Redundant Nerve Root in a Patient With Chronic Lumbar Degenerative Canal Stenosis

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ABSTRACT

Objective: The purpose of this case report is to describe the diagnostic imaging features of redundant nerve roots caused by chronic lumbar degenerative canal stenosis (CLDCS).

Clinical Features: A 56-year-old male presented with severe low back pain. He experienced pain during minimal active lumbar range of motion. The patient demonstrated weakness of the right iliopsoas and hypoesthesia of the L-2 dermatome. A working diagnosis of CLDCS was established. The patient's worsening severe low back pain warranted magnetic resonance imaging of the lumbar spine, which was performed for further evaluation. Magnetic resonance imaging demonstrated disk protrusion and canal stenosis with tortuosity of the cauda equina consistent with redundant nerve root appearance.

Intervention and Outcome: The patient was treated with chiropractic flexion distraction, which was followed by a course of acupuncture and spinal manipulation. The patient self-discharged following clinical improvement.

Conclusions: This case demonstrated CLDCS with associated redundant nerve roots. Conservative treatment included chiropractic diversified lumbar spinal manipulation, acupuncture, and electrical stimulation. The patient self-discharged following clinical improvement in 3 months. (J Chiropr Med 2017;16:236-241)

Key Indexing Terms: Canal Stenosis; Lumbar Spine; Cauda Equina; Redundant Nerve Root

INTRODUCTION

Redundant nerve root (RNR) is an engorged tortuous nerve caused by severe chronic lumbar degenerative canal stenosis (CLDCS).^{1,2} Redundant nerve root is a complication that arises as a result of continuous and chronic compressive forces on the nerve roots within the canal of a CLDCS. Chronic lumbar degenerative canal stenosis is the result of degenerative narrowing of the lumbar spinal canal caused by bulging of an intervertebral disk, osseous hypertrophy of the vertebral neural arch, apophyseal joint arthrosis, ligamentum flavum hypertrophy, and/or degenerative spondylolisthesis.³ Symptoms, which gradually progress and worsen,³ include pain in the low back, buttock, and lower extremity accompanied by numbness.^{3,4}

Neurogenic intermittent claudication signs include weakness while walking and relief with forward bending.³ In some cases, neurologic deficits, including bowel and bladder incontinence, lower extremity motor weakness, and sensory deficits as well as reduced or absent lower extremity deep tendon reflexes are experienced.³ There is, however, little correlation between clinical symptoms and dural cross-sectional area.^{4,5}

Myelography was first utilized in the diagnosis of RNR, but most recently, magnetic resonance imaging (MRI) has been employed.⁶ Although the pathophysiological mechanism of RNR formation remains unclear, mechanical trapping above or below the level of degenerative stenosis is assumed to cause its serpiginous appearance. The reported prevalence of RNR varies, with some observing it in 33.8% to 42% of patients with CLDCS.¹ There is no statistical gender difference for RNR.⁷

The purpose of this case study was to present the diagnostic imaging findings of a patient with CLDCS with associated redundant nerve roots.

CASE REPORT

A 56-year-old male had an onset of severe low back pain after throwing trash into a dumpster. He immediately presented to the local emergency department (ED) complaining of severe low back pain, and a computed

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tomography (CT) of the lumbar spine was performed. The CT findings indicated lumbar spine degeneration that was most advanced at L2 and L3. Disk herniation was not visible on this imaging study. He was treated with muscle relaxants and oral corticosteroid medication.

The patient presented to our chiropractic teaching clinic within 3 days of his ED visit, complaining of continuing severe, sharp low back pain that radiated into the right anterior thigh. He rated his pain as 10 on a numerical pain scale of 0 to 10, with 10 being the worst pain experienced. His vitals were normal. His physical examination included pain on minimal active lumbar ranges of motion. On the initial examination, all lower extremity myotomes were 5 out of 5, and heel walk and toe walk were negative. Iliopsoas motor evaluation produced 5 out of 5 strength bilaterally, and testing of the right iliopsoas reproduced the chief complaint. Straight leg raise (SLR), standing Kemp, and Yeoman tests reproduced his chief complaint on the right side, with no radiation past the right buttock. No neurologic deficits were identified initially. History, physical examination, and CT findings led to a working differential diagnosis of lumbar erector spinae myalgia, segmental dysfunction, degenerative joint disease, facet syndrome, and/or disk herniation of the lumbar spine.

