Spinal mobilization vs conventional physiotherapy in the management of chronic low back pain due to spinal disk degeneration: a randomized controlled trial

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ABSTRACT

Objectives: The aim of the study was to examine the efficacy of spinal mobilization in subjects with low back pain (LBP) and associated spinal disk degeneration.

Methods: Seventy-five subjects suffering from chronic LBP (>3 months) were randomly allocated into 3 groups of 25 subjects each. Each group received five treatment sessions with the first group receiving manual therapy (MT) (spinal mobilization), the second a sham treatment, and the third conventional physiotherapy (CP) (stretching exercises, transcutaneous electrical nerve stimulation, and massage). Subjects were assessed for their pain intensity using the numerical pain rating scale and for their self-reported disability using the Oswestry and Roland-Morris Questionnaire at baseline and after the completion of the five treatment sessions.

Results: Paired *t*-tests showed a significant improvement for all outcome measures in the MT and CP group ($p < 0.05$). Analysis of covariance revealed that the MT group had significant improvement in all outcome measures in comparison with the sham and CP group ($p < 0.05$), whereas no significant difference was observed between the sham and CP group ($p > 0.05$).

Discussion: MT is preferable to CP in order to reduce the pain intensity and disability in subjects with chronic LBP and associated disk degeneration. The findings of this study may lead to the establishment of spinal mobilization as one of the most preferable approaches for the management of LBP due to disk degeneration.

Level of evidence: 1b.

KEYWORDS

Intervertebral disk degeneration; chronic low back pain; manual therapy; spinal mobilization; physiotherapy; TENS; massage; hamstring stretching

Introduction

Back pain is a health problem with high impact on both the quality of life of an individual as well as a nation's economy.¹ It is a condition affecting 60–80% of the world's population at some point in life^{2,3} and its chronicity can lead to disability.^{4,5} In recent years, there has been a change in the evaluation and treatment of low back pain (LBP). There is evidence to suggest that chronic LBP may be a biopsychosocial phenomenon, with concomitant contributions of pathoanatomical and biomechanical factors.⁶

On an international level, the reported prevalence of LBP cases reach as high as 56.5% in a population of 1829 people in Qatar.⁷ Similarly, the review from Hoy et al.⁸ showed that in Denmark, the recorded prevalence ranged from 6.3 to 19.3%, 18.9% in Canada, 36% in the United Kingdom, and 18.4% in Israel.

In Greece, in a population of 2000 people chosen randomly with the definition of the sample quotas based

on gender, age group, geographical area, and type of residence, 31.6% ($N = 633$, 55% younger than 45 years) showed symptoms of LBP during the last month and of those, 46.6% experienced sciatica.⁹ Of this population, 36% received medication, 28.1% visited a doctor, 1.3% was hospitalized, and 1.1% underwent surgery during the same period.⁹ Similar percentages were recorded in the study of Koroivessis et al.,¹⁰ wherein a population of 674 randomly selected people aged 20 years or older, stratified by gender, age, socioeconomic status, and employment, 39.5% experienced LBP in the past 6 months. Of those, 62.4% experienced sciatica, 37.2% received medication, 54.1% visited a doctor, 15.8% received physical therapy, 6.8% hospitalized, and 4.9% had surgery during the same period. It is worth noting that age, sex, social and health status, and lifestyle choices are indicators of increased risk of LBP. Data indicate that individuals over 65 years of age, women, individuals with a low educational level, working in manual labor positions,

smokers, and recipients of antidepressant medications, are affected at a higher rate.^{9,10}

One potential cause of back pain includes degeneration of the intervertebral disk.¹¹ The treatment of acute LBP includes relative rest, activity modification, non-steroidal anti-inflammatory medication, and physical therapy.^{12–15} In chronic LBP patients, priority is given to support the patients to improve their functionality and reduce the pain rather than trying to provide a cure.¹⁶

