Lumbar Disc Herniation with Abnormal Unilateral Radiculopathy: A Case Study

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Abstract

Lumbar disc herniations are one of the most common back injuries. Distal radiculopathies are common complications that accompany disc herniations, but in the case of this 19-year-old male collegiate cheerleader, his symptoms did not resolve with normal rehabilitation and healing time. His immediate treatment plan included traditional Mckenzie extension protocol with sciatic nerve glides as well as erector spinae, glute, and quadratus lumborum soft tissue releases for eight weeks, followed by two epidural steroid injections during his third month post-injury. Corrective strengthening exercises that targeted his core, glutes, and back muscles were completed for a total of twelve months, with a short break during the summer between academic years. He is currently seventeen months post-injury and can complete all activities of daily living (ADLs) without issue and only experiences small limitations when asked to hip hinge with a straight leg during activity. This case study aims to educate current and future orthopedic professionals about potential disc herniation complications and the treatment plan that helped this athlete live comfortably again.

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Introduction

The spine is designed to keep the human body vertical and serve as the intermediary between the lower and upper extremities. This requires a fine balance between strength and flexibility, so that movement can occur at each joint without sacrificing the stability of the whole body. Injuries such as disc herniation can occur when there is excessive force at a specific point along the spinal column, which can lead to neurological complications and possible surgical intervention. Manual injury evaluation by a certified athletic trainer or physician is sufficiently successful at diagnosing this ailment, and both surgical and non-surgical interventions have good long-term success rates (as measured by diagnostic tools such as the Lower Extremity Functional Scale [LEFS]).

Literature Review

Anatomy

The spine is comprised of thirty-three vertebrae and twenty-three intervertebral discs, which can be subdivided into five different sections: cervical, thoracic, lumbar, sacral, and coccygeal. The anterior part of each vertebra bears weight, and the posterior part protects the spinal cord.[1] Through the intervertebral foramen run the spinal nerves as they branch off of the spinal cord, each going to their respective distal locations.[2] In between each vertebra is an intervertebral disc, which has its own anatomy in order to act as an efficient shock absorber that allows the forces to be dispersed equally across each segment.[1] See Figures 1 and 2 for a detailed depiction of these structures.

Each disc has three parts: the outer, middle, and innermost lamellae. The outer lamellae, also known as the annulus fibrosus, is comprised of mostly type I collagen fibers that protect the rest of the disc from deep bending or twisting occurring between each vertebra.[3] The middle lamellae's texture changes with age; before age 35 it is more fluid-like, whereas afterward, it

becomes more fibrous to offer more protection against compressive forces.[4] The innermost lamellae, or the nucleus pulposus, is majorly composed of water and, therefore, the least dense of the three portions. This allows it to easily disperse the forces that are applied to it, but the structural integrity is low.[3,5]

Injuries to this area fall on a scale from mild to severe. A "bulging" and a "herniated" disc are different descriptors for the same ailment, in which the outer annulus fibrosus is partially or fully torn, allowing the gelatinous nucleus pulposus to be displaced and potentially apply unwanted pressure to the surrounding nerves.[6] The most common segments that suffer from a herniation are L4-L5 and L5-S1.[7] On the same vein, degenerative disc disease is a chronic condition where the height of one or many discs decreases over time, lowering its ability to absorb shock and disperse forces. This ailment is most common in individuals over the age of 50[8], but in my clinical experience as a certified athletic trainer, it can also be present in younger individuals who experience lots of stress on their spine in sports such as gymnastics or parkour.

The herniation of an intervertebral disc occurs as the result of compression or shearing at one segment of the spine, often with lumbar flexion or twisting (see Figure 3).[6,9] Disc disruption risk (degeneration, bulging, or herniation) is directly correlated with a patient's age. As the human body ages, the disc's fluidity and ability to disperse forces decreases, therefore increasing the risk for injury.[10] Brinjikji et al. found that 20-year-old patients only had a 37% chance of having disc degeneration, but 96% of 80-year-old patients met the diagnostic criteria. Similarly, the rate of bulging discs was 30% of the 20-year-old patients compared to 84% of the 80-year-old patients. Rates of disc protrusion followed the same trend, with only 29% of the 20-year-olds suffering from such an ailment compared to 43% of the 80-year-olds.[10]

