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ORIGINAL ARTICLE

Enhancing quality of life through physical exercise in a patient with triple lumbar disc herniation: A longitudinal case study

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Abstract

Lumbar disc herniation, a growing condition, significantly impacts work productivity, mental health, and quality of life. It alters functional movement patterns and causes improper compensatory body positioning, leading to muscle dysfunction. Physical exercise is a key treatment for chronic cases. This case study examined a 37-year-old male with moderate triple lumbar disc herniation and degenerative disc changes at L3-L4, L4-L5, and L5-S1. The subject followed a 10-week home-based exercise program performed 4 to 5 times weekly for 45 minutes per session. The program consisted of variations of body-weight exercises, supplemented with additional equipment, and progressively increased in intensity and volume, targeting hip joint mobility and strengthening of deep back, abdominal, and thigh muscles. Initial and final assessments included the Pain Detect test, the Short Form Health Survey-36 on quality of life, Manual Muscle Testing (MMT), Functional Movement Screen (FMS), and body composition analysis. Questionnaires indicated significant pain reduction and improvements in physical condition and psychosocial well-being. MMT improved from 4 to 5, FMS from 2 to 3, and body composition showed positive changes: weight (+1.5%), body water (+3.4%), skeletal muscle (+2.8%), and body fat (-6.6%). The subject reported substantial pain reduction, improved physical condition and psychosocial well-being, as well as enhanced muscle strength, functional movement patterns, and body composition. This case study highlights the program's effectiveness in treating lumbar disc herniation and enhancing quality of life. Additionally, the program is suitable for preventing lumbar disc herniation and improving overall quality of life in the broader population.

Keywords: pain intesity · pain description · psychosocial well-being · muscle strength · functional movement patterns · body composition

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Introduction

The global prevalence of low back pain was 7.83% in 2017, with approximately 577 million people experiencing this condition at some point in their lives (Maher et al., 2017). Low back pain is a leading cause of disability worldwide (Hoy et al., 2014) and results in more work absences than conditions such as diabetes, hypertension, asthma, and cardiovascular or respiratory diseases combined (Frymoyer, 1988). About 90% of diagnosed cases of lumbar disc herniation are classified as "non-specific pain," where the exact cause and specific diagnosis remain unknown (B. Kim & Yim, 2020; Maher et al., 2017). Identifying the specific cause of lower back pain is often challenging and rarely possible (Koes et al., 2010).

Disc herniation occurs when the intervertebral disc of the spinal column is damaged, resulting in prolapse and the penetration of the gelatinous nucleus into the intervertebral openings. This can exert pressure on the roots of the spinal nerves or lead to central penetration into the spinal canal, potentially damaging the spinal cord and cauda equina (Benovic & Zivkovic, 2011). This condition impairs motor control, triggering compensatory movements that result in various dysfunctions of the trunk and lower extremity muscles. Furthermore, patients often experience limitations in daily activities, reduced work productivity, mental health challenges, and a diminished quality of life. These issues collectively contribute to significant economic burdens (Rash et al., 2018) and represent a common healthcare and socio-economic challenge (Gaskin & Richard, 2012; Kent & Keating, 2005).

Exercise therapy is recommended as the first-line treatment during the chronic stage of low back pain, aiming to reduce pain intensity and functional limitations (Hayden et al., 2021; Quentin et al., 2021). The choice of therapeutic methods and approaches varies depending on whether the injury is in the acute or chronic stage. During the acute stage, exercises focus exclusively on strengthening the trunk muscles, particularly the deep muscles of the back and abdominal region, as their stability is crucial for maintaining proper load distribution across the pelvic girdle, spinal column, and associated structures (B. Kim & Yim, 2020). Research on home-based exercise programs designed to manage lower back pain has consistently demonstrated their effectiveness in reducing pain intensity, improving functionality, mitigating psychological impacts, and enhancing overall quality of life (Frih et al., 2009; Kanas et al., 2018; Quentin et al., 2021). Based on these findings, a specific ten-week home-based exercise program was developed to progressively increase load and focus on stretching hypertonic muscle groups, as well as strengthening the trunk and thigh musculature, with the aim of recovery and quality-of-life improvement for patients diagnosed with chronic triple lumbar disc herniation.

The goal of this study is to evaluate the effects of a specific ten-week home-based exercise program for individuals with chronic triple lumbar disc herniation, using a case study approach. The program's impact was assessed in terms of pain reduction, quality-of-life improvement, enhanced physical abilities and functionality, and changes in the participants' body composition.