Physiotherapy seems to display ambiguous outcomes. The use of modalities (ultrasound, transcutaneous electrical nerve stimulation – TENS, diathermy, and heat/cold) has been investigated,^{17–22} as well as that of exercise^{23–26} and other manual therapy (MT) treatment techniques.^{23,27–29} In particular, MT techniques can be divided into two main groups, mobilization and manipulation.³⁰ Mobilization is performed within the normal joint motion limits in a way that it may be stopped by the patient, whereas manipulation is a rapid movement at the end of the range of movement that cannot be controlled by the patient.³⁰

Even though there is research regarding MT for LBP,^{23,27–29} there is no evidence from randomized controlled trials regarding the efficacy of spinal mobilization in patients suffering from chronic LBP stemming from different levels of spinal disk degeneration. The purpose of the study was to evaluate the efficacy of spinal mobilization in chronic LBP patients and comparing it with the conventional physiotherapy (CP) (exercise and modality use).

Methods

This was a pragmatic, randomized, sham-controlled trial (Appendix A). The study was approved by the ethics committee of the Physiotherapy Department of the Technological Educational Institute of Central Greece (reference number 32/06-03-2013) and the protocol was registered at an internationally available database for clinical trials (<https://clinicaltrials.gov/>, NCT02645123). Before their participation, volunteers were asked to sign an informed consent.

Sample

The experiment took place at the Biomechanics laboratory of the Physiotherapy Department of the Technological Educational Institute of Central Greece between January 2013 and September 2014. The study involved 75 subjects, 42 male and 33 female, with an age range of 21–78 years. Subjects were LBP sufferers visiting an orthopedic physician who referred them for physiotherapy. To estimate the number of subjects, a statistical power software (G* Power, version 3.1.9.2) was used, which showed that for a large effect size ($f = 0.4$),

with $\alpha = 0.05$ and statistical power of 80%, the study required a total sample of 73 subjects.

The subjects were initially evaluated by the treating physician and orthopedist and the inclusion criteria were: (a) pain in the lumbar spine for a period longer than 3 months^{31–33} and (b) recent MRI (within 12 months) in the lumbar region so that the treating physician could evaluate the grade of the intervertebral disk degeneration according to the modified Pfirrmann scale.³⁴ This scale in both its original³⁵ and its modified version³⁴ has been found to be reliable in determining the level of disk degeneration across all age ranges. The exclusion criteria were: (1) history of spinal surgery, (2) history of autoimmune disease (ankylosing spondylitis, rheumatoid arthritis, or other), (3) history of spondylolysis or spondylolisthesis, (4) spinal fractures, (5) pregnancy, (6) respiratory and/or cardiac pathology, (7) history of stroke, (8) cauda equina syndrome, (9) continuous use of pain medications, (10) spinal inflammation, (11) spinal tumor, (12) subjects receiving immunosuppressant medication, (13) corticosteroid medication use in the last month, and (14) osteoporosis.

Subjects were advised not to receive pain-controlling medication during the experimental period, unless deemed necessary. In the eventuality of pain medication usage, each subject's usage was recorded and subjects were excluded if they used pain medication continuously or on the days of the interventions.

Procedure

The subjects were randomly allocated in 3 groups of 25 subjects each: the MT, the sham treatment (ST) and the CP group (Figure 1). The randomization process was achieved using the internet-based software Graphpad.³⁶

The MT group was treated using MT techniques (spinal mobilization: passive accessory intervertebral movements and passive physiological intervertebral movements, five sessions lasting 10 min each, one session per week)^{32,37–40} to the vertebral levels that showed disk degeneration. For example if there was degeneration of the disk between the fourth and the fifth lumbar vertebra, both vertebrae received mobilization as there is evidence to suggest that chronic LBP may be stemming from degenerated disks.⁴¹ One session of MT per week, even though uncommon in clinical practice, was chosen due to technical reasons and because there is evidence to suggest its efficacy in improving pain³² and disability³⁷ in subjects with chronic LBP. Also, even a single treatment of spinal mobilization has been found to display positive outcome on LBP levels.^{40,42} All MT interventions were performed by one physiotherapist (GK) with 17 years of experience in physiotherapy, 12 of which in the application of MT techniques.

In the ST group, the investigator (GK) held their hand in a static position gently touching the skin overlying

Figure 1. Flow chart of the study.