Neurological Complications

Due to the mechanism of injury and proximity to the spinal nerve roots, subsequent neurological conditions are common in conjunction with a disc injury. Sciatica is a condition where specifically the sciatic nerve is compressed, causing burning, shooting, numbness, and/or tingling to shoot down the patient's leg along the dermatome distribution. It can be caused by tightness in the piriformis muscle, sacroiliac joint dysfunction, or in almost 90% of cases, it is caused by nerve root compression from a herniated disc. More unlikely causes for sciatica include stenosis of the lumbar canal or the vertebral foramen, as well as tumors or cysts. With positive neurological findings but negative structural findings (fracture or disc herniation), straightforward sciatica will likely resolve with rest and rehabilitation exercises. If symptoms persist after six to eight weeks of conservative treatment, imaging should be conducted to rule out a structural abnormality that could be causing the neurological symptoms.[11] It is important to be aware of such complications and include pertinent special tests in order to discover neurological deficits upon lower back examinations.

Injury Evaluation

Orthopedic evaluations traditionally begin with a detailed patient history, which starts to paint the picture of how the injury occurred and what the patient is experiencing. If they are suffering from a herniated disc, they are likely to report a superficial pain that remains in a pinpoint location, potentially accompanied by a "sharp, burning, or stabbing pain" that travels down the leg on the posterior or lateral side. In more severe cases, decreased distal motor or neurological function in the affected leg may be present as well. Difficulty with bladder or bowel movements is rare but possible with a herniation of the central S1-S2 disc. If these severe symptoms are present, emergency surgery may be warranted to prevent permanent deficiencies.[7]

The patient's pain is likely exacerbated with pressure applied to the damaged annulus fibrosus fibers, such as long periods of standing or sitting as well as twisting motions. This means that when their range of motion (ROM) is evaluated, they will likely report pain with lumbar flexion but not with lumbar extension. Side bending may illicit pain when flexing towards the contralateral side, with resolution when bending towards the ipsilateral side. Their gait may appear antalgic if they are experiencing distal motor dysfunction. Upon palpation, they should not have tenderness over their spinous processes but may feel discomfort when pressure is applied over the disc that is herniated. Muscle strength may be impacted, therefore their ability in each direction of their lower extremity should be scored on a scale of 0 (no contraction) to 5 (full resistance against gravity). Dermatome and myotome evaluations should be performed to further distinguish which nerve root is being affected. If red flags such as major trauma to the area, bladder or bowel dysfunction, and/or major neurological deficit are present, more severe ailments such as vertebral fracture, tumor, infection, or cauda equina syndrome should be included in the differential diagnosis.[7]

Specific special tests are designed to apply stress to certain body tissues in an attempt to recreate the patient's symptoms, and their effectiveness is evaluated in terms of sensitivity (a test's ability to identify a true positive diagnosis) and specificity (a test's ability to identify a true negative diagnosis). In the evaluation of the effectiveness of disc herniation special tests, Van Der Windt et al. found that the Straight Leg Raising test showed high sensitivity (pooled estimate 0.92, 95% CI: 0.87 to 0.95) but variable specificity (0.10 to 1.00, pooled estimate 0.28, 95% CI: 0.18 to 0.40) in those who were deemed surgical cases (incidence rate of disc herniation between 58% and 98%).[12] Similarly, Devillé et al. conducted a systematic review and found that the Straight Leg Raising test had a pooled sensitivity of 0.91 (95% CI 0.82–0.94) and a pooled

specificity of 0.26 (95% CI 0.16–0.38).[13] When compared to the Slump test, Majlesi et al. found that the Slump test had a higher sensitivity (0.84 versus 0.52 respectively), but the Straight Leg Raising test had a higher specificity (0.89 versus 0.83 respectively).[14] These numbers mean that these tests, when completed together, are overall found to be effective in diagnosing a herniated disc, but magnetic resonance imaging (MRI) is the gold standard to fully assess tissue damage.

