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ORIGINAL RESEARCH

Multidisciplinary Conservative Treatment Outcomes of in-Patient Physiotherapy Set-Up Among Patients with Lumbar Disc Herniation in Dhaka City, Bangladesh: A Retrospective, Cross-Sectional Study

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Background: The study aimed to determine the outcome of Multidisciplinary physiotherapist-led conservative treatment of lumbar disc herniation at an in-patient set-up of a specialized spine center in Dhaka, Bangladesh.

Methods: This was a retrospective cross-sectional study of 228 cases completing treatment and follow-up sessions. The outcome was evaluated as pain at rest and five different functional positions, neurological recovery, and Magnetic resonance imaging (MRI) changes during discharge and follow-up.

Results: 80.3% had a complete recovery with a typical motor and sensory status, no limitations in straight leg raise (SLR), no cauda equina symptom (CES), and no or <3 pain during more than 30 minutes of daily living activities. Statistically significant changes were noted at all outcome measures at the follow-up (day 90), compared to baseline (day 1) P<0.01. In the posthoc tests, pain, SLR, and CES had the most significant improvement at discharge (day 12) compared to the baseline (P < 0.01) and at follow-up compared to discharge (P < 0.01). No major adverse events noted.

Conclusion: Physiotherapist-led in-patient treatment results in significant resting and functional pain outcomes in 12 days. Also, the improvements in neurological recovery and normalizing disc position are statistically significant in 90 days.

Keywords: lumbar disc herniation, multidisciplinary, conservative treatment, physiotherapy

Introduction

Lumbar disc herniation (LDH) is one of the most prevalent causes of low back pain,[1,2] that frequently affects the L4-L5 and L5-S1 levels.[1] The condition results from the abnormal biomechanical pressures imposed on the intervertebral disc and their inability to reconstruct due to their avascular nature.[3] The predominant symptoms are radicular, perceptual abnormalities, and weakness in the distribution of one or more lumbosacral nerve roots.[4,5] In the early days, the patient typically complains of discomfort in postures that increase disc pressure, such as sitting, standing, walking, or activities. The pain eases with rest or lying in bed.[6] In recent studies, the average age of patients with a herniated disc was 41 years, and males were more likely to be diagnosed than

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females (57% versus 43%, respectively).[7] There are many predisposing factors, but an increase in body mass index (BMI) is a risk factor for lumbar disc herniation, which is assumed to be owing to more significant axial stress on the lumbar spine.[8] Also, a positive correlation exists between cumulative exposure to physical workload and lumbar disc herniation, indicating a higher risk of herniation in jobs with high physical demands.[9]

The clinical diagnosis of lumbar disc herniation is a comprehensive approach. The North American Spine Society's (NASS) Evidence-Based Guideline Development Committee suggested manual muscle testing, sensory testing, and the supine SLR test (including its crossed leg variation) as the gold standard for the clinical diagnosis of LDH.[10,11] Treatment of LDH has two approaches, conservative and operative treatment. Conservative treatment is the primary treatment option, but surgical treatment is required for cases with Cauda Equina Syndrome (CES).[12] In a study in Dhaka, Bangladesh, Cauda equina syndrome (CES) was found in 4.7% of LDH cases.[8,9] CES is a clinical consequence of LDH characterized by severe impairments in the lumbosacral motor or sensory distribution, bowel or bladder incontinence, and progressive deterioration of pain or function (especially walking).[8,9,12] However, some studies suggest that surgery reduces disco-genic pressure that extends for a shorter duration of fewer than two years.[13] After surgical treatment, almost 32% of recurrences are reported,[14] and possible causes were a higher rate of disc height, a higher percentage of the occupied spinal canal by the herniation of disc materials, and the presence of degenerative facet joint changes. Conservative management of LDH includes medication, spinal epidural, decompression therapy, physiotherapy, manual and exercise therapy, electrotherapeutic modalities, and lifestyle modifications.[15] The multi-disciplinary team for conservative treatment includes a physician, surgeon, or interventional physician and a physical therapist. Additional team members may consist of nurses, radiologists, neurologists, anesthesiologists, spine fellows, psychologists, and case managers.[1] Evidence suggests conservative management has a similar long-term effect to surgical management.[15] Among conservative approaches, Physiotherapy management of LDH aims to improve myofascial and neural sensitivity, osteokinemetic or arthrokinematic mobility, and functional restoration, which reduces or abolishes pain and enhances intervertebral disc healing and decompresses the neural structures.[16] The outcome of physiotherapy in LDH was found to be significantly positive on pain, spinal range of motion, bothersome in activities, fear avoidance in functional tasks, neurological recovery, and disability in experimental studies in Bangladeshi settings for short and longer duration in outpatient set-up.[17] The stated study did not estimate any indicators of success rates. Still, a study from Australia[18] has 59% of LDH cases with an improvement of disability by a mean duration of 8.7 months in an outpatient setting.

Although there is evidence of outpatient physiotherapy services, In-patient physiotherapy set-ups are designed to focus on physiotherapists-led rehabilitation in the musculoskeletal area.[19] In in-patient physiotherapy services, patients have an extended scope to receive Advanced practice physiotherapy (APP)[20] and extensive supervision from a physiotherapist and a multidisciplinary team. Evidence suggests that physiotherapists can provide equal care and efficiency in musculoskeletal health compared to physicians.[21] To the best of our knowledge, there are no studies evaluating the multidisciplinary outcome of LDH in the in-patient physiotherapy set-up where physicians and physiotherapists worked as a team, performed a comprehensive assessment, and ensured the best possible care for the patients. The study aimed to find the multidisciplinary conservative treatment outcomes among patients with Lumbar Disc Herniation at an in-patient physiotherapy set-up in Dhaka City, Bangladesh. The objectives are to (1) present the demographic, social, and physical factors associated with LDH, (2) Characterize the clinical variables of LDH at Baseline before the intervention, (3) detect the overall outcome of a multidisciplinary approach to pain, function and neurological indicators for the cases with LDH, (4) detect the success rate of interventions and (5) elicit the outcome based on successful versus unsuccessful cases.

Methodology

Study Design

The study is a retrospective cross-sectional study of lumbar disc herniation (LDH) cases who completed in-patient physiotherapy services and post-discharge follow-up between January 2021 and July 2022.

