had progressed to chronic adhesive capsulitis with or without intraarticular injections,[9] some of our patients could not tolerate the capsular stretching pain. End-range mobilization techniques (EMTs), reported by Cyriax,[9] and Maitland,[11] have been evaluated by Vermeulen et al.[2] for the treatment of adhesive capsulitis. According to Vermeulen et al., all seven patients who received EMTs twice a week for 3 months maintained the gain in joint mobility after 9 months of follow-up.[2]

Mobilization with movement (MWM) technique is another option of joint mobilization proposed by Mulligan.[12] This technique is proposed to restore normal joint alignment rather than stretch tightened tissues to regain normal arthrokinematics. The mechanism is to find a position that best allows for pain-free gliding motion while the patient is performing a pain-limited motion, in order to reduce pain and increase the range of motion (ROM). It can be a dynamic and loaded joint relaxation modality rather than a static mobilization mentioned by Maitland.[11] The combination of MWM and other conventional agents and techniques for treating a patient with complicated DeQuervain's Tenosynovitis, reported by Backstrom, was successful.[13] However, only few reports are available in literature about the evaluation of the effect of MWM in the treatment of frozen shoulder. The similarity of these two techniques, MWMs and EMTs, lies in passive mobilization to increase the extensibility of the shoulder capsule. These two methods differ in that MWMs attempt to avoid distortion of involved soft tissues to increase the range of motion in the shoulder without pain while EMTs attempts to stretch the soft tissues and are not pain-free.

The objective of this randomized study is to compare the efficacy between modified MWMs and EMTs in the management of patients with adhesive capsulitis.

METHODS

Subjects

Patients of either sex presenting with frozen shoulder were included if they had (1) a painful stiff shoulder for at least 3 weeks, (2) restriction in passive shoulder abduction, flexion in the sagittal plane, or lateral rotation compared with the other side, and (3) capsular pattern[9,10] of structure injury. Patients were excluded if they had (1) diabetes mellitus, (2) a painful stiff shoulder after a major trauma, (3) osteoarthrosis or bony damage due to trauma on the radiographs of the affected shoulder, or (4) any of the non-capsular pattern structure injuries, including bursitis, tendinitis, and ligament sprain. Written informed consent was obtained from all study subjects and that the rights of human subjects were protected.

Treatment assignment

This was a randomized, evaluator-blind, parallel comparison study. During the period between February 2000 and February 2001, 80 patients consented to enroll in the study and were randomly assigned to one of the two treatment groups: A) MWMs, and B) EMTs. Definition of acuity phase was referred to the stages by Ombregt et al.[10] (Table 1) "Acute phase" was defined as patients with symptoms of stage III, "subacute phase" referred to stage II, and "chronic phase" referred to stage I. Physiotherapy with MWMs or EMTs was performed

three times a week for 40 minutes starting on Day 1 when the patients were considered to be at subacute or chronic phase. All the MWM sessions were performed by a physical therapist with 12 years' experience, while the EMTs sessions were performed by a therapist with 25 years' experience. All patients from the same group received the same instructions regarding rest and elevation of the affected shoulder. After physical therapy, patients were assessed on Days 1, 3, 7, 14, 21, 28, 56 and 84. Both active and passive range of motion for flexion, internal rotation, external rotation, and abduction, along with the severity of pain using 10 cm visual analogue scales (V.A.S.) were measured prior to and after the treatment sessions by the appointed therapist who did not have the knowledge of patients' treatment assignment. Range of motion measures were assessed with the patient in the supine position.[14] Rotation was measured at 90^0 abduction or at the maximum obtainable amount of abduction if patients were not able to abduct to 90^0.[15] Clinical assessments, range of motion and pain scale, were made on the same day in a room at constant temperature by the same physical therapist.

Mobilization With Movement (MWM)

The gliding direction of MWM does not usually follow the concave-convex theory,[16] therefore it should be found through trial and error. The decision to use a particular joint glide that causes less pain is determined by the patient's pain tolerance. The following are four types of MWM[12] which were applied to all of our study subjects with 10 to 15 repetitions of each gliding.