Surgical/Non-Surgical Treatment

There are options for both conservative and surgical intervention to alleviate the symptoms of disc herniation. The biggest factors that contribute to this decision are the degree of disc disruption, coexisting neurological or muscular deficits, and the patient's response to conservative treatment. With a total patient population in the few hundred, the Maine Lumbar Spine Study, the Spine Patient Outcomes Research Trial (SPORT), and the Hague Spine Intervention Prognostic Study Group all found that early surgical intervention relieves a disc herniation patient's symptoms quicker than conservative care, but in the long-term, the outcomes are the same.[15–17] Kerr et al and Lurie et al found that up to eight years after treatment, the outcomes of uncomplicated disc herniation patients were found to be the same in both the surgical and non-surgical groups.[16,18] If the patient has sciatica due to a disc herniation, their sciatica symptoms resolve twice as fast after surgery compared to strictly conservative treatment, but the outcomes one and two years after treatment were the same between groups.[17] Another advantage of swift surgical intervention is the mental side of recovery; the patient is more likely to be confident in their ability to make a full recovery and return to their activities of daily living after surgical intervention compared to conservative treatment.[17] In total, as the degree of complication increases, the likelihood of surgery also increases.[18]

Conservative Intervention Strategies

In my experience as a certified athletic trainer, the textbook rehabilitation strategy for a herniated disc is following the Mckenzie Extension protocol. This is an exercise strategy created by Robin Mckenzie in the 1950s, and it intends to achieve centralization of the patient's back pain. This is achieved because as extension stress pushes the extruded nucleus anteriorly, it encourages its reabsorption, taking away the unwanted pressure on the nerve roots. Four go-to exercises are a part of this protocol, ranging from laying prone to lumbar extension while standing. It is intended that the patient advances from each phase as their disability decreases and their comfort level increases. This is not to be confused with the Williams protocol, which has the patient move into flexion rather than extension.[19]

In previous studies, Clare et al found that in the short term, the Mckenzie protocol decreased the patient's pain scores by an average of 8.6 points on a 0 to 100 scale (95% CI 3.5 to 13.7) and decreased their level of disability by 5.4 points on a 0-to-100-point scale (95% CI 2.4 to 8.4) compared to a control. This protocol has also been adapted for cervical disc herniations, but its efficacy is less thoroughly studied.[20] It is important to note that in my clinical experience, each patient responds differently to treatment protocols. So, including Mckenzie extensions in their low back pain rehabilitation is key, but it should be catered to their specific needs and their personal response.

Outcome Measurement

With any kind of injury, it can be hard to track long-term progress over time. The patient may easily become frustrated with the recovery process if they do not feel that their efforts are reaping their intended results, and this will negatively impact their adherence to their treatment

program. One of the tools that medical professionals use to quantify a patient's progress is called a functional scale, which is a questionnaire that is reputable and is usually specific to the body region of the patient's injury. One of these is called the Lower Extremity Functional Scale, or LEFS, and it has been used in countless research studies up to this point. It has been found to have high test-retest reliability (with correlation coefficients between 0.85 and 0.99[21]), and the potential error is around ±5.3 points[22]. Binkley et al. also found that the minimal difference for clinical importance is 9 points[22], and Mehta et al. found that the LEFS was maximally responsive to patients with varying injuries to their lower extremities with effect sizes greater than 0.8 on a consistent basis[21]. The data from both the above-named studies build a solid case for the reliability, validity, and responsiveness of the LEFS tool.

To complete the LEFS, the patient responds to a series of twenty prompts, which list a certain activity and asks the patient to rank their level of difficulty to complete. The scale starts at a "0", which denotes "extreme difficulty or unable to perform", and goes up to a "4", which denotes "no difficulty". The tasks range from "getting into or out of the bath" to "making sharp turns while running fast", so they include activities of daily living as well as higher-level exercises. The score is then totaled and compared to their pre-injury baseline or their previous response post-injury. A higher score indicates a higher level of ability, and a lower score indicates a lower level of ability.

Summary

Lumbar disc herniations are a common injury in both the athletic and non-athletic populations. They are easily diagnosed with an orthopedic examination as well as magnetic resonance imaging, and the long-term outcomes post-treatment are positive. Surgical and non-surgical interventions are both effective in resolving the patient's symptoms, but those who

undergo surgery often recover from their symptoms more quickly. Specific rehabilitation exercises such as Mckenzie extensions are helpful aids in the conservative treatment process, during which outcome measures are often used to quantitatively track the patient's progress.

