The Use of a Modified Treatment Based Classification System to Treat an Adolescent with Imaging Evidence of a Herniated Disc

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ABSTRACT

Background and Purpose: According to recent research, lumbar disc herniation in the adolescent population is extremely rare and accounts for only 0.5% to 6.8% of total disc herniations. The link between the use of pathology or a treatment based classification approach for guiding treatment has yet to be determined in an adolescent population. The purpose of this case study was to address how a modified treatment based classification system was used for guidance of determining interventions for an adolescent patient with a herniated disc.

Case Description: The patient was an adolescent male, aged 17, with low back pain and a documented herniated disc at L5-S1. No centralization occurred with repeated lumbar movements, however, he had positive results for the straight leg raise and slump test.

Intervention: The patient was instructed in neurodynamic exercises including a straight leg raise activity with progression to a slump stretch, along with a lumbar stabilization program.

Outcome: This patient attended 13 physical therapy visits over an 8-week period. He showed a clinically meaningful change in the Oswestry Low Back Disability Questionnaire, ROM for the straight leg raise, the SF-12, and pain intensity rating.

Discussion and Conclusions: Use of a treatment based classification system for an adolescent patient with a known herniated disc seems to be appropriate treatment based on the outcomes of this case report. Further research is needed to determine if this type of rehabilitation would be beneficial for a larger group of adolescents with low back pain.

Key Words: *low back pain, Oswestry Disability Questionnaire, treatment based classification, herniated disc*

INTRODUCTION

Low back pain is the fifth most common reason adults require physician visits in the United States.[1] At some point in time, 80% of the general adult population will experience some type of low back pain.[2] In adults, the causes of low back pain are hypothesized to include muscle strain, tendonitis, mechanical low back pain, herniated disc, and facet dysfunction.[2] In regards to the adolescent population, low back pain can potentially be caused by muscular, ligamentous, infectious, or congenital pathologies of the lumbar spine.[3] A collection of signs and symptoms including back pain, scoliosis, and motor and sensory deficits are usually first considered as a sign of neoplastic disease in adolescents.[3] However, if trauma or intense sports precipitates the complaint of low back pain and sciatica, a herniated disc may be the cause. According to recent research, lumbar disc herniation in the adolescent population is extremely rare and only accounts for 0.5% to 6.8% of total disc herniations.[3]

Pathology based treatment models rely on the identification of underlying pathology potentially causing low back pain to dictate treatment.[6] A specific example of a pathology based model is treatment that is based on hypothetical disc movements. In vitro and in vivo studies[7-9] have shown that lumbar extension causes an anterior migration of nuclear tissue, while flexion causes a posterior displacement of the nuclear tissue. Lumbar extension exercises may also reduce pain by decreasing the forces acting on pain sensitive tissue. Lumbar extension can transfer a compression force from the intervertebral disc and vertebral body to the apophyseal joint reducing nuclear pressure.[10] These biomechanical findings have been the basis for the use of lumbar movements, especially lumbar extension, during rehabilitation to reduce low back pain.

Several treatment based classification models have emerged that de-emphasize the importance of basing treatment on hypothetical lumbar disc responses.[11,12] These treatment approaches incorporate movement assessment with the goal of provoking a pattern of response to pain called centralization. Centralization is a phenomenon that occurs when symptoms move from a distal to proximal location during repeated lumbar flexion and extension movements. It is then recorded which direction of movement causes centralization to occur, this is a patient's directional preference.[12] For example, if a patient's pain were to centralize with flexion, a patient would be prescribed flexion based exercises, avoidance of extension exercises, and possible use of unloading exercises including aquatic therapy and de-weighting treadmill training. Treatment based classification models do not only include the identification of centralization because not all patients experience this phenomenon.[11,14,15] Currently there is evidence for several treatment classification subgroups of patients with acute and subacute low back pain, including patients likely to benefit from manipulation, lumbar stabilization, directional exercise, and traction.[14,15] Other potential patient subgroups for LBP include lumbar spinal stenosis and neural tension.[14,19]

Research on classification systems has been completed almost exclusively on adult participants, with a common age range of 30 to 60.[6,16] A recent article by Clifford and colleagues[17] was performed to see if childhood and adolescent patients could be classified using 4 categories from a previously described treatment based classification model. The most common classification for low back pain was specific exercise in adults,[16] however, with adolescents the most common classification was immobilization.[17] It is important to note that this study of

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adolescents addressed only classification of patients into a subgroup and did not look into specific interventions and their outcomes.

