ORIGINAL ARTICLE

Effects of physical therapy on improving disc height index, postural stability, pain and function in persons with discogenic low back pain

Muhammad Osama[1], Aamer Naeem[2], Sameen Tariq[3], Sumera Mushtaq[4], Furqan Ahmed Siddiqi[5], Sabah Afridi[6]

Abstract

Objective: To determine if physical therapy is capable of improving disc height index, pain, functional disability, lumbar range of motion, postural stability and gait in persons with discogenic low back pain.

Methods: A quasi-experimental study was conducted at the Foundation University College of Physical Therapy, Foundation University, Islamabad, and Radiology Department, Fauji Foundation Hospital, Rawalpindi, Pakistan, from May 2022 to June 2023, and comprised patients of either gender having postero-lateral disc herniation and discogenic low back pain. Pain was assessed using the visual analogue scale, disc height index was measured via magnetic resonance imaging, postural stability was evaluated using the Biodex balance system, lumbar range of motion was measured via inclinometer, and functional disability was assessed using the Oswestry disability index. Treatment protocol spanned 2 weeks and consisted of 5 supervised sessions per week. The protocol included interferential therapy combined with heating pack, Mckenzie's extension bias protocol, manual lumbar traction and rotational mobilisation. Data was collected at baseline and post-intervention. Data was analysed using SPSS 21.

Results: Of the 22 patients, 18(81.8%) were males and 4(18.2%) were females. The overall mean age was 40.13±10.08 years, mean weight was 70.54±11.38kg and mean height was 160.58±13.52 cm. A significant improvement was noted in terms of all outcome measures post-intervention compared to baseline values ($p<0.05$) except for cadence ($p>0.05$).

Conclusion: Physical therapy showed promising results in terms of improving disc height index in subjects with discogenic low back pain, along with pain, functional disability, lumbar range of motion, postural stability and gait.

Clinical Trial Number: https://clinicaltrials.gov/study/NCT05326594.

Keywords: Disc height, Disc herniation, Disc protrusion, Disc prolapse, Low-back pain, Lumbar radiculopathy, Physical therapy, Physiotherapy, Postural stability. (JPMA 75: 378; 2025)

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Introduction

Lumbar spine is the second most common site of musculoskeletal symptoms, preceded only by cervical spine, and is associated with the greatest disability.[1,2] Research has shown that 62.5% of otherwise healthy young adults report symptoms in the lumbar region[1,2] and >80% people suffer from low-back pain (LBP) at least once in their life.[2] Lumbar intervertebral disc (IVD) herniation and degenerative disc disorders in the lumbar spine can lead to discogenic low-back pain (DLBP), and the most common direction of disc herniation is reported to be postero-lateral in direction which is commonly associated with lumbar radiculopathy and sciatica.[3] It has been reported that 58.6% of symptomatic younger patients aged 20-30 years have radiological evidence of lumbar IVD degeneration[4] and the number of hospital admissions with a specific diagnosis of disc-related LBP is as high as 685.6 per 100,000 population.[5] Furthermore, lumbar disc-related disorders are reported as the most common cause of LBP-associated surgery in working age population.[5] Studies have shown that lumbar IVD herniation and DLBP also result in impaired postural stability (PS).[6,7] Furthermore, such individuals are also observed to have impaired gait and decreased gait stability.[8-10] Previously, there was a lack of objective measure to quantify the extent of lumbar IVD degeneration and herniation, and the assessments were mostly subjective.[11] However, recently disc height index (DHI) has been established as a convenient, valid and reliable continuous measure for quantifying the extent of IVD degeneration and prolapse.[11] Studies have also shown that restoration of disc height is linked with reduction in pain, underlining the clinical significance of disc height in LBP management.[12] Among diverse treatment options available for managing DLBP, physical therapy (PT) has emerged as particularly promising due to its cost-effectiveness and absence of adverse effects commonly associated with pharmacological and surgical management options.[13] Furthermore, PT not only alleviates symptoms and enhances function in persons with DLBP,

[1-5]Foundation University Islamabad, Pakistan; [6]Brainstorm Research (brainstormresearch.org), Islamabad, Pakistan.