Population and Sample

We have screened 338 files of LDH cases from the specialized Spine center of the Agrani Specialized Physiotherapy Centre (ASPC) in Dhaka, Bangladesh, served between January 2021 and July 2022 as population. Two hundred twenty-eight files were

taken as a sample according to eligibility criteria. The inclusion criteria were (1) Diagnosis of Lumbar disc herniation through magnetic resonance imaging (MRI) with sensory, motor testing, and supine straight leg raise test (SLR) according to the Working Group of the North American Spine Society's (NASS),[10,11] (2) Completed at least 12 days' in-patient physiotherapy treatment, and (3) have a follow-up evaluation for at least 90 days after discharge. The exclusion criteria were (1) patients diagnosed without an MRI, (2) completed in-patient rehabilitation with a break in the middle of stay, (3) patients with a previous history of LDH surgery, (4) patients having other issues along with LDH (eg, spondylolisthesis, spinal fracture, etc.).

Multidisciplinary Assessment

The physician's assessment and diagnosis were the primary MRI and clinical examination screening. Physicians were of neuro-medicine, neurosurgery, orthopedic surgery, and Physiatry specialty. The physiotherapist's assessment was supervised by two advanced physiotherapy practitioners with a Master of Physiotherapy degree and 20 years of experience in musculoskeletal services who were recruited separately out of the research team. The assessment protocol was pre-determined, structured, and stored in a repository.[22] The physiotherapy assessment had five parts [Supplementary file 1]. The first part was a subjective assessment comprised identities, anthropometric measurement, referral diagnosis, chief complaints, and history of present complaints. The second part includes pain assessment at rest, sitting for more than 5 minutes, standing for more than 5 minutes, walking for more than 5 minutes, pain in maintaining functional movements, and pain in performing 30 minutes of daily activities. The third part was the selective lumbopelvic muscle stretch and strength test. The fourth part was the neurological assessment of sensory and motor examination of lumbosacral nerve roots, straight leg raise (SLR), Dural test or sign, and nerve sensitivity test. And the last part is the provisional diagnosis of affected structures. Physiotherapy assessment was performed during admission (Day 1), discharge, and follow-up sessions.

Multidisciplinary Treatment

The treatment approach is described in Table 1. Physicians prescribed a wide range of medications to control pain and associated impairments as a simple analgesic as paracetamol, tramadol/paracetamol, codeine-based analgesics, Non-steroidal anti-inflammatory drug, opioid analgesics, muscle relaxants, corticosteroids, neuropathic medications. The physiotherapy treatment process included stretching exercises, activation, isometric exercise, isotonic exercises, neural stretching, local release of neuro-sensitive structures, activation of nerve function, spinal mobilization and ROM exercises, postural advice or modifications, home exercise, and interventions to manage adverse events.

Study Variables

Outcome Variables

There were five main outcome variables for assessing the multidisciplinary conservative management of LDH.

Magnetic Resonance Imaging (MRI)

The changes in MRI imaging from initial diagnosis (Day 1) and follow-up sessions (after Day 90) were the first outcome variable; this variable was categorized by bulging, protrusion, extrusion, migration, and sequestration as per MRI reports.[23]

10-Centimeter Visual Analogue Scale

The second variable was pain assessment from the initial day of center-based rehabilitation, with a follow-up after discharge. Pain variables were documented three times, at rest, sitting for more than 5 minutes, standing for more than 5 minutes, walking for more than 5 minutes, maintaining regular transitional movements, and 30-minutes of daily activities. VAS is a validated tool for measuring the outcome of LDH;[24] in a 10 cm scale pain is quantified by a 10 cm Visual Analogue Scale ranging between 0 and 10 cm, with higher scores indicating extreme pain.

Neurological Outcome Indicators

The third outcome variable was the sensory and motor status, directed to the lumbar 2 to sacral one dermatome and myotome. Sensory had three categories, intact, impaired, and diminished, and the motor score was determined by the universal system of

Table 1 Interventions by the Multi-Disciplinary Team

Interventions	Doses	Professionals Involved
Pre-intervention screening through Subjective assessment, history, objective assessment, clinical examinations, Radiological and imaging findings analysis, and diagnosis of Lumbar disc herniation (LDH).	N/A	Physician & Physiotherapist
Relative rest in the rehabilitation center	2 weeks	Physician & Physiotherapist
Drugs Prescribed for pain management as simple analgesic as paracetamol, tramadol/paracetamol, codeine-based analgesic, Non-steroidal anti-inflammatory drug, opioid analgesics, muscle relaxants, corticosteroids, neuropathic medications.	Bid day or thrice a day for a maximum of 12 days*.	Neuro-medicine, Orthopedic surgeon, and general Physician
Physiotherapy interventions prescribed through an assessment and treatment process named "Structural diagnosis and management (SDM)" [S1 file], approach as three mandatory and two optional steps. **	45 minutes, session; Three times a day for 6 days/week; 2 weeks***	Physiotherapist
Step 1 (mandatory): Assessment of the extensibility of selective lumbopelvic muscle of both side as Lumbar Extensor and Flexor, quardatus lumborum (QL), Iliopsoas, Piriformis, Hip Adductor, Quadriceps, Hamstring, gluteus minimus, medius and maximus, Ankle Dorsi-flexior, Ankle Planter flexor and subsequent treatment through stretching exercises.	15 minutes, per session; Two times a day for 6 days/week;	
Step 2 (mandatory): Assessment of the strength of Iliopsoas, Rectus & Transverse Abdominis, quadratus lumborum (QL), Piriformis, Hip Adductor, Quadriceps, Hamstring, gluteus minimus, medius and maximus, lumbar extensor and pelvic floor muscles and subsequent treatment through activation, isometric exercise, and isotonic exercises.	25 minutes, per session; Two times a day for 6 days/week;	
Step 3 (mandatory): Neuro-dynamic assessment of Sciatic nerve, Tibial nerve, Sural nerve, Common Peroneal nerve, Femoral and Saphenous nerve and subsequent neural stretching, local release of neuro-sensitive structures, and activation of nerve function.	25 minutes, per session; one times a day for 6 days/week;	
Step 4 (Optional): Assessment of Osetokinetic and arthrokinematic motion of lumbar spine and spinal mobilization and ROM exercises.	15 minutes, per session; two times a day for 6 days/week;	
Step 5 (Optional): Work, daily activities and postural assessment and provide postural advice or modifications and home exercise.	25 minutes session, 2 sessions during the last 2 days of discharge	
Adverse effect management for muscle soreness or increase in pain: Ice and rest by stopping 1–2 sessions of manual therapy, with analgesic if necessary.	If needed	Physiotherapist and Physician

Notes: *Drugs were taped off if patient's pain eases or comes to a tolerable condition; **Mandatory steps were performed for all patients and optional parts to the selected patients, if there are residual issues remaining after mandatory steps; ***Treatments were combined and synchronized as per the assessment and patient's physical status.