Children and adolescents who present with low back pain often have an underlying pathological cause.[4] It is important for the pediatric patient to undergo a careful and thorough patient history and physical examination with those results guiding appropriate diagnostic imaging studies.[1] In contrast, it is more common for low back pain to be of nonspecific causes for adults. Adult patients with severe low back pain often have no identifiable pathology. In an article by Jensen et al,[5] 98 asymptomatic adults received an MRI to determine the prevalence of abnormal findings in the lumbar spine. Of these 98 individuals, over half revealed a disc bulge at an intervertebral disk and about a quarter revealed at least one disk protrusion. Similar studies documenting false positive rates of imaging findings have not been completed in adolescent samples, so the appropriateness of treatment based classification with evidence of pathology is still open to debate for adolescents. Therefore, the purpose of this case study was to address how a modified treatment based classification system was used for guidance of determining specific interventions for an adolescent patient with a herniated disc.

CASE DESCRIPTION

History

The patient was a 17-year-old male who reported a one year history of low back pain before his initial physical therapy visit. This patient reported that the pain began following a camping trip with the boy scouts, where he pulled a tree stump out of the ground. Specifically, the patient stated that his primary complaint was sharp pain that travels down the left posterior thigh and can occasionally travel into the left calf. This patient also had an increase in pain with prolonged postures, including sitting for periods of 1 hour or longer and/or standing for longer than 30 minutes. The patient reported an exacerbation of the sharp pain in the left posterior thigh and low back symptoms following an increase in physical activities approximately 3 weeks prior to his initial physical therapy visit.

For this condition, the patient has had 3 epidural treatments and 2 magnetic resonance imaging studies, with the most current being 2 months prior to his initial evaluation. The most current MRI reveals a loss of height with a small central disc herniation at L5-S1, which impinges slightly on the central left S1 nerve root. The MRI also reveals that the anterior to posterior diameter of the lower lumbar canal is mildly small due to congenitally short pedicles.

Initial Impression

Based on this patient's past medical history and subjective report, it was our original hypothesis that because of the presence of a herniated disc, centralization would occur with repeated lumbar motions and the patient would be given interventions based on his directional preference. However, since this patient showed no strong directional postural preference in his subjective report, other options for treatment, including neurodynamic exercises and lumbar stabilization, may have to be considered if no centralization were to occur.

Examination

The patient was initially given a health questionnaire prior to the beginning of the examination to screen for red and yellow flags. Red flags are possible serious systemic diseases that may be contributing to the patient's pain and can include cancer, infection, and fracture. Yellow flags are any social or psychological distress that may prolong the patient's condition. No remarkable findings were noted with regards to red and yellow flags with this patient.

The patient completed a modified version of the Oswestry Low Back Disability Questionnaire (ODQ) as part of his initial examination. The patient's initial score on the modified ODQ was 26 out of 100 total points (26%). The patient was also asked to rate his pain based on the numeric rating scale for pain. This scale asks the patient to rate his/her pain intensity on a numeric scale from 0 ("no pain") to 10 ("worst pain imaginable"). At initial evaluation, this patient rated his average pain intensity at 6/10.

