Mobilization Techniques in Subjects With Frozen Shoulder Syndrome: Randomized Multiple-Treatment Trial

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Background and Purpose

The purpose of this study was to compare the use of 3 mobilization techniques—end-range mobilization (ERM), mid-range mobilization (MRM), and mobilization with movement (MWM)—in the management of subjects with frozen shoulder syndrome (FSS).

Subjects

Twenty-eight subjects with FSS were recruited.

Methods

A multiple-treatment trial on 2 groups (A-B-A-C and A-C-A-B, where A=MRM, B=ERM, and C=MWM) was carried out. The duration of each treatment was 3 weeks, for a total of 12 weeks. Outcome measures included the functional score and shoulder kinematics.

Results

Overall, subjects in both groups improved over the 12 weeks. Statistically significant improvements were found in ERM and MWM. Additionally, MWM corrected scapulohumeral rhythm significantly better than ERM did.

Discussion and Conclusion

In subjects with FSS, ERM and MWM were more effective than MRM in increasing mobility and functional ability. Movement strategies in terms of scapulohumeral rhythm improved after 3 weeks of MWM.

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Frozen shoulder syndrome (FSS) is a condition of uncertain etiology characterized by a progressive loss of both active and passive shoulder motion.[1–3] Clinical syndromes include pain, a limited range of motion (ROM), and muscle weakness from disuse.[1,2,4] The natural history is uncertain. Some authors[5,6] have argued that adhesive capsulitis is a self-limiting disease lasting as little as 6 months, whereas other authors[7–9] suggest that it is a more chronic disorder causing long-term disability.

Although the pathogenesis of FSS is unknown, several authors[10–13] have proposed that impaired shoulder movements are related to shoulder capsule adhesions, contracted soft tissues, and adherent axillary recess. Cyriax[10] suggested that tightness in a joint capsule would result in a pattern of proportional motion restriction (a shoulder capsular pattern in which external rotation would be more limited than abduction, which would be more limited than internal rotation). Based on the absence of a significant correlation between joint-space capacity and restricted shoulder ROM, contracted soft tissue around the shoulder may be related to restricted shoulder ROM.[11] Vermeulen and colleagues[3,12] indicated that adherent axillary recess hinders humeral head mobility, resulting in diminished mobility of the shoulder. Furthermore, they documented that abnormal scapular motion existed in patients with FSS despite improvement in glenohumeral motion following a 3-month period of physical therapy intervention.[13] Apparently, impaired shoulder movements affect function. In longitudinal follow-up studies lasting from 6 months to 2 years,[3,12–15] significant numbers of patients with FSS demonstrated moderate functional deficits.

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.[3,16–23] Mid-range mobilization (MRM), end-range mobilization (ERM), and mobilization with movement (MWM) techniques have been advocated by Maitland,[17] Kaltenborn,[18] and Mulligan,[19,20] but they did not base their suggestions on research. Additionally, few studies have described the use of these techniques in patients with FSS. Due to the performance of techniques (MRM and ERM with or without interscalene brachial plexus blocks), a lack of quantitative and qualitative outcome criteria, an inappropriate research design (case reports and clinical trials without controls), and utilization of other treatment modalities (home exercises and hot and cold packs), it is not possible to draw firm conclusions about the efficacy of mobilization in patients with FSS.

The aim of our study was to investigate the effect of mobilization treatment and to determine whether a difference of treatment efficacy exists among 3 mobilization techniques (MRM, ERM, and MWM) in patients with FSS. The functional status and kinematic variables of three-dimensional shoulder complex movements were included in this study. The null hypothesis was that there would be no significant difference among the 3 mobilization techniques in the functional status and shoulder kinematics during arm elevations.

Method

Research Design and Treatment Assignment

A multiple-treatment trial on 2 groups was carried out. The multiple-treatment trial involves the application of 2 or more treatments in a single subject.[24,25] It is used to compare the effects of 2 or more treatments. We used the multiple-treatment design to leverage the potential to assess differences among 3 different forms of mobilization with only 2 groups.