Case Study

Background and Initial Injury

The case athlete was a 6'2" 225-pound 19-year-old male cheerleader, who has a previous sport history that includes parkour, ice hockey, martial arts, and gymnastics before he began cheerleading in the fall of 2019. On November 23rd, 2021, while at home with his family over Thanksgiving break, he texted his athletic trainer to report that he was having difficulty going up and down the stairs. He sent a video that showed an inability to perform a calf raise on his left leg, which was not inhibited by the pain but rather a complete lack of gastrocnemius activation. He had been dealing with lower back paraspinal spasms in the preceding four to six weeks, but with rehabilitation exercises and treatment, he was able to exist without too much discomfort. Upon virtual evaluation, he reported no known trauma or mechanism of injury to the affected area. He had full plantarflexion, inversion, and eversion ankle range of motion while non-weight bearing with his knee straight as well as bent but reported an inability to fully dorsiflex on the affected side. He also had slightly diminished sensation on the back of his gastrocnemius compared bilaterally, but he reported no complete numbness or tingling.

When he returned to campus a few days later, his sport-specific athletic trainer performed an in-person evaluation and found no signs of structural damage to his spine, sacroiliac joint, or sciatic nerve. Different from his previous back pain, this time he was experiencing a "tight string" sensation running from his lower left glute, down his hamstring, to the back of his knee joint. This "tightness" was also associated with burning and stinging sensations in this region as

well as some numbness in his posterior left calf. He had been taking prescription-strength meloxicam since his back spasms started, which was during the four to six weeks previous to the neurological symptoms starting. And, at this point in time, he reported no pain directly in his back, just the posterior leg discomfort. We continued for one week with palliative care, which included e-stimulation (e-STIM) and light instrument-assisted soft tissue massage (IASTM) in hopes of neural improvement. When his symptoms remained the same and no improvement was made, a referral was made to the team physician for an additional evaluation. Upon the physician's evaluation, he was found to have no tenderness to palpation over his lumbar spine. He had a positive Lasegue's test, a positive Braggards test, a positive Nachlas test, a recreation of the "tight string" sensation with a bilateral seated Kemp's test, and the straight leg raise test was also positive with minimal range of motion. His standing Kemp's test was negative. The common finding was that his symptoms were recreated when he was asked to hinge at the hip with a straight leg on the affected side or close the sacroiliac joint space with compression or rotation. A neurological screening confirmed that he had diminished sensation in his posterior and lower lateral calf, as well as his lateral thigh. His Achilles and patellar tendon reflexes were found to be 2+ (normal), and he had full (5/5) manual muscle strength with plantar flexion, dorsiflexion, and knee extension, but only moderate (4/5) strength with left knee flexion and hip extension. At this time, lumbar radiographs and magnetic resonance imaging (MRI) were ordered, and he was instructed to continue with rehabilitation exercises and prescription strength anti-inflammatory medication.

X-rays came back negative for bony abnormalities in his lumbar spine. MRI results showed an L5-S1 posterior disc protrusion favoring the left side, causing moderate to severe left foraminal stenosis and displacement of the nerve root, as well as mild disc bulging at the L4-L5

level. There was also a slight narrowing of the right foramen as well, but not at all to the degree that it was on the left. These findings explain why his symptoms are primarily affecting his left side, but the right-sided movement still caused left-side symptoms. At this time, now about two weeks after his onset of neurological symptoms, we began the Mckenzie extension protocol. He completed upwards of 100 Mckenzie extensions per day in hopes of conservatively remodeling his disc. He was hopeful that he may still be able to compete in the Universal Cheerleaders Association (UCA) Nationals competition in mid-January, but he remained realistic that if he cannot consistently practice during the month of December, he will not be able to successfully perform the routine. His top priority was to regain normal leg function and complete his activities of daily living with significantly less pain before returning to any kind of organized athletic activity.

Phase I: Disc Herniation Rehabilitation

About two weeks later, his leg symptoms began to resolve, and he was able to complete partial single-leg calf raises on the affected leg. He reported posterior calf sensation was within 80% of normal, and after meeting with the team physician as well as another specialist, he was cleared to return to very limited practice under the guidance of his athletic trainer. He was scheduled to receive an interlaminar epidural steroid injection after he returned from Christmas break, and if that helped his symptoms continue to resolve, he would be cleared for full participation. But, if his symptoms persisted after the injection, he would forgo the Nationals competition and pursue alternative treatment options from there.