Correspondence: Muhammad Osama. e-mail: osamadpt@gmail.com

ORCID ID: 0000-0003-1467-2038

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but also addresses underlying biomechanical deficits,[13-16] unlike pharmacological management. Recent studies have demonstrated that PT, specifically in the form of spinal decompression therapy, can result in an improvement in disc height and regression of lumbar postero-lateral IVD (PIVD) herniation in individuals with DLBP.[15,17,18] However, spinal decompression is a costly modality, and there is a need for evidence regarding the effectiveness of PT, focusing on manual therapy and exercise, which could serve as a more cost-effective alternative in persons with lumbar IVD herniation and DLBP. The current study was planned to determine if PT consisting of manual therapy and exercise can improve disc height index, pain, functional disability, lumbar range of motion (ROM), PS and gait in persons with DLBP.

Subjects and Methods

A quasi-experimental study was conducted at the Foundation University College of Physical Therapy (FUCP), Foundation University, Islamabad, and Radiology Department, Fauji Foundation Hospital, Rawalpindi, Pakistan, from May 2022 to June 2023. After approval from the ethics review committee, the study was prospectively registered at clinicaltrials.gov (NCT05326594). The participants were recruited via purposive sampling and comprised of male and female patients aged 18-70 years old having LBP intensity <8/10 cm on the Visual Analogue Scale (VAS), positive centralization and peripheralization phenomenon, unilateral radiating LBP, straight leg raise (SLR) >30° and <70°, with PIVD prolapse/herniation and low signal intensity of IVD on T2-weighted image and high intensity zone towards the posterior aspect of IVD on magnetic resonance imaging (MRI).[19] Individuals with anterior, postero-central and circumferential disc bulge, lumbar spondylolisthesis or vertebral fracture, history of spinal surgery, lumbar disc sequestration, cauda equina, spinal stenosis, myelopathy, bilateral radiating symptoms, and any musculoskeletal, metabolic or neurological disorders that could impair gait or PS were excluded. Informed consent was acquired from all the participants.

The outcome measures included pain, DHI, lumbar ROM, functional disability and spatio-temporal gait parameters. Pain was measured using VAS, which is a valid and reliable tool for measuring pain severity in LBP patients.[20] DHI was calculated on the basis of MRI scans (Vantage Titan, 1.5 Tesla, 71cm wide bore, Toshiba Corporation©, Japan) by a trained radiologist in line with literature (Figure 1).[21] The MRI scan was performed early in the morning in a non-weight bearing position to ensure consistency in disc height and hydration. Performing MRI early in the morning standardises disc height measurements by controlling for diurnal variation, as overnight rehydration increases disc height, while daily activities compress the discs. Morning scans capture discs in a maximally hydrated state, reducing variability and ensuring consistent, accurate comparisons.

PS was measured using Biodex Balance System (BBS) (Figure 2) having established validity and reliability with an intra-class correlation coefficient (ICC$_{3,1}$) of 0.88-0.96 for LBP patients.[22] Lumbar ROM was measured using 2

