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Efficacy of Spinal Manipulation as a Part of Physical Therapy Program in Patients with Lumbar Disc Herniation: A Randomized Controlled Trial

Authors
Neveen Abdel Latif Abdel Raoof[1], Nevein Mohammed Mohammed Gharib[2]
Sahar Mohammed Adel[1]
[1]Department of Basic Science, Faculty of Physical Therapy, Cairo University, Giza, Egypt
[2]Physical Therapy Department for Neuromuscular Disorders and its Surgery, Faculty of Physical Therapy, Cairo University, Giza, Egypt
Corresponding Author
Sahar Mohammed Adel
Department of Basic Science, Faculty of Physical Therapy, Cairo University, Giza, Egypt
Email: *smadel@pnu.edu.sa*

Abstract

Objective: *To investigate the effect of a combined spinal manipulation plus physical therapy program on pain intensity, physical function and asymmetry of lumbar facet angles in patients with lumbar disc herniation.*

Methods: *This was a single blinded randomized controlled study design. Thirty patients with lumbar disc herniation from both sexes and aged between 20 – 45 years participated in the study. They were randomly divided into two groups of equal number; experimental and control groups. Patients in the experimental group received a designed physical therapy program in addition to lumbar manipulation techniques applied to L4-L5 level. Those in the control group received the same physical therapy program only. Treatment was given three days/ week for continuous four weeks. Assessment was performed before and after treatment using Visual analogue scale (VAS), Modified Oswestry low back pain disability questionnaire (ODQ) and facet joint angle asymmetry.*

Results: *Patients in the experimental group showed a significant improvement as compared with those in the control group. Pain intensity was 3.6±0.91 for the experimental group and 4.9±1.33 for the control group (P=0.002). Physical function measured by Oswestry disability questionnaire was 28.76±7.3 for the experimental group and 35.48±9.2 for the control group (p=0.007). There was a significant improvement in the asymmetry of facet angles between both sides in both groups (in favour of the experimental group).*

Conclusions: *Spinal manipulation combined with proper physiotherapy program has an objective effect on pain, physical function and asymmetry of lumbar facet angles in patients with lumbar disc herniation.*

Keywords: *Lumbar disc herniation; Spinal manipulation; Pain; Physical function; Facet angles asymmetry.*

Introduction

Lumbar disc herniation (LDH) is one of most common diseases that produces low back pain and/or leg pain[1]. The prevalence of symptomatic lumbar herniated discs ranges from 1% to 3% along lifetime[2], although LDH is anatomically

evident in 20% to 40% of imaging tests among asymptomatic persons [3]. The highest prevalence is among those aged between 30 and 50 years but can also occur in adolescents and older people [4]. Several studies reported that patients with LDH also exhibited signs of asymmetry of facet joint angles (facet tropism)[5,6]. This combination is also considered as a common radiological feature of herniation of the lumbar discs[7]. Facet tropism increases shear forces, making it a potential risk factor for early degeneration and herniation of the corresponding disc[8].

Many therapeutic interventions are used for management of LDH but the results are conflicting[9]. Spinal manipulations are commonly used for treatment of LDH[10]. The benefits and hazards of this intervention are not known; however, some researchers recommended its use in cases of LDH, even after failure of other modalities[11,12]. The current body of evidence suggests spinal manipulation as a method of improving pain, range of motion[13], loosening of adhesive fibrosis around the prolapsed discs or facet joints and entrapped synovial folds, adjusting disc displacement, inhibiting nociceptive impulses and relaxing spasmodic muscles [9].However, there are no studies that have evaluated the efficacy of spinal manipulation on facet joint asymmetry with respect to cases of LDH. Some studies reported that spinal manipulation can cause disc herniations and cauda equina syndrome[14,15]. Results are also conflicting for chronic spinal pain[16-17]. These contradictory results might be partially attributed to variation in study design and poor methodological quality [18].