Oxford muscle grading (0–5). The fourth was the straight leg raise (SLR) test, ranging from positive and negative. Any provocation of leg radicular symptoms within 75 degrees is considered positive.[25] The fifth outcome variables were the equine cauda syndrome (CES) as the red flag signs of lumbar radiculopathy diagnosed according to NICE guideline.[26] The presence of any one symptom of CES was considered positive. All outcomes were documented for baseline, discharge, and follow-up, and MRI changes were recorded at baseline and follow-up.

Successful Cases

In the follow-up data taken on Day 90, the cases with five positive indicators as (1) 0 pain sore in 30 minutes of daily activities, (2) intact sensory status, (3) grade 5 motor score in all dermatome and myotomes at L1-S1, (4) negative SLR, and (5) negative CES were considered successful cases of treatment.

Explanatory Variables

The explanatory variables were age, gender, BMI, occupation or work, co-morbidities, duration of symptom, duration of work, and symptom description (central, ipsilateral, contralateral, and bilateral symptoms).

Data Collection

From 228 files, the investigation, diagnosis, drug treatment, physiotherapy interventions, and periodic assessments were documented, preserved, and audited from structured printed medical documents in the means of the measurements taken on day 1, discharge after day 12, and follow-up after day 90. Seven physiotherapists converted the hard copies of medical data to a Microsoft Excel dataset, and two independent researchers completed data extraction; missing data were further queried and filled up. The incomplete dataset was removed and audited by a team member of the authors. After that, the data were prepared for analysis. The study process followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline [Supplementary file 2].

Statistical Analysis

Data were coded and analyzed using the Statistical Package of Social Sciences (SPSS) software V.20 (IBM Corporation). Normality distribution of the data was performed using the Kolmogorov–Smirnov and Shapiro–Wilk tests. The descriptive statistics [Table 2] were performed by frequency and percentage for categorical and non-parametric data, and mean and standard deviation for continuous and parametric data. In addition, baseline compatibility is accomplished by successful versus unsuccessful cases by pretest indicators through the Independent *t*-test or Mann–Whitney *U*-test. The overall outcome [Table 3] from Day 1 to day 90 was determined through one-way ANOVA or Friedman test for

Table 2 Descriptive of Socio-Demographic and Baseline Clinical Values (Day 1)

Variables		Total 228 (100%)	Successful 183 (80.3%)	Unsuccessful 45 (19.7%)	p
Age	Age in years	39±11.650	39.60±11.701	36.53±11.232	0.114[a]
Gender	Male Female	148 (64.9%) 80 (35.1%)	121 (66.1%) 62 (33.9%)	18(40%) 27 (60%)	0.441[b]
BMI	Underweight <18.5 Normal 18.5–24.9 Overweight 25–29.9 Obesity ≥30	4 (1.8%) 124 (54.4%) 96 (42.1%) 4 (1.8%)	2 (1.1%) 99 (54.1%) 78 (42.6%) 4 (2.2%)	2 (4.4%) 25 (55.6%) 18 (40%) 0	0.406[b]
Occupation or work	Housewife Businessman Student Teacher Farmer Service holder Labor Banker Unemployed	65 (28.5%) 39 (17.1%) 21 (9.2%) 4 (1.8%) 6 (2.6%) 73 (32%) 9 (3.9%) 4 (1.8%) 7 (3.1%)	50 (27.3%) 33 (18%) 15 (8.2%) 4 (2.2%) 3 (1.6%) 59 (32.2%) 8(4.4%) 4 (2.2%) 7 (3.8%)	15 (33.3%) 6 (13.3%) 6 (13.3) 0 3 (6.7%) 14 (31.1%) 1(2.2%) 0 0	0.253[b]
Co-morbidity	Hypertension Diabetes Heart Disease Kidney disease COPD	53 (23%) 18 (7%) 7 (3%) 16 (7%) 5 (2%)	40 (21%) 10 (5%) 6 (3%) 14 (7%) 5 (3%)	13 (28%) 8 (17%) 1 (2%) 2 (2%) 0	0.29[b]
Duration of symptom	In weeks	2.82±1.169	2.83±1.176	2.76±1.151	0.701[a]

(*Continued*)

Table 2 (Continued).

