Classification-based approach for management of an adolescent with LBP, lower extremity pain, and a relevant postural deformity

Jason Dudzic¹, Brett Szymusiak¹, Hannah McCormick¹, Eric R Miller²

¹Hamot Medical Center, Orthopaedic Institute, Erie, PA, USA, ²D'Youville College, Buffalo, NY, USA

A 15-year-old female presented to physical therapy 2 months after a traumatic injury with severe low back pain, referred unilateral leg pain below the knee, and a lumbar lateral shift. A classification-based approach, mechanical diagnosis and therapy, was utilized to identify the patient with respect to a particular subgroup, and interventions were applied according to symptomatic response to loading strategies, sustained and repeated movements. Outcome measures included the Modified Oswestry Disability Questionnaire (MODQ) and a visual analog scale (VAS) for pain rating. After nine visits (4 weeks), there was a 60% improvement in MODQ score, 0/10 pain on the VAS, and the patient resumed participation in recreational activities. At the 1-year follow-up, there was a 78% overall improvement in MODQ score with continued 0/10 rated pain. Improvements after nine visits and at the 1-year follow-up both exceeded the minimal clinically important difference for the MODQ.

Keywords: Adolescent low back pain, Classification-based treatment, Lumbar lateral shift, Repeated movements

Introduction

While classification-based systems have been used with varying success in the adult low back pain (LBP) population, little research has been conducted to describe the non-surgical management of adolescents with LBP. Leboeuf-Yde and Kyvik¹ reported that the incidence of LBP increased greatly in the early teen years, and by the ages of 18 years (female) and 20 years (male), more than 50% of this population had experienced at least one episode of LBP. Parisini *et al.*² reported that 2.5% (129 subjects) of cases undergoing discectomy in their practice were aged 9–18 years, with only 0.01% (19) of those patients having received physical therapy before surgery. Similar findings³ were found with low referral rates to physical therapists for children and adolescents with LBP when compared to adults, concluding that further research is needed to examine the referral patterns of this population. These findings support the need for study of the causes, prevention, and treatment in childhood and adolescent populations.

Lumbar disc pathology in patients under 20 years of age is thought to represent between 1.3 and 3.2% of all lumbar pathology.^{4,5} Furthermore, current

management of adolescents with lumbar disc pathology appears to be guided by the results of diagnostic imaging. Although there are inherent limitations in the use of diagnostic imaging for the identification of symptomatic disc pathology, it seems that morphological spinal changes can be observed in children at an early age.⁶ As possible information bias regarding LBP and a degree of uncertainty about magnetic resonance imaging (MRI) metrics exist, associating the results of diagnostic imaging with clinical presentation, including observation of postural abnormalities, remains essential.

The field of physical therapy has made a dramatic shift away from the utilization of an injury or biomedical model of LBP, which focuses on pathoanatomic causes of pain, to classification-based systems. In a classification-based approach, a patient's signs, symptoms, and response to examination procedures supersede anatomic causes of pain. The patient's clinical examination findings are then categorized into defined subgroups, which dictate intervention strategies. Multiple classification-based systems have been proposed, and efficacy of these systems has been validated to varying degrees in adult populations.^{7–13} Interestingly, none of these systems have been investigated in an adolescent population. Clifford and Fritz³ provided a retrospective analysis

Correspondence to: Jason Dudzic, Hamot Medical Center, Hamot Orthopaedic Institute, Erie, PA, USA. Email: jason.dudzic@hamot.org

of adolescents treated in physical therapy who were classified based on adult classifications and found that there may be differences in the classification pattern between age groups. Currently, the only attempt to classify adolescents with LBP showed that the most common classification was immobilization, followed by mobilization, and finally specific exercises.³ However, the phenomenon of centralization has not been tested beyond sagittal plane motions in the adolescent population.