Therefore, the purpose of this study was to investigate the benefit, if any, of additional spinal manipulation as opposed to traditional physical therapy program in patients with symptomatic LDH, expressed in terms of pain intensity, physical function and asymmetry of facet angles at L4-L5 level.

Subjects and methods

Subjects

Thirty patients, 17 females and 13 males with lumbar disc herniation at L4-L5 level were recruited from the neurological physical therapy outpatient clinic of the faculty of Physical Therapy, Cairo University, Egypt after research ethics board (REB) approval from the Faculty of Physical Therapy. Their ages ranged between 20 and 45 years and their body mass index ranged from 20-25 Kg/m². Their CT or MRI confirmed the diagnosis.

To be eligible for inclusion; each participant had to report chronic low back pain of at least 3 months' duration; with or without radicular pain in the lower limb and to be currently seeking care for low back pain. The exclusion criteria were: 1) spinal pathology (e.g., spondylolisthesis, tumor, infection, fracture), 2) pregnancy, diabetic neuropathy, previous spinal surgery, 3) herniated disc classified as extrusion or sequestration, 4) history of osteoporosis and metabolic disease causing osteopenia, 5) previous treatment with spinal manipulation to exclude possible blinding failure and 6) refusal to give written informed consent.

The patients were randomly assigned into two equal groups; experimental and control groups with 15 patients in each by using computer generated lists[9]. Patients in both groups received traditional physical therapy program for three days/week for successive four weeks which consisted of the application of infrared radiation, therapeutic ultrasound and a designed exercise program for lumbar spine. Patients in the experimental group received additional lumbar manipulation techniques applied to L4-L5 level for three days/week for successive four weeks[19]. After explaining the experimental protocol to the participants, those participants who volunteered to be in the study signed informed consents prior to beginning data collection.

Instrumentations

For assessment: The asymmetry of facet angle in lumbar spine (facet joint tropism) at L4-L5 level was evaluated by computerized axial tomography (CT) of lumbar spine. It is the method of choice for evaluation of lumbar region dysfunctions and it can easily measure the asymmetry of facet angle in this region [20].

For treatment:

- Infra red radiation (IRR) device: Non-luminous infrared generators, emitting long IRR around 3000-4000 nm.
- Ultrasound (US) Device: Enraf Nonius-Sonoplus 590 is a microprocessor controlled unit for continuous and pulsed US therapy. This apparatus allows 1MHz frequency with transducer having an affective radiating area of 5.0cm^2. Gel was used as a coupling medium.

Procedures

The study was a single blind randomized controlled trial with two measures; pre treatment and post treatment (after four weeks from the start of the treatment program).

Outcome measures

Pain intensity was assessed by using visual analogue scale (VAS). Self report of physical function was assessed by using modified Oswestry low back pain disability questionnaire (ODQ) and the asymmetry of lumbar facet angle at L4-L5 level was evaluated by CT.

- Visual analogue scale (VAS) was used to measure pain intensity pre and post treatment for each patient. VAS is a self reported pain assessment tool that requires the subject to place an X on a 10 cm long straight line with stops on each end. The left stop corresponds to ‘‘no pain’’, and the right stop to ‘‘unbearable pain’’ [21].

Modified Oswestry low back pain disability questionnaire (ODQ): This questionnaire gives information as to how back or leg pain is affecting the ability to manage in everyday life. The questionnaire consists of 10 items addressing different aspects of function including pain intensity, personal care, lifting, walking, sitting, standing, sleeping, social life, travelling and employment/ Homemaking. Each item is scored from 0 to 5, with higher values representing greater disability. Each patient was instructed to choose the most suitable answer that represents

his/her level of function. If the first statement is marked, the section score = zero. If the last statement is marked the section score = 5. ODQ was reported to be reliable and had sufficient width scale to detect the progression or regression in most subjects with low back pain. The total score is multiplied by 2 and expressed as a percentage [22].