Examination of this patient was structured to start with single and repeated lumbar motions to determine the patient's directional preference. Single range of motion (ROM) movements were observed first. In standing, the patient was asked to perform trunk flexion, extension, right and left side bending, and right and left rotation. Trunk flexion and extension both reproduced patient's pain in the left posterior thigh, however, this did not return to baseline. Specific range of motion measurements were not assessed secondary to the evidence that suggests that lumbar ROM has a weak correlation with overall disability in patients with low back pain.[18] Following single movements, the patient was asked to perform repeated movements for flexion and extension (10 repetitions of each direction). Repeated flexion and extension had no effect on the patient's pain. Since the repeated lumbar motions had no effect on the patient, directionally based exercises would not likely benefit the patient at this time and alternate hypotheses were explored.

Due to the fact that this patient reported no improvement or change in his symptoms with repeated lumbar motions, further neurological and neurodynamic testing was performed. The rationale for this examination strategy was based on a case series by George[19] and a randomized trial by Cleland and colleagues,[14] who reported that patients with leg symptoms who did not respond to repeated lumbar motions and exhibit positive neurodynamic test may benefit from neurodynamic stretching techniques. For this patient, neurological testing revealed equal and intact bilateral patellar and Achilles tendon reflexes. Light touch sensation was also intact and equal bilaterally for lower extremities. Neurodynamic testing was performed, including the straight leg raise (SLR) test and slump test. A neurodynamic test is considered positive if the patient's symptoms can be reproduced or if the response on the involved side differs from the uninvolved side.[20] The SLR test has been documented as an important test for diagnosis of lumbar disc herniation and nerve root inflammation.[20] A SLR test was performed on bilateral lower extremities, which revealed a positive test on the left (reproduction of patient's pain at 30°). For outcome purposes, the range of motion obtained during the straight leg test was documented. The right straight leg raise was measured at 80°, and the left straight leg raise was measured at 30°. The slump test has been used in the literature to assess the peripheral nerves of the lower extremities, along with neural structures in the spinal canal and the connective tissues.[20] Slump testing was also performed on bilateral lower extremities, with a positive test on the left.

Flexibility testing, manual muscle testing of the trunk and lower extremities, and lower extremity range of motion were all evaluated. Bilateral ROM and MMT of bilateral lower extremities were also performed to address any deficits that may be contributing to this patient's low back pain. Specific grades for the muscle groups with a deficit and results of flexibility testing are listed in Table 1.

EVALUATION

Diagnosis

Our original hypothesis of a centralization phenomenon related to the pathology of a herniated disc was not supported by our examination findings. It was our clinical opinion that although lumbar pathology was present in this patient, he was unlikely to benefit from directionally based exercise treatment at this time. We further examined the patient to look for limitations that would allow us to tailor a specific exercise program for this patient. Based on research by Cleland and colleagues[15] in adults, patients that did not respond to repeated lumbar movements and had positive neurodynamic tests would likely benefit from a neurodynamic stretching program. Therefore it was determined that this patient best fit into a subgroup of patients that would benefit from neurodynamic stretching despite the presence of a herniated disc. This patient would undergo therapy to address the alterations in neurodynamic activities along with a stabilization program to address muscular strength deficits and prevent reoccurrence. Research by Clifford[17] has shown that adolescents with low back pain are most likely classified into a lumbar immobilization group with a focus on trunk strengthening and stabilization. Despite the lack of obvious signs for lumbar instability in this patient, it was our opinion that this would be a beneficial addition to prevent reoccurrence of low back pain.

Prognosis

According to the literature, the natural progression of low back pain is positive. Due to the lower prevalence of low back pain in adolescence, there is a lack of evidence supporting the prognosis of low back pain in adolescents. In adult patients, studies have shown that 30% to 60% of patients will recover from low back pain in 1 week, 60% to 90% will recover within 6 weeks, and 95% will recover within 12 weeks.[21] Based on our clinical opinion of this patient's age and symptoms along with our clinical experiences with other patients, it was recommended that this patient would likely require 4 to 8 weeks of therapy twice a week. Throughout this patient's episode of care, this patient was re-evaluated to monitor his progress and correctly re-categorize if necessary.