Mechanical diagnosis and therapy (MDT) is a system found to be a reliable method for properly trained examiners to classify adult patients with LBP into defined treatment categories.^{14,15} Examining repeated lumbar movements as utilized in MDT, Long *et al.*¹⁶ showed that patients who moved in the direction of symptomatic preference had significantly greater improvement than those who moved in the direction opposite their symptomatic preference. Such a preference, described as an immediate, lasting improvement in pain from performing repeated movements was first described by McKenzie.¹⁷ A phenomenon called centralization may be reported in the course of uncovering a directional preference. Centralization describes the phenomenon by which distal limb pain emanating from, but not necessarily felt in the spine, is immediately or eventually abolished in response to the deliberate application of loading strategies.¹⁸ Observing and interpreting centralization has been found to have both intra- and inter-tester reliability.^{14,15,19}

This case is unique in that the adolescent patient described, presented with a relevant lateral shift and lower extremity symptoms with lumbar disc pathology identified on MRI. Imaging results were obtained before the patient's consultation with the authors and merely supported the theoretical model of symptomatic disc pathology without affecting or directing her treatment. The purpose of this case report was to describe the non-operative management of an adolescent female with severe lumbar and lower extremity pain utilizing the MDT classification-based system.

Patient Characteristics

The patient was an active 15-year-old female high school student whose symptoms arose following a traumatic blow to her lower lumbar spine while playing ice hockey. She denied a prior history of LBP and described no significant medical or surgical history. Previous treatment of the patient included physical therapy at another facility approximately 2 months after her injury. This course of intervention included two visits per week for 3 weeks before the patient's referral to the primary and secondary authors of this case report for evaluation and

treatment. Her chief complaint was of right sided LBP, right posterior hip pain, and right posterior knee pain. The surgeon's documentation indicated that she demonstrated a positive straight leg raise test reproducing LBP and lower extremity pain. An MRI of the low back was ordered upon the initial visit with the surgeon.

Her MRI displayed a broad-based right paracentral and lateral recess disc protrusion at L5-S1 slightly displacing the right S1 nerve root in the lateral recess. It also revealed a diffuse annular disc bulge at L4-L5 with flattening of the thecal sac anteriorly without definite nerve root impingement. Diagnostic findings were used in this case report only to support the theoretical model of symptomatic disc pathology and did not affect the treatment or assessment of the patient. The initial physician's diagnosis of the patient included lumbar disc herniation.

The following was taken from documentation obtained from the facility where physical therapy was originally implemented; therefore, justification for examination and treatment was not provided in this paper. The physical therapist documented symmetrical strength in the patient's lower extremities but reduced lumbar lordosis. Owing to a significant loss of lumbar extension motion, the therapist determined that the patient required lumbar extension exercises; however, following the initiation of the approach, the intensity of her LBP improved but her symptoms peripheralized into the posterior calf, lateral ankle, and foot. Extension exercises were aborted and modalities for pain modulation, including moist heat and interferential electrical stimulation, were administered.

Following this initial course of physical therapy at another facility, the patient experienced an exacerbation of symptoms, noting severe difficulty standing erect after swimming the breaststroke. She underwent a transforaminal epidural injection but presented to the emergency department the next day with persistent severe pain. Surgical intervention was recommended by a neurosurgeon based upon the results of her MRI. She was also referred for physical therapy consultation with the primary and secondary authors of this paper (JD and BS), who are both credentialed in MDT. The authors had 7 and 5 years of experience, respectively, at the time the patient was managed.

Examination

Upon presentation to the authors' clinic, an MDT examination was conducted. The patient recounted that her spine was forced into extension and left lumbar side-bending when she was injured. A system review was not performed due to the traumatic

Figure 1 Posterior view demonstrates patient's left lateral shift in the frontal plane and lateral view demonstrates patient's lumbar kyphotic deformity in sagittal plane.

mechanism of injury and the absence of red flags, suggesting that the patient's signs and symptoms were mechanical in nature. Upon initial observation, the patient demonstrated considerable antalgia secondary to complaints of severe right sided lumbar and right posterior lower extremity pain to her knee. Neurological examination was unremarkable for the assessment of deep tendon reflexes, myotomes, and pathological reflexes; however, the patient's lower extremity pain appeared to follow the S1 dermatome. She verbally rated her pain from 4/10 at best to 7/10 at worst on the visual analog scale (VAS) (0–10 scale), an outcome measure shown to be a reliable indicator of pain perception.²⁰ The patient was also asked to complete the Modified Oswestry Disability Questionnaire (MODQ) at her first visit. This self-report outcome measure is shown to have high test–retest reliability in measuring disability related to LBP.²¹ Her pre-treatment score was 44/50 (88%), suggesting severe functional limitations and disability secondary to pain.