Measuring procedures of facet joint angle by CT:

The lumbar facet angles at L4-L5 level were measured using the method of Karacan et al [7] by an independent radiologist who did not know the aim of the study. A line was drawn between the two edges of each of the superior articular facets. A mid-sagittal line was drawn passing through the centre of the disc and the centre of the base of the spinous process. The facet joint angle was defined as the angle between the facet line and the mid-sagittal line and it was measured bilaterally and the difference between the two sides was then calculated (Fig. 1). It was reported that this method of measurement has good intra observer and inter observer reliability [23].

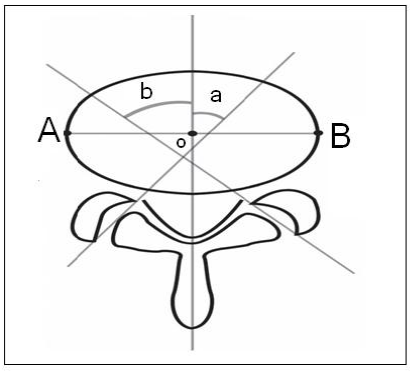

Fig. 1: Measurement of facet tropism, quoted from Lee et al [23]. A line was drawn between the two margins of each of the superior articular facets. The midsagittal line passed through the centre of the disc (O) and the centre of the base of the spinous process. The angle between the facet line and the midsagittal line was measured for each side of the spine. The difference of the right and left facet angles (a-b) of each patient was then calculated.

Treatment Procedures:

All patients in both groups received traditional physical therapy program in the form of infrared radiation (for 20 minutes) followed by ultrasound therapy. For each patient, ultrasound was applied at the lower back with a frequency of 1 MHz, in a continuous mode and 0.5 W/cm² for five minutes using moving head technique. This was followed by exercise program in the form of massage, stretching exercises for back muscles to improve mobility and decrease muscle spasm and to hamstrings to decrease posterior pelvic tilt, and back exercises in the form of static, bridging and active exercises from standing and prone positions. Finally, core stabilization exercises [24] were also given in the form of quadruped, bridge and plank (side and prone) progressions aiming to activation of transverses abdominus and multifidi coordinated with hip musculature. The exercise program was applied for 45 minutes within the pain free range.

Patients in the experimental group received additional lumbar manipulation techniques in the form of: indirect rotation, postro-anterior central pressure and transverse vertebral pressure techniques.

1- Indirect rotation technique

Patient position: side lying with the head rested on a pillow. The lower shoulder is pulled forward by grasping the arm at the elbow and gently but firmly rotating the spine. The uppermost arm rests on the lateral wall of the chest. The uppermost leg is flexed at the hip (to about 50° to 60°) and the knee flexed to a right angle. The foot rests behind the knee of the lower leg. A pillow was given to the patient to hold and act as a physical barrier.

Therapist position: standing facing the patient at the waist level with one hand was used to push the trochanteric area of the hip forwards and the other to force the front of the shoulder downwards and backwards so that the patient's trunk was rotated in the opposite direction. The finger tips of the proximal and distal hands were placed on the above and below spinous processes to monitor motion.

Technique: the patient's trunk was passively rotated backward to "take up the slack" and the forearm of the therapist was rested on the patient's torso. Steady rotational movement was applied until a full stretch was reached to both shoulder and hip. Maintaining sustained pressure for one to two seconds at the end of the range and a sharp rotational thrust was applied to the hip through the distal forearm by pulling the patient's lower trunk toward the therapist's body [25,26].

2- Postro-anterior central vertebral pressure technique:

Patient position: Prone with a pillow placed under the abdominal region for patient comfort and to provide a neutral lumbosacral curve; with the arms by his/her side or hanging over the sides of the couch and the head turned conformably to one side.

Therapist position: Standing facing the patient at the level of lumbosacral spine. The manipulating hand was positioned with the heel of the hand (pisiform bone) placed over the spinous process. The therapist's trunk was aligned directly over the spine, so the manipulating force is directed downward and not at an angle.

Technique: The manipulation force was directed to produce anterior glide in the form of sudden small amplitude pressure to the spinous process of the involved vertebra that produces a sudden movement of a small range [26,27].