Fortunately, he returned from break with continued progress, and he was cleared to participate in the competition, which included executing a back tuck as his only tumbling skill. He continued the 100 Mckenzie extensions per day up until the day of competition, and he

successfully competed alongside his teammates. When he returned home, the same rehabilitation program continued through the month of March. Throughout those additional two and a half months, he continued to regain leg function and muscle capability, as well pain-free activities of daily living. He could now get in and out of his sedan without excruciating pain, and he started to back squat with weight again. During this time he received two epidural steroid injections, which brought a small dose of relief but no miraculous turnaround.

Phase II: Re-Flare

Towards the end of March, he experienced a backslide in his symptoms. He was returning to his pre-injury back squat weights, and he believes he moved slightly abnormally during one repetition and "tweaked it again". His symptoms at this time included sacroiliac joint discomfort as well as a return of the neurological symptoms, but this time they remained centralized in his left lower glute to about mid-hamstring, rather than most of the way down his leg. We returned to the Mckenzie extensions, as well as additional palliative rehab rather than the high-level core and glute strengthening he had progressed to. By mid-April, he had improved from this re-flare, and no longer felt he needed anti-inflammatories to manage his pain each day. At this time, he revisited the team physician, who found his neurological exam to be grossly intact, and no tenderness to palpation over his lumbar spine, paraspinal muscles, or sacroiliac joint. In terms of special tests, his standing and seated bilateral Kemp's tests were negative, and his active lumbar spine range of motion was within normal limits. The straight leg raise test was still positive on his left side with an impaired range of motion compared to the right. At this time dry needling was completed on his lumbar paraspinal muscles, and he was told to continue rehabilitation exercises but only use anti-inflammatory medications as needed.

Rehabilitation exercises were completed for approximately three more weeks, and then the patient returned home for summer break. During this time he reported he was not completely pain-free, but he was able to complete most of his activities of daily living without major impairment. But, when faced with situations he had not encountered since the incident, he did report a few peculiar findings. For example, he visited San Francisco at one point, which involved both sitting on a cramped airplane for multiple hours continuously and walking on a very steep incline. Sitting for prolonged periods did increase his symptoms, but his pain levels were manageable. But, when walking a steep incline, he noticed a decreased anterior tibialis activation on the affected side compared bilaterally. All of this is to say that his recovery continued, but at a slightly lower rate than he had been experiencing up to this point.

Phase III: Post-Summer Progress

Upon his return to Blacksburg at the beginning of August, he followed up with the team physician for re-evaluation. He continued to report no pain directly in his back, but the "tight string" remained from his left lower glute to about mid-hamstring. And while he had significantly improved since the onset of his symptoms, he had not yet experienced complete relief. Then, once summer practices began to increase in intensity and frequency, he saw an increase in his symptoms. He was still most exacerbated when attempting to flex at the hip while maintaining a straight knee, like in a Romanian deadlift or "scoop" dynamic hamstring stretch. At this time, he denied any numbness or tingling, and no more muscle weakness after the original gastrocnemius issue resolved. He continued to have no tenderness to palpation over his lumbar spine, sacroiliac joint, or piriformis and hamstring muscles. With active range of motion, he was immediately positive for pain with standing hip flexion with even a slight change in range of motion, but negative when moving into extension. His standing Kemp's test remained positive

on the left side, but this time he reported pain more in the area of his quadratus lumborum. The straight leg test also remained positive for pain and recreation of his symptoms. In lay terms, this means that he was still experiencing pain when simultaneously rotating and extending his lumbar spine to the left side, but the pain was in his musculature and not his spine. The "tight string" sensation remained with straight-legged hip flexion. His lower extremity manual muscle testing remained a full 5/5, and his neurological screening was grossly intact. At this point, an electromyography (EMG) test was ordered to study the conductivity of the nerves in his affected lower extremity. He was also prescribed formal physical therapy, to work in conjunction with the rehabilitation exercises he was already completing with his athletic trainer.