In a comparison of 3 different forms of mobilization with 2 groups, the advantages of our design were the following. First, a high adherence rate was expected in our subjects. The subjects usually did not adhere to the treatment program when the effects of treatment were not obvious, leading to loss of follow-up during MRM treatment in our study. Second, the overall number of subjects needed to reach a level of statistical power was lower in our design than in 3 different forms of mobilization with 2 groups. Third, each subject served as his or her own control in each group in our design. Variability in individual differences among subjects was removed from the error term in each group in our design.

Consenting subjects were randomly assigned by computer-generated permuted block randomization of 5 by sequentially numbered, sealed, opaque envelopes to receive different mobilization treatments. In group 1, an A-B-A-C (A=MRM, B=ERM, and C=MWM) multiple-treatment design was used. In group 2, an A-C-A-B multiple-treatment design was used. The 2 groups used here were intended to counterbalance the order effects of treatments. There were 3 weeks in each phase. The differences in outcomes across the 4 phases of the study were examined. Because of our mobilization procedures, the subjects were not masked to the intervention. To minimize bias, an independent trained outcome assessor, masked to treatment allocation, evaluated the participants at baseline and at 3-week intervals for 12 weeks.

Subjects

Subjects with FSS were recruited from the clinics in the Department of Physical Medicine and Rehabilitation at National Taiwan University Hospital. Based on the judgment of what constitutes clinically meaningful differences and variability estimates from previous studies,[3,12,21,22] a sample size of 15 subjects per group provided 80% power to detect differences of 5 degrees of ROM between the preintervention and postintervention measurements as well as between the 2 groups of interest at an alpha level of .05 with a 2-tailed test. The sample size estimate should be based on functional outcome as a standard to assess the effect of intervention. Variability, lack of reliability, or not enough sensitivity of functional outcome assessments in previous studies, however, precluded our use of a functional status measure. Thus, we used ROM to determine the sample size in our study.

The participants received written and verbal explanations of the purposes and procedures of the study. If they agreed to participate, they signed informed consent forms approved by the Human Subjects Committee of National Taiwan University Hospital.All subjects with FSS fulfilled the following inclusion criteria: (1) having a painful stiff shoulder for at least 3 months, (2) having limited ROM of a shoulder joint (ROM losses of 25% or greater compared with the noninvolved shoulder in at least 2 of the following shoulder motions: glenohumeral flexion, abduction, or medial and lateral rotation), and (3) the consent of the subject's physician to participate in the study. The exclusion criteria were: (1) diabetes mellitus, (2) a history of surgery on the particular shoulder, (3) rheumatoid arthritis, (4) a painful stiff shoulder after a severe trauma, (5) fracture of the shoulder complex, (6) rotator cuff rupture, or (7) tendon calcification.

Interventions

Participants in both groups received mobilization treatments twice a week for 30 minutes and a simple exercise program comprising pendular exercises and scapular setting (isometric scapular retraction). A physical therapist with 8 years of clinical experience in manual therapy provided the intervention. No other interventions—including physical modalities (ie, ultrasound, shortwave diathermy, and electrotherapy), intra-articular steroid injection, or arthrographic joint distension—were allowed for the duration of the trial. The subjects were not instructed in home exercises in order to exclude the influence of their adherence to the exercise protocol. Additionally, frequent reminders during instruction and telephone calls were given to the subjects to persuade them not to do home exercises.

Mid-Range Mobilization

An MRM technique was performed on the involved shoulder, as described by Maitland[17] and Kaltenborn.[18] With the subject in a relaxed supine position, the humerus was moved to the resting position (40° of abduction). While the humerus was held in this position, 10 to 15 repetitions of the mobilization techniques were applied.

End-Range Mobilization

In addition to the MRM technique, ERM has been recommended.[3,16,17] The intent of ERM was not only to restore joint play but also to stretch contracted periarticular structures. We used the techniques described by Vermeulen et al[3] and Maitland[17] as follows. At the start of each intervention session, the physical therapist examined the subject's ROM to obtain information about the end-range position and the end-feel of the glenohumeral joint. Then, the therapist's hands were placed close to the glenohumeral joint, and the humerus was brought into a position of maximal range in different directions. Ten to 15 repetitions of intensive mobilization techniques, varying the plane of elevation or varying the degree of rotation in the end-range position, were applied.