Method

Subject

The study involved a 37-year-old male subject with a body height of 176.0 cm and a body weight of 84.5 kg. The participant was physically active prior to the injury and had been diagnosed with chronic triple lumbar disc herniation through magnetic resonance imaging. The condition was characterized by moderate severity of degenerative disc changes at the following spinal levels: L3-L4, L4-L5, and L5-S1 (Figure 1).

The subject exhibited limited movements, particularly when bending, leaning, or lifting objects, although walking remained unaffected. Moderate lumbar back pain was reported during the four weeks preceding the testing. The participant voluntarily provided written informed consent before participating. The participant was physically capable for the prescribed activities, contributing to the empirical research without any financial compensation.

Study design and procedures

The exercise program was conducted over a 10-week period in a home setting, performed independently by the subject after prior familiarization with proper exercise techniques. The program was carried out 4–5 times per week, with each session lasting 45 minutes. Initial testing was conducted before the start of the exercise program to design and adapt the plan to the subject's specific needs. The final test was conducted under the same conditions as the initial test, following the same order and performed by the same examiner, to evaluate the effects of the exercise program. The experiment was conducted in accordance with the

Declaration of Helsinki. This study was approved by the ethics committee of the Faculty of Sport and Physical Education, University of Belgrade [02-175/25-1].

Training program

The exercise program was conducted at home, independently by the subject, following prior familiarization with proper exercise techniques. It included variations of exercises using body weight, additional equipment, and a progressive increase in both intensity and training volume. The program aimed to improve flexibility and strength through hip flexor muscle stretching and active strengthening of the deep back muscles, rectus and oblique abdominal muscles, as well as thigh muscles.

In the introductory and preparatory phase, the subject began with the "cat-cow" exercise (Figure 2). This was followed by the spinal mobilization with leg movements (SMWLM) technique (Figure 3), which combines spinal column mobilization with active leg movements. This technique was designed to reduce pain, improve mobility and stability of the lumbar region, and decompress nerve structures (Selim et al., 2022).

The main phase of the training focused on strengthening key muscle groups to compensate for the lost stability caused by disc herniation and to reduce pressure on the spinal column. In the final phase, special attention was given to stretching the hip flexor muscles (Figure 4 and 5) to maintain functional hip mobility and further alleviate pressure on the spinal column.

Initial and final testing

The subject first completed the Pain Detect Test and the Short Form Health Survey-36 (SF-36) during the initial and final testing phases. Body composition was subsequently measured using the InBody770 analyzer. Muscle strength was then assessed through Manual Muscle Testing (MMT), and movement quality was evaluated using the Functional Movement Screen (FMS), following established protocols and standards (Ciesla et al., 2011; Cook et al., 2014a, 2014b).

The Pain Detect Test is a reliable and straightforward tool developed to assess the presence of a neuropathic pain component in patients with low back pain (Freynhagen et al., 2006). The scale ranges from a minimum score of -1 to a maximum of 38. A final score of 12 or less suggests that the neuropathic component of pain is unlikely (probability less than 15%). Conversely, a score of 19 or more indicates a high likelihood of neuropathic pain (probability greater than 90%) (Freynhagen et al., 2006).

The SF-36 consists of 36 questions, 35 of which analyze eight health dimensions, while one question compares the general quality of life to that of the previous year. The first set of health dimensions focuses on physical health, including general health status, physical functioning, activity limitations due to physical problems, and physical pain. The second set addresses mental health, including vitality, social functioning, activity limitations due to emotional problems, and mental health (Ware & Sherbourne, 1992).

During MMT, the strength of the following muscles was assessed using manual resistance: musculus rectus abdominis – trunk flexion, musculi extensores trunci – trunk extension, musculus obliquus abdominis externus et internus – trunk rotation, musculus iliopsoas – hip flexion, musculus gluteus maximus – hip extension. The strength grading scale ranged from 1 to 5, with 5 indicating the subject's ability to provide maximum resistance. Manual resistance ratings were recorded immediately after each test was performed (Ciesla et al., 2011).

In the FMS test, the subject performed the following assessments: (1) deep squat, (2) inline lunge, (3) step over an obstacle, (4) shoulder girdle mobility, (5) active straight leg raise, (6) push-up trunk stability, (7) rotary trunk stability (Cook et al., 2014a, 2014b). The FMS grading scale ranged from 1 to 3, with 3 representing the highest quality of movement. The performance of the FMS tests was recorded on video, and the results were analyzed through post-processing by reviewing the recordings (Cook et al., 2014a, 2014b).