Notes: MT: manual therapy, CP: conventional physiotherapy, ST: sham treatment.

the lumbar spine for 10 min and did not make any other intervention (one session per week).^{39,43} Subjects were unaware of their inclusion in this group and, after being asked following the trial, thought they were receiving actual treatment at the time of the intervention.

In the CP group, the investigator (GK) applied exercise (static stretching of the hamstring muscles of both lower limbs for 5 min – 5 sets × 1 min each),⁴⁴ TENS in the lumbar area (two channels, biphasic pulse, frequency 90 Hz, pulse width 100 ms, duration 20 min, intensity according to the sensation of the patient)⁴⁵ and Swedish type massage (effleurage, petrissage, kneading, rhythmic pressures, and rolling in the lumbar area) for 15 min.⁴⁶ Each participant received five sessions (one session per week). Subjects did not receive any home exercise program or advice so as to standardize the procedure.

The numerical pain rating scale (NPRS) was used to record the intensity of pain for each individual. The subjects were also asked to complete two questionnaires (Greek version of the Oswestry and Roland-Morris) that related to the self reported impact of back pain in their everyday life in terms of disability. These measurement tools were chosen because of their high reliability and validity, and for both questionnaires higher scores indicate increased disability.^{4,47} The principal investigator (GK) recorded the pain (NPRS) at baseline before the implementation of any treatment and at the end of each treatment period of all groups (at week five) and also collected the subject-completed questionnaires. In addition, for exploratory purposes, all subjects were contacted (by GK) 6 months after their final physiotherapy session, so as to evaluate which subjects sought further help from a health care practitioner.

Statistical analysis

Data normality was tested using the Kolmogorov–Smirnov statistical test. For the descriptive statistics the mean (M) was used as an indicator of central tendency and the standard deviation (SD) as a dispersion index. The differences among the three groups in anthropometric characteristics and baseline measurements of the dependent variables were tested using the statistical test of the analysis of variance (one-way ANOVA) checking the homogeneity with the Levene test.⁴⁸ The efficacy of each treatment was tested with the paired *t*-test.⁴⁹ The comparison in the efficacy of the three treatments (MT, ST, and CP), was performed with the analysis of covariance (ANCOVA), using as a covariance factor the baseline values of each dependent variable and comparing them to the values of the same variables among the different groups after treatment application.⁵⁰ The differences between groups regarding the percentage of change were evaluated with the analysis of variance (one-way ANOVA). To assess the percentage of change in the clinical indicators (NPRS, ODI, and RMDQ), the following mathematical formula was used: $((A-B)/A) \times 100\%$, where *A* is the value before, and *B* is the value after the interventions. A positive number would indicate improvement and a negative, the opposite. Correlations between the grade of the intervertebral disk degeneration and the percentage of change of the clinical characteristics of each patient (NPRS and Oswestry and Roland-Morris questionnaires) were tested using the Spearman correlation coefficient.⁵¹ Positive correlation indicated that, for the given intervention, higher disk degeneration was associated with increased percentage of change

Table 1. Baseline characteristics of the Manual therapy (MT) (n = 25), the Sham treatment (ST) (n = 25), and the Conventional physiotherapy (CP) (n = 25) group

	MT group	ST group	CP group	p ^a
Gender (♂/♀)	12/13	14/11	16/9	0.52
Age (years) M(SD)	46.96(16.07)	50.08(12.61)	45.48(14.58)	0.53
Height (cm) M(SD)	170.61(8.36)	173.54(8.71)	173.87(7.2)	0.3
Weight (kg) M(SD)	77.37(15.14)	76.2(10.3)	75.7(9.82)	0.88
GDD M(SD)	4.72(1.31)	4.88(0.97)	4.72(0.79)	0.8
Pain NPRS M(SD)	5.96(1.37)	6.12(1.05)	6(1)	0.85
Oswestry (%) M(SD)	33.28(15.02)	32(8.32)	31.04(11.07)	0.8
Roland-Morris M(SD)	8.56(3.56)	10(1.96)	9.96(3.13)	0.2

Notes: M: Mean, SD: standard deviation GDD: grade of disk degeneration, NPRS: numerical pain rating scale, GDD: grade of disk degeneration.^aResults from one-way ANOVA test.