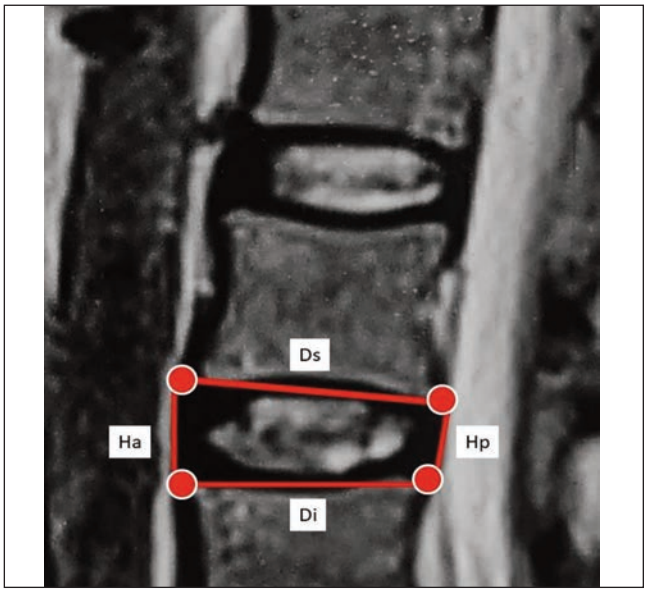

Figure-1: Calculation of disc height index (DHI) via magnetic resonance imaging (MRI) scan using the formula DHI=[(Ha+Hp)/(Ds+Di)]×100, adapted from literature(21).

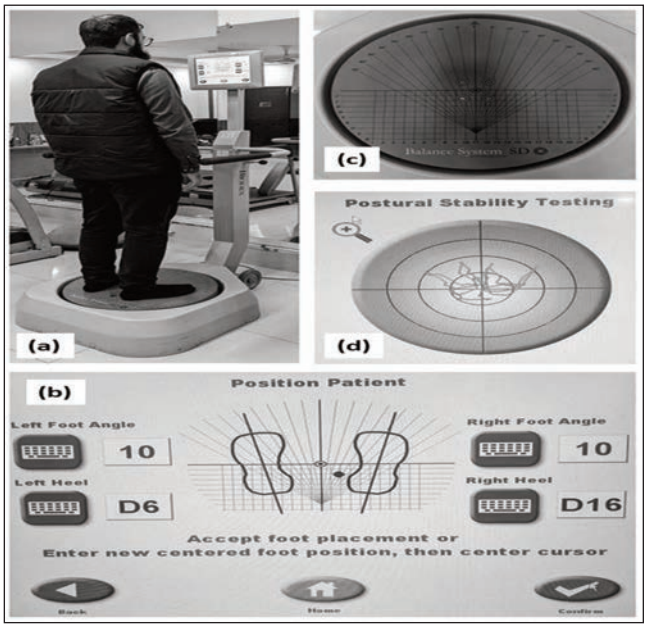

Figure-2: (A) A participant standing on the platform of Biodex Balance System (BBS) for the measurement of postural stability (PS). (B) The participant's centre of gravity (COG) represented by a black dot on the visual display unit, while the foot placement, aligned with the platform grid, was recorded and entered into the system. (C) A grid marked on the BBS platform to identify foot positions of the participants. (D) The test report of postural stability analysis showing the tracing of COG of the participant traced on a grid that was distributed into 4 zones and quadrants.[6]

Table: Comparison of baseline and post-treatment outcomes after 10 sessions of intervention.

Variables		Pre	Post	Paired Differences			*p*-value
		Mean±SD	Mean±SD	Mean±SD	95% Confidence Interval		
					Lower	Upper	
Disc Height Index		0.33±0.09	0.37±0.08	-0.04±0.12	-0.09	0.01	0.039
Pain (Visual Analogue Scale)		6.33±1.24	1.79±1.64	4.54±1.67	3.84	5.25	<0.001
Oswestry Disability Index (ODI)		49.33±13.32	25.42±15.19	23.92±12.86	18.49	29.35	<0.001
ROM	Flexion (°)	26.67±9.85	38.33±11.20	-11.67±7.47	-14.82	-8.51	<0.001
	Extension (°)	14.58±4.64	17.08±4.64	-2.50±3.90	-4.15	-0.85	0.005
Gait	Cadence	104.14±19.04	111.88±27.34	-7.75±28.50	-19.79	4.29	0.196
	Stride Length (m)	1.05±0.24	1.22±0.35	-4.55±21.50	-13.63	4.53	0.039
	Gait Velocity (m/s)	0.96±0.27	1.13±0.25	-0.17±0.35	-0.32	-0.02	0.028
Postural Stability	Overall stability index (Eyes open)	3.83±3.20	1.84±1.21	1.98±3.00	0.72	3.25	0.004
	Overall Stability Index (Eyes Closed)	7.98±3.89	6.64±4.77	1.34±2.70	0.20	2.45	0.023