Variables		Total 228 (100%)	Successful 183 (80.3%)	Unsuccessful 45 (19.7%)	p
Duration of work	In hours	8.91±2.443	8.90±2.536	8.96±2.044	0.895[a]
Symptom description	Central Ipsilateral Contralateral Bilateral	107 (46.9%) 27 (11.8%) 46 (20.2%) 48 (21.1%)	85 (46.4%) 22 (12%) 35 (19.1%) 41 (22.4%)	22 (48.9%) 5 (11.1%) 11 (24.4%) 7 (15.6%)	0.501[b]
MRI L3-L4	Normal Bulging Protrusion Extrusion	110 (48.2%) 88 (38.6%) 21 (9.2%) 9 (3.9%)	94 (51.4%) 75 (41%) 10 (5.5%) 4 (2.2%)	16 (35.6%) 13 (28.9%) 11 (24.4%) 5 (11.1)	0.001[b]*
MRI L4-L5	Bulging Protrusion Extrusion Migration Sequestration	81 (35.5%) 82 (36%) 45 (19.7%) 16 (7%) 4 (1.8%)	62 (33.9%) 69 (37.7%) 35 (19.1%) 14 (7.7%) 3 (1.6%)	19 (42.2%) 13 (28.9%) 10 (22.2%) 2 (4.4%) 1 (2.2%)	0.487[b]
MRI L5-S1	Bulging Protrusion Extrusion Migration Sequestration	28 (12.3%) 130 (57%) 32 (14%) 24 (10.5%) 13 (5.7%)	20 (10.9%) 103 (56.3%) 29 (15.8%) 18 (9.8%) 12 (6.6%)	8 (17.8%) 27 (60%) 3 (6.7%) 6 (13.3%) 1 (2.2%)	0.135[b]
Pain	Rest	3.60±.589	3.61±0.591	3.56±0.586	0.501[a]
Pain	Sitting >5 min	7.56±.727	7.57±0.722	7.51±.757	0.501[a]
Pain	Standing >5 min	7.64±.646	7.65±0.618	7.58±.753	0.501[a]
Pain	Walking >5 min	7.64±.646	7.65±0.618	7.58±.753	0.501[a]
Pain	Any movement	7.64±.646	7.65±0.618	7.58±.753	0.501[a]
Pain	ADL	7.64±.646	7.65±0.618	7.58±.753	0.501[a]
Sensory L4	Intact Impaired	198 (86.8%) 30 (13.2%)	169 (92.3%) 14 (7.7%)	29 (64.4%) 16 (35.6%)	0.0001[b]**
Sensory L5	Intact Impaired	81 (35.5%) 147 (64.5%)	62 (33.9%) 121 (66.1%)	19 (42.2%) 26 (57.8%)	0.295[b]
Sensory S1	Intact Impaired	28 (12.3%) 200 (87.7%)	20 (10.9%) 163 (89.1%)	8 (17.8%) 37 (82.2%)	0.210[b]
Motor L4		4.35±0.702	4.44±0.633	4±0.853	0.0001[a]**
Motor L5		3.36±0.480	3.34±0.475	3.42±0.499	0.297[a]
Motor S1		3.12±0.329	3.11±0.313	3.18±0.387	0.212[a]
SLR	Positive	228 (100%)	183 (100%)	45 (100%)	1[b]
CES/ Red flag	Positive Negative	158 (69.3%) 70 (30.7%)	60 (32.8%) 123 (67.2%)	35 (77.8%) 10 (22.2%)	0.170[b]

Notes: Baseline difference at Day 1 between successful and unsuccessful cases were measured by [a]Independent *t*-test; [b]Mann–Whitney *U*-test; Level of significance*P<0.05, **P<0.01; Measures of L1, L2 and L3 level were omitted due to majority (99.9%) of normal indicators.

Table 3 Overall Clinical Outcome in Different Time Frame

Variables	Day 1 to Day 90 (3 Measures[¶])	Day 1 to Day 12 (2 Measures)	Day 12 to Day 90 (2 Measures)
MRI L3-L4[¶]	0.0001[d]***	NT	NT
MRI L4-L5[¶]	0.003[d]**	NT	NT
MRI L5-S1[¶]	0.0001[d]***	NT	NT
Pain at rest	0.0001[b]***	0.0001[c]***	0.53[c]
Pain at >5 min sitting	0.0001[b]***	0.001[c]**	0.01[c]*
Pain at >5 min standing	0.0001[b]***	0.001[c]**	0.01[c]*
Pain at >5 min walking	0.0001[b]***	0.001[c]**	0.01[c]*
Pain at functional movement	0.0001[b]***	0.001[c]**	0.01[c]*
Pain at >30 min ADL	0.001[b]**	0.01[c]*	0.01[c]*
Sensory L4	0.001[a]**	0.01[d]*	0.001[d]**
Sensory L5	0.001[a]**	0.1[d]	0.001[d]**
Sensory S1	0.001[a]**	0.3[d]	0.001[d]**
Motor L4	0.0001[b]***	0.01[c]*	0.001[c]**
Motor L5	0.001[b]**	0.1[c]	0.01[c]*
Motor S1	0.001[b]**	0.5[c]	0.001[c]**
SLR	0.001[a]**	0.001[d]**	0.7[d]
CES/ Red flag	0.001[a]**	0.01[d]*	0.01[d]*

Notes: [¶]2 times measurement taken for MRI Only [a]Friedman Test, [b]Repeated measure ANOVA; [c]Paired *t*-test, [d]Wilcoxon test; Level of significance *P<0.05, ** P<0.01, ***P<0.001; Measures of L1, L2 and L3 level were omitted due to majority (99.9%) of normal indicators.

Abbreviations: NT, Not tested; MRI, Magnetic resonance imaging; SLR, Straight leg raise; CES, Cauda Equina Syndrome.

three measurements, for two measures, or as a Post-hoc test, paired *t*-test or Wilcoxon test was used. A further determination of Clinical outcomes between successful and unsuccessful cases [Table 4] from day 1 to day 90, the Kruskal–Wallis test and Repeated measure ANOVA between subjects' estimates were employed, with a posthoc test by Independent *t*-test or Mann–Whitney *U*-test. Levels of significance were at <0.05, <0.01, <0.001, and for the posthoc test, Bonferroni correction has been made and p values estimated as a minimum of P<0.01.

Results

Two hundred twenty-eight cases with a lumbar disc herniation (LDH) received multidisciplinary conservative management, and we retrieved their clinical information on Day 1, Day 12, and Day 90. Overall, 183 (80.3%) cases were successfully treated, and 45 (19.7%) did not have clinical success, according to our indicators. The mean age of the cases was 39 years (SD 11.650); male cases were 148 (64.9%) compared to female 80 (35.1%). Body mass index (BMI) of the cases was normal for 124 (54.4%) cases, whereas 96 (42.1%) had overweight and 4(1.8%) had obese. Among female 65 (28.5%) were homemaker, and among male 39 (17.1%) was businessman. Another major portion 73 (32%) service holders from both gender working in the offices of Dhaka city. Hypertension was the major co-morbidity 53 (23%), 18 (7%) had diabetes, and 16 (7%) had kidney diseases. There was no statistically significant baseline compatibility ($P < 0.05$) between the socio-demographic variables of the successful and unsuccessful cases, except for the baseline compatibility of L3-L4 MRI, motor and sensory status ($P < 0.05$). Before taking the multidisciplinary treatment, LDH

Table 4 Clinical Outcome in Between Group Comparison (Successful versus Unsuccessful Cases)