The EMG study found reduced amplitude (1.8 μV) in his left superior fibular nerve, as well as prolonged distal peak latency in his right superior fibular sensory nerve (3.8ms). These findings are congruent with a remote left S1 radiculopathy, without any deficiencies in S1 innervated muscles to confirm. These results did not give any conclusive findings to explain the "tight string" sensation he was still experiencing, but they did give his medical team confidence in his overall nerve health after such a significant disc herniation. He continued with physical therapy, which progressively improved his glute firing and core strength, as assessed by manual observation and strength testing. Over the following fall months, he began consistently tumbling again without increased pain for the first time since the original injury. He was able to participate in the fall football season, followed by home basketball games and a rigorous UCA Nationals season. Our team physician completed dry needling on his left hamstring and lumbar erector spinae muscles along with a piriformis trigger point injection in November 2022. By December, he was able to complete all cheer-related activities without increased discomfort, and the "tight string" sensation only flared up when he attempted to flex at the hip with his knee fully extended.

In January 2023 he competed in the UCA Nationals competition without increased pain in the area of his previous injury. He did experience a small setback of quadratus lumborum spasm on the same left side, which in turn caused sacroiliac joint discomfort. This flare-up was very short-lived, and he could confirm that it was different from his pre-existing back pain.

Current Status

Since returning from the competition, he has been able to only take meloxicam on rare occasions, but he otherwise continues to complete his activities of daily living as well as all desired athletic activities without any pain. He describes his current status as "about 80-90%" of his pre-injury status, accounting for the few movements that recreate the "tight string" sensation (hip flexion with a straight leg and Romanian deadlifts). He is happy with his current degree of health and mobility and does not feel inhibited by any long-lasting effects of his injury. After graduation, he plans to work in digital media as a visual effects artist, while continuing to lift weights and perform stunts.

Custom Functional Scale

To maintain patient adherence during the course of this extensive rehabilitation process, I created a custom functional scale based on the Lower Extremity Functional Scale (LEFS). After spending extensive amounts of time with this athlete following his first six months of rehabilitation during the 2021-2022 academic year, I learned that this athlete considered himself a "numbers guy", and he finds himself naturally gravitating towards quantitative data to determine the quality of the things around him. He was also becoming easily frustrated with the monotony of such a long recovery process, and his attendance and attitude were suffering. With this knowledge, I knew that a functional scale would show him his progress over time in an

objective way, but the specific outcomes included in the LEFS were not all directly applicable to his activities of daily living or sport-specific movements. Therefore, I sat down with the athlete and pitched him my idea, and then included him in the creation of his own custom functional scale. His outcomes ranged from common tasks like putting on shoes and socks to high-level athletic performance such as martial arts or completing a back, which were goals that he wanted to get back to as he continued to recover. Figures 4 and 5 show his results, one of which focuses on outcomes that no longer cause him pain in his daily life, and the other shows the outcomes that still create some discomfort but have improved since the onset of his injury.

Discussion

Clinical Takeaways

Back injuries, though all too common, can be extremely debilitating and their effects can last long after the original incident. Dozens of muscles attach to this region, and the intervertebral discs are critical shock absorbers that disseminate the stress that flows up from the lower body. This overlap can make pinpointing a lower back injury difficult, like in the case of this male cheerleader. We can't know if his muscular irregularities caused him to be predisposed to a disc herniation, or if the disc herniation was the root cause of the subsequent neural and soft tissue complications. That being said, the key to this athlete's success was persistent rehabilitation exercises multiple times per week, as well as maintaining full body flexibility. And with a long-term rehabilitation process such as this, it was the job of the certified athletic trainer to continue to keep the patient engaged and buying into the healing process. I was able to achieve this by continuous patient education, dissemination of literature to show that these methods were proven to be effective, and even the development of a personalized LEFS-style survey to show him his progress each month. As he prepares to graduate this year, future planning will have to

be done to ensure he has the necessary tools to continue his maintenance work so that he can be protected from future injury to this area.

Limitations

One limitation of this case study is that it is the unique story of one individual's journey through a complicated injury. This story cannot speak to the experience of every individual who suffers from a disc herniation, but it can educate healthcare professionals about the circumstances of this individual's case that can help them prepare for potentially unique circumstances in the future.