The patient passed the flexion tolerance test and was treated with chiropractic flexion–distraction and responded well, as shown by pain reduction. He returned the next day, and while greeting the clinician, he immediately reported a 10 out of 10 score of pain. He was sweating and stated he could only find minor relief from lying supine with his knees bent. At this point, he was unable to undergo positioning for any chiropractic adjustment (manipulation) because of the severity of his pain. He was referred back to the ED for additional evaluation and treatment. Following

evaluation at the ED, a noncontrast lumbar spine MRI was performed.

The MRI showed circumferential disk bulge with a right lateral broad-based disk protrusion and right intervertebral foramen and canal stenosis at L2/L3. There was a circumferential disk bulge with bilateral foraminal encroachment, extraforaminal right disk herniation, and canal stenosis at L4/L5. In addition, there was a circumferential disk bulge at L3/L4, central focal protrusion at L5/S1, and multilevel discogenic spondylosis. Above the stenotic L2/L3 level, multiple loop-shaped nerves of the cauda equina were identified, which was consistent with the presence of RNR (Figs 1A, 1B, and 1C).

Following the second ED evaluation, clinical re-evaluation was performed at our clinic. The patient presented to the clinic with noticeable pain, left antalgic leaning position, and distress. The patient obtained relief from pain by lying recumbent on the floor of the waiting room. Eventually, he was placed onto a wheelchair and taken to the treatment room. Upon questioning, the patient reported no bowel, bladder, or sexual dysfunction. Increased pain upon coughing and defecation was reported. On examination, there was severe edema in the right lumbar region, with severe spasm of the erector spinae. Fasciculation of the right quadriceps muscle group was also noted. The patient's chief complaint was reproduced upon light palpation of the right side of sacrum. The patient demonstrated interval development of a sensorimotor deficit. This included weakness (4 out of 5) of the right iliopsoas and hypoesthesia of the L-2 dermatome. SLR was positive, reproducing pain into the right buttock. The new working diagnosis, therefore, was CLDCS.

This episode of treatment included a total of 5 acupuncture treatments. Acupuncture was performed on

Fig 1. A, Sagittal T2-weighted magnetic resonance imaging (MRI) scan demonstrates degenerative changes of the lumbar spine with disk herniation and vertebral canal stenosis at L2/L3 and L4/L5 (arrows). Elongated and tortuous nerve roots of the cauda equina can be identified (arrowhead). B, Zoom demonstrating the redundant nerve roots (arrowhead). C, Axial T2-weighted MRI scan at the L2/L3 level demonstrating disk herniation with ventral thecal sac compression (arrow).

the right lower extremity by using Bladder 23, 24, 54, and 36, Kidney 1, and Gallbladder 30 and 39 points for pain reduction. After the 5 acupuncture treatments, a total of 27 episodes of chiropractic diversified lumbar manipulations were employed. Electric stimulation at 10 seconds of contraction with 50 seconds of relaxation for 10 minutes per session was also included for reduction of pain and muscle tonicity. The patient tolerated this course of care and demonstrated a slow reduction of low back pain over a 3-month span. The patient self-discharged following clinical improvement. Chiropractic spinal flexion–distraction was discontinued because of lack of relief and pain exacerbation. The patient provided written consent to publish this case report.

DISCUSSION

The broadest definition for lumbar canal stenosis (LCS) is narrowing of the spinal canal. The differential diagnosis of LCS includes primary (congenital) or secondary (degenerative, posttraumatic and postoperative), with degenerative (CLDCS) factors being the most common cause.⁸ Redundant nerve root is a complication that arises as a result of continuous and chronic compressive forces on the nerve roots within the canal of a CLDCS. In contrast to case study, Chan et al. described a patient demonstrating bladder and bowel dysfunction associated with LCS and RNR.⁹

This case report demonstrates key clinical and imaging findings of CLDCS and associated RNR. Chronic lumbar degenerative canal stenosis with or without RNR can be treated conservatively or with decompressive surgery. A study by Choi et al. involved 30 patients (male = 9, female = 21) who were diagnosed with CLDCS.¹⁰ They were divided into the conservative treatment group (CTG, $n = 16$) and the flexion–distraction manipulation treatment group (FMG, $n = 15$).¹⁰ The FMG underwent physical therapy (hot pack [20 min], interferential current therapy [15 min] and ultrasound therapy [5 min]) for 40 minutes per session, followed by 5 episodes of flexion–distraction manipulation therapy.¹⁰ The CTG only received physical therapy.¹⁰ The FMG showed significant decrease in the visual analog scale compared with the CTG.¹⁰