3- Transverse vertebral pressure technique:

Positions of the patient and the therapist were the same as in the postro-anterior central vertebral pressure technique, but the pad of the left thumb of the therapist was placed against the right lateral surface of the spinous process of the vertebrae being treated, and the right thumb was used for reinforcement by placing the pad of the right thumb over the nail of the left thumb. The fingers of both hands were spread out over the patient back for more stabilization.

Technique: The thumbs were positioned to fit deeply into the groove beside the spine in a relaxed manner. Lateral pressure over the spinous processes of L4 and L5 vertebrae was carried out in an appropriate thrusting force from right to the left and vice versa. The pressure was exerted from the side of the spinous process [28].

Data analysis and statistical design

All analyses were conducted using the SPSS statistical package, version 16.00. Descriptive statistics were used in the form of means and standard deviations for all variables. The paired and unpaired t-tests were used to compare the pre- and post-treatment values of the measured parameters within the group and between the two groups (experimental and control groups) respectively. The outcome measures were VAS, ODQ and facet angle asymmetry. The alpha was set at $p \leq 0.05$.

Results

For this study, 51 patients were identified as potential participants (Fig. 2). Of these, 13 (25.4%) were excluded because they failed to fulfill the inclusion criteria, 5 patients (9.8%) refused to participate in the study and 3 patients (5.8%) did not return the consent form. Thus, of the original pool, 30 patients (58.8%) with chronic low back accompanied with disc herniation were included in the study: 17 females and 13 males. They were randomly assigned into two equal groups; experimental and control groups. The demographic characteristics of the two groups are listed in table 1. There were non-significant differences in the demographic characteristics between the experimental and the control groups.