1. Superior/posterior MWMs: Increase the abduction of shoulder joint.

   While asking a patient to abduct his/her shoulder joint, the therapist applied a superior gliding force over the head of the humerus to mobilize adhesive capsule and avoid distorting involved soft tissues rather than relaxing glenohumeral joint. If the superior glide was not successful, the therapist would try another direction of gliding. When the arm was correctly positioned, the patient felt no pain. This was repeated ten times. (Figure 1)
2. Superior MWMs: Increase the flexion of shoulder joint.

   Application of a superior gliding force during shoulder flexion. (Figure 2)
3. Anterior/inferior MWMs: Improve the internal rotation of the shoulder.

   Application of an anterior/inferior gliding force through the armpit while the shoulder is internally rotating. (Figure 3)
4. Posterior MWMs: Improve the external rotation of the shoulder.

   Application of a posterior gliding force while the shoulder is externally rotating. (Figure 4)

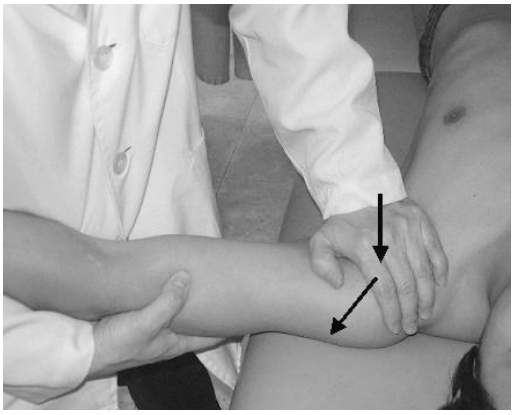

Figure 1. Superior and Posterior MWMs for abduction loss

Figure 2. Superior MWMs for shoulder flexion loss

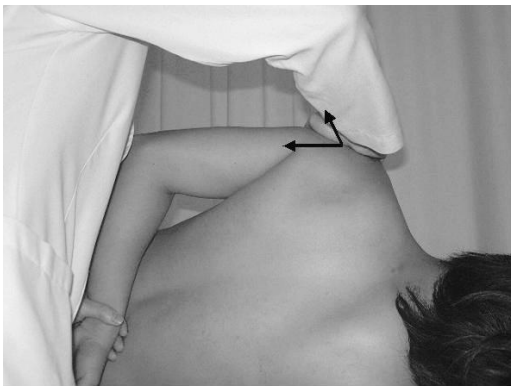

Figure 3. Anterior and inferior MWMs for shoulder internal rotation loss

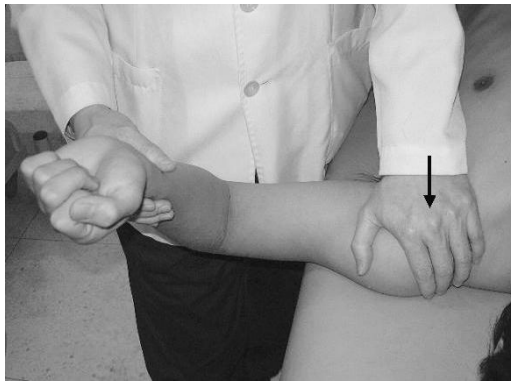

Figure 4. Posterior MWMs for shoulder external rotation loss

End-Range Mobilization Techniques (EMTs)

