Efficacy of "therapist-selected" versus "randomly selected" mobilisation techniques for the treatment of low back pain: A randomised controlled trial

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The aim of this study was to establish whether the mobilisation technique selected by the treating physiotherapist is more effective in relieving low back pain than a randomly selected mobilisation technique. Two manipulative physiotherapists and 140 subjects suffering non-specific low back pain participated. Baseline measurements were taken before treatment allocation; the therapist then assessed subjects and nominated the preferred treatment grade, spinal level to be treated and mobilisation technique to be used. The subjects were then randomly allocated to one of two groups. One group received the preferred mobilisation technique as selected by the therapist; the other group received a randomly assigned mobilisation technique. All mobilisation treatments were applied to the nominated spinal level using the nominated treatment grade. Follow-up measures were taken immediately after intervention. Two-way ANOVA was used to analyse the data; the first factor was the treatment group and the second factor was the direction of the patient's most painful movement. The choice of mobilisation treatment had no effect on any outcome measure investigated in this study; however, post hoc tests revealed that mobilisation treatment applied to the lower lumbar levels had a greater analgesic effect than when applied to upper lumbar levels. The results of this study confirm that lumbar mobilisation treatment has an immediate effect in relieving low back pain, however the specific technique used seems unimportant. **[Chiradejnant A, Maher CG, Latimer J and Stepkovitch N (2003): Efficacy of "therapist-selected" versus "randomly-selected" mobilisation techniques for the treatment of low back pain: A randomised controlled trial. *Australian Journal of Physiotherapy* 49: 233–241]**

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Introduction

There are a number of methods used to treat patients with low back pain. These include exercise therapy, massage, ergonomic advice, electrotherapy, short-wave diathermy and spinal manipulative therapy. Clinical trials have shown spinal manipulative therapy to be effective in reducing pain (Chiradejnant et al 2002a, Goodsell et al 2000, Hsieh et al 2002, Sanders et al 1990, Triano et al 1995) and disability (Farrell and Twomey 1982, Hsieh et al 2002, Koes et al 1992, Nwuga 1982), however the manner in which spinal manipulative therapy produces these effects is not well understood.

The term spinal manipulative therapy includes both manipulation and mobilisation treatments (Maitland et al 2001). The differences between these two techniques are the force amplitude and the velocity of the force applied to the target vertebra. Manipulation involves high velocity, low-amplitude thrusting, usually at the end of range of movement, whereas mobilisation involves low velocity, either small or large amplitude oscillatory movements applied anywhere in a range of movement (Maitland et al 2001). The decision as to whether to apply manipulation or mobilisation is influenced by the clinical presentation of the patient (Maitland et al 2001) as well as the treatment preferences of the clinician.

The biomechanical effects of spinal mobilisation have been investigated in a number of studies using both cadaveric specimens and subjects without low back pain (Lee and Evans 1992a, 1992b, 1994, 1997; McCollam and Benson 1993, Petty 1995). In a series of cadaveric studies, Lee and Evans (1992a, 1992b, 1994) noted that spinal postero-anterior mobilisation produced extension moments and shear forces to lumbar motion segments. A subsequent in-vivo study noted that a static force of 150 N applied to the L_4 spinous process caused the upper motion segments to extend whereas the lower segment tended to flex (Lee and Evans 1997). Lee and Evans (1992a) also noted in an in-vivo study that the posteroanterior displacement in response to a 150 N posteroanterior force was greater at the lower lumbar levels.

The effect of posteroanterior mobilisation on lumbar range of motion is at present unclear because most studies have recruited subjects without low back pain, and the studies have had inconsistent findings (McCollam and Benson 1993, Petty 1995). McCollam and Benson (1993) reported an increase in lumbar extension range of movement following spinal mobilisation treatment, whereas the study by Petty (1995) noted no change in range of movement. A plausible explanation for the different findings could be the differences in treatment dose. The treatment dose includes treatment grade, spinal level treated, treatment duration and frequency (Maitland et al 2001). In the McCollam and Benson (1993) study, posteroanterior mobilisation treatment was applied to three locations (L_3–L_5) for three minutes at each level whereas in the later study (Petty 1995) posteroanterior mobilisation treatment was applied to only L_3 for two minutes.