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Appendix

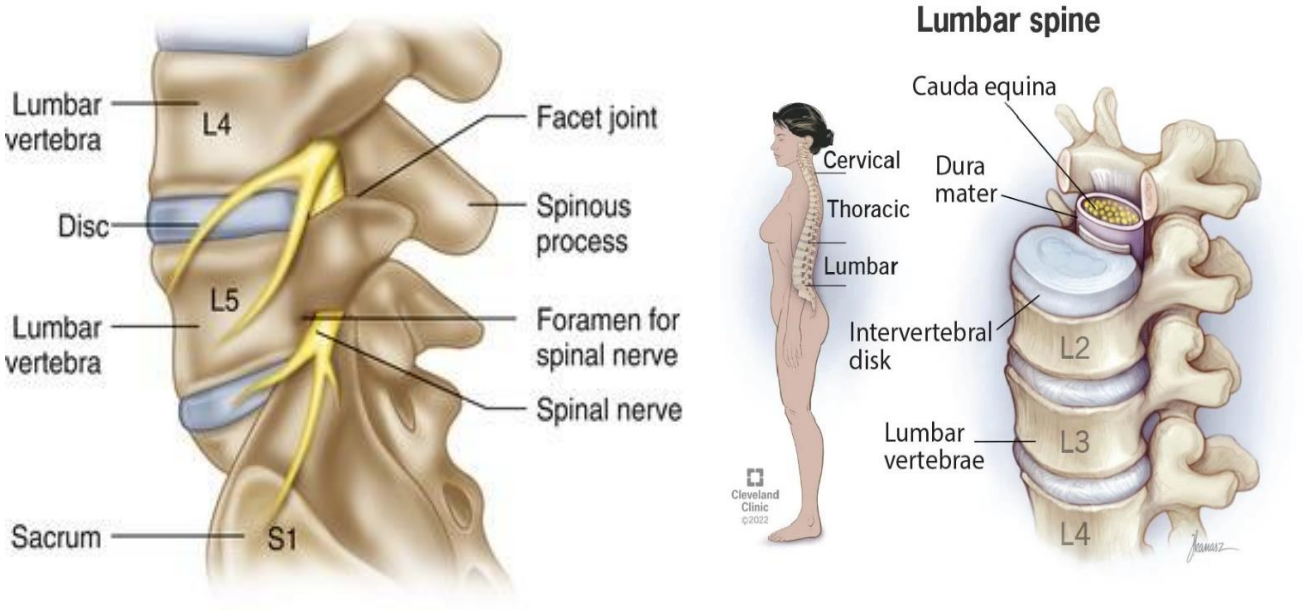

Figure 1 (left): The Springer website shows the detailed anatomy of the lumbar spine and the foramen through which the nerve roots protrude.
https://my.clevelandclinic.org/health/articles/22396-lumbar-spine

Figure 2 (right): A cross section of the lumbar spine shows the intervertebral discs and the three main sections of the spinal cord. https://my.clevelandclinic.org/health/articles/22396-lumbar-spine

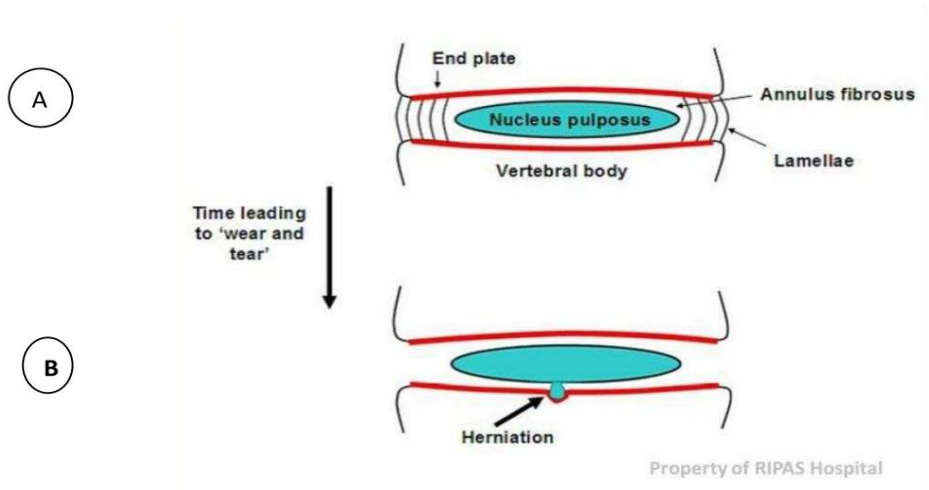

Figure 2: Image from Rathore et al. depicts the structural anatomy of an intervertebral disc and what a herniation of a disc looks like.