Postural assessment in standing revealed lumbar kyphosis and a left lateral shift (Fig. 1). Her active lumbar range of motion was markedly obstructed into side-gliding right and extension. McKenzie¹⁷ defines side-gliding as the combination of lumbar rotation and side-bending simultaneously. This movement is thought to produce a lateral shearing of the lumbar segments on the sacrum as opposed to the compressive and tensile forces created by a traditional side bend. McKenzie and May¹⁸ identified criteria for a relevant lateral shift. These criteria include: 'upper body is visibly and unmistakably shifted to one side, onset of shift occurred with back pain, patient is unable to correct the shift voluntarily, and if the patient is able to correct the shift they cannot maintain correction' (p. 614). Reliably identifying a lateral shift has been suggested to depend on the experience and training of the examiner.²² For

this reason, the incidence of relevant lateral shifts varies. Donahue *et al.*²³ showed poor reliability in determining the presence of a lateral shift; however, the therapists involved in their study did not report any postgraduate training in MDT. Others²² have reported moderate reliability in detection of lateral shifts when assessed by therapists trained in MDT.

Using the MDT criteria to identify the relevance of a lateral shift, it was determined that the patient's shift was, in fact, relevant and associated with her symptoms. The patient attempted self-correction of the deformity by side gliding right in standing, which resulted in immediate peripheralization of symptoms to the right lateral calf. Manual lateral shift correction in standing, as described by McKenzie¹⁷ was attempted; however, both patient-generated and therapist-generated shift correction resulted in peripheralization of symptoms to the lateral calf. Unable to reduce her distal-most symptoms in loaded positions, the examiner progressed to an unloaded assessment. According to McKenzie and May,¹⁸ 'the application of extension in the presence of the lateral deformity can significantly worsen or peripheralise symptoms. The lateral principle is always adopted immediately and repeated sagittal plane movements are not explored' (p. 615). Therefore, the patient was placed in right side-lying and was rotated to the left. The symptoms in her leg decreased in this position. A bolster was placed under her right hip to increase the side-glide force necessary for shift correction with less gravity-induced compressive force, as introduced in standing (Fig. 2A). After several minutes in this position, her leg symptoms abolished without return upon immediate standing; however, she noted return of only right sided LBP after five steps of ambulation.

Clinical Impression

Because of the patient's symptom location and presence of a deformity, she was classified in the MDT system as a lumbar derangement with unilateral/asymmetrical symptoms below the knee with a relevant lateral shift. McKenzie utilizes the term 'derangement' to describe abnormalities within the motion segment of the spine or bone-disc-bone interface.¹⁷ While the dynamic disc model is conceptually utilized to explain the derangement syndromes, in actuality, the syndrome is based upon examination findings and directional preference without regard to the disc or specific anatomical structures as the source of pathology.

Treatment rationale was guided by the patient's aforementioned classification. Intervention and progression within the MDT system was based on correction of the postural deformity and reducing or centralizing distal symptoms through the appropriate loading/unloading strategy. This was achieved

Figure 2 (A) Sustained lumbar rotation left with bolster under right iliac crest for side-glide right over pressure. (B) Lumbar extension in wedge position.

through identification of a directional preference using movements or positioning that incorporated lateral or asymmetrical forces as well as the eventual return to treatment in the sagittal plane.

Intervention

Direct physical therapy visits included a frequency of 1–3 sessions per week over a 4 week period. Positioning and repeated movements were utilized in

an attempt to correct a relevant lateral shift followed eventually by correction of lumbar kyphosis (Table 1).