Mobilization With Movement

The use of MWM for peripheral joints was developed by Mulligan.[19,20] This technique combines a sustained application of a manual technique "gliding" force to a joint with concurrent physiologic (osteo-kinematic) motion of the joint, either actively performed by the subject or passively performed by the therapist. The manual force, or mobilization, is theoretically intended to cause repositioning of bone positional faults. The intent of MWM is to restore pain-free motion at joints that have painful limitation of range of movement.

The MWM technique was performed on the involved shoulder as described by Mulligan.[19,20] With the subject in a relaxed sitting position, a belt was placed around the head of the humerus to glide the humerus head appropriately, as the therapist's hand was used over the appropriate aspect of the head of the humerus. A counter pressure also was applied to the scapula with the therapist's other hand. 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.

Outcome Assessment

Disability assessment. The Flexilevel Scale of Shoulder Function (FLEX-SF) is a self-administered, shoulder-specific, fixed-item index consisting of 3 levels of function. In this scale, respondents answer a single item that grossly classifies their level of function as low, medium, or high.[26] They then respond only to

the items that targeted their level of function. Scores are recorded from 1, indicating the most limited function, to 50, indicating the absence of limited function in the subject. This scale has been shown to have high reliability (intraclass correlation coefficient [ICC]=.90) and validity (responsiveness index=1.2).

Shoulder complex kinematics. The FASTRAK motion analysis system* was used to record shoulder complex kinematics. The details of the method can be found in our previous reports.[27,28] In general, 3 sensors for the system were attached to the bony landmarks. One sensor was attached to the sternum, and one sensor was attached to the flat bony surface of the scapular acromion with adhesive tape. The third sensor was attached to the distal humerus with Velcro straps.†

The local coordinate system developed from the digitized anatomical landmarks for the trunk and humerus was used to describe clinically relevant motions of the shoulder. Scapular orientation relative to the thorax was described using a Euler angle sequence of rotation about Z_s (protraction/retraction), rotation about Y'_s (downward/upward rotation), and rotation about X''_s (posterior/anterior tipping). Humeral orientation relative to the thorax was described using a Euler angle sequence in which the first rotation represented the plane of elevation, the second rotation defined the amount of elevation, and the third rotation described the amount of axial rotation.

Recordings started with the subjects in a sitting position with arms relaxed at the sides. Kinematic data were collected for 5 seconds in this resting seated posture. Subjects then were asked to perform full active ROM in 3 tests: abduction in the scapular plane, hand-to-neck, and hand-to-scapula. Hand-to-neck and hand-to-scapula tests represented function-related tests.[29] To determine the abduction in the scapular plane, subjects were guided to remain in the scapular plane oriented 40 degrees anterior to the coronal plane. Three replicated movements were performed in each test to the maximum possible active motions of the arms. The order of tests was randomized. To quantitatively characterize shoulder and scapular kinematics, the peak humeral elevation angle, the scapulohumeral rhythm (slope of scapular upward rotation to glenohumeral elevation), and the peak scapular tilt were used as dependent variables in the abduction in the scapular-plane test. For the hand-to-neck and hand-to-scapula tests, the peak external rotation ROM and peak internal rotation ROM were used as dependent variables. All of the dependent variables were calculated from the mean of 3 trials. Good reliability (ICC=.91–.99) of this method has been demonstrated.[28]

Data Analysis

All analyses were conducted with SPSS for Windows, version 11.0.‡ To test whether a difference of treatment efficacy existed among mobilization techniques in subjects with FSS, for each group, an analysis of covariance (ANCOVA) was performed using the follow-up data at 3, 6, 9, and 12 weeks for each of the outcomes, with adjustment for the baseline values of the outcome of interest. To test the efficacy of 2 treatments (ERM versus MWM), independent *t* tests were conducted to compare change of outcome variables between 2 groups (A-B in one group versus A-C in the other group at 6 weeks, A-C in one group versus A-B in the other group at 12 weeks). For the analysis, dropout data were excluded. Additionally, intention-to-treat analysis was performed by including the dropout data (carrying the last data point forward into analysis). A secondary analysis exploring the effect of subjects dropping out was performed using chi-square tests and survival analysis.

