

# The initial effects of a Mulligan's mobilization with movement technique on range of movement and pressure pain threshold in pain-limited shoulders

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## Abstract

There is little known about the specific manual therapy techniques used to treat painfully limited shoulders and their effects on range of movement (ROM) and pressure pain threshold (PPT). The objective of this study was to investigate the initial effects of a Mulligan's mobilization with movement (MWM) technique on shoulder ROM in the plane of the scapula and PPT in participants with anterior shoulder pain. A repeated measures, double-blind randomized-controlled trial with a crossover design was conducted with 24 subjects (11 males and 13 females). ROM and PPT were measured before and after the application of MWM, sham and control conditions. Significant and clinically meaningful improvements in both ROM (15.3%,  $F(2,46) = 16.31$   $P = 0.00$ ) and PPT (20.2%,  $F(2,46) = 3.44$ ,  $P = 0.04$ ) occurred immediately after post treatment. The results indicate that this specific manual therapy treatment has an immediate positive effect on both ROM and pain in subjects with painful limitation of shoulder movement. Further study is needed to evaluate the duration of such effects and the mechanism by which this occurs.

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## 1. Introduction

Shoulder pain with a subsequent restriction of movement is a common problem in both the sporting and working population. Approximately 1% of adults consult a general medical practitioner with an episode of shoulder pain each year (Bridges-Wegg, 1992; Pope et al., 1997).

There is a dearth of high-quality trials that support or refute the use of physiotherapy in shoulder pain (Green et al., 2004), but there is some support for individualized programmes of manual therapy and exercises in the treatment of shoulder impingement syndrome (Michener et al., 2004). Two trials conducted by Bang

and Deyle (2000) and Nicholson (1985), which rated six and five out of ten, respectively, on the PEDro quality rating scale ([www.pedro.fhs.usyd.edu.au](http://www.pedro.fhs.usyd.edu.au)), reported that supervised exercise combined with manual therapy was better than supervised exercise alone in the treatment of shoulder impingement.

Mobilization with movement (MWM) is a class of manual therapy techniques that is widely used in the management of musculoskeletal pain. It involves the manual application of a sustained glide by a therapist to a joint while a concurrent movement of the joint is actively performed by the patient (Mulligan, 1999). Studies using MWM techniques on the elbow and ankle have shown them to be effective in reducing pain as measured by visual analogue scale (VAS) and pressure pain threshold (PPT) and increasing joint range of movement (ROM) (Vicenzino and Wright, 1995;

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O'Brien and Vicenzino, 1998; Chen et al., 1999; Abbott, 2001; Abbott et al., 2001; Paungmali et al., 2003a; Collins et al., 2004).

During shoulder movement in participants with no pathology the humeral head remains relatively centered in the glenoid, predominantly through small translatory glides in the glenoid (Harryman et al., 1990). Earlier studies have identified that altered shoulder kinematics are associated with shoulder pain (Howell et al., 1988; Ludewig and Cook, 2000, 2002; Halder et al., 2001). Kinematic studies of patients with impingement, rotator cuff tears, loss of capsuloligamentous integrity or neuromuscular fatigue, have demonstrated abnormal or excessive superior and/or anterior translation of the humeral head in the glenoid fossa (Fu et al., 1991; Kamkar and Irrgang, 1993; Flatow et al., 1994). It would appear that excessive translation of the humeral head along the glenoid results in pain and functional impairment (Matsen et al., 1993). It has been suggested that the application of a posterior glide MWM to the shoulder may correct this fault and allow optimal pain-free motion to occur (Mulligan, 1999). Hsu et al. (2000) in a study of 11 cadavers, found the application of an anterior–posterior glide towards the end of range of abduction was effective in improving the range of glenohumeral abduction. To date, no studies have investigated the effects of the MWM in people with shoulder pain and reduced ROM. The aim of our study was to evaluate the effect of a MWM on shoulder ROM and PPT.

## 2. Methods

A repeated measures, crossover, double-blinded randomized, placebo-controlled trial was conducted to evaluate the initial effects of a shoulder MWM on ROM and PPT. This design was used to reduce the effects of individual variation and strengthen internal validity.