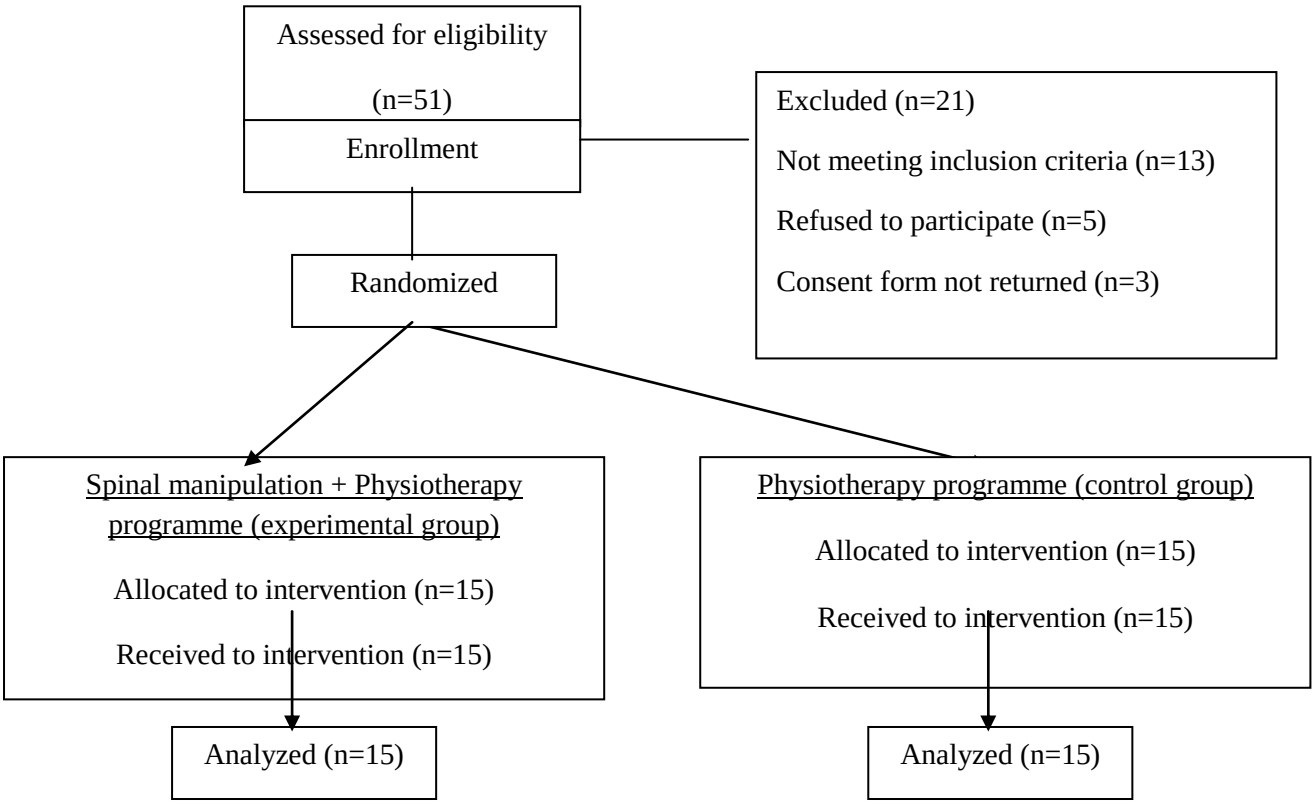

Fig 2. Participants flow through the study.

Table 1. Demographic characteristics of patients in both groups

	Experimental group (n=15)	Control group (n=15)	t-value	p-value
Age (year)	34.46±6.9	34.6±6.91	0.95	0.05
Weight (Kg)	68.0±5.68	67.86±5.46	0.94	0.06
Height (cm)	168.8±8.17	168.2±7.23	0.83	0.21

Values are mean ± SD. *Significant at p<0.05.

The results of the present study showed a statistically non-significant difference in the mean values of pre data of all variables including VAS, ODQ and asymmetry of facet angles between both sides at L4-L5 level. Comparison between pre and post treatment mean values of all variables being tested in both the experimental and control groups showed statistically significant differences.

Additionally, there was a significant difference between the two groups post-treatment in the mean values of all variables being tested. The changes in the mean values of all variables tested are presented in Table 2.

Table 2. Changes in outcome measures in the experimental and control groups at baseline and following treatment.

	Baseline	Post-treatment	t-value
VAS			
Experimental (N=15)	7.0±1.2	3.6±0.91	11.5
Control (N=15)	7.36±0.84	4.9±1.33	5.73
P value	0.24	0.002*	
ODQ			
Experimental (N=15)	52.0±6.55	28.76±7.3	8.64
Control (N=15)	54.13±6.99	35.48±9.2	6.19
P value	0.43	0.007*	
Asymmetry of facet angle between both sides			
Experimental (N=15)	7.11±0.34	2.54±0.15	12.4
Control (N=15)	7.0±0.33	5.9±0.18	11.9
P value	0.27	0.0001*	

Values are mean ± SD. VAS: Visual analogue scale.

ODQ: Modified Oswestry low back pain disability questionnaire.

*Significant at p<0.05.

Discussion

The results of the present study demonstrated that patients in both the experimental and control groups showed significant improvement in pain intensity scores, disability scores and asymmetry of lumbar facet angles (in favour of the experimental group). The significant improvement in the experimental group as compared to the

control group in all outcome measures might be attributed to the combined effect of both manipulation and the training exercise program. It was reported that spinal manipulation, combined with spinal stabilization and manual therapy treatment to the soft-tissues supporting the spine can achieve a greater level of improvement and minimize the recurrence. Moreover, spinal manipulation as a single therapy is not sufficient to lengthen muscles that are chronically shortened or rehabilitate degenerated or deconditioned structures [29]. Therefore, spinal manipulation should be combined with exercise program to gain good results.

The significant reduction of pain intensity scores measured by VAS in the experimental group as compared to the control group might be attributed to the additional effect of lumbar manipulation in the experimental group as a result of several mechanisms:

1) The direct effect of spinal manipulation on pain itself. Spinal manipulation can increase pain tolerance or its threshold through its ability to alter central sensory processing by removing subthreshold mechanical or chemical stimuli from paraspinal tissues [30]. Additionally, spinal manipulation might reduce pain by means of its effects on the inflow of sensory information to the central nervous system. The mechanical input may ultimately reduce nociceptive input from receptive nerve endings in innervated paraspinal tissues [31].