INTERVENTIONS

This patient was seen in the physical therapy clinic for 13 visits over a 6-week period. Interventions included stretching, neurodynamic techniques, and lumbar stabilization. These interventions were chosen based on the patient's deficits in muscle length, neuromobility, and core strength found upon examination. Following the evaluation, stretching and neurodynamic techniques were taught to the patient as his home exercise program. Initial stretching activities, to improve muscle length, included a prone quadriceps stretch, a supine hamstring stretch for the right lower extremity only, and a bilateral knee to chest stretch for the lumbar spine. These exercises were to be performed 3 times each for a 30-second hold, 3 times a day. This patient was first shown a slump stretch in seated position to improve neuromobility; however, he was unable to tolerate this position secondary to pain. Another neurodynamic technique was shown to the patient to replace the slump stretch. For this technique, the patient was in a supine position on the plinth. This patient was given a stretch strap to place around the foot and by use of bilateral upper extremities, the patient performed a passive straight leg raise on the left until his pain symptoms were reproduced. The patient was then told to lower the leg until symptoms subsided and perform a small 'pumping' motion, moving the leg slowly up and down in about a 5° range for 30 seconds. This exercise was to be performed twice for 30 seconds once a day. At the patient's second visit, the current home exercise program was reviewed. The patient was instructed to continue with all of the prescribed exercises and a basic lumbar stabilization program was initiated (Table 2). These specific trunk strengthening exercises were performed by the patient from visits 2 to 4 with supervision and cueing for correction of form. Upon the fifth visit, a reassessment was performed on the patient. Pain of the lower extremity had moved from a distal location to a more proximal location. The pain in the posterior thigh had diminished significantly and the straight leg raise exercise for neuromobility no longer reproduced patient's pain. The patient was instructed in slump stretch activity, as a progression of neuromobility. In a seated position at the edge of the plinth, patient's starting position was a correct upright posture. The patient instructions for the slump stretch were as follows: "slump into bad posture, next bring your chin to your chest, then straighten out left leg, return to upright posture." The patient was instructed to repeat this exercise for 20 repetitions, twice a day. Due to the patient's improving symptoms, progression of the lumbar stabilization program also occurred on visit 5 (Table 2). These exercises were to target the spinal extensor muscles, multifidus, rectus abdominus, and the obliques. The patient continued with the lumbar stabilization program and slump stretching for visits 5 through 8. At visit 9, progression of the lumbar stabilization program occurred again based on the patient's improving abilities (Table 2). Included in this group of exercises was the side support exercise,[22] shown by intramuscular EMG to be the most effective training method for the abdominal wall. This exercise has been incorporated by Brennan et al[23] in clinical testing and has shown to be an important exercise for lumbar stabilization.

OUTCOMES

For this patient, the primary outcome measures were the Oswestry Low Back Disability Questionnaire (ODQ) and the straight leg raise measurement. The

Table 1. Examination Findings

Muscle Group	Manual Muscle Test Grade	Flexibility Test	Result
Abdominals	3/5	Thomas Test	Positive
Quadratus lumborun	4-/5 (bilateral)	Ely's Test	Positive
Trunk Extensors	3+/5	Ober's Test	Negative
Trunk Rotators	4-/5 (bilateral)		

secondary measures include the SF-12 and the patient's pain intensity ratings. The primary measures were taken on visit 1, visit 8, and visit 13. Results reported on the Oswestry questionnaire have been reported to have high test-retest reliability (r = 0.99).[24] The patient's scores on the ODQ are reported in Table 3. In the literature, a minimal clinically important difference (MCID) is often reported for a standardized assessment to determine whether a significant change has occurred and for the ODQ the MCID is a 6-point difference.[24] This patient reported a 10-point change at each assessment so clinically meaningful changes were reported. At initial evaluation, a straight leg raise measurement was taken of bilateral lower extremities. According to the literature, there is high intra-rater (0.83) and inter-rater reliability (0.77) for measuring range of motion of the straight leg raise with a goniometer.[25] The patient's measurements for the straight leg raise are reported in Table 3. According to the literature, a meaningful clinical difference (MCD) for measuring the straight leg raise is greater than 12°[26] and our measurements demonstrated a change of 40°, which indicates a clinically meaningful change occurred. Along with an increase in the range of motion, an important distinction was that the straight leg raise no longer reproduced the patient's pain in the posterior thigh at the end of therapy.

