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Physical Therapy Management of a Patient with Residual Neurologic Deficits Following Lumbar Decompression Surgery

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Abstract

Background: The symptoms associated with lumbar spinal stenosis (LSS) can severely impact a person's quality of life. Along with back pain, symptoms might include lower extremity numbness, tingling, pain, cramping, motor control deficits, and weakness. Both lumbar decompression surgery and physical rehabilitation are considered effective treatments for LSS. **Case Description**: The patient was a 76-year-old male with a 30-year history of back pain and LSS. He had recently undergone a lumbar decompression surgery which relieved the majority of the pain, but motor deficits remained. He was referred to physical therapy to improve ambulation and decrease fall risk. **Intervention Strategies**: The patient underwent two months of physical therapy focused on the following intervention strategies: gait training, ankle motor control, general lower extremity strengthening, lower extremity endurance training, static and dynamic balance training. The main focus of treatment was shifted towards functional improvements one month into treatment. **Outcome Measures**: The outcome measures used throughout this patient's treatment included the Four Stage Balance Test, Oswestry Disability Index, and manual muscle testing of the lower extremities. **Discussion:** The purpose of this case study was to describe the specific balance, resistance, and gait training interventions used to treat a patient status post lumbar decompression surgery for chronic LSS. The patient showed clinically meaningful improvement in perceived disability. The patient was able to decrease use of assistive devices considerably, and showed improvements in lower extremity strength, ambulation quality, static balance, dynamic balance, and fall risk.

Keywords: Lumbar decompression; neurology; orthopedics; physical therapy; rehabilitation

Introduction

Lower back pain (LBP) affects people of all ages, and is one of the most common conditions for which healthcare is sought. While many cases resolve without seeking treatment, the recurrence and morbidity of LBP can lead to a significant impact across a person's lifespan. The prevalence of severe lower back pain increases with age, and it's estimated that 5-10% of these cases will go on to become chronic in nature.[1,2]

One of the most common presentations of lower back pain in elderly adults is lumbar spinal stenosis (LSS).[3] This condition is characterized by narrowing of spaces surrounding the spinal cord and/or nerve roots. The resultant symptoms are back pain, leg pain, numbness, tingling, and other neurogenic symptoms extending throughout the lower extremities.[3] In many cases the accumulation of these symptoms leads to diminished walking capacity and functional mobility.[3] Common causes of stenosis include: intervertebral disc herniation, ligamentum flavum hypertrophy, degradation of the facet joints, and osteophyte formation.[3] As the population of elderly persons in the United States continues to rise, so does the proportion of patients experiencing LSS symptoms.[4]

There's an active debate as to which treatment approach yields the best outcomes for patients experiencing LSS. Common options for LSS include: physical therapy, epidural steroid injections, and lumbar decompression surgery. Lumbar decompression has become the most common spinal surgery in patients over 65 years old.[1] Lumbar decompression surgery followed by a bout of physical therapy has been shown to provide positive outcomes for patients, including a 5.1-point decrease in pain using a 10 cm Visual Analog Scale.[4] However, most established rehabilitation protocols are attributed to conservative treatment without prior surgery.[4] There is relatively little research available on optimal physical therapy treatment following surgical intervention. Thus, the purpose of this case study is to describe the specific balance, resistance, and gait training interventions used to treat a patient status post lumbar decompression surgery for chronic LSS with positive outcomes.

Patient History

A 76-year-old male with a 30-year history of lower back pain and transient left-sided radiating leg pain and numbness was referred to physical therapy 45 days following a lumbar decompression surgery. His symptoms had been fairly consistent and non-debilitating until he suffered a fall approximately 11 months ago. The patient fell off of a rolling stool and landed on his buttock, which severely exacerbated his symptoms. Diagnostic imaging studies revealed that he had central stenosis of L3-L5 due to disc bulging, L4-L5 herniated disc, facet arthropathy, and ligamentum flavum hypertrophy. Prior to the fall the patient was living fully independently without an assistive device. Following the fall, he was suffering from severe LBP, left-sided lower extremity pain and numbness in the posterior/lateral aspect, and noted several instances of tripping over rugs at home. He was using a standard walker for ambulation, and intermittently using a wheelchair for locomotion.