The techniques we adopted were those described by Maitland[11] and Vermeulen et al.[2] Information about the end-range position and the end-feel of the glenohumeral joint was obtained by the physical therapist through examining the patient's ROM in all directions at the beginning of each intervention session. While the patient was in a supine position, interventions were performed after a few minutes of warm up consisting of rhythmic mid-range mobilizations. The therapist placed his hands close to the glenohumeral joint and brought it into a position of maximal flexion in the sagittal plane. After repeating 10 to 15 intensive mobilizations in this end-range position, the therapist then changed the direction of mobilization by altering the plane of elevation or degree of rotation. In each direction of mobilization, the therapist repeated the techniques 10 to 15 times before changing the direction. The mobilization grade and the duration of prolonged stress were adjusted with patient's acceptability. According to Vermeulen et al.,[2] minimizing reflex muscle activity was essential to EMTs. Sometimes it might be important to obtain necessary muscle relaxation by moving the shoulder once or twice through the whole ROM. The patient had to inform the therapist whenever pain occurred during and after each session, and the therapist might then alter the direction or degree of mobilization or continue the same mobilization based on his experience.

Statistical Analysis

Patients who failed to comply with the therapy course for at least 2 weeks were excluded from the analysis. Evaluation results of patients who did not return were considered to be the same as the previous available visit, i.e., no improvement scenario. The minimal sample size required to detect a 36% difference between groups in proportion of patients with the same or worse condition from baseline by the end of study, with a power of 80% and a significant level of 5%, was 20 patients for each of the two groups. Fisher's exact test and Student's t-test were performed to compare the categorical and continuous variables, respectively, between the two treatment groups. The average of ROM and pain variables measured prior to and after treatment sessions was considered as the performance at each visit. Changes from baseline of all measures were also graphically illustrated over time, and Student's t-test was performed at each time point for between group comparisons. Two-way analysis of variance (ANOVA) with repeated measures was also performed to examine the time effect, treatment effect and interaction of both. All statistical analyses were performed with SAS v8.02 software. A p-value smaller than 0.05 was considered to be statistically significant.

RESULTS

A total of 80 patients were enrolled and randomly assigned to either group with 40 patients in each treatment arm. However, by the end of two weeks after the initial physiotherapy session, only 18 and 22 patients remained in the MWMs and EMTs group, respectively.

The 40 patients who received treatment courses for more than two weeks were included in the analysis set. All of the 40 patients remained in the study for at least 4 weeks and 14 (35%) of them were evaluated for as long as 12 weeks. None of the basic characteristics in terms of age, gender, body weight, height, body mass index (BMI), duration of symptoms, and previous intraarticular injections were significantly different between the two treatment groups. (Table 2)

Table 1. Definition of acuity phase [10]

Symptoms	Stage I (Chronic)	Stage II (Subacute phase)	Stage III (Acute phase)
Pain at rest?	No		Yes
Pain below the elbow?	No	Transitional stage	Yes
Can lie on the affected side at night?	Yes	IIa: Pain at end of movement	No
End-feel?	Elastic	IIb: Pain before end of movement	Abnormal: hard or muscle spasm

Table 2. Basic characteristics

	MWMs (N=18)	EMTs (N=22)	Total (N=40)	p-value*
Follow-up completed				0.76
Visit 6 (28 days)	10 (55.6%)	10 (45.5%)	20 (50.0%)	
Visit 7 (56 days)	2 (11.1%)	4 (18.2%)	6 (15.0%)	
Visit 8 (84 days)	6 (33.3%)	8 (36.4%)	14 (35.0%)	
Age (years)				0.85
Mean ± SD	54.6 ± 17.0	55.5 ± 14.3	55.1 ± 15.4	
Range	21-78	33-86	21-86	
Sex				1.00
Female (%)	8 (44.4%)	10 (45.5%)	18 (45.0%)	
Male (%)	10 (55.6%)	12 (54.5%)	22 (55.0%)	
Weight (kg)				0.51
Mean ± SD	60.4 ± 13.2	62.8 ± 8.3	61.8 ± 10.7	
Range	38-83	50-80	38-83	
Height (cm)				0.95
Mean ± SD	163.9 ± 9.2	164.1 ± 7.0	164.0 ± 8.0	
Range	149-178	152-178	149-178	
BMI (kg/m^2)				0.32
Mean ± SD	22.3 ± 3.6	23.3 ± 2.6	22.9 ± 3.1	
Range	16.0-28.7	18.8-28.0	16.0-28.7	
Duration of symptom (Month)				0.81
Mean ± SD	2.81 ± 1.74	2.68 ± 1.48	2.74 ± 1.58	
Range	0.75-7.0	0.75-5.0	0.75-7.0	
Previous intraarticular injections				1.00
	6 (33.3%)	7 (31.8%)	13 (32.5%)	

* p-value by Fisher's exact test or Student's t-test, when appropriate.