Variables	Day 1 to Day 90 (3 Measures¶)	Day 1 to Day 12 (2 Measures)	Day 12 to Day 90 (2 Measures)
MRI L3-L4¶	0.006[a]**	NT	NT
MRI L4-L5¶	0.48[a]	NT	NT
MRI L5-S1¶	0.26[a]	NT	NT
Pain at rest	0.0001[b]***	0.78[c]	0.79[c]
Pain at >5 min sitting	0.0001[b]***	0.60[c]	0.78[c]
Pain at >5 min standing	0.0001[b]***	0.5[c]	0.001[c]**
Pain at >5 min walking	0.0001[b]***	0.68[c]	0.001[c]**
Pain at functional movement	0.0001[b]***	0.69[c]	0.01[c]*
Pain at >30 min ADL	0.001[b]**	0.5[c]	0.001[c]*
Sensory L4	0.001[a]**	0.001[d]**	0.001[d]**
Sensory L5	0.001[a]**	0.40[d]	0.001[d]**
Sensory S1	0.001[a]**	0.90[d]	0.001[d]**
Motor L4	0.0001[b]***	0.001[c]**	0.001[c]**
Motor L5	0.001[b]**	0.29[c]	0.001[c]**
Motor S1	0.001[b]**	0.21[c]	0.001[c]**
SLR	1.0[a]	0.001[d]**	1.0[d]
CES/ Red flag	0.17[a]	0.001[d]**	1.0[d]

Notes: ¶2 times measurement taken for MRI Only [a]Kruskal–Wallis test, [b]Repeated measure ANOVA with between subjects measures; [c]Independent *t*-test, [d]Mann–Whitney *U*-test; Level of significance *P<0.05, **P<0.01, ***P<0.001; Measures of L1, L2 and L3 level were omitted due to majority (99.9%) of normal indicators.
Abbreviations: NT, Not tested; MRI, Magnetic resonance imaging; SLR, Straight leg raise; CES, Cauda Equina Syndrome.

cases had a mean duration of their symptoms as 2.82 weeks (SD 1.169). For the cases with LDH, the usual duration of office work was 8.91 hours in a day (SD 2.4). The majority had central low back pain 107 (46.9%), 27 (11.8%) had ipsilateral referred pain (problem and symptom on the same side), 46 (20.2%) had contralateral referred pain (problems and symptoms are on the opposite side) and 48 (21.1%) had symptoms in both legs. MRI of the lumbosacral spine finds discs of L1-2 and L2-3 level was normal for all the cases, but there was a diverse report in the rest of the levels [Table 2]. The disc in between lumbar 3 and 4, 110 (48.2%) were normal, 88 (38.6%) were bulged, 21 (9.2%) was protruded and 9 (3.9%) had extrusion. There was no normal status of the disc position in between L4 and L5; 81 (35.5%) had bulging, 82 (36%) had a protrusion, 45 (19.7%) were extruded, 16 (7%) were migrated, 4(1.8%) were sequestrated. In the disc situated between L5 and S1 level, 28 (12.3%) were bulged, 130 (57%) were protruded, 32 (14%) were extruded, 24 (10.5%) was migrated in the space of spinal cord and 13 (5.7%) were sequestrated.

Outcome of Pain

On day 1, the average pain at rest was 3.6 centimeters on the 10-centimeter scale (SD 0.5) [Table 2]. The pain had a statistically significant decline of scores noted on Day 90 compared to the scores of Day 1($P < 0.001$) [Table 3] and at posthoc analysis on day 12 compared to day 1 ($P < 0.001$). The overall changes in resting pain from Day 12 to Day 90 were not statistically significant. Compared to the successful versus unsuccessful cases, there was a substantial change in

resting pain in successful cases on the 90th day compared to the first day ($P < 0.01$) [Table 4]. Moreover, no statistical changes were noted in between-group posthoc tests of between-group analysis. The changes of pain in sitting for more than 5 minutes, standing for more than 5 minutes, walking for more than 5 minutes, functional movements, and daily living activities for more than 30 minutes have a statistically significant change on day 90 compared to day 1 ($P < 0.01$), and in all comparison of all time frames (Table 3). In the group comparison, significant changes were noted in successful cases on day 90 compared to day 1 ($P < 0.01$). In the between-group posthoc test majority, had no differences separately between day 1 and day 12 and day 12 to day 90 (Table 4). Figure 1 shows the changes in pain in their mean scores with 95% confidence interval error bars.