The patient went through a 4-month period of using opioid and muscle relaxer medications, along with general inactivity in an effort to relieve symptoms. As symptoms continued to worsen he received a L4-5 transforaminal epidural steroid injection 5 months after his fall with mild symptom relief. Following multiple neurosurgeon consultations, he underwent a lumbar decompression surgery roughly 6 months after his initial fall. The surgery involved the following procedures: laminectomies of L3-L5, L4-5 discectomy, and medial facetectomies of L3-L5. The patient commented that after the surgery he was no longer having neurogenic claudication symptoms, but numbness and mild lower back pain persisted.

The patient was referred to physical therapy with the following diagnoses: lumbar stenosis with neurogenic claudication and left lumbar radiculopathy. For the initial two months following surgery the patient was seen by a home health physical therapist for general strengthening. The patient was then referred to outpatient physical therapy approximately 8 months after his initial fall, 2 months after his LSS procedure. The referral to outpatient services was on the basis of consistent functional improvement necessitating higher level challenges, and the patient no longer being home bound.

Outpatient Examination and Evaluation

The standardized outcome measure chosen to evaluate the patient was the Oswestry Disability Index (ODI). The ODI is a subjective questionnaire completed by the patient. It assesses perceived levels of disability in 10 common activities of daily living (ADL).[5] There are 50 points possible, 5 per ADL, and each is assigned 2 percentage points for a total disability percentage score out of 100%. Therefore, more points are correlated with a greater percentage, and greater perceived disability. The minimal detectable change (MDC) is 10%, or 5 points.[7] The ODI was chosen because it has been shown to be a reliable, valid, and responsive functional outcome measure for patients with chronic LBP.[6] The ODI has also been shown to have a strong correlation with walking tests and walking capacity.[5] The ODI's association with walking ability was relevant because the majority of the patient's goals for therapy included an ambulation component. At the initial evaluation the patient's ODI score was 15, or 30% disability. This fits within the moderate classification of disability.[7]

Manual muscle tests were performed on the patient's lower extremities. Minimal hip strength deficits were noted bilateral. More substantial strength deficits were noted in both ankles, with the left side being more significantly affected. These results can be found in table 2. The Four Stage Balance Test (FSBT) was also used to assess the patient's balance and risk for falls. The test involves the patient assuming 4 different static stances, each more difficult than the last, and attempting to hold each for 10 seconds without support. The order of stances tested are feet together, semi-tandem, tandem, and one-legged. Once the patient is not able to hold a position for at least 10 seconds the FSBT is complete, and the following stances are not attempted. Patients who are 65 years or older that can't progress to, or hold the tandem stance for at least 10 seconds are considered to have an increased risk for falls.[8] The patient was not able to achieve 10 seconds of tandem stance with either foot orientation, indicating that he was at risk for falls at the time of the initial evaluation.

Active range of motion (ROM) testing revealed more impairments hindering the patient's function. While most fell within normal ranges for a man his age, he exhibited limited trunk extension. The patient was not able to extend past neutral, and the active movement caused sharp pain in his left lower back and hip. In addition, ankle dorsiflexion and plantar flexion were limited in both active and passive ROM. These ROM measures were taken both actively and passively to assess joint restrictions versus volitional control deficits. The right ankle was restricted equally in both passive and active motions, unable to achieve a neutral position with either. This indicated that joint restrictions were likely the limiting factor. The patient noted that the motion of the right ankle had been minimal since an ankle reconstructive surgery 30 years ago preceded by a severe motor vehicle accident. The left ankle motion was limited both passively and actively, though active motion was considerably more restricted. This signified that volitional ankle control may have been the principal limitation in the left ankle, with joint restrictions likely present as well. Both ankles sat in an inverted position, and were unable achieve neutral actively or passively.

Sensation and reflexes were also tested. Unsurprisingly, there were sensory deficits noted in the L4 and L5 dermatomal distributions on the left leg. The patient inconsistently reported light touch sensation in the left leg signifying impairment, but accurately described light touch in the right leg. Achilles reflexes were absent in both ankles. A left patellar reflex was difficult to elicit, but was found to be 1+ with repeated trials. The right patellar reflex was easily produced and found to be 2+.

Co-morbidities limiting therapy include significantly decreased right ankle range of motion following reconstructive surgery 30+ years ago, left hip osteoarthritis (OA), and bilateral knee OA. The patient's primary complaints at the beginning of outpatient treatment were gait difficulties, balance impairment, lower extremity numbness, and pain in the left lower back and buttock. When asked about his perception of his balance difficulties, the patient reported that "my ankles don't pick up like they're supposed to, they're always catching on rugs making me lose my balance." The patient's primary goals for therapy included improved confidence with balance, ambulating without an assistive device, and improved endurance to tolerate being more active.