BMI: body mass index

Table 3. Percentage of patients with ROM measures the same as or worse than baseline

	MWMs (N=18)		EMTs (N=22)		Total		
	N	%	N	%	N	%	p-value[2]
Flexion							
AROM							
Day 28[1]	0	0.0	1	4.5	1	2.5	NS
Day 84[1]	0	0.0	0	0.0	0	0	NS
PROM							
Day 28	0	0.0	1	4.5	1	2.5	NS
Day 84	0	0.0	0	0.0	0	0	NS
IR							
AROM							
Day 28	1	5.6	6	27.3	7	17.5	NS
Day 84	1	5.6	5	22.7	6	15.0	NS
PROM							
Day 28	1	5.6	6	27.3	7	17.5	NS
Day 84	1	5.6	6	27.3	7	17.5	NS
ER							
AROM							
Day 28	0	0.0	1	4.5	1	2.5	NS
Day 84	0	0.0	1	4.5	1	2.5	NS
PROM							
Day 28	0	0.0	1	4.5	1	2.5	NS
Day 84	0	0.0	2	9.1	2	5.0	NS
ABD							
AROM							
Day 28	0	0.0	1	4.5	1	2.5	NS
Day 84	0	0.0	0	0.0	0	0.0	NS
PROM							
Day 28	0	0.0	3	13.6	3	7.5	NS
Day 84	0	0.0	2	9.1	2	5.0	NS
VAS							
Day 28	1[3]	5.6	0	0.0	0	0.0	NS
Day 84	1[3]	5.6	0	0.0	0	0.0	NS

VAS: visual analogue scales; AROM: active range of motion; PROM: passive range of motion; NS: not significant; IR: internal rotation; ER: external rotation; ABD: abduction

1: The previous available assessment was used when the patient did not return on Day 84.

2: Fisher's exact test was performed for the two-sample comparison.

3: The subject had a VAS=2.0 throughout the entire study period.