Results

Pain Detect Test

During the final assessment, the subject reported a significant reduction in pain intensity compared to the initial test, including lower ratings for the most intense and average pain experienced over the previous four weeks (Table 1). At the initial assessment, the total pain description score was 11 out of 35. Light touch of the painful region did not elicit pain, cold and heat caused only barely noticeable discomfort, and light finger pressure induced moderate pain. Tingling, pricking, and burning sensations were also barely noticeable, while sudden attacks of severe pain, resembling electric shocks, were experienced at a moderate intensity. Numbness was mild. By the final

assessment, the total pain description score had decreased to 2 out of 35 (Table 1). None of the previously reported symptoms were present, except for occasional mild episodes of severe pain resembling electric shocks.

Short Form Health Survey-36

During the initial assessment, the subject rated his health as very good, although worse than a year ago. He reported moderate body pain and limitations in certain activities, such as bending, leaning, performing tasks requiring moderate effort, lifting objects, and engaging in vigorous activities. However, walking, bathing, and dressing were unaffected. In his professional life, restrictions included shorter working hours and a reduced workload, though these were not due to emotional problems. Emotionally, the subject occasionally felt nervous, exhausted, and in pain but was mostly energetic, calm, and happy. By the final assessment, the subject rated his health as excellent and better than a year ago. He experienced no restrictions in daily or professional activities, and body pain was minimal. Emotionally, he was rarely nervous or exhausted, and most of the time, he had plenty of energy, remained calm, and felt happy.

Manual muscle testing

In the final testing compared to the initial testing, the subject improved his MMT scores by one grade in all muscles, except for the trunk extensor muscles (mm. extensores trunci), where resistance remained at level 5 (Table 2).

Functional movement screen

In the final test, compared to the initial test, the subject either improved or maintained his performance on the FMS test, depending on the task, achieving the maximum score in all tasks except for shoulder girdle mobility, where he retained his previous result (Table 3).

Body composition

In the final test, compared to the initial test, the subject showed an increase in body mass (+1.3 kg), water mass (+1.7 kg), and muscle mass (+1.1 kg), while fat mass decreased (-0.8 kg) (Table 4).

Discussion

The aim of this case study was to develop, implement, and evaluate the effectiveness of a specific ten-week home-based exercise program for an individual with triple lumbar disc herniation. The results indicate a significant reduction in pain and improvements in quality of life, including increased muscle strength, enhanced functional movement patterns, improved body composition, and better psychosocial health. These findings confirm the effectiveness of appropriate physical activity in the recovery process for lumbar disc herniation. Furthermore, they align with prior research emphasizing exercise as a key therapy for reducing pain and functional limitations in chronic disc herniation cases (Bernstein et al., 2017; Hayden et al., 2021; Quentin et al., 2021).

The results of the Pain Detect Test demonstrated a significant reduction in pain perception (Table 1), affirming the effectiveness of the program in alleviating painful symptoms. These findings are consistent with research showing that tailored exercise programs can substantially reduce pain levels in patients with lumbar disc herniation (Puntumetakul et al., 2018; Qaseem et al., 2017). The SF-36 questionnaire revealed improvements in psychosocial health, including reduced feelings of nervousness and exhaustion and increased calmness and happiness. These positive changes can be attributed to pain reduction and enhanced functionality, which enable better daily living and social interactions while mitigating feelings of isolation and frustration. Additionally, physical activity promotes the release of endogenous endorphins, the body's natural pain relievers, and supports neurochemical processes that improve mood (Basso & Suzuki, 2017). Changes in body composition, including increased muscle mass and decreased body fat (Table 4), may further boost self-confidence, positively impacting mental health.

The analysis of MMT results (Table 2) showed a notable increase in trunk muscle strength following the exercise program. Specifically, the strength of the m. rectus abdominis, m. obliquus externus et internus, and m. iliopsoas increased from 4 to 5, while the strength of the m. gluteus maximus improved from 3+ to 4+. Functional stability of the spinal column, as evidenced by improved FMS scores (Table 3), was achieved by strengthening stabilizing muscles such as m. transversus abdominis and m. multifidus. This process, achieved by increasing intra-abdominal pressure (Vleeming et al., 2014), enhanced coordination and movement control, reduced tissue tension and irritation, and contributed to pain relief (T.H. Kim et al., 2015; Salavati et al., 2016; Tsao & Hodges, 2008). These findings suggest that increased muscle strength promotes motor learning and neuromuscular control, resulting in reduced pain and improved functionality in daily activities. Similar outcomes have been observed in subjects

with comparable conditions after exercise interventions (Comerford & Mottram, 2001; Koumantakis et al., 2005).