The final objective assessment observed in the initial evaluation was gait analysis. The patient's gait was assessed while using a single point cane in his right hand. Initial antalgic observations

included bilateral decreased step length and slow gait speed, though neither of these were measured. He walked with a significant hip drop bilaterally, though it was more substantial on the left side. Both of his ankles were inverted throughout the gait cycle, with the right ankle being more inverted than the left. He would also hip hike on each side, and circumduct the corresponding leg to help clear his foot from the floor. The patient declined to walk without the cane due to safety concerns.

Clinical Impression

The patient's most prominent issue affecting function was determined to be deficient balance. There was a myriad of factors potentially influencing his balance. These factors included impairments in: ankle strength, hip strength, lower extremity sensation, and ankle range of motion. Other factors that weren't tested but could have contributed to balance compromise include: vestibular dysfunction, impaired proprioception, decreased endurance, and impaired vision. These weren't tested, however, in the interest of time. The physical therapist determined that the patient was an appropriate candidate for continued physical therapy to address the deficits mentioned above. Since the most prominent objective deficits were found in the ankles, and the patient believed his inability to pick up his foot was causing his losses of balance, improvements in ankle motor control and ROM became the initial focus of treatment. The patient was seen in physical therapy 2 days/week for 8 weeks, for 30 minutes per session.

Interventions

Impairment specific interventions – Phase I

The interventions used with this patient began with impairment-specific exercises. These exercises were used throughout the first 4 weeks of treatment, with progression, as the patient was able to tolerate additional strength, ROM and balance challenges.

The first 5-8 minutes of treatment sessions would typically begin with a warm-up and endurance training on the Nustep recumbent stepper at a challenging, but tolerable resistance. The patient was allowed to use both upper and lower extremities. The remainder of the treatment session would focus on one or more of the four following areas: ankle strength, ankle motor control, ankle ROM, general lower extremity strengthening, and static balance training. See table 1a for more details on ankle exercises and table 1b for lower extremity strengthening exercises used in this phase of treatment.

The home exercise program for this phase of treatment targeted each of the deficits listed above. After the initial evaluation the patient was given sit to stand exercises, double leg bridges in supine, and seated ankle pump exercises to do at home. Static standing balance exercises were added to the home exercise program after approximately four visits when it was determined that the patient could perform them safely without supervision. Standing balance exercises for home were either in a stance with his feet together, or in a semi tandem stance.

A re-evaluation after approximately 4 weeks of care revealed only minimal progress in ankle strength, ROM, and motor control. However, he was making functional gains, reporting fewer losses of balance, no longer using a wheelchair, and beginning to use a cane for ambulation around the house. It was decided that treatment should shift emphasis towards multi-faceted interventions that further challenge balance dynamically, thus a second phase of treatment was initiated.

Function focused interventions – Phase II

The second phase of treatment focused on regaining function, and improving ambulation. The lower extremity strengthening exercises were continued from phase I (see table 1b) and additional balance exercises were added (see table 1c). This phase of treatment included functional mobility training, dynamic balance exercises, and gait training.

As the focus of our sessions shifted, so did the focus of the home exercise program. The static balance exercises were progressed and made dynamic, hip strengthening exercises were moved to standing, and ankle ROM exercises were excluded. The modified home exercise program included the following exercises: standing marches, sink squats, and standing hip exercises with a red elastic Theraband. Standing balance exercises in semi tandem stance were also progressed with the following

modifications: increasing anterior-posterior distance between feet, decreasing medial-lateral distance between feet, closing eyes, slowly turning head.