We evaluated the potential errors which might affect the accuracy of the data. First, anthropometric variables were considered as possible covariates using ANCOVA, including body weight and body height. Second, validating sensor placements with sensors fixed to pins embedded in the bone, Karduna et al[30] indicated that data collected from the acromion method were acceptable when humeral elevation stayed below 120 degrees. We compared the scapular kinematic variables by dividing the subjects into 2 groups: those with humeral elevation less than 120 degrees during the tasks and those with humeral elevation greater than 120 degrees during the tasks. Third, Karduna et al[30] also found scapular motion to be overrepresented by an average of 6 degrees when using acromion-based surface sensor techniques. We adjusted the data based on the assumed bias by adding 6 degrees to the humeral elevations that were greater than 120 degrees, which adjusted for this error.

Results

Thirty subjects were recruited and randomly assigned to 2 groups (Tab. 1). Two subjects failed to attend the treatment. In addition, 3 subjects in the A-B-A-C group were lost to follow-up because there was no improvement during MRM treatment at 9 weeks. In the A-C-A-B group, 2 subjects were lost to follow-up because there was no im-

* Polhemus Inc, 1 Hercules Dr, PO Box 560, Colchester, VT 05446.
† Velcro USA Inc, 406 Brown Ave, Manchester, NH 03103.
‡ SPSS Inc, 233 S Wacker Dr, Chicago, IL 60606.

provement during MRM treatments at 3 weeks and 9 weeks (Fig. 1). No subject reported performing home exercises.

Similar results were found between exclusion of dropout data and intention-to-treat analysis (inclusion of dropout data). There were significant improvements ($P<.01$) in FLEX-SF, arm elevation, scapulohumeral rhythm, humeral external rotation, and humeral internal rotation for ERM and MWM for both groups. No significant improvement in outcomes was shown with MRM for either group (Tab. 2). There was no significant difference in outcome improvement between ERM and MWM except in scapulohumeral rhythm (Tab. 3). Mid-range mobilization corrected scapulohumeral rhythm significantly better (from 0.92 to 0.68) than ERM did (from 0.83 to 0.78) in subjects with FSS (Fig. 2).

There were no significant differences in numbers of subjects dropping out in each group (Pearson $\chi^2=.094$, $P=.76$). A further secondary analysis was performed using survival analysis. A life table was produced using time to drop out as the survival variable, and comparisons were made between the 2 groups using the Wilcoxon (Gehan) statistic. There also were no significant differences in the survival experiences of the 2 groups (value=0.035, $P=.851$).

Regarding the accuracy of the data, neither of the 2 covariates (body weight and body height) significantly influenced the results of the analysis ($P>.05$). There was no difference in the scapular kinematic variables between the 2 groups with humeral elevations less than or greater than 120 degrees during the tasks ($P>.05$). Even with the addition of the adjusted bias, neither the ANCOVA nor the *t*-test results changed. Therefore, the placement error is likely to have had little effect on our results.

Table 1.
Basic Characteristics of Subjects With Frozen Shoulder in the 2 Intervention Groups (n=28)[a]

Characteristic	A-B-A-C Group (n=14)	A-C-A-B Group (n=14)	P[b]
Age (y), $\bar{X}\pm SD$	53.3±6.5	58±10.1	.38
Duration of symptoms (wk), $\bar{X}\pm SD$	18±8	22±10	.56
Female	13	11	
Dominant hand[c]	8	7	
FLEX-SF, $\bar{X}\pm SD$	26.8±4.4	28±3.7	.23
Arm elevation (°), $\bar{X}\pm SD$	106±26	116±15	.34
Scapular tipping (°), $\bar{X}\pm SD$	12.7±7.9	10.9±7.0	.16
Scapulohumeral rhythm, $\bar{X}\pm SD$	0.9±0.3	0.8±0.3	.43
Humeral lateral rotation (°), $\bar{X}\pm SD$	45.8±16.2	38.2±13.6	.13
Humeral medial rotation (°), $\bar{X}\pm SD$	13.4±7.6	13.1±9.7	.64

[a] A=mid-range mobilization, B=end-range mobilization, C=mobilization with movement, FLEX-SF=Flexilevel Scale of Shoulder Function.
[b] Differences in subject characteristics between the 2 groups at baseline, independent *t* test.
[c] Involved hand was dominant hand in these subjects.