Secondary measures included the SF-12 and the patient's pain level ratings. These secondary measures were taken at initial and final visit (Table 4). There is no current literature on the reliability of the SF-12, however, there is research on the reliability on the SF-36. Since the SF-36 and the SF-12 are scored in the same fashion, for this case study data from the SF-36 was used to describe our outcomes with the SF-12. The physical functioning portion of the questionnaire has been reported to have a reliable internal consistency, reported as a Cronbach's alpha (0.93).[27] The SF-36 is reported to have a standard deviation of 10.[27] A MCD can be calculated with the use of the standard deviation and the reliability coefficient. A MCD for the SF-36 would be 7.31. Our patient in this case study had a difference of 15.5, this would be considered a meaningful clinical difference.

From initial evaluation to this patient's final visit, the percentage of decrease in his current pain report was 100% (Table 4). According to recent literature, it has been documented that a minimal clinically important difference when referring to the numerical rating scale is 20%, regardless of the initial severity of the pain.[28] At initial evaluation, this patient was unable to sit for a long period of time, stand for a long period of time, and was unable to tie his shoes without reproducing his pain symptoms. At his final visit, he reported being able to sit or stand for an extended period of time without pain and was able to bend and tie his shoes without pain as well. Strength improvements also occurred in this patient from initial evaluation (Table 1) to the final evaluation. At his final visit, this patient had an increase in all muscle groups tested initially, with the final manual muscle grades measuring 5/5 for all tested muscle groups.

DISCUSSION

Debate about the most efficient way to treat low back pain has existed for a long period of time in physical therapy. The primary treatment models have been pathology based and classification schemes. In recent years, research has shown that the treatment based classification model can be successfully used in adult patients with low back pain regardless of the underlying pathology.[11] Patient with low back pain who are blinded to the knowledge of their pathology have shown no difference in outcomes compared to the patients who know about the pathology.[29] Also these patients show significantly higher general health scores when blinded to the knowledge of underlying pathology.[29] It is important to note that imaging is important for a patient that presents with red flags during the examination and evaluation portion of a treatment session. In this group of patients, it is important to rule out a more serious underlying pathology that may be contributing to this patient's pain.

However, in adolescent patients a link between pathology and the appropriate basis for treatment has yet to be documented in the literature. In our case study, the patient had a known pathology of a herniated disc and it was our original hypothesis that this patient would experience relief with either repeated lumbar flexion or extension. The pathology model concerning a herniated disc has shown that lumbar extension exercises can be beneficial in relieving pressure on the disc and therefore, pain in the low back. However, this patient experienced no relief from repeated lumbar movements, thus justifying another approach.

Based on a case series by George[19] and a randomized trial from Cleland et al,[14] adult patients with symptoms that do not change with repeated lumbar movement benefit from neurodynamic techniques. It was our belief that this type of treatment could be successfully used with an adolescent even with a herniated disc, after clinical determination that there was no nerve root compression or other neurological signs that would provide contraindications to stressing the neurological tissue.

Table 2. Interventions

Exercises (visit 2-4)	Repetitions	Exercises (visit 5-8)	Repetitions	Exercises (visit 9-13)	Repetitions
Posterior Pelvic Tilt	3 sets of 10 repetitions	Quadruped alternating arm and leg	2 sets of 20 repetitions	Prone over therapy ball alternating arm and leg	2 sets of 20 repetitions
Bridging	3 sets of 10 repetitions	Quadruped multifidus exercise	2 sets of 20 repetitions	Supine on therapy ball, alternating lift of lower extremities	2 sets of 20 repetitions
Supine alternating arm and leg movement	3 sets of 10 repetitions	Abdominal Crunches	3 sets of 20 repetitions	Supine bilateral leg lowering	3 sets of 10 repetitions
Stretches (hamstring, quadriceps, lumbar spine)	30 second hold, 3 repetitions	Trunk rotation	3 sets of 20 with 17 pound weight	Trunk rotation	3 sets of 20 with 20 pound weight
		Supine Unilateral Leg Lowering	3 sets of 10 repetitions	Side Support Exercise	30 second hold, 3 repetitions