Table 1a. Phase I interventions- ankle focus

	Set up	Description (D)	Progression (P)
Ankle Strength and Motor Control			
Half foam roll ankle rockers	Patient seated edge of mat. One or both feet placed on the flat edge of half foam roll. Cues provided for slow, controlled movements	D1: Foam roll placed parallel to foot→slow transitions between inversion and eversion D2: Foam roll placed perpendicular to foot→ slow transitions between plantar flexion and dorsiflexion	P1: Both feet on foam roll→one foot on foam roll P2: Ankle weight placed on foam roll
Theraband (Tband)-resisted 4 way ankle movements	Patient in long sitting. Therapist holds yellow Tband in medial, lateral, superior, or inferior positions	D1: Therapist holds Tband in the 4 different positions patient moves his ankle opposite the direction of resistance: plantar flexion (PF), dorsiflexion (DF), inversion, and eversion	P1: Progress resistance of the Tband yellow → red
Proprioceptive neuromuscular facilitation	Patient in long sitting. Therapist is facing the patient	D1: Patient moves ankle into PF while therapist provides concentric resistance. At end range the patient is cued to move ankle into DF while the therapist provides eccentric PF resistance. D2: The exercise is repeated with DF resistance	P1: Exercise in long sitting→ once tolerated patient was moved to short sitting so that DF movement is against gravity
Ankle ROM			
Calf stretching	Patient stands on a tilt board with railing in front of him for balance support	D1: Patient leans into the railing while keeping his knees locked in extension, and heels remaining in contact with the board	P1: increase duration of the held stretch 10-15 → 30 seconds
Gastrocnemius/soleus soft tissue manipulation (STM)	Patient lies in prone. Therapist stands at the patient's feet	D1: Therapist applies STM techniques along the length of the calf and achilles tendon	
Joint mobilizations grades 2-4	Patient lies in supine. Therapist stands at the patient's feet.	D1 (posterior talus glides): Therapist stabilizes the distal tibiofibular joint with one hand and applies a posterior force to the anterior talus	P1: Grade 2 and 3 mobilizations→ grade 4

*****D1, D2, etc. describe the different methods used to complete the exercise. P1, P2, etc. describe the different progressions used to make each exercise more challenging.

Table 1b. Phase I and II Interventions - General lower extremity strengthening

	Set up	Description (D)	Progression (P)
Sit to stand exercises	Patient begins by sitting on an 18 inch chair with a 2.5 inch Airex foam pad placed on the seat	D1: Patient transitions from sitting to standing without pushing through upper extremities, or allowing the backs of his legs to make contact with the chair. Verbal cues from therapist frequently needed to avoid above compensations.	P1: Remove Airex pad for increased sit depth P2: Add red Tband loop around the knees and cue the patient to keep knees apart
Standing Tband-resisted hip abduction and extension	Patient stands with a railing in front of him for balance support, and Tband loop around each ankle	D1 (extension): Patient extends hip posteriorly while keeping knee extended. Verbal cues from therapist frequently needed to avoid trunk leaning compensations. Repeat with opposite leg. D2 (abduction): Patient repeats the same procedure described above, but the moving leg moves laterally.	P1: Progressed resistance of Tband from yellow → red → green as tolerated
Double leg bridges	Patient lays in hooklying position	Patient lifts buttock upwards off the table, and towards the ceiling, and holds for 2 seconds before lowering back to the table	P1: Increased time the end range position is held for P2: Red Tband loop is placed around each knee
Tband side steps	Patient stands facing countertop for balance support with Tband loop around each ankle	D1: Patient side steps 5 paces to the right while not allowing the Tband to slacken. Verbal cues from therapist needed to avoid trunk leaning compensations. Patient repeats same procedure side stepping to the left	P1: Increase Tband resistance from red→ green→ blue P2: Patient holds mini-squat while performing side steps

*****D1, D2, etc. describe the different methods used to complete the exercise. P1, P2, etc. describe the different progressions used to make each exercise more challenging.

Table 1c. Phases II - Balance and gait training

	Set up	Description (D)	Progression (P)
Balance Training			
Static standing balance	Patient stands in parallel bars, but does not use upper extremity support unless necessary to catch his balance	D1: Standing with feet together D2: Standing in semi-tandem stance D3: standing in tandem stance	P1: Stand on Airex pad P2: Close eyes P3: Turn head slowly from side to side P4: Use any combinations of P1-3
Standing marches	Patient stands in parallel bars, but does not use upper extremities support unless necessary to catch his balance	D1: Patient marches alternating knees towards the ceiling	P1: Slow down the movement, thus increasing single leg stance time
Lateral hurdle step overs	Patient stands in parallel bars with a small hurdle placed to the right or left side of both feet	D1: Patient alternates side-stepping over a hurdle in each direction with each foot making contact on either side	P1: Hands on parallel bars for assistance→ un supported stepping
Gait training			
Hurdle training	Hurdles placed roughly 3 feet apart consecutively. Patient is wearing gait belt. Therapist holds gait belt with contact guard assist	D1: Patient steps straight over each hurdle with both feet. Verbal cues provided by therapist to avoid stepping lateral of hurdle or shuffling between hurdles	P1: Decrease distance between each hurdle P2: Consecutive lateral hurdle step overs
High stepping	Patient is wearing gait belt. Therapist holds belt with contact guard assist	D1: Patient walks forward with a marching gait pattern, lifting alternating knees as high as possible	P1: Add dumbbell in one hand→ increase weight of dumbbell
Tandem gait	Patient is wearing gait belt and stands along a 10 foot taped line on the floor. Therapist holds belt with contact guard assist	D1: Patient walks along the length of the taped line, with each foot placed on its perspective side of the line.	P1: Decrease distance between foot placement P2: Alternating feet placed on the taped line