At her first MDT visit, it was found that sustained rotation left with side-glide right overpressure with a bolster (Fig. 2A) abolished her symptoms and remained better upon return to standing. At her next follow-up visit, she reported that her right lower extremity symptoms centralized to her knee. The patient was able to achieve a prone over four pillows

Table 1 Summary of interventions

Visit	Signs/symptoms	Intervention (mobility phase)
1	<ul style="list-style-type: none"> ● Severe lumbar pain with RLE pain (distal to the knee) ● Acute lumbar kyphosis, left lateral shift 	<ul style="list-style-type: none"> ● Initial evaluation completed ● HEP: sustained rotation left (3–5 minutes, as much as possible) with right side-glide overpressure via bolster (Fig. 2A)
2	<ul style="list-style-type: none"> ● Acute lumbar kyphosis, left lateral shift ● Improved RLE symptoms 	<ul style="list-style-type: none"> ● Sustained lumbar rotation as previously described, followed by initiation of prone progression beginning with prone over four pillows
3	<ul style="list-style-type: none"> ● Lateral deformity corrected ● Abolishment of RLE pain even with ambulation and minimal LBP ● Lumbar kyphosis present 	<ul style="list-style-type: none"> ● Prone progression attempted in prone lying over three pillows ● HEP: sustained rotation followed by prone over pillows removing pillows over time
4	<ul style="list-style-type: none"> ● Acute lumbar kyphosis 	<ul style="list-style-type: none"> ● Prone lying with right hip flexed, abducted, and externally rotated (wedge position) ● Repeated extension in prone wedge position (Fig. 2B) ● HEP: prone wedge position (3–5 minutes, at least 4 × /day)
5	<ul style="list-style-type: none"> ● Acute lumbar kyphosis 	<ul style="list-style-type: none"> ● Lumbar strapping applied using tape in an 'X' shaped pattern across lumbar spine for flexion avoidance or lordosis maintenance ● HEP: repeated extension in wedge position (Fig. 2B) (10 × , at least 4 × /day)
6	<ul style="list-style-type: none"> ● Acute lumbar kyphosis 	<ul style="list-style-type: none"> ● Sustained lumbar rotation left followed by repeated extension in prone (pure sagittal plane) ● HEP: sustained lumbar rotation left followed by repeated sagittal extension in prone (10 × , at least 4 × /day)
7	<ul style="list-style-type: none"> ● Neutral lumbar spine 	<ul style="list-style-type: none"> ● Repeated lumbar extension in prone with patient overpressure (exhale while in end-range extension) ● HEP: repeated extension with patient overpressure (10 × , at least 4 × /day). Instructed to return to rotation if symptoms peripheralized
8	<ul style="list-style-type: none"> ● Lumbar extension motion restored 	<ul style="list-style-type: none"> ● Reassessed lumbar lordosis and extension range of motion ● HEP: continued extension exercises
9	<ul style="list-style-type: none"> ● 0/10 VAS pain rating at rest ● Only intermittent symptoms in the evenings ● Flexion/extension motion unrestricted ● No motion obstruction in side-glide 	<ul style="list-style-type: none"> ● HEP: repeated lumbar extension prone, followed by repeated lumbar flexion supine, followed by repeated lumbar extension prone (10 × each, 3–4 × /day)

Note: RLE: right lower extremity; HEP: home exercise program.

position immediately after performing sustained left rotation for approximately 5 minutes. She was able to achieve a prone flat position over approximately 30 minutes. She was instructed in sustained left rotation followed by prone progression for her home exercises. Prone progression began by placing pillows under the patient's abdomen in prone. The pillows were removed one by one as symptoms centralized until the patient was able to tolerate prone lying and subsequent extension in lying.

At her third visit (4 days later) the lateral shift had corrected; however, the acute lumbar kyphosis persisted. She no longer had right lower extremity symptoms and complained of central LBP. Her symptoms still peripheralized with any form of sagittal extension; therefore, her exercises at home remained unchanged.

At the fourth visit (6 days later), sagittal extension (including prone flat) peripheralized her symptoms. Consequently, she was placed prone with her right hip flexed, abducted and externally rotated (wedge position, Fig. 2B). This position uses the leg as a lever to provide left lumbar rotation with right side-bending. She was able to perform repeated lumbar extension in this position without pain. Repeated lumbar extension in the wedge position was given as her new home exercise program.

By her seventh visit (15 days since beginning MDT), she reported 75% relief of symptoms and her lumbar deformities completely resolved. She was able to perform sagittal extension in lying with patient overpressure (exhale at end-range extension) without pain.