Conservative management of CLDCS includes NSAIDs, patient education, manual therapy, exercise therapy, and physical and rehabilitation activities.¹¹ The use of the flexion tolerance test has been designed for evaluating patient's pain tolerance and range of motion capacity.¹² This information is used to establish the starting point for therapeutic treatment.¹² Chiropractic spinal flexion–distraction therapy, which is another method of manual therapy, is a conservative treatment that creates negative pressure on the intervertebral disk and reduces posterior disk pressure on the opening of the facet joints and expands

the intervertebral foramen and spinal canal.¹³ This treatment method is used to alleviate low back pain and disability in patients with CLDCS.¹⁴ When conservative treatment fails and patient's daily activities are affected, then surgical options may relieve symptoms.¹⁵

Surgical outcomes for RNR have limited study. Ono et al. reported that RNR is irreversible and that symptoms are not likely to resolve even after decompressive surgery.¹⁶ This opinion has been supported by Min et al.; in their study, 68 patients underwent laminectomy for single-level lumbar stenosis.⁷ For comparison of interventions, 1 group had RNR ($n = 23$) and a second group did not have RNR ($n = 45$). The results were slightly better in those with no RNR, although not statistically significant. The surgical outcomes were measured by using the Japanese Orthopedic Association's evaluation system for low back pain syndrome before and after surgery.⁷

Our case demonstrates the classic association of CLDCS and RNR in a 56-year-old male. Typically, the appearance of RNR is that of thickened, elongated, and tortuous nerve roots in the subarachnoid space adjacent to the site of CLDCS.⁹ Chiropractic management was successfully employed for CLDCS and associated RNR utilizing acupuncture, chiropractic diversified lumbar spinal manipulation, and chiropractic spinal flexion–distraction. Chiropractic spinal flexion–distraction was discontinued because of pain exacerbation and lack of relief, although is not a contraindication for patients with CLDCS. A similar case reported by Hakan et al.⁴ was that of a 71-year-old woman who presented with increasing low back pain and progressive numbness in the lower extremities. Almost identical, sagittal T-2 weighted MRI demonstrated CLDCS with thick, long, and tortuous nerve roots. In contrast to our case, in which the treatment was conservative, decompressive laminectomy was performed and her symptoms resolved immediately in the early postoperative period.⁴

In the past, myelography was the only imaging method for distinguishing RNR.¹⁶ Its imaging pattern has been described as a serpiginous, intradural filling defect associated with partial or complete blockage of the contrast.^{5,16} Supine body positioning yields better depiction of RNR on myelography.⁶ Currently, MRI has replaced myelography as the imaging modality of choice for RNR.⁶

Diagnostic imaging requires multiplanar information to diagnose RNR. Magnetic resonance imaging is the main diagnostic modality for RNR evaluation in the evaluation of CLDCS.⁹ Although nerve roots appear isointense on T-1 weighted and isointense or slightly hypointense on T-2 weighted pulse sequences, RNR presents with a serpiginous configuration within the thecal sac on sagittal images.⁹ The exact etiology of RNR is unclear. However, the pathophysiology appears to be related to chronic degenerative spinal canal stenosis at the segment above or below (Fig 2). This constriction leads to mechanical trapping and stretching of the nerve roots above, causing them to dilate and produce an

Fig 2. Normal canal with nerve roots (left) and lumbar canal stenosis with redundant nerve roots (right).

uneven pattern of length and distribution simulating a “bag of worms” (Figs 3A, 3B).^{5,9,11}

The radiologic differential diagnosis for serpiginous elongated nerve roots includes a number of disorders. Spinal dural arteriovenous fistula (SDAVF) and less frequent plexiform neurofibroma or neurinoma. Also included are hypertrophic neuropathies, such as arachnoiditis and chronic inflammatory demyelinating polyneuropathies, causing a similar appearance. Last, some hereditary neuropathies, such as Charcot-Marie-Tooth type 1 (not type 2) and Dejerine-Sottas syndromes, are included in the differential diagnosis.⁶