Table 2. Efficacy of manual therapy (MT) (n = 25), sham treatment (ST) (n = 25), and Conventional physiotherapy (CP) (n = 25) on pain and disability of patients with low back pain

Group	Outcome measure	Pre-treatment M (SD)	Post-treatment M (SD)	Mean difference	95%CI	t-value	p
MT	Pain NPRS	5.96(1.37)	1.22(1.1)	4.74	4.11, 5.37	15.438	0.001
	Oswestry (%)	33.28(15.02)	9.84(3.87)	23.44	16.83, 30.05	7.318	0.001
	Roland-Morris	8.56(3.56)	2.44(1.76)	6.12	4.53, 7.71	7.938	0.001
ST	Pain NPRS	6.12(1.05)	5.88(0.92)	0.24	-0.05, 0.53	1.659	0.11
	Oswestry (%)	32(8.32)	31.76(8.51)	0.24	-0.63, 1.11	0.569	0.57
	Roland-Morris	10(1.95)	10.04(2.05)	-0.04	-0.36, 0.28	-0.253	0.80
CP	Pain NPRS	6(1)	4.96(0.89)	1.04	0.69, 1.38	6.186	0.001
	Oswestry (%)	31.04(11.07)	27.28(9.53)	3.76	2.22, 5.29	5.066	0.001
	Roland-Morris	9.96(3.13)	8.76(2.96)	1.2	0.86, 1.53	7.348	0.001

Notes: M: mean, SD: standard deviation, 95% CI: 95% confidence intervals, NPRS: numerical pain rating scale.

Table 3. Comparison of the efficacy of manual therapy (MT), sham treatment (ST), and conventional physiotherapy (CP) on pain and disability of subjects with low back pain

	Adjusted mean MT group	Adjusted mean ST group	Adjusted mean CP group	F-value	Partial η^2	p
NPRS	1.24	5.84	4.97	200.254	0.849	0.001
Oswestry (%)	9.39	31.8	27.69	89.941	0.717	0.001
Roland-Morris	2.91	9.79	8.53	98.984	0.736	0.001

Note: Mean following the intervention, NPRS: numerical pain rating scale.

(improvement). Negative correlation indicated that higher disk degeneration was associated with lower percentage of change (improvement). Clinically, this correlation would indicate the efficacy of each intervention depending on the disk degeneration grade.

When a statistically significant difference was detected (either using ANOVA or ANCOVA), *post hoc* tests with the Bonferroni correction⁴⁸ were used to determine the differences amongst the interventions. Finally, the difference in the three groups regarding the need of subjects to seek another health care practitioner during the period of six months following completion of the interventions was examined using chi-squared tests.

The significance level for all statistical comparisons was set at 0.05. The data were analyzed using the statistical package for social sciences (SPSS, version 20).

Results

No participant was excluded from the trial and the analysis was performed on the originally assigned groups. All subjects of each group attended all treatment sessions. The baseline characteristics of the three groups were similar (Table 1). The degree of disk degeneration of each participant is presented in Appendix B.

Paired *t*-tests revealed that the MT and CP groups improved significantly in all the clinical indices (NPRS, Oswestry, and Roland-Morris) ($p < 0.05$), whereas no significant improvements were found for the ST group ($p > 0.05$). These findings are reported in Table 2.

The ANCOVA test revealed that the efficacy of the three treatment methods significantly differed for all the clinical indices (NPRS, Oswestry, and Roland-Morris) ($p < 0.05$). *Post hoc* analysis with Bonferroni correction showed that this difference was significant between MT and ST group ($p < 0.05$) and between the MT and CP group ($p < 0.05$) for each one of the clinical indices. No significant difference was observed between the ST and the CP group ($p > 0.05$). Table 3 presents the adjusted means and the significance of the differences derived from the ANCOVA.

The change in each dependent variable was also expressed as a percentage for each one of the treatment groups (Figure 2). One-way ANOVA showed that the MT group experienced significantly higher percent improvement in comparison with the other two groups for each one of the dependent variables ($p < 0.05$). The CP group presented a significantly higher improvement in pain NPRS and Roland-Morris questionnaire in comparison with the ST group ($p < 0.05$), whereas the same groups did not differ in Oswestry questionnaire scores ($p = 0.69$).