Changes in Neurological Indicators

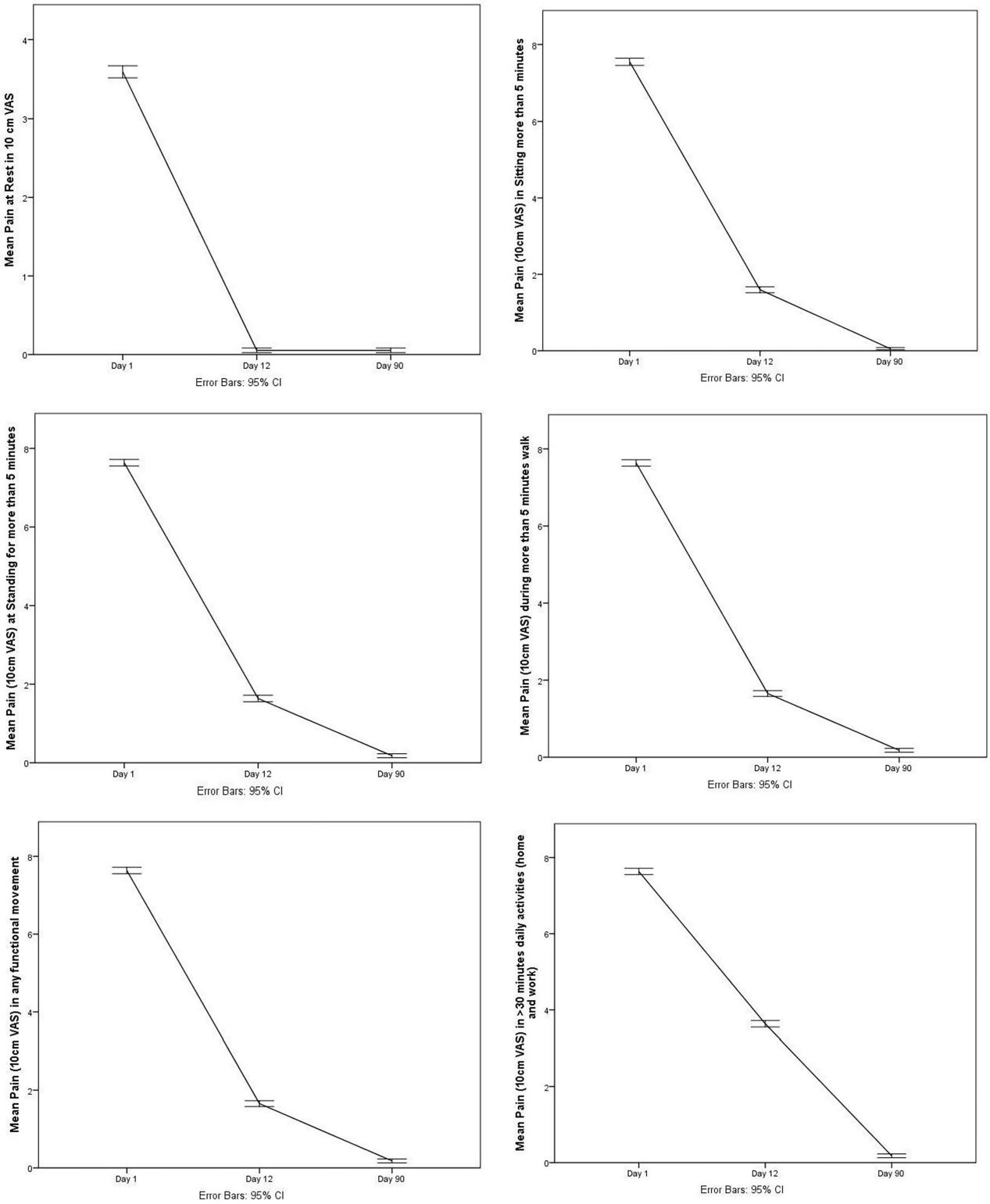
On day 1 (Table 2), in the L4 dermatome 30 (13.2%) had impaired sensation, and similar impairment in sensation was noted as 147 (64.5%) in L5 and 200 (87.7%) in the S1 dermatome. The sensory status of L1 to L3 was normal. The overall improvement of sensory status was statistically significant on day 90 compared to day 1 ($P < 0.001$), day 12 compared to day 1, and day 90 compared to day 12 ($P < 0.05$). The improvements in sensory status were significantly higher for the successful cases in the same time frames ($P < 0.01$) compared to the unsuccessful group. Before treatment, motor score measured in the oxford muscle grading system was found at muscles of the L5 nerve root as an average of 3.36 on a 0–5 scale (SD 0.4), and at muscles of the S1 nerve root, 3.12 (SD 0.3). Motor status of the muscles of L1 to L3 were grade 5. Overall improvements in the motor score of the muscles of L4, L5, and S1 nerve roots were significant in the outcome measures taken between day 90 compared to day 1 ($P < 0.001$). The result was consistent for post-hoc analysis of motor score from day 1 to day 12, and day 12 to day 90 ($P < 0.01$). The improvements were also noted in the successful group at day 90 compared to day 1 ($P < 0.001$) and at post-hoc between day 12 and day 90 ($P < 0.01$). The between-group changes of mean motor scores in three measurements are shown in Figure 2. All the cases had a positive straight leg raise (SLR) before the intervention, and 158 (69.3%) had any one of the symptoms of Cauda equina syndrome (CES) (Table 2). SLR and CES had significant improvement on day 90 ($P < 0.001$) and Day 12 ($P < 0.001$) compared to day 1 (Table 3). The changes in SLR and CES are also visualized in Figure 3.

Changes in MRI

There were statistically significant changes in the disc position at the level between L3 and L4, L4 and L5, and L5 and S1 in the MRI images noted at day 90 compared to day 1 ($P < 0.01$) (Table 3). In group comparison, the Successful group had a significant change of disc position at the L3 and L4 level only ($P < 0.01$) compared to the unsuccessful cases. The changes in MRI are presented in Figure 4.