The patient became pain-free with a resting, verbally reported VAS score of 0/10 at her ninth visit (26 days after beginning MDT), but noted mild pain in the evenings. She was able to perform recovery of function exercises, which included repeated supine flexion in conjunction with prone extension exercises. She completed the MODQ at this visit and scored 14/50 (28%), suggesting moderate disability.

Outcomes

After nine visits, there was a 60% improvement in MODQ score, 0/10 pain on the VAS, and the patient had resumed participation in recreational activities (Table 2). At 1-year follow-up by phone, the patient reported complete relief of symptoms with occasional central LBP produced by activities requiring sustained flexion; however, she was able to relieve these

symptoms with sagittal plane extension exercises. She returned to jogging for cardiovascular fitness without exacerbation of symptoms. She reported no limitation in any recreational activities. She was mailed a follow-up discharge MODQ, and at 1-year post-treatment her score was 5/50 (78% overall improvement and minimal disability). Improvements after nine visits and at 1 year both exceeded the minimal clinically important difference for the MODQ.²¹

Discussion

This case provides a detailed description of the assessment and management of an adolescent female with LBP and radicular pain utilizing the MDT classification system. The patient's previous treatment at another facility primarily consisted of passive modalities and impairment-based exercise prescription with limited outcomes and a recommendation for surgical intervention. Utilizing a classification-based approach the principle authors were able to classify this individual using a directional preference outside of sagittal plane motions. The improved patient outcome after assignment to a subgroup, which directed the intervention, was consistent with previous research comparing the benefits of classification-based treatment to standard care.¹⁰

In a retrospective review of the management of adolescents with LBP, Clifford and Fritz³ noted a large percentage of patients that were intolerant to lumbar extension and an absence of subjects demonstrating centralization or a directional preference to a specific exercise direction. While the patient described in this case was initially intolerant to extension, she was particularly unique in her presentation to physical therapy as an adolescent with a lateral shift and confirmed discogenic pathology. Her symptoms centralized and reduced with sustained positioning in an unloaded side-lying posture, which allowed for subsequent tolerance to extension exercises. To these authors' knowledge, the successful clinical management of an adolescent with a lateral shift deformity has not been reported in the literature.

A patient identified with a relevant lateral shift deformity is typically managed using shift correction techniques in a weight bearing position.¹⁶ Gillan *et al.*²⁴ found lateral shift correction in weight bearing, as described by McKenzie, to be effective in reducing pain and disability in an adult population. However, in this case report, the patient's intolerance to movements in the frontal plane in weight bearing

Table 2 Outcome measures and results during the 1-year follow-up

Self-report measure	Pre-treatment (visit 1)	Post-treatment (visit 9)	1 year
MODQ	44/50	14/50	5/50
VAS	4–7/10	0/10	0/10

necessitated the use of modified positioning in side-lying over a bolster, providing a progressive reduction in symptoms and correction of the deformity. Sallade²⁵ provides a description of the successful management of two patients using a variation on McKenzie's lateral shift correction technique unloading the patient's spine by having the patient hang from a bar while the shift correction was attempted. The premise for management of the patient in this case was similar in that by reducing compressive forces on the spine in a side-lying posture, correction of the spinal deformity was completed with less resistance and pain encountered by the patient.

Following correction of the lateral shift, an extension program was implemented. While the loss of extension range of motion and the intolerance to movements into extension in adolescents with LBP has been attributed to spondylolytic pathology,^{3,26} the subject of this case report had confirmed discogenic pathology with nerve involvement at the S1 level. Consistent with McKenzie's classification-based approach, lateral shift correction should precede the implementation of an extension progression and in this case, was associated with restoration of full pain-free range of motion.

The profession of physical therapy continues to refine classification-based systems and identify patient populations and subgroups of diagnoses that are most amenable to specific therapeutic interventions.^{7–14,27,28} Overwhelmingly, surgical intervention has been the accepted and recommended path for the adolescent population frequently based on diagnostic imaging alone. This case provides practitioners with a detailed description of the clinical decision making utilized to classify and manage an adolescent with LBP and lower extremity pain irrespective of the pathoanatomic diagnosis. Additional research investigating the conservative management of adolescent LBP is needed, with particular emphasis on recognizing centralization and peripheralization with respect to coronal and transverse plane movements and the utilization of various loading strategies.

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