Figure 2. Percentage improvement of pain and disability for each treatment group.

Table 4. Correlations between disk degeneration grade and percentage of change of each clinical parameter for the manual therapy (MT), the sham treatment (ST), and the conventional physiotherapy (CP) group

	MT group	ST group	CP group
Pain NPRS	$r_s: 0.371$ $p: 0.068$	$r_s: 0.045$ $p: 0.83$	$r_s: 0.197$ $p: 0.345$
Oswestry	$r_s: 0.508$ $p: 0.01$	$r_s: -0.114$ $p: 0.589$	$r_s: -0.437$ $p: 0.029$
Roland-Morris	$r_s: 0.484$ $p: 0.014$	$r_s: -0.102$ $p: 0.629$	$r_s: 0.134$ $p: 0.523$

Note: NPRS: numerical pain rating scale.

Analysis of correlations between the grade of intervertebral disk degeneration with the percentage of change (between before and after) of the clinical indicators of the different treatment methods, revealed different degrees of association between groups (Table 4). Specifically, in the group receiving MT, there was positive correlation between the degree of degeneration of the intervertebral disk and the percentage of improvement in the Oswestry and Roland-Morris questionnaire ($r = 0.508$ and 0.484 , respectively), whereas there was no significant correlation with percent improvement in pain levels ($r = 0.371$, $p = 0.068$). For the other two groups, there was no correlation, apart from the conventional therapy group that was presented with moderate negative correlation with improving disability ($r = -0.437$, Oswestry questionnaire only).

For the group that received MT, none but one needed to visit a health care professional. For the CP group, 10 out of 25 subjects had to revisit their health care provider. For the group receiving ST, 21 out of 25 sought further help. Upon questioning, all subjects of the ST group were oblivious of their inclusion in this group at the time of the intervention. Chi-square analyses revealed that the need for subjects to visit a health care professional was

significantly different between all groups (MT vs. CP $p = 0.002$; CP vs. ST $p = 0.001$; MT vs. ST $p < 0.001$).

Discussion

Although MT techniques are commonly used in the management of patients with chronic LBP, there is relatively little research in their clinical efficacy or their mechanism of action.³⁹ This study focused on the effect of spinal mobilization to the chronic LBP subjects' clinical presentation related to intervertebral disk degeneration. The results suggest that the application of five sessions, lasting 10 min each, produced statistically significant differences in the subjects' clinical presentation.

The application of ST had no clinical effect whereas the application of CP showed statistically significant differences in all clinical parameters. However, it was in the MT group that the greatest improvements occurred for the same number of sessions. It is suggested that for an intervention to be considered clinically significant, improvement in pain levels should be at least 35%^{52,53} In this study, in the MT group, the average improvement in pain rose by 78.1%, while for CP it rose by 16.4%. Thus in this study, the clinical improvements observed using five sessions of spinal mobilization were clinically significant.^{52,53}

According to the gate theory for the control of pain,⁵⁴ passive spinal mobilization activates mechanoreceptors of vertebral joints, the stimulus of which is transported by fast myelinated fibers to the posterior horns of the spinal cord, causing blockage to stimuli coming from the nociceptors of the same area.⁵⁵ Furthermore, spinal mobilization involves contact with the skin that can potentially influence the nociceptor activity.⁵⁶ Thus, if the pain is of articular origin, it is possible that the increased

volume of nerve impulses from the skin can result in pain reduction.⁵⁶ However, this was not apparent from the results of the present study where ST did not improve pain levels.