Discussion and Conclusions

Our study showed positive findings. There was an improvement in mobility and functional ability at 12 weeks in subjects treated with the 3 mobilization techniques. Comparing the effectiveness of the 3 treatment strategies in subjects with unilateral FSS, ERM and MWM were more effective than MRM in increasing mobility and functional ability. These results support the findings of previous studies showing improvement after mobilization in a frozen shoulder.[3,12] Additionally, movement strategies in terms of scapulohumeral rhythm improved after 3 weeks of MWM treatment.

For the predominant adhesive capsule and associated soft tissue tightness of FSS, mobilization techniques have been most commonly addressed in clinical treatment approaches and research studies.[3,16–23] Mobilization techniques improve the normal extensibility of the shoulder capsule and stretch the tightened soft tissues to induce beneficial effects. Our results support this premise and indicate that the most beneficial effects can be achieved with ERM or MWM, and not MRM, techniques. Although MRM might extend the adhesive capsule, we believe that the adhesive capsule and associated contracted periarticular structures can only be stretched by ERM or MWM.

Attention to abnormal scapulohumeral rhythm during arm elevation should be increased in rehabilitation programs for subjects with FSS. Vermeulen et al[13] observed 10 subjects with unilateral FSS for 3 months and indicated that improvement in glenohumeral motion following a 3-month period of physical therapy intervention did not significantly correspond to normalization of abnormal scapular motion. Consistent with their findings, our subjects showed abnormal scapulohumeral rhythm after 3-month treatments. Normalization of scapulohumeral