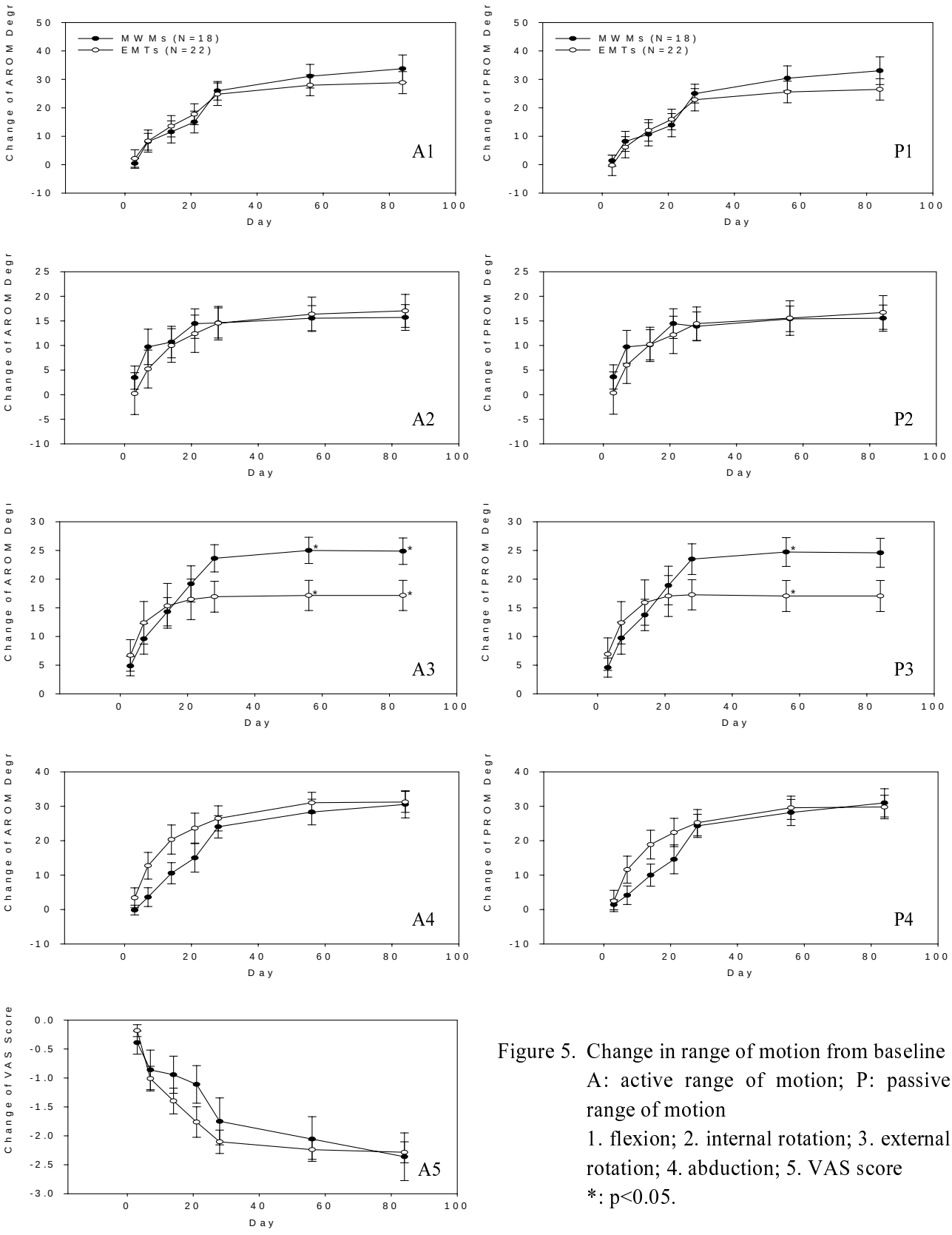

Figure 5. Change in range of motion from baseline
A: active range of motion; P: passive range of motion
1. flexion; 2. internal rotation; 3. external rotation; 4. abduction; 5. VAS score
*: $p<0.05$.

All of the baseline measurements of both active and passive ROM and pain scale were not significantly different between the two groups (Data not shown). The last visit when all patients were evaluated was Day 28, and the final study visit was Day 84. The proportion of patients with conditions no better than baseline after 4 weeks (28 days) and 12 weeks (84 days) of treatment was not significantly different between MWMs and EMTs groups in all of the ROM and pain variables, though a larger proportion of patients receiving EMTs had unimproved internal rotation evaluation (both active and passive range of motion) after one-month follow-up (1/18, 5.6% for MWMs vs. 6/22, 27.3% for EMTs on Day 28, p=0.105). (Table 3) In addition to having a better mobilization performance, more than 50% of patients from both groups had pain relieved (VAS ≤ 3) after 4 weeks of treatment: 8 (44.4%) for MWM and 11 (50%) for EMT on Day 28; 4 (22.2%) for MWM and 10 (45.5%) for EMT on Day 84. None of the range of motion assessments from patients in the MWM group remained the same or worse, comparing to baseline, in all active measures except for one (5.6%) patient whose active and passive ROMs of internal rotation were not improved after four weeks of treatment. Slightly more EMTs patients (at least one for each measure) remained the same or worse than baseline at Day 28. (Table 3)