ROM: Range of motion, SD: Standard deviation

inclinometers with a high inter-rater reliability (r=0.94, p<0.001) for lumbar ROM.[23] Spatio-temporal gait parameters were measured using visual gait analysis, and the participants were asked to walk a distance of 30 m, during which the total number of steps was counted and time taken to cover the distance was measured, after which stride length, gait velocity and cadence were calculated. Functional disability was measured using the Oswestry Disability Index (ODI) with an internal consistency Cronbach's alpha value of 0.89 and ICC[2,1] of 0.95 for the Urdu version, which is culturally adopted for the Pakistani population.[24] Data was collected at the baseline and after 2 weeks of treatment via self-reported questionnaires and objective assessment.

The PT treatment protocol was administered for 2 weeks, consisting of 5 supervised treatment sessions per week, including interferential therapy in combination with heating pack for 20 minutes, followed by McKenzie's extension bias protocol, general and segmental manual lumbar traction (15 seconds hold, for 6 repetitions), and lumbar joint rotational mobilisation away from the painful side. Participants were also prescribed McKenzie's extension bias exercises as home exercise programme, and were educated to avoid flexion biased activities. The participants were encouraged to maintain an exercise dairy to ensure compliance with home exercise plan. Treatment was provided by the same therapist to all the participants to ensure consistency and standardisation, minimise variability and to ensure the reliability and internal validity of the findings.

Data was analysed using SPSS 21. Data normality was checked using Shapiro-Wilk and Kolmogorov tests. In case data was not normally distributed, data transformation was applied. Paired t-test was used to compare the baseline and post-treatment scores. Data was presented as means ± standard deviation, or as frequencies and percentages, as appropriate. The mean difference was reported along with its 95% confidence interval (CI). P<0.05 was considered significant.

The sample size was determined using the Open Epi calculator,[25] based on literature[26,27] with 95% CI and power 0.8. To enhance the validity and generalisability of the findings and to account for potential dropouts, the sample size was inflated.

Results

Of the 22 patients, 18(81.8%) were males and 4(18.2%) were females. The overall mean age was 40.13±10.08 years, mean weight was 70.54±11.38 kg and mean height was 160.58±13.52 cm. All the 18(100%) males were workstation office workers, and all the 4(100%) females were housewives. All the 22(100%) participants had good socio-economic status.

A significant improvement (p<0.05) was noted in terms of all outcome measures post-intervention compared to baseline values (p<0.05) except for cadence (p>0.05) (Table).

Discussion

The current findings showed a promising effect of PT in the management of DLBP not only in terms of clinical and biomechanical outcomes, such as pain, functional disability, lumbar ROM, PS and gait, but also in terms of radiological outcomes, with significant improvement in terms of DHI.

The increase in DHI observed after PT intervention in the current study is particularly noteworthy, as it signifies a potential reversal of IVD herniation or prolapse in persons with DLBP.[16] Given that DHI has been established as a reliable measure of disc degeneration and prolapse,[11] the observed improvements suggest a positive response of the IVD to the PT treatment.[12] This is in accordance with earlier findings showing the ability of McKenzie's extension bias protocol to influence the morphology of lumbar IVD, resulting in the anterior translation of the nucleus

pulposus.[16] This anterior migration of nucleus pulposus decreases the extent of PIVD prolapse or herniation, thereby increasing the DHI.