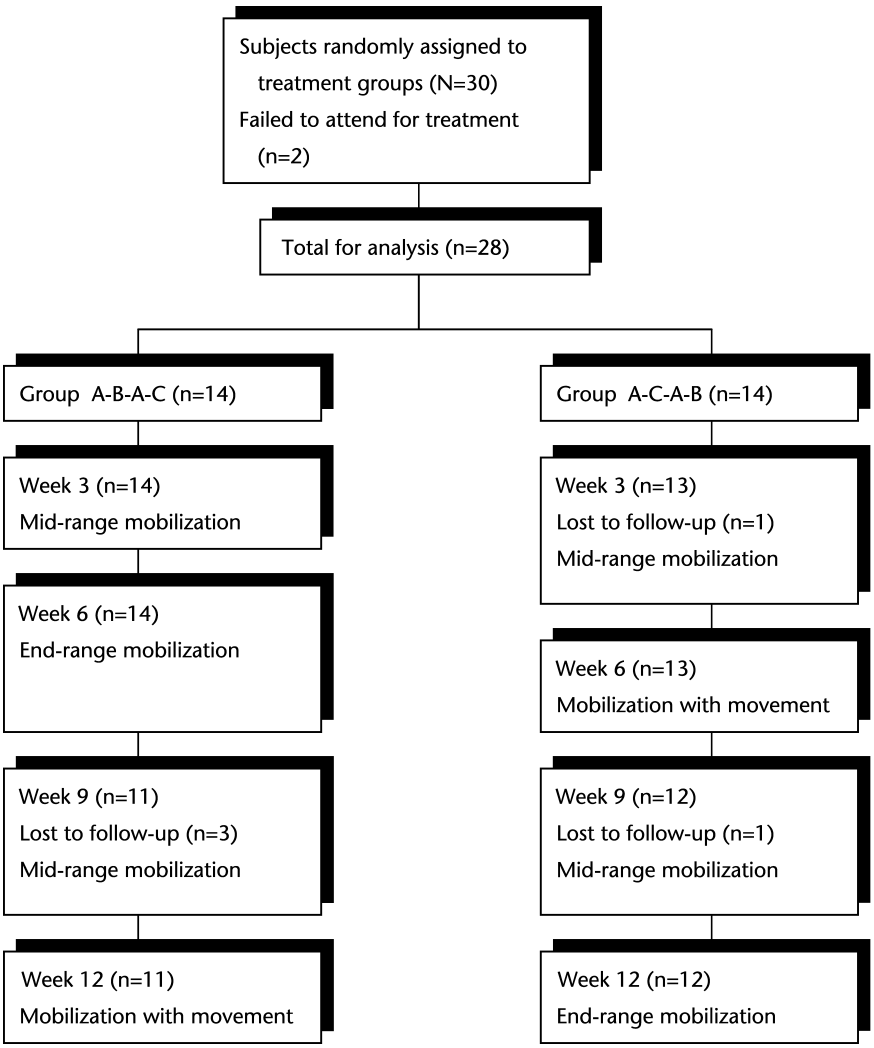

Figure 1.
Flow diagram indicating progress of subjects through the study and stage at which subjects were lost to follow-up. A=mid-range mobilization, B=end-range mobilization, C=mobilization with movement.

rhythm, however, was achieved with MWM techniques in our subjects. Furthermore, improved mobility and functional ability also were observed after MWM treatment. These findings suggest to us that MWM could increase mobility and improve motor strategies with regard to the scapulohumeral rhythm in people with FSS.

Completion is difficult for subjects in a study that demonstrates no improvement with the intervention. The overall participation rates were less than in another study,[12] where completion rates were 96 out of 116 (83%) at 12 months. We recruited 30 subjects, of whom 23 (77%) completed the full 12-week study. The most common reason for dropping out was unwillingness of the subject to continue due to a lack of improvement following treatment. Five subjects without significant improvement dropped out during MRM treatment. These subjects were allowed to have alternative treatments (eg, ERM or MWM techniques). Although they showed improvements after these alternative treatments, we excluded these data to avoid biasing our results. Additionally, similar results were found by including dropout data in the intention-to-treat analysis, which further validates our findings.

Because of substantial FLEX-SF variation of improvement in the relatively small sample size between ERM and MWM groups, the lack of statistical significance may have been due to type II error (not enough power). We considered a FLEX-SF score difference of 3 points between groups (minimal clinically important difference and responsiveness were 3.02 and 1.12, respectively, for the FLEX-SF in Cook and colleagues' investigation[26]) to be clinically meaningful. Using the obtained standard deviation (5.7) between the 2 groups, the power was .38 to detect a FLEX-SF score difference of 3 points between groups (α=.05). A sample size of 50 subjects per group would have been required to achieve a power level of .80 to detect FLEX-SF score difference of 3 points between the 2 groups. Thus, a different treatment effect between ERM and MWM groups is likely and needs to be further investigated.

No benefit was shown during MRM treatment, but different missing data due to subjects dropping out due to lack of improvement at 3 and 9 weeks between the 2 groups makes interpretation difficult. We addressed this by secondary analysis (ie, analysis of dropping out between 2 groups and survival analysis). There were no differences in numbers of subjects dropping out and no significant differences in the survival experiences of the 2 groups. These findings suggest that the multiple-treatment trial on our 2 groups was balanced. It may be, however, that subjects continued in the treatment for reasons other than treatment effectiveness.

Table 2.
Mean Values of Change in Main Outcome Measures in Mobilization Groups and End-Range Mobilization and Mobilization With Movement Effect Compared With Mid-Range Mobilization Effect After Randomization[a]

Outcome Measure	Mean Changes (95% CI) for A-B-A-C Group			Mean Changes (95% CI) for A-C-A-B Group		
	End-Range Mobilization	Mobilization With Movement	Mid-Range Mobilization	Mobilization With Movement	End-Range Mobilization	Mid-Range Mobilization
FLEX-SF	5.1 (3.9–6.3)[b]	4.5 (3.1–5.9)[b]	0.2 (−1.6–1.4)	7.0 (1.2–13.2)[b]	5.9 (1.2–11.2)[b]	2.3 (−0.8–6.3)
Arm elevation (°)	11.7 (5.5–17.9)[b]	6.9 (1.2–11.2)[b]	3.2 (−5.6–8)	17.6 (9.2–22.1)[b]	6.0 (1.2–11.4)[b]	3.5 (−2.3–6.8)
Scapular tipping (°)	0.1 (−3.9–4.0)	0.4 (−1.9–2.8)	1.7 (−0.3–3.7)	0.4 (−3.2–4.0)	1.1 (−0.1–2.4)	1.1 (−3.5–1.3)
Scapulohumeral rhythm	0.2 (−0.1–0.3)	0.3 (0.1–0.4)[b]	0.1 (−0.1–0.2)	0.2 (0.1–0.3)[b]	0.1 (−0.1–0.2)	0.1 (−0.1–0.2)
Humeral lateral rotation (°)	12.4 (9.1–15.8)[b]	9.1 (6.4–11.8)[b]	3.4 (−3.5–10.3)	7.5 (1.2–10.3)[b]	8.9 (3.2–11.6)[b]	1.1 (−4.6–5.3)
Humeral medial rotation (°)	4.1 (0.2–7.9)[b]	2.1 (−1.3–5.4)	1.1 (−4.4–5.5)	4.0 (0.2–8.0)[b]	2.0 (−1.3–5.5)	0.3 (−5.2–4.7)