The two studies that have examined the effect of spinal mobilisation in patients with spinal pain reached similar results regarding pain relief. Goodsell and colleagues (2000) demonstrated that a single treatment of three 1-minute repetitions of spinal posteroanterior mobilisation reduced the pain experienced with lumbar movement. Our previous study (Chiradejnant et al 2002a) demonstrated that a single treatment of two 1-minute repetitions of spinal posteroanterior mobilisation reduced resting pain but not the pain experienced with movement.

Prior to applying spinal mobilisation, the therapist assesses the patient to determine the precise form of mobilisation to apply. Mobilisation treatment may vary in terms of the target vertebral level, the point of contact with the spine and the characteristics of the applied force (Grieve 1991, Maitland et al 2001). When manually assessing the patient, the therapist assesses the mechanical response of the spine by relating the amount of force applied to the displacement produced. At the same time, the patient is questioned about symptom provocation. The response at one level is compared with adjacent spinal levels and combined with information from the rest of the clinical assessment; the optimal spinal level to treat is then selected (Grieve 1991; Maitland et al 2001, Magarey 1985). Subsequently, treatment is delivered specifically to that spinal level. Our previous study (Chiradejnant et al 2002a) provided some evidence to support this approach, finding that spinal mobilisation applied to the therapist-selected level is more effective in reducing pain than spinal mobilisation treatment applied to a randomly selected spinal level.

Once the correct spinal level to treat is identified, physiotherapists then select the most appropriate mobilisation technique to apply (Maitland et al 2001, Magarey 1985). For example, Maitland and colleagues (2001) describe five common lumbar mobilisation techniques that vary in terms of their point of contact with the spine and the direction of the force application. The physiotherapist may apply a posteroanterior directed force to the spinous process, or over the right or left transverse process, or a transverse force to the left or right side of the spinous process. The most appropriate mobilisation technique is determined and then used, as oscillatory movements at a grade and point in range determined by the clinical presentation. The grades of manual treatment have been described in detail by Maitland and colleagues (2001) and Magarey (1985). However, while it is common practice to match the mobilisation technique to the patient's presentation, there is no evidence that treating a patient with the therapist-selected or 'correct' mobilisation technique produces a better outcome than a 'randomly-selected' mobilisation technique. The aim of this study was, therefore, to establish whether mobilisation treatment for patients with non-specific low back pain using the mobilisation technique indicated by the clinical presentation (hereafter called 'correct' technique) is more effective in reducing symptoms than using a randomly assigned mobilisation technique.

Method

The immediate effect of the type of technique used for mobilisation treatment on pain and range of movement was investigated using a factorial design. The first independent variable "group" had two levels; "correct" mobilisation technique and 'randomly-assigned' mobilisation technique. The second independent variable, the subject's most painful movement direction, had four levels; lumbar flexion, extension, right lateral flexion and left lateral flexion. Subjects suffering non-specific low back pain were randomly assigned, using concealed allocation, to receive either mobilisation treatment using the correct mobilisation technique as identified by the treating physiotherapist, or to receive mobilisation treatment using a randomly assigned mobilisation technique. In both groups, subjects received one of the following five mobilisation techniques: the central posteroanterior pressure, right or left unilateral posteroanterior pressures and right or left transverse pressures.

All mobilisation treatments were applied to the most significant spinal level identified by the treating physiotherapist. Two manipulative physiotherapists and 140 subjects with non-specific low back pain participated, both physiotherapists treating their own patients. All measures of outcome were performed by an investigator (AC) who was blind to group allocation.

Subjects *Physiotherapists* Two qualified physiotherapists with 21 and 14 years clinical experience working in private physiotherapy practices in Sydney, Australia, participated and performed the spinal mobilisation treatments in this study. Both had postgraduate university training in manipulative physiotherapy.

Patients To be eligible for the study the patient's resting pain had to be more than 2 on a 0 to 10 pain scale and the treating physiotherapist had to agree that spinal mobilisation treatment was indicated. Patients were excluded if they exhibited any red flag conditions such as malignancy, or inflammatory or infectious diseases affecting the spine that would contraindicate the use of manual treatment (Maitland et al 2001). All subjects agreeing to participate gave consent in writing after the procedures had been fully explained. Ethical approval to conduct the study was obtained from The University of Sydney Human Research Ethics Committee.