*****D1, D2, etc. describe the different methods used to complete the exercise. P1, P2, etc. describe the different progressions used to make each exercise more challenging.

Outcomes

After 15 visits over approximately 8 weeks, the patient had sufficiently achieved his goals, reached full independence with activities of daily living, and thus was discharged from physical therapy. He was instructed to continue with his HEP. The objective measures assessed at the initial evaluation were repeated at discharge. The detailed results of these measures are summarized in Tables 2, 3, and 4. The patient's hip strength improved bilaterally, but ankle strength gains were only seen in the right lower extremity. The MDC for the ODI is 5 points, or 10%.[7] Thus, the patient made clinically meaningful improvement in his reported ODI measures, improving from 15 to 4 (30^{th} % to 8^{th} %). Further, the FSBT improved across 3 of the 4 stages, with the feet together stage being limited by a ceiling effect. Since the patient was able to hold tandem stance for ten seconds, he was not considered to be at risk for falls at discharge.[8]

Outcome measures that could have been assessed, but were not used due to time constraints include the Berg Balance Scale (BBS) and the Functional Gait Assessment (FGA). Both of these would have been applicable based on the patient's reported impairments. The BBS is comprised of 14 balance activities, and the FGA has 10 ambulation activities. Both of these measures require a fair amount of items to assess, limiting their usefulness in our clinic with 30 minute appointment blocks. Accordingly, we chose outcome measures requiring less time to administer to ensure that we would have enough time for treatment in our sessions.

Over the course of 8 weeks, improvements were seen in balance, strength, and perceived disability as evidenced by the MMT, FSBT, and ODI results. According to the ODI classification system, the patient was considered in the moderate disability category at the beginning of treatment.[7] At discharge he met the designation of minimal disability.[7] Since he was able to hold a tandem stance for at least 10 seconds, he was no longer considered at risk for falls according to the FSBT.[8] Improvements were not seen in ROM or strength in the left ankle, though motor control gains were qualitatively observed with PNF exercises. The lack of progress made with the left ankle was attributed to residual neuropathy secondary to chronic stenosis.

The most pertinent improvements made throughout the course of treatment were in activities of daily living. First and foremost, the patient's goals centered around improving ambulation and fall risk. At the beginning of treatment, the patient was using a walker and wheelchair. At discharge the patient was using a single point cane in the yard and community, and was no longer using an assistive device for household ambulation. He also reported that he was rarely experiencing losses of balance due to tripping over rugs, something that happened frequently before beginning physical therapy. Lastly, the patient stated that he was able to return to his previous hobbies of walking around his acreage, performing yard work, and chopping wood.

Table 2 Manual Muscle Testing for Lower Extremity Strength

	Initial Eval		Re-eval - 4 weeks		Discharge – 8 weeks	
Movement	Right	Left	Right	Left	Right	Left
Hip flexion	4+/5	4+/5	5/5	5/5	5/5	5/5
Hip extension	4+/5	4+/5	4+/5	4+/5	5/5	5/5
Hip abduction	5/5	5/5	5/5	5/5	5/5	5/5
Knee flexion	5/5	5/5	5/5	5/5	5/5	5/5
Knee extension	5/5	5/5	5/5	5/5	5/5	5/5
Dorsiflexion	4/5	4/5	4/5	4/5	5/5	4/5
Plantar flexion	4/5	2/5	4/5	2/5	5/5	2/5

Table 3 Oswestry Disability Index

Results	Initial Eval	Discharge – 8 weeks
ODI score	15	4
ODI percentage	30	8

Table 4 Four Stage Balance Test Durations

Stances	Initial Eval	Discharge – 8 weeks
Feet together	>30 sec	>30 sec
Semi tandem	15 sec	>30 sec
Tandem	5 sec	10 sec
Single Leg	<1 sec both legs	5 sec R leg/ 3 sec L leg