### 2.1. Participants

Twenty-four participants (11 males and 13 females) aged between 20 and 64 years (mean 46.1 years  $SD+9.86$ ) were recruited from the general population in southeast Queensland. The primary inclusion criterion was the inability to elevate the arm greater than  $100^\circ$  in the plane of the scapula because of the presence of pain over the anterior aspect of either shoulder. The duration of the pain had to be greater than one month to ensure that there was an established shoulder condition and for less than one year so as to limit the study population to those whose pain was not likely to be a result of such conditions as recalcitrant frozen shoulder. The main exclusion criterion was shoulder pain that was deemed not to be musculoskeletal in origin. Other exclusion criteria were any medical

condition that would exclude the patient from physiotherapy treatment, active inflammatory disease, infection, cancer, neuromuscular disorders and fractures around the shoulder. The participants were also screened for involvement of the cervical spine that may have contributed to the shoulder condition and excluded if there was evidence of cervical spine referral of pain to the shoulder. A physiotherapist who holds a post-graduate Sports physiotherapy degree and has greater than 15 years clinical experience performed all screening examinations.

Ethical clearance was obtained from the University of Queensland's Medical Research Ethics Committee and signed informed consent was gained from all participants prior to their inclusion in the study.

### 2.2. Outcome measures (dependent variables)

The outcome measures were taken by an investigator skilled in their application and who remained blind to the allotted treatment condition. The outcome measures used were range of glenohumeral elevation in the plane of the scapula and PPT over the anterior shoulder.

#### 2.2.1. Pain-free range of movement in the scapular plane

A universal goniometer was used to measure the ROM in the plane of the scapula. This has been shown to demonstrate good intra-tester reliability if consistent landmarks are used (Hayes et al., 2001). The plane of the scapula is defined as  $30^\circ$  anterior to the coronal plane. This was calculated by aligning the axis of the goniometer along the superior aspect of the shoulder and moving one arm of the goniometer  $30^\circ$  forward from that frontal plane whilst the other arm of the goniometer remained in the frontal plane. The patient was then asked to move the affected arm in that plane through a small arc of movement short of pain, by aligning the arm movement to a vertical line drawn up the wall. The line on the wall was used to aid test–retest repeatability.

Goniometric measurement of elevation in the plane of the scapula was achieved by aligning the centre of the goniometer with the centre of the glenohumeral joint, one arm of the instrument along the lateral border of the scapula and the other along the humerus in line with the lateral epicondyle aided by skin markers. A measure of active ROM was taken. The participant was asked to move the arm into elevation along the plane of the scapula just to the onset of pain and this process was repeated three times. This technique was in accordance with guidelines of goniometric measurement as outlined by Moore (Gerhardt, 1992).

#### 2.2.2. Pressure pain threshold

A quantitative measure of pain was obtained by the use of pressure pain algometry, which has demonstrated

good inter- and intra-rater correlation and reliability in other studies (Pontinen, 1998).

The most sensitive point was located over the anterior aspect of the shoulder by manual palpation and marked with a permanent marker so that the same point could be used for pre- and post-condition application measures. As in previous work carried out in this laboratory, (Sterling et al., 2001; Paungmali et al., 2003a; Collins et al., 2004) pressure was applied via a digital pressure algometer (Somedic AB, Farsta, Sweden) applied perpendicular to the skin at a rate of 40 kPa/s through a rubber-tipped probe (area 1 cm<sup>2</sup>). The patient was instructed to activate a button as soon as a change of sensation from one of pressure to one of pain was experienced (threshold of pain). This process was repeated three times with a 30-s rest period between each measurement.

### 2.3. *Experimental conditions (independent variables)*

There were two independent variables in the research design; treatment condition and time (pre-, post-application). Treatment condition had three levels, which included the MWM, a sham and a control condition. A physiotherapist who was blind to the pre- and post-outcome measures (i.e. played no part in taking the outcome measures) applied all conditions. This physiotherapist held both musculoskeletal and sports post-graduate degrees with more than 10 years clinical experience.