Outcome measures *Pain intensity* Subjects' current pain intensity was recorded before and immediately after the intervention using an 11-point pain scale (0 to 10): where '0' was defined as no pain and '10' was defined as the worst pain imaginable. The scale was also used by the subject to rate the maximum pain experienced during lumbar flexion, extension and lateral flexion. The subject's most painful movement was determined by inspection of the pain ratings.

Active movement testing Consistent verbal instructions were used during all lumbar movement tests. Forward bending was measured using the modified finger-tip-to-floor method. The intra-rater and inter-rater reliability of the modified finger-tip-to-floor method have been shown to be high, with intraclass correlation coefficients [$ICC_{(2,1)}$] of 0.98 and 0.95, respectively (Gauvin et al 1990). Isolated lumbar spine range of movement was measured using the double inclinometer method. The inter-rater reliability of the double inclinometer method in measuring lumbar flexion and extension has been shown to be high with Pearson's *r* ranging from 0.96 to 0.99 (Reynolds et al 1991, cited in McCollam and Benson 1993). The criterion-related validity of the double inclinometer method has been demonstrated with high correlations between functional radiography and double inclinometer measures of lumbar flexion and extension (Pearson's *r* of 0.80 and 0.75, respectively) (Saur et al 1996). Although the criterion-related validity of the double inclinometer method in measuring lumbar lateral flexion has not been reported, the reliability is high, similar to that obtained for flexion and extension measures (Newton and Waddell 1991).

For the modified finger-tip-to-floor method, subjects were asked to stand on a 13 cm high platform with their toes close to the edge of the platform. A firm sheet of cardboard was attached to the platform. The subject was asked to slide his or her hands down the front of the cardboard towards the floor moving as far as possible while keeping the knees straight. The distance from the middle fingertip to the floor was then measured using a metal ruler to the nearest 0.5 cm. The measurement was calculated by subtracting the height of the platform (13 cm) from the total distance.

For the double inclinometer method, measurements of lumbar spinal movements were obtained using the protocol described by Waddell and colleagues (1992). In the current study, the Dualer system[a] was employed to measure lumbar range of motion. This system provides two electronic inclinometers. To measure lumbar range one was placed at the level of the T_{12}–L_1 interspinous space and the other at the S_1 spinal level. The manufacturers report accuracy and repeatability of the Dualer in measuring range of movement to be within ±1 degree. The subject was asked to perform all lumbar movements twice and the reading was taken on the second trial.

Global perceived effect The change in the subject's overall symptoms was rated immediately after the treatment intervention using an 11 point box scale (-5 to 5): where '-5' was defined as vastly worst, '0' was defined as unchanged and '5' was defined as completely recovered.

Procedures Once the treating therapist had decided to treat a patient with mobilisation, the patient was invited by the physiotherapist to participate in this study. Planned treatment details including the spinal level to be treated, the grade and the most appropriate type of mobilisation treatment for the subject were recorded by the physiotherapist. Investigator AC checked inclusion and exclusion criteria, and obtained informed consent before enrolling subjects in the study. After enrolment, basic clinical and demographic data were collected to describe the subjects and to establish baseline data.

Subjects were then randomly allocated to the experimental groups using a concealed allocation process. The sealed opaque envelope corresponding to the subject's trial number was drawn from a box and the patient's name was written across the seal of the envelope by investigator AC. The envelope was then given to the treating physiotherapist who opened the envelope to see the treatment group to which the subject had been allocated.

After allocation, investigator AC left the treatment area to ensure that he remained blind to the treatment administered. The subject then received two 1-minute repetitions of mobilisation treatment using either the therapist-selected mobilisation technique or a randomly-assigned mobilisation technique. The treated spinal level and grade of manual treatment used in both groups were those determined appropriate by the physiotherapist prior to treatment allocation. On completion of the intervention, investigator AC was immediately recalled to the treatment area in order to perform the post-intervention measurements. Subjects then continued with their normal physiotherapy treatment. The physiotherapist was unconstrained in further treatment choices.