We hypothesize that applying the SMWLM technique further contributed to these effects by correcting positional irregularities and decompressing nerve structures, directly reducing pain intensity (Selim et al., 2022). These results corroborate findings from systematic reviews emphasizing the efficacy of exercise programs in alleviating pain and mitigating functional limitations in chronic low back pain (Hayden et al., 2021; Quentin et al., 2021).

This case study's strength lies in its longitudinal approach to monitoring a single rare case, offering a detailed clinical perspective. The applied exercise program and testing methods are practical, affordable, and easy to implement without requiring significant material investment or exposing the patient to excessive physical strain. Furthermore, the program is applicable not only for recovery but also as a preventive measure for lumbar disc herniation and for enhancing the quality of life in the general population. Upon request, the complete exercise program can be made available, emphasizing its applicability and openness for future research.

A limitation of this study is the absence of a final magnetic resonance imaging evaluation, as the subject opted to avoid additional radiation exposure. Consequently, the effects could only be assessed on a functional, rather than structural, level. Additionally, the subject performed the exercise program independently without continuous professional supervision, which suggests that a guided and controlled training process could yield even greater functional benefits. Future studies should aim to validate these findings with a larger sample of similar cases, incorporating supervised training and structural assessments using radiological imaging. Such research would provide more comprehensive data on the clinical applicability and effectiveness of exercise programs.

Conclusions

The results of this study indicate a significant reduction in pain and improvements in quality of life, including increased muscle strength, enhanced functional movement patterns, improved body composition, and better psychosocial health in a patient with triple lumbar disc herniation. Furthermore, they align with prior research emphasizing exercise as a key therapy for reducing pain and functional limitations in chronic disc herniation cases. The applied exercise program and testing methods are practical, affordable, and easy to implement without requiring significant material investment or exposing the patient to excessive physical strain. Furthermore, the program is applicable not only for recovery but also as a preventive measure for lumbar disc herniation and for enhancing the quality of life in the general population. Future studies should aim to validate these findings with a larger sample of similar cases, incorporating supervised training and structural assessments using radiological imaging. Such research would provide more comprehensive data on the clinical applicability and effectiveness of exercise programs.

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Table 1. Pain Intensity and Description on Initial and Final Testing

Pain intensity and description	Initial	Final
Pain rating at the time of questionnaire completion	7	1
The most severe pain in the past 4 weeks	8	5
Average pain in the past 4 weeks	6	2
Burning sensation	1	0
Tingling sensation	1	0
Numbness	2	0
Pain induced by light touch	0	0
Pain induced by cold or heat	1	0
Pain induced by gentle pressure	3	0
Sudden attacks of severe pain	3	2

Table 2. Results of MMT on Initial and Final Testing

Muscles	Initial	Final
M. Rectus Abdominis	4	5
M.M. Extensores Trunci	5	5
M. Obliquus Externus et Internus	4	5
M. Iliopsoas	4	5
M. Gluteus Maximus	3+	4+

Table 3. Results of FMS on Initial and Final Testing

Movement	Initial	Final
Deep squat	3	3
Inline lunge	2	3
Step over an obstacle	2	3
Shoulder girdle mobility	2	2
Active straight leg raise	3	3
Push-up trunk stability	3	3
Rotary trunk stability	2	3

Table 4. Body Composition on Initial and Final Testing

	Initial	Final
Weight [kg]	84.5	85.8
Total body water [L]	50.6	52.3
Skeletal muscle mass [kg]	39.5	40.6
Body fat mass [kg]	15.5	14.7
Percentage of body fat [%]	18.3	17.1

Proteins [kg]	13.8	14.0
Minerals [kg]	4.63	4.76

Figure 1. Magnetic resonance imaging of the subject's chronic spinal column condition.

Figure 2. Starting and ending positions for performing the "cat-cow" exercise.

Figure 3. Starting and ending positions for performing the SMWLM technique.

Figure 4. Starting and ending position for stretching the hip flexors.

Figure 5. Starting and ending position for stretching the hip flexors.