[a] A=mid-range mobilization, B=end-range mobilization, C=mobilization with movement, CI=confidence interval, FLEX-SF=Flexilevel Scale of Shoulder Function.
[b] $P<.05$.

Although our results favored the MWM and ERM treatment techniques, the appropriate treatment decision for subjects with FSS may be dependent on the course and duration of symptoms. Reeves[4] documented 3 phases with which to address the progression of FSS: the pain phase, the stiffness phase, and the recovery phase. Our subjects were in the second phase, with primary idiopathic FSS and a mean duration of complaints of 20 weeks.[31,32] The results of this study, therefore, cannot be generalized to other subjects at various stages of signs or symptoms or with secondary FSS as a result of diabetes, cardiac problems, stroke, rheumatoid arthritis, or trauma. It should be noted that the outcome of treatment in subjects with secondary FSS has been documented as less successful.[33] Additionally, our multiple-treatment design limits the generalizability of our findings to normal clinical practice. Although cumulative effects of mobilizations may be expected at the 12-week point, our results at the 6-week point (12 visits) are more reasonable for application to normal clinical practice. Additionally, co-intervention of MWM and ERM treat-

Table 3.
Mean Percentage of Change (±SD) in Main Outcome Measures in End-Range Mobilization Effect Compared With Mobilization With Movement Effect[a]

Outcome Measure	Mean Percentage of Change at 6 Weeks Between Groups			Mean Percentage of Change at 12 Weeks Between Groups		
	End-Range Mobilization	Mobilization With Movement	Difference (95% CI)	Mobilization With Movement	End-Range Mobilization	Difference (95% CI)
FLEX-SF	19.9±8.1	17.25±12.2	2.7 (−5–11)	17.9±6.1	19.2±10.2	2.2 (−4–10)
Arm elevation (°)	11.3±15.1	8.6±7.8	5.6 (−8–10.1)	10.3±18.2	8.8±4.8	3.6 (−5–7.1)
Scapular tipping (°)	31.4±46.3	18.8±28.4	12.7 (−42–68)	28.4±46.3	15.8±29.4	10.7 (−40–62)
Scapulohumeral rhythm	10.7±7.6	24.9±11.7	14.3 (6–22)[b]	25.7±7.6	15.9±11.7	12.8 (4–27)[b]
Humeral lateral rotation (°)	36.4±24.3	34.2±14.3	2.2 (−16–20)	32.7±21.3	35.2±12.3	3.2 (−14–18)
Humeral medial rotation (°)	20.5±24.4	45.6±38.5	25.3 (−8–36)	19.5±21.4	40.6±32.5	21.3 (−5–32)

[a] CI=confidence interval, FLEX-SF=Flexilevel Scale of Shoulder Function.
[b] $P<.05$.