The treatment condition consisted of the application of a postero-lateral glide (MWM) to the affected shoulder (Fig. 1). The participant was seated and the therapist stood beside the participant on the opposite side to the affected shoulder. One hand was placed over the scapula posteriorly while the thenar eminence of the

other hand was placed over the anterior aspect of the head of the humerus. A posterior gliding force was applied to the humeral head. The participant was then asked to raise the affected arm in the plane of the scapula to the point of pain onset while the therapist sustained the gliding force to the humeral head, with care to avoid the sensitive coracoid process. Three sets of 10 repetitions were applied with a rest interval of 30 s between each set. The therapist endeavored to maintain the glide at right angles to the plane of movement throughout the entire range. The participant was instructed that the MWM procedure, including arm elevation, was to be pain free, and must be ceased immediately if any pain was experienced during the application (Mulligan, 1999; Exelby, 2002).

The sham condition replicated the treatment condition except for the hand positioning. The therapist stood on the opposite side of the participant and placed one hand along the clavicle and sternum and the other on the posterior aspect of the humeral head of the affected shoulder. A simulated anterior glide was performed but with minimal pressure actually applied. The participant was asked to elevate the affected shoulder in the plane of the scapula through half of their available pain-free range to minimize the likelihood of pain provocation. The number of repetitions and sets were as per the treatment group.

In the control condition the participant was seated for the same length of time but no manual contact between the therapist and the participant took place.

### 2.4. *Procedure*

Participants were initially assessed for their suitability for inclusion in the study and underwent a physical screening of the affected shoulder and cervical spine by an experienced post-graduate Sports physiotherapist with more than 15 years of clinical experience. This session was also used to familiarize the participant with the testing procedures, laboratory environment and investigators.

Participants attended three sessions at approximately the same time each day to prevent any diurnal variations in joint range and pain potentially confounding results and with at least an intervening 24 h interval to reduce the influence of any carry-over effect. Testing was conducted in a temperature and humidity controlled laboratory. The participants were requested to avoid factors that may influence their shoulder pain, such as analgesics and/or anti-inflammatory medication during the week of testing.

At each experimental session, following the recording of baseline measures, each participant received one of the three treatment conditions (MWM, sham, control), in a randomized order known only to the treating therapist. The treatment allocation sequence was block

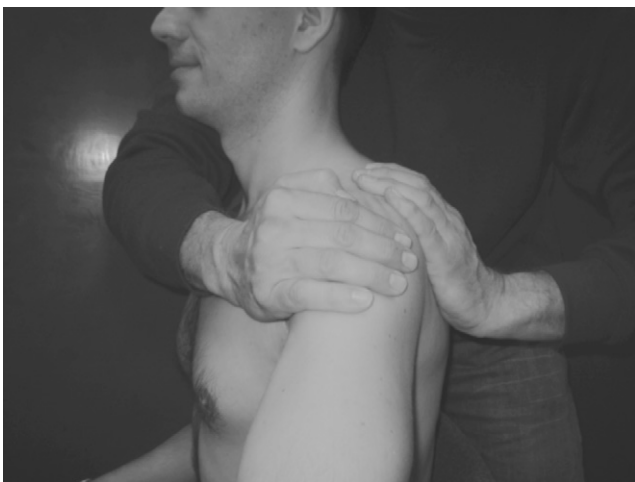


Fig. 1. The MWM technique in which the therapist applies a postero-lateral glide to the humeral head along the plane of the glenohumeral joint while stabilizing the scapula with the other hand.

randomized using the drawing of lots and concealed from the investigator who took the outcome measurements. Following the application, outcome measures were again taken. Participant blinding was facilitated by recruitment of people who had no experience of the manipulative therapy techniques applied to the shoulder and by careful instruction that did not refer to the study's aims of evaluation of a treatment technique. Subjects were informed that the study was investigating the effects of manual handling on shoulder pain. An exit questionnaire assessed the adequacy of patient blinding. Results of the exit questionnaire showed that three participants (12%) correctly guessed they had only received active treatment and none had correctly guessed that they had received either a sham or control.