2) The effect of spinal manipulation on spinal mobility. Spinal manipulation can improve spinal intersegmental hypomobility. Abnormal intersegmental spinal range of motion and hypomobility can lead to dysafferentation which is described as reduced activity of mechanorec-eptors and increased excitation of the nociceptive system which is produced by joint hypomobility [32]. Therefore, when improving spinal intersegmental movement, pain can be improved. This comes in agreement with Patterson[33] who reported that spinal manipulation can reduce motion restrictions, increase proper fluid infusion, and restore mechanoreceptive input to the CNS and subsequently reduce nociceptive inputs to the spinal cord.

3) The ability of spinal manipulation to create negative pressure which reduces compression on any nerve root or other innervated paraspinal tissues [31].

Regarding the results obtained for disability scores measured by ODQ, patients in the experimental group showed a significant improvement of ODQ as compared to the control group. This can be justified by the fact that chronic spinal joint hypomobility, and the resulting pain, can lead to deconditioning syndrome and reduced physical activity, which further promotes decline in a patient's physical condition and subsequently increased disability. Deconditioning syndrome is characterized by specific clinical findings including decreased strength, endurance, flexibility, cardiovascular fitness and proprioception [34]. Therefore, the effect of spinal manipulation on improvement of intersegmental hypomobility and pain will promote more improvement in functional disability. These results were in line with other studies reported that manipulation was effective in

the treatment of symptomatic LDH and resulted in improvement of pain and functional disabilities [16,18,35]. On the other hand, the findings of the current study disagreed with the findings of Ferreira et al [36] who indicated that there was no improvement in pain and function after lumbar manipulation. The different results might be attributed to the selection criteria of the patients that participated in the previous study.

The significant improvement of the asymmetry of facet angles at the level of (L4-L5) in the experimental group more than the control group might be explained by the additional effect of lumbar manipulation in the experimental group. The biomechanical changes caused by spinal manipulation are thought to have very essential role in the correction and realignment of the facet joints. In the available literatures, there were no studies disagreed with the results of the present study about the significant improvement of the asymmetry of lumbar facet angles at L4-L5 in response to lumbar manipulation techniques.

Some points were considered during the conduction of this study to avoid any potential source of bias such as only one examiner took the measurement pre and post treatment and the same therapist was allowed to apply the manipulation techniques for all patients.

There are some limitations to the present trial. The small number of patients might limit the generalization of the results. The age of all participants ranged between 20 and 45 years. Future studies are required to target different ages to enable comparisons of the results across various age groups. The patients included in this study were all suffering from chronic LBP. Further study into the value of manipulation at a more acute stage is warranted to compare the effect of manipulation on both acute and chronic LBP. The lack of follow-up for the patients in both the experimental and control groups might be considered another limitation of the study. The lumbar manipulation techniques conducted in this study were done as a complete regimen performed on the patient, thus the effect of every single manipulation technique was not demonstrated but the improvement reported was attributed to the entire regimen. Therefore, future studies are suggested to evaluate the effect of each technique and to determine the technique of the best effect in this group of patients.

Conclusion

Within the limitations of this study the following conclusion was warranted, the lumbar manipulation techniques proved to have high significant effects on improving pain, degree of disability and asymmetry of lumbar facet angles in patients with LDH. This can provide evidence that spinal manipulation, in conjunction with therapeutic exercises can produce a greater level of recovery and improved outcomes.

Ethical approval: All procedures were approved by the Research Ethics Committee of the Faculty of Physical Therapy, Cairo University, Egypt.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Authors' contributions	NALAR	NMMG	SMA
Research concept and design	√	√	√
Collection and/or assembly of data	√	√	√
Data analysis and interpretation	√	√	√
Writing the article	√	√	√
Critical revision of the article	√	√	√
Final approval of article	√	√	√
Statistical analysis	√	√	√

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