Data analysis The effect of treatment was established by computing difference scores between the baseline and follow-up measurements for each dependent variable (except global perceived effect). Percentage change in current pain intensity and pain intensity for the most painful movement were computed by dividing the change scores for these variables by their baseline values. The dependent variables investigated in this study were global perceived effect, current pain intensity, pain on most painful movement, percentage reduction of the current pain intensity, percentage reduction of the pain intensity on the subject's most painful movement, forward bending range, lumbar flexion range, lumbar extension range, right and left lumbar lateral flexion range, and range on most painful lumbar movement. The mean and standard deviation of the difference scores for all variables were then calculated.

Separate two-way analyses of variance (ANOVA) were performed in order to investigate the effect of treatment group (2 levels) and the subject's most painful movement direction (4 levels) for the 11 dependent variables. In all statistical analyses using SPSS version 10.0.1[b], the significance level was set at alpha = 0.05.

Table 1. Subject characteristics for both groups.

Variables	Correct group (n = 70)	Random group (n = 70)
Age (years)	47.4 (16.4)	45.4 (16.5)
Height (m)	1.70 (0.10)	1.68 (0.10)
Mass (kg)	76.7 (14.5)	76.4 (17.5)
Duration of symptoms (days)	184.1 (539.9)	89.3 (279.7)
Restricted activities of daily living (days)	8.4 (10.3)	7.2 (9.5)
Work loss (days)	4.7 (8.9)	3.9 (7.7)
Number of patients with past history of LBP	11 (15.7%)	9 (12.9%)
Number of patients with leg numbness	11 (15.7%)	16 (22.9%)

Continuous variables are means (SD). The subjects in Correct group received the ‘correct’ mobilisation technique identified by their treating physiotherapist, whereas subjects in Random group received a ‘randomly selected’ mobilisation technique.

Table 2. Mean score (SD) for each variable at baseline.

Variables	Correct group (n = 70)	Random group (n = 70)
Pain (11 point scale)		
Current pain intensity	4.6 (1.5)	4.7 (1.6)
On most painful movement	5.8 (1.8)	5.7 (1.8)
Range of movements		
Modified fingertip-to-floor (cm)	19.6 (17.6)	16.8 (15.2)
Flexion (degrees)	55.4 (18.1)	55.1 (16.2)
Extension (degrees)	19.0 (8.0)	18.5 (7.3)
Right lateral flexion (degrees)	24.6 (7.2)	24.9 (7.1)
Left lateral flexion (degrees)	25.2 (7.9)	25.9 (7.3)
On most painful movement (degrees)	30.3 (19.9)	32.5 (20)

Table 3. Mean change (SD) from baseline to post-intervention for each variable.

Variables	Correct group (n = 70)	Random group (n = 70)
Pain (11-point scale)		
Current pain intensity	1.3 (1.4)	1.2 (1.7)
On most painful movement	1.7 (1.7)	1.4 (1.5)
Percentage reduction of the current pain intensity	29.7 (32.7)	23.9 (37.9)
Percentage reduction of the pain intensity on the subject’s most painful movement	32.3 (32.4)	24.7 (29.7)
Range of movements		
Modified fingertip-to-floor (cm)	2.0 (2.6)	0.5 (5.6)
Flexion (degrees)	-3.5 (3.8)	-1.9 (6.5)
Extension (degrees)	-2.2 (2.9)	-2.6 (2.8)
Right lateral flexion (degrees)	-2.0 (2.5)	-1.9 (2.7)
Left lateral flexion (degrees)	-2.2 (2.6)	-2.2 (2.6)
On most painful movement (degrees)	-3.2 (3.2)	-2.1 (6.3)
Global perceived effect (11 point scale)	1.4 (1.8)	1.2 (1.9)

A positive sign for the difference scores of the modified fingertip-to-floor and a negative sign for the difference scores of the other movement tests represent an increase in range of movement.

Table 4. Two-way ANOVA results testing for effects of intervention and the subject's most painful movement direction, and interaction effects.