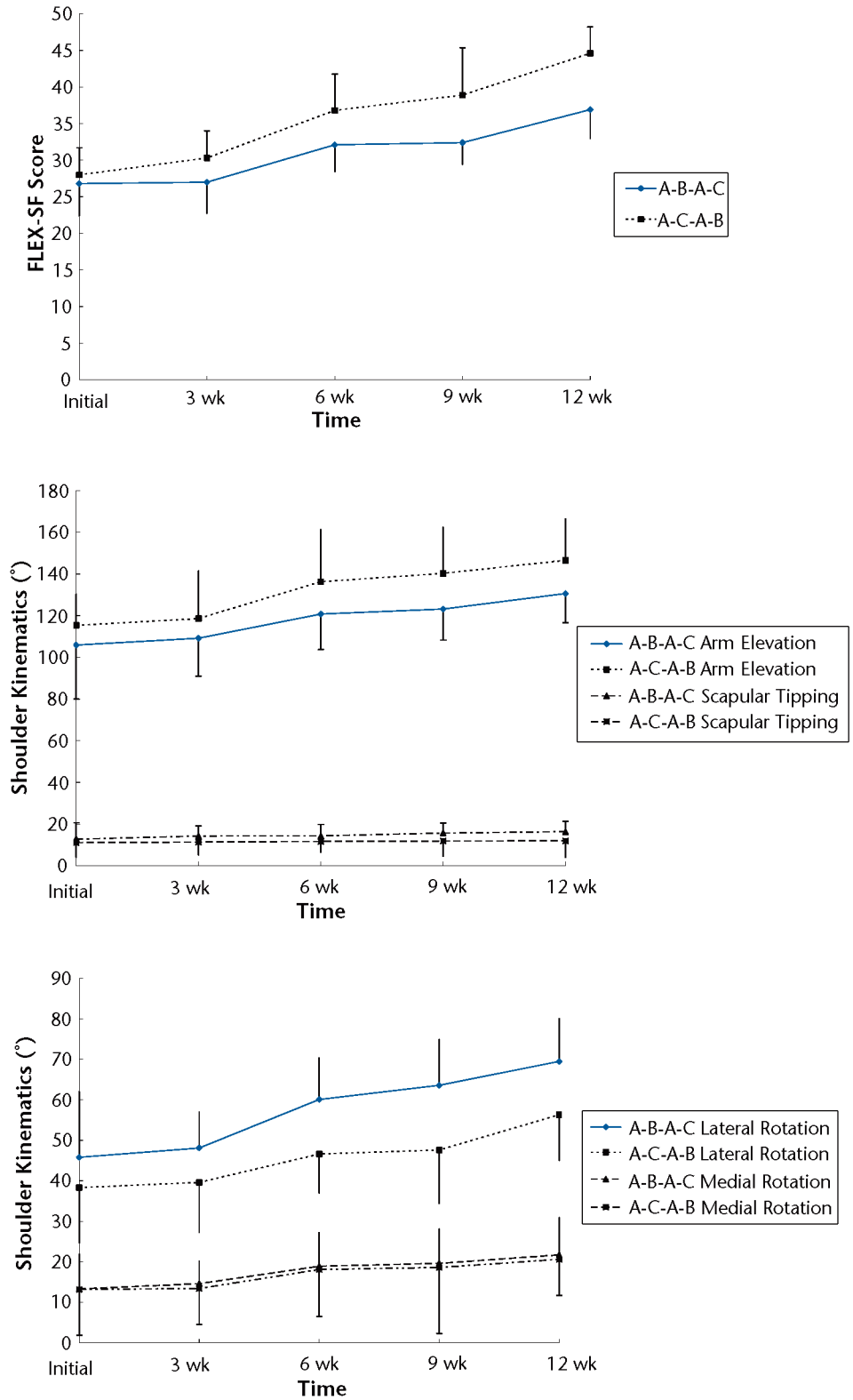

Figure 2.
Summary kinematic data and disability index. A=mid-range mobilization, B=end-range mobilization, C=mobilization with movement, FLEX-SF=Flexilevel Scale of Shoulder Function.

ment techniques may be more beneficial and needs to be further investigated.

Jing-lan Yang, Dr Chang, Dr Wang, and Dr Lin provided concept/idea/research design. Shiau-yee Chen, Dr Wang, and Dr Lin provided writing. Jing-lan Yang, Shiau-yee Chen, and Dr Lin provided data collection. Shiau-yee Chen and Dr Lin provided data analysis. Jing-lan Yang provided project management and facilities/equipment. Dr Lin provided fund procurement. Jing-lan Yang and Dr Chang provided subjects. Dr Chang provided institutional liaisons and consultation (including review of manuscript before submission).

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