There is evidence to suggest⁵⁷ that articular mobilization activates the dorsal periaqueductal gray area (dPAG) of the brain influencing pain perception. Studies^{58–62} have shown an immediate reduction in pain and/or increased activity of the sympathetic nervous system, suggesting indirect association with the dPAG. Data also demonstrate that there is a correlation between increased stimulation of the sympathetic nervous system and the decrease in the threshold of mechanical pain,^{59,61} which further supports the hypothesis that joint mobilization initiates the descending pain inhibitory mechanisms through the stimulation of dPAG. In this study, pain levels were recorded at baseline and after the end of the five sessions. It is not certain though if the reduction in pain levels was due to the activation of descending pain inhibitory mechanisms. This is because the activation of the dPAG causes immediate analgesia^{63,64} and the design of the study did not include the recording of pain levels after each session. Conceivably, the pain reduction observed in this study could have been due to a combination of the above mechanisms. Further research should investigate the middle and long-term effects of such MT treatment in subjects with LBP.

Additionally, this study provides some findings in terms of correlation between the degree of intervertebral disk degeneration and the percentage of change in the clinical indicators before and after the application of the different interventions. Specifically, in the group receiving MT, there was a strong positive correlation between the degree of degeneration and the percentage of change (improvement) in the Oswestry questionnaire and Roland-Morris ($r = 0.508$ and 0.484 , respectively), while there was no correlation with the percentage of change in pain levels ($p = 0.068$, $r = 0.32$). This signifies that, in subjects with a higher the degree of degeneration of the intervertebral disk, the application of spinal mobilization seems to be more effective (higher percentage of change). For the other two groups, there was no correlation except for the CP group, where a moderate to strong negative correlation ($r = -0.437$) to the percentage of improvement of disability was observed (only in the Oswestry questionnaire). This is suggestive that in subjects with a lower degree of degeneration, disability as expressed in the Oswestry questionnaire may be managed through CP.

Another aspect of this study was to evaluate the subjects' need to seek further help over a period of six months. Only one subject sought further treatment in the MT group, 10 in the CT group and 21 in the ST group. Statistical tests revealed that there was significant difference between the groups. This suggests that spinal mobilization may reduce the need for further physiotherapy

visits in subjects with chronic LBP. This is in contrast to the findings of Rasmussen-Barr et al.³⁷ who suggested only a short-term improvement. However, the results of this study are in agreement with those of Goldby et al.³² who evaluated the efficacy of MT up to 24 months after the intervention. Nevertheless, a direct comparison is not possible, as Goldby et al.³² did not provide description of the techniques used. Similarly, the results of this study come in line with the ones from Aure et al.,²³ who evaluated the effectiveness of MT up to 12 months after the intervention. Aure et al.²³ used multiple MT techniques and hence the comparison of the results should be done with caution. Additionally, even though Ferreira et al.⁶⁵ applied 12 sessions of MT, they did not observe retention of the improvements 6 months following the intervention. It should be noted that Ferreira et al.⁶⁵ included both spinal mobilization and manipulation without specifying if such techniques were applied to all the subjects. Again, because of lack of specification in terms of the modalities applied in their sample, the results cannot be compared directly with the present study.

Although the reasons explaining the effectiveness of spinal mobilization are not entirely distinct, the above results provide evidence that spinal mobilization can decrease pain and reduce disability in patients with chronic LBP. Furthermore, the results showed that the greater the intervertebral disk degeneration, the stronger the positive impact of spinal mobilization in terms of disability.

There are some limitations with this study. One possible limitation might be the lack of a home exercise or education program. This was done so as to avoid potential confounders, which might have affected the dependent variables⁴² and also to standardize the process. Another limitation might be the use of an up to one-year-old lumbar MRI scan to assess disk degeneration. Even though the imaging presentation might change in one year, the average scan date of all subjects was not older than five months before the start of their participation in the study. In addition, the researcher that collected the data was the also the one providing the treatment, which may have introduced error or bias in the results.

In this study, spinal mobilization was applied to the segment/s that showed disk degeneration. Perhaps, a future study could compare the efficacy of mobilizing the degenerated segments with mobilizing the symptomatic level as this is more commonly used.⁴²

Overall, this study provides some data on the efficacy of spinal mobilization to a group of subjects suffering from chronic LBP. Taking into account that education, regular exercise, and movement are typically included in a rehabilitation program, it could be more beneficial to combine MT with education and exercise. Further trials are needed to investigate such therapy combination in patients with chronic LBP and intervertebral disk degeneration.

Disclosure statement

No potential conflict of interest was reported by the authors.

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