Variables*	Group intervention		Direction of most painful movement		Interaction	
	$F_{1,132}$	*p* value	$F_{3,132}$	*p* value	$F_{3,132}$	*p* value
Pain						
Current pain intensity	0.09	0.77	1.62	0.19	2.08	0.11
Pain on most painful movement	0.00	0.97	0.26	0.85	2.39	0.07
Percentage reduction of the current pain intensity	0.02	0.89	0.98	0.40	1.96	0.12
Percentage reduction of the pain intensity on the subject's most painful movement	0.04	0.85	0.15	0.93	1.93	0.13
Range of movements						
Modified fingertip-to-floor	0.59	0.44	0.46	0.71	1.29	0.28
Flexion	0.48	0.50	0.57	0.64	0.84	0.48
Extension	2.56	0.11	1.08	0.36	1.48	0.22
Right lateral flexion	0.23	0.63	2.87	0.04**	3.44	0.02**
Left lateral flexion	0.34	0.56	1.73	0.16	4.39	0.006**
On most painful movement	0.28	0.60	0.22	0.88	1.73	0.16
Global perceived effect	0.01	0.94	0.35	0.79	2.04	0.11

*Change between baseline and post-intervention **Significant, $p < 0.05$

Results

One hundred and forty subjects with non-specific low back pain (71 males, 69 females) with a mean age of 46.4 years (SD 16.4, range 18 to 89 years) were recruited. In this sample, the median duration of symptoms was 81 days (interquartile range = 7 to 90 days). A description of subject characteristics for both groups is given in Table 1. Table 2 shows the baseline measures of pain and range of movement. Table 3 shows the mean of change scores (SD) of all variables for both groups investigated in this study. Table 4 shows the results of the two-way ANOVA. There was no significant main effect of intervention on the 11 dependent variables, whereas there was a significant main effect of subjects' most painful movement direction for the right lateral flexion outcome ($F_{3,132} = 2.87$, $p = 0.04$). An effect was also found for the interaction between the group intervention factor and the direction of the subject's most painful movement for the right and left lateral flexion range of movement outcomes ($F_{3,132} = 3.44$, $p = 0.02$ and $F_{3,132} = 4.39$, $p = 0.006$, respectively) but for not for the other nine dependent variables.

Post hoc tests were performed to interpret the interaction effect. A significantly greater increase in right lateral flexion range of motion was found when the 'correct' mobilisation technique was given to subjects whose most painful movement directions were extension and right lateral flexion ($F_{3,132} = 5.48$, $p = 0.02$ and $F_{3,132} = 4.99$, $p = 0.03$, respectively) but not when the most painful movement directions were flexion and left lateral flexion. A significantly greater increase in left lumbar lateral flexion range of motion was found when the 'correct' mobilisation technique was given to subject's whose most painful movement direction was right lateral flexion ($F_{3,132} = 10.82$, $p = 0.001$) but not when the most painful movement was in other directions.

As there was no main effect of the treatment group on any dependent variable, the data were pooled across the treatment groups in order to investigate (1) whether a particular mobilisation technique was more effective than another, or (2) whether mobilisation is more effective when directed to a certain lumbar level. The treatment techniques were classed into three groups: central posteroanterior pressure, unilateral posteroanterior pressures, and transverse pressures. The spinal levels treated were collapsed into two groups: upper lumbar (L_1–L_3) and lower lumbar (L_4–L_5) spine. Again, separate two-way ANOVA were performed to investigate the effect of the mobilisation technique used and the treated spinal level.

Table 5 shows the mean of the change scores (SD) of all variables for the pooled data of the current study. Table 6 shows the results of the two-way ANOVA. There was no significant main effect due to type of mobilisation or interaction effect on the 11 dependent variables (Table 6). However there were effects due to spinal level. The results of the two-way ANOVA demonstrated that spinal mobilisation was associated with better outcomes when applied to the lower lumbar spinal levels than when applied to the upper lumbar spinal levels for four dependent

Table 5. Mean change (SD) of each variable from baseline to post-intervention for the pooled data (current study, n = 140).

Variables	Upper lumbar L_1–L_3 (n = 37)	Lower lumbar L_4–L_5 (n = 103)
Pain (11 point scale)		
Current pain intensity	0.8 (1.2)	1.4 (1.7)
On most painful movement	1.2 (1.2)	1.6 (1.7)
Percentage reduction of the current pain intensity	15.2 (32.8)	31 (35.5)
Percentage reduction of the pain intensity on the subject's most painful movement	19.1 (20.2)	31.8 (33.7)
Range of movements		
Modified fingertip-to-floor (cm)	0.9 (3.6)	1.4 (4.7)
Flexion (degrees)	-2.4 (4)	-2.8 (5.8)
Extension (degrees)	-2.5 (2.2)	-2.3 (3.0)
Right lateral flexion (degrees)	-2.2 (2.6)	-1.8 (2.6)
Left lateral flexion (degrees)	-1.5 (2.6)	-2.4 (2.5)
On most painful movement (degrees)	-2.7 (4.1)	-2.7 (5.3)
Global perceived effect (11 point scale)	1 (1.7)	1.4 (1.8)