The change from baseline for each measure over time is graphically illustrated in Figure 5. Both treatments gradually increased the change from baseline of both active and passive flexion, internal and external rotation, and abduction ROMs. However, there were still patients with measurement below 50% of normal ROM, i.e., less than 90^0 for flexion and abduction, and 45^0 for internal and external rotation. The number of patients with values under 50% normal ROM for either active or passive flexion, internal rotation, external rotation and abduction are respectively as follows: 0, 1 (5.6%), 1 (5.6%), 3 (16.7%) for MWM group and 2 (9.1%), 2 (9.1%), 6 (27.3%), 5 (22.7%) for EMT group on Day 28; 0, 0, 1 (5.6%), 3 (16.7%) for MWM, and 0, 1 (4.5%), 5 (22.7%), 5 (22.7%) for EMT group on Day 84. The effect of MWMs appeared to have a better improvement in external rotation after Visit 6 (Day 28) compared with the EMT group (Figure 5A3 and 5P3). No significant difference between groups was observed for the other assessments. The repeated measures analysis of variance (ANOVA) showed a significant time effect for all efficacy measures in both groups, $p<0.05$. No treatment effect and interaction between time and treatment were found for all measures except that the external rotation had a significant time and treatment interaction, p=0.0015 for active ROM and p=0.0011 for passive ROM. (Data not shown)

DISCUSSION

The results showed that most of the patients receiving either treatment regained their joint mobility and had pain relieved gradually. Although frozen shoulder was considered a self-limiting disorder with spontaneous recovery within two years, it can persist for three years or longer.[17-19] The natural history of adhesive capsulitis was reported to have a mean duration of 30 months with a range of 12-42 months.[17] Significant functional restrictions remained in 60% of patients after 7 years of follow-up in a study by Shafter et al., though pain reduction was notable in most of the patients.[18] With the duration of symptom of our patients ranging from 3 weeks to 7 months, the changes seen in the joint mobility and pain reduction were more likely attributed to the physical therapies rather than to the self-recovery. In Vermeulen's report,[2] all 7 patients maintained their regained mobility at the 9-month follow-up after 3 months of treatment with EMTs. Among 7 patients treated and followed, five reported no pain in the affected shoulder after 3 months of treatment and 9 months after treatment. With a relative short-term of treatment and follow-up period in our study, it is not able to conclude how long the regained mobility would last. Some clinical trials showed that steroid injections might be superior to physiotherapy alone for the treatment of frozen shoulder, especially at acute or subacute stage.[1,20,21] Since intraarticular injection is one of the options for the treatment of frozen shoulder and some patients cannot tolerate the pain caused by mobilization at acute stage, due to ethical considerations, patients are sometimes given intraarticular injections for pain relief at acute stage upon doctors' judgment as one of the regular treatments. Currently, a more immediate alleviation of suffering is still desired by the majority of patients. It is not ethical to use untreated patients as a comparison group, and patients are easily lost in fol-

low-up when their complaints are not resolved immediately or, on the contrary, when they regain their normal function and don't feel it necessary to continue with the treatment sessions. Patients who failed to comply with the treatment course for at least 2 weeks were excluded from the analysis since they were not followed long enough to evaluate the effect of physical therapy, especially when some of them had previous intraarticular injections of steroids before entering the study. For those who remained in the study for more than two weeks, a "no improvement scenario" was considered appropriate for the analysis, and the results should be interpreted with caution due to large portion of loss-to-follow-up during the later period.

The disagreement about treatment effect in the literature might have something to do with the non-specific differential diagnosis. Sometimes shoulder stiffness and pain are caused by disorders other than adhesive capsulitis, for example, severe trauma, osteoarthrosis or bony damage due to trauma, bursitis, tendonitis, or ligament sprain. These disorders often do not respond well to physiotherapy or steroid injection alone according to our experience. The inclusion of patients with such diagnoses into a study might therefore dilute the treatment effect for adhesive capsulitis.