The current findings are also in accordance with earlier studies that have shown that PT treatment results in a significant improvement in disc height and SLR.[14] Even though SLR was not included as an outcome variable in the current study, unlike Oh H. et al., the current study showed significant improvement in lumbar ROM.[14] Moreover, in addition to disc height and SLR, Oh H. et al.'s study did not include pain, functional disability, lumbar ROM, PS and gait as outcome variables.[14] A study by Rubinic DM et al. showed that PT management, including manual axial traction and side lying, resulted in a significant improvement in spinal height.[27] However, that study consisted of healthy participants instead of persons with LBP.[27] Even though the specific treatments administered in the studies by Oh H. et al.[14] and Rubinic DM et al,[27] differ from the current study, they are all different modalities of orthopaedic manual and exercise therapy. Nevertheless, both studies showed promising result of conservative PT using manual therapy and/or exercise in terms of improving DHI.[14,27]

On the other hand, Khanzadeh R. et al. showed no significant improvement in disc height and DHI after receiving suspension therapy or core stability exercises in persons with lumbar IVD herniation. However, a significant improvement was observed in terms of pain in both treatment groups.[26] Similarly, another study showed no significant improvement in disc height or herniation index in persons with lumbar IVD herniation receiving conventional physical therapy consisting of electrotherapy and deep friction massage.[15] Nevertheless, a significant improvement was observed in terms of pain and functional disability.[15] However, it is imperative to point out that in both these studies, no directional bias biomechanical treatment was administered unlike the current study, and perhaps that is the reason these studies have conflicting findings compared to the current study. From the findings of the current study and those conducted earlier,[15,26] it can be assumed that non-directional bias treatment may provide symptomatic relief in persons with DLBP, but for influencing the morphology of IVD, directional bias approach must be adopted.

Numerous studies have shown mechanical traction and spinal decompression therapy to cause significant improvement in MRI-based outcomes, such as disc height and DHI in persons with DLBP.[15,17,18,28,29] While spinal decompression and mechanical traction are effective in terms of radiological and clinical outcomes in persons with DLBP and lumbar IVD herniation, their use poses significant challenges in low- and middle-income countries (LMIC), like Pakistan, on account of being expensive. On the other hand, PT comprising manual therapy and exercise is an inexpensive and effective alternative option, and the current study has shown promising effects of such treatment in terms of disc height index, pain, functional disability, lumbar ROM, PS, and gait in persons with DLBP.

In view of the current findings and review of the existing literature, it is suggested that PT should be considered the first line of treatment in individuals with DLBP and lumbar IVD herniation before considering surgery. However, it is imperative to consider that the success of PT in treating IVD prolapse/herniation and DLBP requires directional bias treatment. For example, the treatment protocol that is effective for PIVD prolapse/herniation may not necessarily be suitable for central IVD prolapse/herniation, and vice versa. Therefore, prescribing a generalised treatment protocol for all types of DLBP and IVD prolapse/herniation, regardless of the direction or extent of herniation, is not recommended.

Moreover, the current study comprised only individuals with PIVD prolapse/herniation, and the treatment protocol was specifically designed for such patients. Therefore, the treatment protocol should not be extrapolated to other types of lumbar IVD prolapse/herniation. It is also important to acknowledge the absence of a control group in the current study, which limited the researchers' ability to monitor the natural progression of the condition and changes in outcomes without PT. However, as the study is an initial attempt to determine the potential of PT in improving both radiological and clinical outcomes in individuals with DLBP, the findings pave the way for future research. Subsequent studies should investigate the effects of PT in randomised controlled settings, incorporating a control group to address the limitations of the current study. Furthermore, the current study included only a limited number of females, and that may have had an impact on the generalisability of the findings.

Conclusion

Conservative PT showed promising results in terms of improving disc height index in persons with DLBP, in addition to pain, function, disability, lumbar ROM, gait and PS. While PT holds promise as an effective treatment modality for DLBP, it is crucial to tailor treatment approaches based on the specific characteristics of IVD prolapse/herniation in persons with DLBP.

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Conflict of Interest: None.

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Author Contribution:

MO: Concept, design, research funding, data acquisition, analysis, interpretation, drafting, revision and final approval.
AN: Implementation of research, data interpretation, revision and final approval.
ST: Data collection, acquisition, entry, treatment, record keeping, revision and final approval.
SM: Data collection, acquisition, record keeping and final approval.
FAS: Implementation of research, revision and final approval.
SA: Data entry, analysis, interpretation, drafting, revision and final approval.