A positive sign for change in the modified fingertip-to-floor and a negative sign for change in other movement tests represent an increase in range of movement.

variables: current pain intensity was reduced by 0.6 units more on the 0 to 10 scale ($p = 0.04$), percentage of the current pain intensity was reduced by 16% more ($p = 0.03$), percentage of the pain intensity on subject's worst movement was reduced by 13% more ($p = 0.02$) and left lateral flexion range of movement was increased by 0.9 degrees more ($p = 0.04$).

A further question raised in this study was whether the effect of the spinal level would remain if the data of the current study (n = 140) and the previous study (n = 120) (Chiradejnant et al 2002a) were pooled. The data from 260 subjects with low back pain were analysed, the spinal levels treated were classed into two groups: upper (L_1–L_3) and lower (L_4–L_5) lumbar levels. An independent-samples *t*-test was performed to compare the effect when mobilisation was delivered to the upper lumbar levels to the effect when it was delivered to the lower lumbar levels.

Table 7 shows the mean of the change scores (SD) of all variables for the pooled data (n = 260) and *t*-test results. The results of the *t*-test demonstrated that spinal mobilisation applied to the lower lumbar spinal levels was associated with greater relief of pain than when applied to the upper lumbar spinal levels on five dependent variables: current pain intensity was reduced by 0.5 units more on the 0 to 10 scale ($p = 0.01$), pain intensity on most painful movement was reduced by 0.5 units more on the 0 to 10 scale ($p = 0.01$), percentage of the current pain intensity was reduced by 15% more ($p < 0.001$), percentage of the pain intensity on subject's worst movement was reduced by 14% more ($p < 0.001$), and global perceived effect was improved by 0.4 units more on the –5 to 5 scale ($p = 0.04$).

Discussion

Although a range of lumbar mobilisation techniques are used in the treatment of patients with low back pain, no previous study has evaluated whether one mobilisation technique is more effective than the others. It has been recommended, for example, that the central posteroanterior mobilisation technique should be the first choice of mobilisation treatment for bilaterally distributed low back symptoms (Maitland et al 2001). Our results, however, provide no evidence to support this view. In the primary analysis, we found no difference between therapist-selected and randomly-selected mobilisation techniques. The secondary analysis did not find any difference in effect for the five various techniques. These findings are contrary to the clinical recommendations in manual therapy texts (Maitland et al 2001, Grieve 1991).

A number of factors may be responsible for these unexpected findings. In the current study, the inclusion criteria were broad: subjects were patients with non-specific low back pain with current pain intensity more than 2 on a 0 to 10 scale. Potentially we may have recruited a heterogeneous group of patients and conceivably, the response to mobilisation treatment could differ from one type of patient to another. Further research investigating the efficacy of various types of mobilisation treatment in smaller more homogenous subsets of patients is indicated.

Table 6. Two-way ANOVA results testing for effects of type of mobilisation treatments (3 levels) and spinal level treated (2 levels), and interaction effects.

Variables*	Type of mobilisation		Spinal level treated		Interaction	
	$F_{2,134}$	*p* value	$F_{1,134}$	*p* value	$F_{2,134}$	*p* value
Pain						
Current pain intensity	0.21	0.81	4.54	0.04**	0.05	0.95
On most painful movement	0.90	0.41	2.71	0.10	0.78	0.46
Percentage reduction of the current pain intensity	1.29	0.28	5.17	0.03**	0.02	0.98
Percentage reduction of the pain intensity on the subject's most painful movement	2.00	0.14	5.48	0.02**	0.74	0.48
Range of movements						
Modified fingertip-to-floor	1.26	0.29	0.42	0.52	0.07	0.94
Flexion	0.97	0.38	0.10	0.75	0.60	0.55
Extension	1.32	0.27	0.06	0.81	0.84	0.44
Right lateral flexion	0.53	0.59	0.34	0.56	1.28	0.28
Left lateral flexion	0.20	0.82	4.54	0.04**	0.72	0.49
On most painful movement	2.35	0.10	0.04	0.84	0.31	0.74
Global perceived effect	2.13	0.12	1.04	0.31	0.21	0.81

*Change between baseline and post-intervention **Significant, $p < 0.05$

Table 7. Mean change (SD) and *t*-test results for the pooled data (n = 260). *t*-tests were performed to determine whether different treatment outcomes were associated with treatments targeted to upper lumbar versus lower lumbar levels.