Since the MWM technique for frozen shoulder was relatively new to our therapist as compared with EMTs at the time the study began, the maneuvering skills for both groups might have been slightly different. In order to minimize the inter-person variation, we appointed only one experienced therapist for each group. All patients receiving MWMs had all range of motion assessments better than baseline except that one out of 18 (5.6%) patients had internal rotation ROM unimproved on both Day 28 and the end of the follow-up (Day 84). More (6/22, 27.3%) patients from the EMT group had unchanged or worse internal rotation condition on Day 28. Besides, according to the experience of the authors, the MWM caused less pain during the treatment sessions than EMTs did, though this was not systematically evaluated in our study. Although most of the patients with improved range of motion for all measures, some patients' mobility function remained unsatisfactory, i.e., with a range of motion below 50% of normal ROM. The two treatment groups had a similar pattern of improvement during the early period, i.e., by Day 14, which might be partially explained by the effect of previous steroid injections. The MWM group appeared to have a better effect upon the external rotation after 4 weeks of treatment, and the improving rate in terms of change from baseline ROM was higher in MWM group than in EMT group. (Figures 5A3 and 5P3) The effectiveness of MWM might result from (1) repositioning of abnormal tissues and repositioning of joint component, (2) normal output to central nerves system (CNS), (3) defacilitation of CNS, (4) normal output to tissue, and (5) normal positioning maintained by neuromuscular control.[22] However, it still calls for further investigation to explore why MWM was more effective than EMT in terms of the improvement of ER loss.

This study fails to show that MWMs are superior to EMTs in overall assessments statistically, but the percentages of patients with improved ROMs and assessment results greater than 50% of normal ROM by the end of the study were slightly higher in patients receiving MWMs than in those who received EMTs. The lack of statistical significance might be explained by small sample size, loss-to-follow-up of patients, previous steroid injection effect, inconsistent maneuver skill for both therapies, and insufficient follow-up duration. Further studies with larger sample sizes, longer period of treatment and follow-up, fresh patients without history of steroid injections, and extra effort to keep patients from turning to other therapy alternatives or withdrawal due to recovery are needed to investigate the efficacy and duration of the treatment effect of MWM.

CONCLUSION

This is the first randomized study to evaluate the treatment effect of MWMs for adhesive capsulitis of the shoulder joint, with a larger study population than that in the case reports published by Vermeulen et al.[2] (seven patients) and Backstrom[13] (one patient) for the evaluation of EMTs and MWMs. The procedure is safe and effective, and causes less pain. Nonetheless, to establish its superiority to other techniques and the duration of effect still calls for randomized studies with a larger sample size, a longer period of follow-up, and patients without previous steroid injections.

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比較動態關節鬆動術與活動極限下做關節鬆動術治療冰凍肩療效之隨機分配臨床試驗

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本研究之目的為比較動態關節鬆動術與活動極限下做關節鬆動術對於治療冰凍肩的療效。對於 18 位接受動態關節鬆動術及 22 位接受活動極限下做關節鬆動術治療超過兩週以上的個案進行評估。為一隨機分配、評估者單盲、及平行比較的研究。由同一位物理治療師進行肩關節主動及被動的彎曲、內轉、外轉、外展活動度及疼痛量表評估。大部份個案的疼痛指數均隨著治療而下降，各項評估結果沒有改善的比例在一個月的追蹤時兩組均無顯著差異，雖然動態關節鬆動術組在內轉的測量上比活動極限下做關節鬆動術組有較低的未改善比例((1/18 比 6/22, p=0.105)。此外在二維重複測量的多變項分析(2-way ANOVA with repeated measures)的結果顯示在一個月的追蹤時，動態關節鬆動術治療的患者在外轉上有顯著較活動極限下做關節鬆動術組為佳的改善，$p<0.05$。本研究顯示動態關節鬆動術對於冰凍肩的治療有與活動極限下做關節鬆動術相當的效果，欲進一步瞭解其療效的持續期則需更深入的研究及探討。(中華復健醫誌 2003; 31(4): 187 - 197)

關鍵詞：冰凍肩(frozen shoulder)，關節囊炎(adhesive capsulitis)，關節鬆動術(mobilization techniques)，肩(shoulder)，臨床試驗(clinical trial)

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