From the differential diagnosis, SDAVF is the most common spinal vascular malformation with a male gender predilection.¹⁷ Spinal dural arteriovenous fistula creates serpentine and dilated intervertebral veins or perimedullary venous plexus, creating flow voids on T2-weighted images.¹⁷ Its most striking characteristic is spinal cord edema caused by chronic venous hypertension and stasis.¹⁷ Lack of serpentine flow voids and absence of enlarged draining veins with no spinal cord edema help avoid diagnostic confusion. Plexiform neurofibroma is one of the major characteristics of neurofibromatosis type 1 occurring in 30% of cases.¹⁷

They can be multiple with diffuse neural expansion extending out of the intervertebral foramen and developing a dumb-bell tumor.¹⁸ This finding differentiates neurofibromatosis type 1 from RNR.

Arachnoiditis is a neuropathic disease caused by chronic inflammation of the meningeal arachnoid layer leading to scar tissue formation, adhesion, and nerve root compression and clumping.¹⁹ When inflammation and scarring causes nerve roots to peripherally adhere to the inner membrane of the thecal sac, the “empty sac” pattern is seen.¹⁹ The most common site is the lumbar spine. Magnetic resonance imaging usually demonstrates irregular narrowing of the dural sac and a disrupted cauda equina.²⁰ The “empty sac” appearance is unique to arachnoiditis and differentiates it from RNR.

Charcot-Marie-Tooth type 1 and Dejerine-Sottas are syndromes included in a subgroup of disorders causing hypertrophic polyneuropathy.¹⁴ Multiple episodes of demyelination and remyelination of Schwann cells result in many layers, giving it the original term “onion bulb” neuropathy.¹⁴ Hypertrophic polyneuropathies manifest as enlarged nerve roots in the cauda equina and dorsal root ganglia on MRI.¹⁴ Enlargement of nerve roots without tortuosity differentiates hypertrophic neuropathies from RNR.

Fig 3. A, Intraoperative view demonstrates normal appearance of the cauda equina. Reproduced with permission from Fabrizio Pignotti.²⁴ B, Presence of tortuous, elongated and engorged nerve roots of the cauda equina. Reproduced with permission from Tayfun Hakan.⁴

High-resolution imaging technology for nerve root evaluation is evolving. Diffusion weighted imaging (DWI) may play an important diagnostic role in degenerative lumbar disease with root compression.²¹ Diffusion weighted imaging provides valuable information regarding the microstructure of compressed nerve fibers.²¹ It is an extremely sensitive means of measuring microscopic water diffusion within a nerve. The metric is described by a parameter known as *apparent diffusion coefficient*. Mean apparent diffusion coefficient values are higher in compressed spinal nerve roots compared with intact nerve roots.²² This suggests demyelination and edema (restrictive diffusion).²² The DWI technique promises a noninvasive diagnostic assessment of early changes associated with degenerative compression of spinal nerves.²³

Our patient presented with acute low back pain, and the diagnosis was CLDCS. No surgery was indicated because of the minimal neurologic findings. We employed conservative treatment, which included chiropractic diversified lumbar manipulation, acupuncture, and electrical stimulation. Slow reduction of pain and symptoms occurred over a 3-month span. The patient self-discharged following clinical improvement. The combination of conservative interventions provided reduction of the patient's pain and inflammation related to his CLDCS.

Clinical Application

Chronic lumbar degenerative canal stenosis is an increasingly common presentation in clinical practice. The differential diagnosis and treatment described in this case report provides clinicians with valuable resources for timely management and optimal outcome.

Limitation

A limitation of this case report, as with any, is its failure of generalizability with respect to diagnosis or treatment across all patients with spinal canal stenosis.

CONCLUSIONS

This case report described the workup and management of a patient with CLDCS and associated RNR. Magnetic resonance imaging findings of RNR helped reinforce the diagnosis of CLDCS, an increasingly more frequently encountered clinical entity.

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No funding sources or conflicts of interest were reported for this study.

CONTRIBUTORSHIP INFORMATION

Concept development (provided idea for the research): F.V., N.K.

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Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript):

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Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): F.V., A.H., N.K.

Practical Applications

- Redundant nerve root appearance is associated with chronic lumbar degenerative canal stenosis.
- Redundant nerve root appearance may be confused with other diseases.
- Diagnostic imaging may assist with the identification of RNR.
- Familiarity with this finding may facilitate timely diagnosis and proper treatment.

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