### 3. Reliability

Acceptable intra-rater reliability was determined through analysis of pre- to post-control measures of ROM and PPT. For this study the intra-class correlation coefficient (ICC 2,1) and standard error of the measurement (SEM) for ROM were estimated to be 0.98 and 1.33° respectively. The ICC 2,1 and the SEM for PPT were estimated to be 0.96 and 10.7 kPa respectively. This indicates that both the size of the error (SEM) and the ICC are indicative of reliable measures.

### 4. Data management and analysis

Two independent variables were incorporated into the research design: treatment (MWM, sham, control) and time (pre- and post-application). Dependent variables included ROM and PPT. Prior to analysis, the average of triplicate measures of ROM and PPT were calculated.

A two-factor analysis of variance (ANOVA) and appropriate post-hoc tests of simple effects were then performed on each of the two dependent variables to

test the hypothesis that MWM produced changes in excess of sham and control from pre- to post-application ( $P = 0.05$ ).

## 5. Results

### 5.1. Range of movement

There was a significant Time by Condition interaction effect for ROM ( $F_{(2,46)} = 16.3$ ,  $P = 0.000$ ) with a significant mean improvement of 16° ( $P = 0.000$ ) pre- to post-treatment after the application of the MWM compared with 4° ( $P = 0.06$ ) for the sham application and no change ( $P = 0.84$ ) for the control condition (Table 1). The mean differences between the MWM and Sham (10°) and MWM and Control (11°) were statistically different after application;  $P < .02$ ; where they were not different at baseline.

### 5.2. Pressure pain threshold

There was a significant Time by Condition interaction for PPT ( $F_{(2,46)} = 3.4$ ,  $P = 0.04$ ), which demonstrated a mean improvement of 63 kPa following the application of the MWM ( $P = 0.000$ ) pre- to post-treatment application compared with 26 kPa ( $P = 0.05$ ) for the sham application and 20 kPa ( $P = 0.07$ ) for the Control application. The mean differences between the MWM and Sham (45 kPa;  $P = 0.04$ ) and between MWM and Control (46 kPa;  $P = 0.02$ ) were statistically significant. There were no significant differences pre-application.

### 5.3. Methodological considerations

There was no loss to follow-up and no adverse effects reported. There was no carry-over effect when the pre-application data for all experiment sessions (i.e. before each intervention was applied) were evaluated.

Table 1

The mean (95% CI) for range of movement (ROM) in degrees and pressure pain threshold (PPT) in kPa for the mobilization with movement treatment technique (MWM), Sham (S) and Control (C). Also included are the mean differences (95% CI) between pre- and post-intervention, as well as the differences between MWM-S and MWM-C

	MWM	Mean (95% CI)		Condition mean differences (95% CI)		
		Sham	Control	MWM-S	MWM-C	
ROM	Pre	102.2 (94.5 to 109.9)	103.9 (96.4 to 111.5)	106.2 (96.9 to 115.5)	−1.8 (−8.7 to 5.2)	−3.9 (−11.4 to 3.5)
	Post	117.8 (110.2 to 125.5)	107.9 (98.7 to 117.1)	106.4 (96.7 to 116.2)	9.9 (4.3 to 15.6)*	11.4 (2.3 to 20.5)*
	Diff	15.6 (10.1 to 21.1)*	3.9 (−0.1 to 7.9)	0.27 (−2.4 to 3)	N/A	N/A
PPT	Pre	310.8 (258.8 to 362.9)	302.5 (252.3 to 352.6)	307.1 (254.7 to 359.5)	8.4 (−27.7 to 44.6)	3.8 (−36.7 to 44.2)
	Post	373.4 (313.6 to 433.1)	328.3 (275.6 to 381.0)	327.1 (271.1 to 383.0)	45.1 (1.7 to 88.4)*	46.3 (9.1 to 83.6)*
	Diff	62.6 (33.6 to 91.5)*	25.9 (0.2 to 51.6)*	20 (−1.5 to 41.5)	N/A	N/A

\*Denotes a statistical significant difference  $P < 0.05$ .