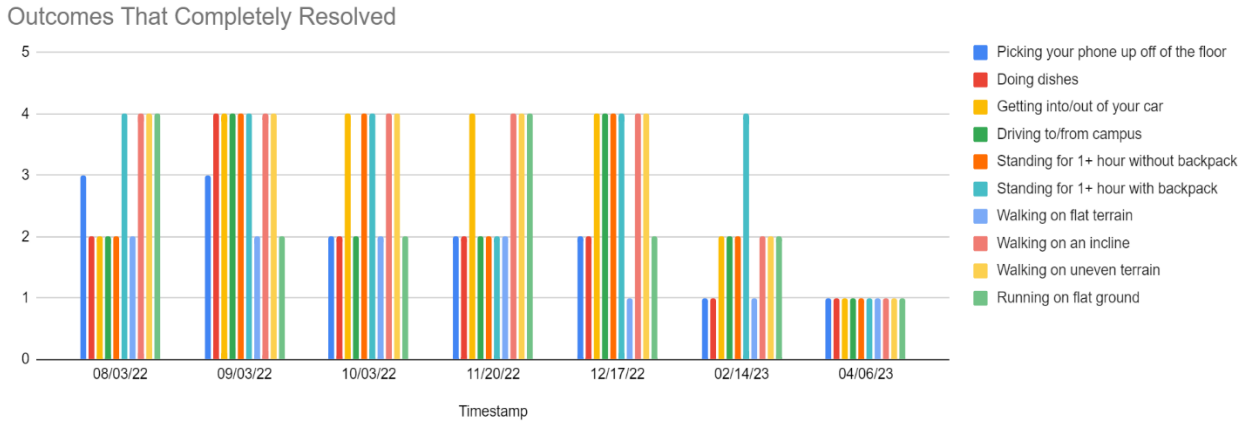

Figure 3: This figure displays the functional outcomes from the custom functional scale that over the course of the 2022-2023 academic year that completely resolved.

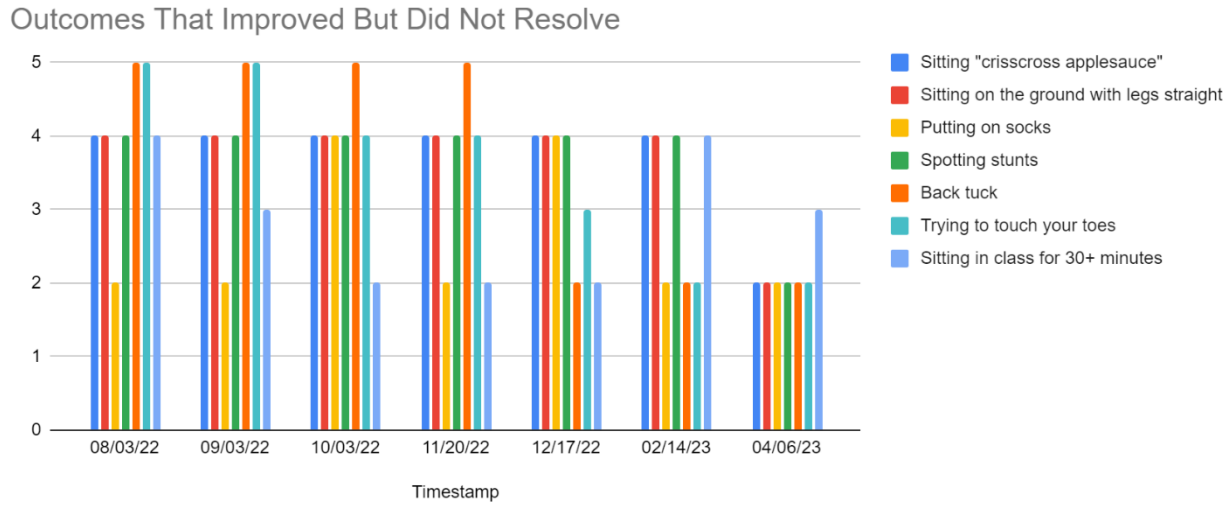

Figure 4: This figure displays the outcome scores from the custom functional scale for which the patient reported improvement but not resolution.