Variables	Upper lumbar (L_1–L_3) (n = 105)	Lower lumbar (L_4–L_5) (n = 155)	*t*-test	
			$t_{1,258}$	*p* value
Pain (11 point scale)				
Current pain intensity	0.9 (1.3)	1.4 (1.6)	-2.51	0.01*
On most painful movement	1.1 (1.2)	1.6 (1.7)	-2.50	0.01*
Percentage reduction of the current pain intensity	5.5 (20.1)	20.7 (32.3)	-4.27	<0.001*
Percentage reduction of the pain intensity on the subject's most painful movement	6.9 (14.9)	21.3 (31.2)	-4.40	<0.001*
Range of movements				
Modified fingertip-to-floor (cm)	1.1 (3.4)	1.4 (4.2)	-0.69	0.49
Flexion (degrees)	-2 (4)	-2.3 (5.1)	0.60	0.55
Extension (degrees)	-2.1 (2.7)	-2.5 (2.9)	1.01	0.31
Right lateral flexion (degrees)	-2.3 (2.6)	-2.1 (2.8)	-0.46	0.65
Left lateral flexion (degrees)	-2 (2.4)	-2.4 (2.7)	1.45	0.15
On most painful movement (degrees)	-2.9 (3.7)	-2.7 (4.8)	-0.53	0.60
Global perceived effect (11 point scale)	1 (1.6)	1.4 (1.8)	-2.09	0.04*

A positive sign for change in the modified fingertip-to-floor and a negative sign for change in the other movement tests represent an increased in range of movement. *Significant, $p < 0.05$

Another feature of our study that could account for our results is the use of therapist-chosen rather than standardised treatment force characteristics (eg the peak force, frequency and amplitude of force used in the treatment). In the current study, the treatment force characteristics were decided by the treating physiotherapist based on the patients' clinical presentation as is usual in clinical practice. However, previous research has demonstrated that the force characteristics vary depending on both patient and therapist characteristics (Chiradejnant et al 2002b). Therefore, a different result may occur if treatment force characteristics are standardised. Further, in this study we investigated the immediate effect of a single treatment. It would be useful to investigate how various dose parameters affect the outcome of a course of treatment in both the short and long term.

We were surprised that mobilisation treatment was associated with greater relief of back pain when applied to the lower lumbar spinal levels. To our knowledge, this effect has not been noted in previous research or discussed in manual therapy texts. One possible explanation for this effect could be the differing mobility of lumbar spinal levels in response to the application of posteroanterior force (Lee and Evans 1992a). When a posteroanterior force was applied to the lumbar spine in vivo, Lee and Evans (1992a) reported greater posteroanterior translation at lower lumbar spinal levels. The greater pain relief found in the current study could be explained by the clinical recommendations of Maitland and colleagues (2001) and Magarey (1985). These authors have suggested that a large oscillation of mobilisation treatment would result in more pain relief than a smaller oscillation of mobilisation treatment. However, the mobility of the lumbar spine in other planes, such as the coronal plane, has not been well investigated. Therefore, caution should be exercised in interpreting these results.

The principal finding of this study is that various lumbar mobilisation techniques have similar immediate effects on pain and range of movement in subjects with non-specific low back pain. It appears, however, that mobilisation treatment applied to lower lumbar spinal levels is associated with a greater immediate analgesic effect than mobilisation applied to upper levels. Further research is required to understand the mechanism for the analgesic effect seen immediately following mobilisation treatment.

Footnotes [a]Dualer Plus™, JTech, 324 W. 1120N, American Fork, Utah 84003. [b]SPSS version 10.0.1 for Windows, SPSS Inc., 233s. Wacker Drive, Chicago, Illinois 60606

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