## 6. Discussion

This study demonstrated that the application of the Mulligan's MWM technique to participants with a painful restriction of shoulder movement produced an immediate and significant improvement in ROM and PPT pre- to post-intervention when compared to sham or control conditions. There are no other published studies of the effects of this technique on participants with shoulder pain. However, these findings are consistent with studies conducted in other joints of the body that have shown similar effects with the MWM techniques (O'Brien and Vicenzino, 1998; Abbott et al., 2001; Paungmali et al., 2003b; Collins et al., 2004).

The clinical relevance of the magnitude of improvement in ROM gained following the MWM compared to the Sham ( $10^\circ$ ) after only one treatment session is arguably comparable to  $42^\circ$  improvement in abduction following four sessions of intensive massage (van den Dolden and Roberts, 2003) and  $22^\circ$  improvement after 4–10 sessions of individualized shoulder treatment (mainly exercises) over a month (Ginn et al., 1997).

Wright (1995) has postulated that the mechanisms responsible for manual therapy treatment effects (e.g. as in the increases in ROM and PPT in our study) may feasibly involve changes in the joint, muscle, pain and motor control systems. In our study the standardized mean difference (SMD) for ROM (1.2) was greater than the SMD for PPT (0.9). The change in ROM was not related to the change in PPT (Pearson's correlation coefficient  $R = 0.29$   $P = 0.17$ ) possibly indicating that the underlying mechanisms of the MWM may be related to local joint or muscle structures rather than the pain system.

The technical difference between the MWM and sham application was that the MWM involved the application of a postero-lateral joint glide while the patient performed an active movement compared with the sham that involved no glide. This data, when considered along with studies showing that forward translation of the humeral head painfully limits shoulder movement, (Ludewig and Cook, 2000) leads us to speculate that Mulligan's proposed mechanism of action for MWM's as a reduction of a positional fault may have some credence.

The application of the shoulder MWM also resulted in small but positive changes in PPT pre- to post-intervention. The mean differences between the MWM and the sham and the MWM and the control condition post-intervention were 45 kPa (95% CI: 2–88) and 45 kPa (95% CI: 9–84), respectively. Other studies of the upper limb have demonstrated similar effects in PPT following the application of a Mulligan's MWM (Vicenzino et al., 2001, Paungmali et al., 2003b). These studies, along with others (Sterling et al., 2001; Paungmali et al., 2003a; Souvlis et al., 2005) have

proposed that manipulative therapy may provide sufficient sensory input to activate the endogenous pain inhibitory systems. Further studies need to be conducted in the shoulder to determine if endogenous pain inhibitory systems are involved in manipulation-induced changes of PPT in the shoulder.

The comparison between the MWM and Sham conditions should also take into account that the latter limited abduction to half available range: that is, some of the difference between MWM and Sham may be attributable to the MWM utilizing a greater range of abduction. Certainly, ethically it was undesirable to ask participants to experience repeated pain and pragmatically it is difficult to ensure compliance with return visits to the experiment if the subject was experiencing repeated painful movements at these visits.

A limitation of this study was that only the initial effects of the MWM were measured and the time-course of these effects is as yet unknown. Therefore inferences drawn from this study should be limited to those seen in a single treatment session. Another limitation is that only measures of impairment (ROM, PPT) were made, but no measures of function or disability. Several case studies/series have shown that continued treatment with a MWM coincided with a resolution of the condition on function and disability measures (Vicenzino and Wright, 1995; Hsieh et al., 2002; Kochar and Dogra, 2002). Further studies to evaluate such issues as the time-course of the effect of this particular MWM, and the outcome on disability and function after a course of treatment are warranted.

## 7. Conclusion

The results from this study indicate that the shoulder MWM may be a useful manual therapy technique to apply to participants with a painful limitation of shoulder elevation in order to predominantly gain an initial improvement in ROM and PPT.

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