Table 3. Primary and Secondary Outcome Measures

Primary Outcomes	Visit 1	Visit 8	Visit 13	Difference Visit 1 to 8	Difference Visit 8 to 13
ODQ	26%	16%	6%	10%*	10%*
SLR (Right)	80°	85°	85°	5°	0°
SLR (Left)	30°	70°	80°	40°*	10°
Secondary Outcomes	**Visit 1**		**Visit 13**	**Difference Visit 1 to 13**	
SF-12 (physical functioning)	37.3		52.8	15.5*	
Pain Level Ratings	6/10		0/10	100%*	

*Clinically meaningful change occurred based on MCID values
ODQ – Oswestry Low Back Disability Questionnaire
SLR – Straight Leg Raise MCID for ODQ = 6 points MCID for SLR = 12.56°
MCD for SF-12 = 7.31 points MCID for pain level rating = 20%

It should be noted that this patient required a modification of this stretch as an initial exercise secondary to pain and eventually progressed to the use of a slump stretch. It should also be noted that we did combined rehabilitation techniques for neuromobility and lumbar stabilization. It was our opinion that a combination of these 2 techniques would be most beneficial for a patient this age. Supporting this opinion was previously mentioned neurodynamic exercise articles by Cleland[14] and George,[19] along with the article by Clifford,[17] which reported that adolescents with low back pain were most often classified into the lumbar immobilization group with a focus on lumbar stabilization and strengthening. The lumbar stabilization exercises to target the spinal extensor muscles, multifidus, abdominals, and obliques were chosen for this patient based on previous clinical experience.

Based on the findings of this study, this author would use a treatment based classification system to guide interventions and rehabilitation for an adolescent with low back pain. Once red flags have been ruled out, the use of neurodynamic exercises in combination with a lumbar stabilization program appeared to be a safe and effective treatment progression. This type of classification system allows for a tailored intervention program to be developed based on an individual's presenting symptoms. We think it may be important to incorporate a lumbar stabilization program for all adolescent patients for prevention of the development of chronic low back pain.

Based on the meaningful changes in the primary and secondary outcomes with this patient, the use of a modified classification approach for treatment of an adolescent with low back pain and leg symptoms may be a viable way to guide interventions, however, we lack the proper study design to make definitive treatment recommendations. Further research is needed to determine if there is a link between pathology and treatment for adolescents with back pain or if a classification system can be used to guide treatment for adolescents regardless of pathology. This author proposes a study with a large group of adolescents with the chief complaint of low back pain. All adolescents would undergo diagnostic testing to determine whether specific pathology of a herniated disc existed, and to rule out serious underlying pathology that would exclude them from physical therapy treatment. The patients would then be randomly assigned to 1 of 2 therapists. The therapists and patients would be blinded to the fact of whether a herniated disc was or was not present, similar to the Modic et al[29] study previously cited. The therapists would then classify the patient's based on either a directional preference during repeated lumbar movements or no preference to repeated lumbar movements and a positive slump test. Based on the patient's classification, the patients would undergo matched intervention programs for an 8-week episode of care. At the end of the 8-week period, the patients would be analyzed to determine the effects of the therapy provided and analyzed to compare the effects on patient's with a known pathology of a herniated disc and patients without pathology. Follow-up imaging will also be done to determine is existing pathology showed advancements. The primary outcome measures for these patients would be the Oswestry Low Back Disability Questionnaire, pain level ratings, and the SF-12. Follow-up for the treatment would also take place at 1 month and 6 months following treatment, to determine the long-term effects of treatment on the patients.

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