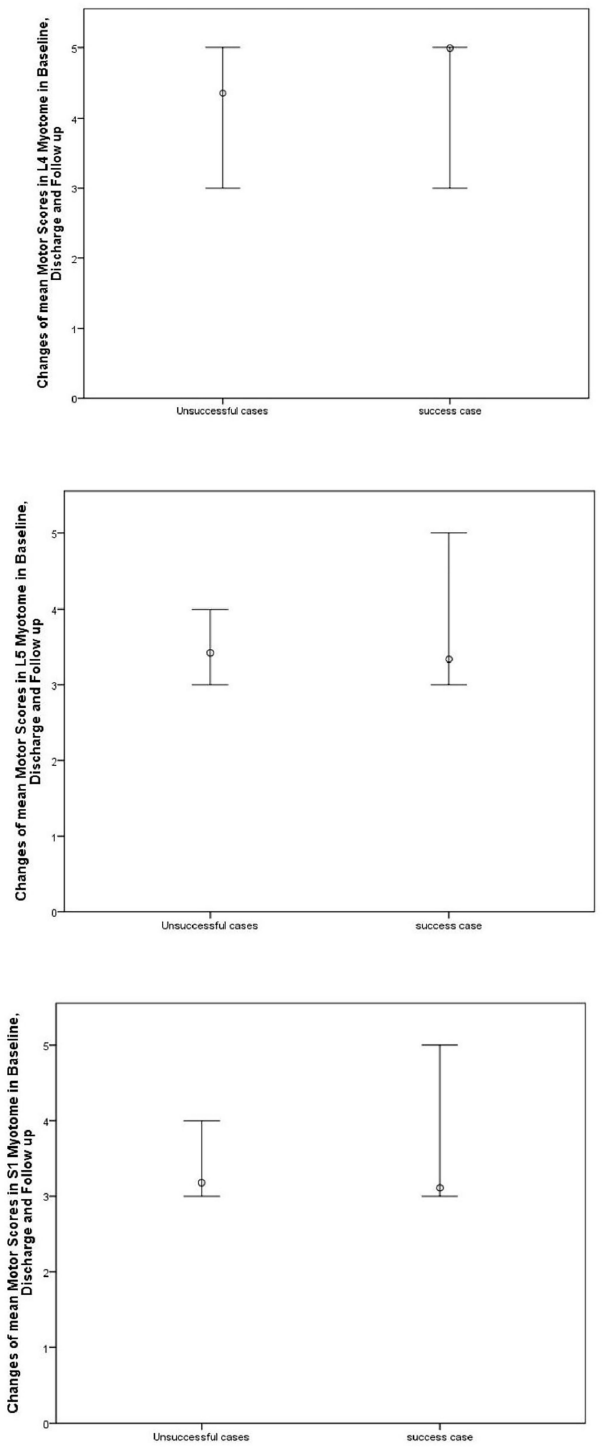
Discussion

The study was intended to find the outcome of a multidisciplinary approach of conservative management for LDH cases in a physiotherapist-led in-patient set-up in Dhaka city. From the database of a specialized spine center, 18 months of clinical data were extracted to generate the result. Two hundred twenty-eight cases of LDH completing 12-days comprehensive in-patient care by taking medications prescribed by a physician and physiotherapy prescribed by an advanced practice physiotherapy practitioner had statistically significant ($P<0.05$) outcomes in pain at rest and five different functional positions, neurological changes measured by physical tests (SLR, sensory, motor, CES), and normalization of disc position measured by MRI in the short term for 12 days and in the long term for 90 days. 80.3% were successful cases as they have complete recovery in physical and functional status. Full recovery is indicated by performing daily or livelihood activities for more than 30 minutes without painful symptoms, intact neurological functions in sensory and motor tests, a negative result in provocation tests as straight leg raise, and no cauda equina signs. On Day 1, the MRI study shows all the participants have either one or multiple compression in unilateral and bilateral nerve roots of L4, L5, and S1 levels according to Van Rijn classification systems.[27] Only 48% of cases had a normal disc position at L3/L4 level on day one, and at day 90, it improved to 96%, so 48% of herniated discs recovered up to day 90. The rate of improvement by changing the abnormal disc position to normal was 71% for L4/L5 and 69% for L5/S1 (Figure 4). A recent systematic review and meta-analysis on the physiotherapy interventions for lumbar disc herniation



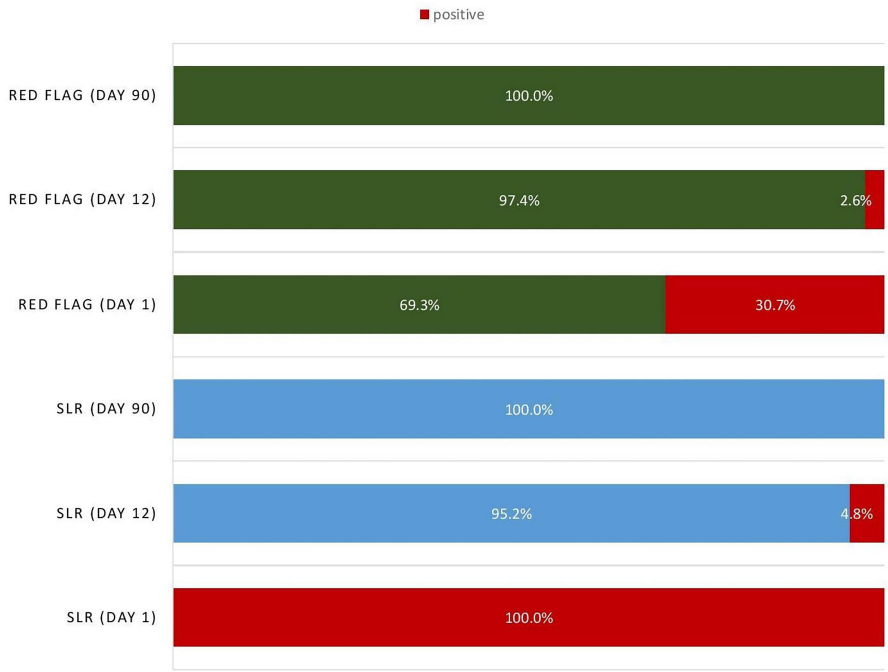
Changes of pain in 10 centimeter Visual analogue scale has been presented through mean pain in 0 cm to 10 cm with 95% CI error bars from the baseline (Day 1), Discharge (Day 12) and Follow up (Day 90). Pain measured in six positions, rest, more than 5 minutes sitting, more than 5 minutes standing, more than 5 minutes walking, functional movement and more than 30 minutes of daily activities.

Figure 1 Changes of pain from baseline to follow up.



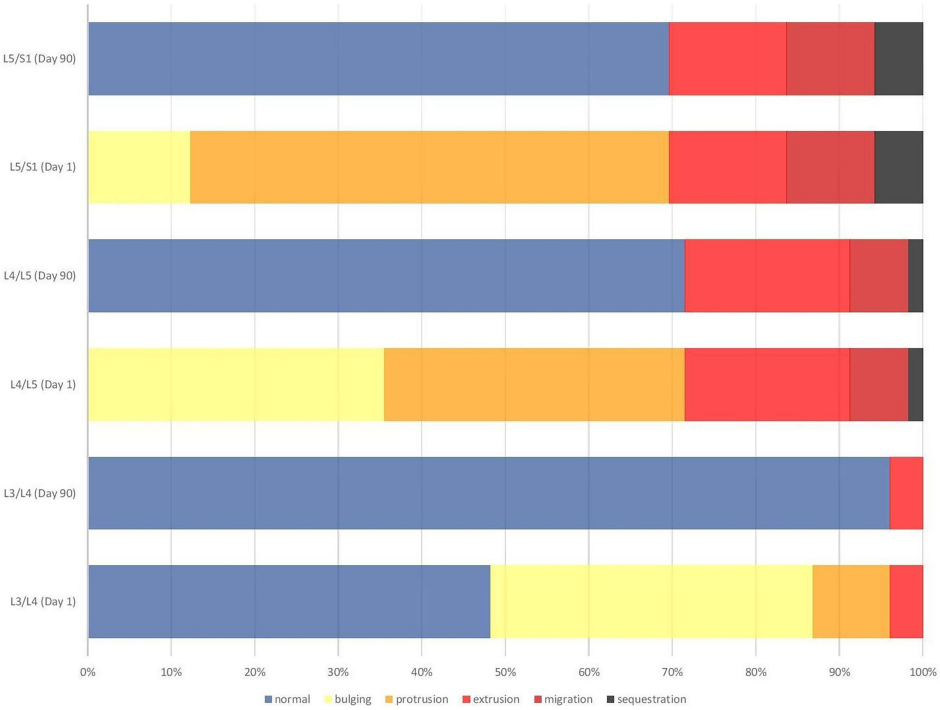
Changes in the mean score of muscle strength in L4, L5 and S1 myotome in 0-5 scale Oxford muscle grade in Discharge (Day 12) and Follow up (Day 90) in successful and unsuccessful cases presented in the I-beam, lower part indicates Day 1 (Baseline), upper part indicates Day 90 (Follow-up) and middle circle indicates Day 12 (Discharge).