Discussion

The purpose of this case study was to describe a treatment protocol for a patient who had recently underwent a lumbar decompression surgery, with a relatively successful outcome. The initial treatment strategy was aimed at improving the patient's deficits in ankle ROM, ankle motor control, and hip strength. After the 4 week progress assessment, the treatment strategy shifted focus to gait training, dynamic balance, and functional activities. The initial grouping of interventions did not yield dramatic progress towards the patient's functional goals. However, these treatments may have helped provide a basis to prepare for the more functional challenges later on. This case highlights the value of a patient-specific plan to optimize function even after surgical intervention.

Diagnoses of LSS can present with vastly different presentations. For instance, imaging may reveal severe stenosis when a patient is asymptomatic, or vice versa. About half of patients with LSS will have a stable presentation of symptoms, neither worsening nor improving.[11] The patient presented in this case study fell into this grouping. Before seeking treatment, he was functionally independent for years, and his LSS symptoms were sufficiently managed. It wasn't until a fall occurred that surgical intervention needed to be considered. This highlights the decision-making process that should be utilized when treating a patient with LSS. This patient, like many others, likely had long-standing structural changes throughout his lumbar spine. Structural pathologies like central stenosis, disc herniation, facet arthropathy, and ligamentum flavum hypertrophy were all found on his magnetic resonance images following the fall. Most, if not all of these abnormalities are associated with long term degenerative changes, and were likely present before the fall.[11] This shows that not all structural pathologies require surgical intervention. However, an exacerbation that prevents LSS symptoms from returning to baseline, in this case a fall from a stool, may necessitate a consideration for surgery.

The optimal treatment for lumbar spinal stenosis is still open for debate. A Cochrane review done by Patel et al[1] supported both conservative treatment, and minimally invasive decompression surgery for LSS. However, a study done by Fritz et al[9] showed that physical therapy may prevent, or at least delay the need for surgery. The results of this study revealed that patients who received physical therapy for chronic LSS with neurogenic claudication were less likely to undergo surgery within one year compared to those who did not. Despite that, there is also evidence that supports surgery over conservative management. A study conducted by Atlas et al[10] showed at 10 year follow up, the patients who underwent surgery had improved function, relief of leg symptoms, and satisfaction compared to those treated non-surgically. Although, the results also showed that disability and return to work were similar regardless of the treatment provided, suggesting not all outcomes are equally responsive to surgery.

The fact of the matter is that both surgical, and physical therapy management of LSS are viable options for treatment. What is more pertinent to this case study is the combination of surgery with post-operative physical therapy. A Cochrane review done by McGregor et al[1] demonstrated moderate quality evidence of post-operative active rehabilitation managed by a physical therapist being more effective than simply postoperative advice and programs for preventing deep vein thromboses. Specifically, in a geriatric population of individuals with LSS, one study found postoperative physical therapy involving functional ambulation training reduced pain and increased independence in patients.[4] While there is limited research in this area, there is some evidence supporting the use of supervised physical therapy following surgical treatment of LSS.

This case was further complicated by the past medical history resulting in ankle impairments that were not readily resolved. However, the patient was otherwise relatively healthy. It is likely that other co-morbidities or LSS-related impairments may be present for many patients with LSS who undergo surgical intervention. Accordingly, there is not likely to be one approach that will prove effective for all patients with this condition. However, as demonstrated in this case, combinations of strengthening, balance, and functional activities have good potential for assisting patients in regaining function and achieving their rehabilitation goals.

Conclusion

This case study highlighted the strategies used to treat a patient who underwent a lumbar decompression surgery following years of managing chronic LSS. This patient was no longer experiencing the intense pain that was present before the surgery, but the lower extremity weakness and motor control deficits remained. The intervention strategies targeted balance deficits, gait training, lower extremity endurance and strength, and ankle motor control. Outcome measures and balance assessments revealed improvement in perceived disability and fall risk. Improvement in ambulation was also observed, and an assistive device was no longer needed for household ambulation. However, gait improvement could not be adequately assessed due to lack of specific outcome measures. Further research on specific treatment protocols for patients status post lumbar decompression surgery is warranted to determine which interventions would provide the most benefit to this patient population.

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