Figure 2 Changes of motor status of lower limb motor nerves.



Straight leg raise considered positive for the cases provocation of symptoms below 75 degrees in the passive maneuver[7]; Red Flag sign considered as cauda equina syndrome (CES) as Numbness (diminished sensory) and weakness (Motor weakness) in one or both legs, deterioration or loss of bowel and/or bladder control, or numbness of the saddle area around the back passage[8];

Figure 3 Changes of red flag sign and straight leg raise.



Changes of MRI is represented by the degree of disc displacement shown in the Magnetic resonance imaging (MRI) categorized by normal, bulging, protrusion, extrusion, migration and sequestration according to the guideline by North American Spine Society[8]

Figure 4 Changes of magnetic resonance imaging of lumbar discs.

elicits manual and manipulative interventions that can correct the position of the intervertebral disc by restoring spine biomechanics and restoring the neurological functions by reducing the pressure on nerves and synovial fold.[28] The restoration of spinal biomechanics is enhanced by ensuring flexibility and strength of the intra-spinal muscles, improving the mobility of the motion segments of the spine that reduces the intradiscal pressure facilitating the nucleus pulposus to migrate towards the center of the intervertebral disc.[29] The biomechanical correction minimizes the sensitivity of the nerves, creating decompression to the spinal nerves, and straight leg raise (SLR) improves. The meta-analysis[28] shows any advanced practice physiotherapy (such as specialized manual therapy) can significantly reduce lower limb radicular pain, improve neural mobility examined by (SLR) and improves function-related disability status. Our study measured painful impairments at rest and 5 functional positions that relate to the patient's impairment in function (more than 5 minutes sitting, standing, walking. Functional movements), livelihood, and participation (more than 30 minutes daily living activities) and found a significant change between day one and day 90, day 1 and day 12, and day 12 and day 90 ($P<0.01$). Our study had 54% patients with lower limb radiculopathy and 69% with any one of the symptoms of red flag sign or cauda equina syndrome (CES). Their improvements were clinically and statistically significant in improving SLR and CES syndromes with a conservative physiotherapist-led in-patient management approach. A randomized clinical crossover trial on 120 patients[29] elicits that physiotherapists' manipulative therapy has an equal outcome for patients with lumbar disc herniation compared to microdiscectomy (surgery) in the short and long term. This crossover trial reports three failed patients with manipulative therapy underwent surgery. They resulted in no change of their state, whereas five failed surgery patients who underwent manipulative therapy had a favored outcome. After one year of intervention, surgery and manipulative therapy cases had equal results.[29] None of our patients were reported to have surgery after the follow-up screening.

Our study cases had an acute or sub-acute stage of LDH as they attended within 1 to 4 weeks of their symptoms. Patients with early intervention have a good outcome in pain, fear avoidance in work, function, and disability induced by LDH.[17] However, chronic cases with LDH also have a sustainable and favorable outcome in pain, function, and disability.[18] Still, early physiotherapy intervention is a cost-saving, efficient and effective intervention for LDH.[30] Our study result adheres to the hypothesis of "Virginia Mason example for a pathway for LBP management"[30] in the context of an efficient, quicker, and sustainable outcome of a physiotherapist-led multidisciplinary intervention for LDH. We did not perform a cost analysis as it was not documented along with the clinical data stored in the study setting; the maximum cost of treatment of the in-patient physiotherapy set-up was 3000 per day in Bangladeshi currency (USD 30) except the cost of medicine, MRI and physician's visit. A usual MRI cost for the Lumbosacral spine costs between 5000 and 7000, and physician's visits reneged from 500 to 1200 in Bangladeshi currency. The study had some limitations as this was a retrospective cross-sectional survey of the clinical records of LDH, no randomization process or control, and the possibility of documentation bias. Also, the study was conducted in a single set-up. There are a few physiotherapist-led in-patient set-ups for mechanical spinal disorders, and designing a prospective clinical trial needs well-structured on-field data. To our best knowledge, this is the first study in this region to evaluate a short and long-term outcome of advanced physiotherapy practice with a multidisciplinary team within an in-patient set-up. The future direction of the study will be a randomized clinical or crossover trial to examine the outcome unbiased, rigorous, and conclusive.

Conclusion

Physiotherapist-led multidisciplinary conservative treatment in an in-patient physiotherapy set-up results in a significant outcome in resting and functional pain, neurological recovery, and disc position for patients with Lumbar Disc Herniation. The pain outcome is rapid and more influential in 12 days' admission, but neurological recovery and normalizing disc position are more significant in 90 days. The treatment has an 80% of success rate concerning complete neurological recovery and restoration of daily living activities for more than 30 minutes, with no relapsing of symptoms.

Data Sharing Statement

Data is available as LDH dataset.xls in Mendeley Data, V1, www.doi.org/10.17632/ym5h3prdmp.1.

Institutional Review Board

Ethical approval was obtained before data collection from the Institutional review board of the Institute of Physiotherapy, Rehabilitation and Research (BPA-IPRR/IRB/06/16/20394) on June 16, 2022.

Informed Consent Statement

The study was a retrospective study on treated patients. During the intervention, participants provided consent in written form through informed consent of assessment, treatment, and using unanimous data for conducting research later.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declared no conflicts of interest in this work.

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