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Lateral Cervical - Stress Radiographs



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Demographics

64 y.o. Male

Caption

The study reveals no acute fracture seen. There is degenerative disc narrowing between C5 and C7 with anterior spondylitic changes between C4 and C7. No evidence of instability on the flexion and extension views. Bone density appears unremarkable. IMPRESSION: DEGENERATIVE CHANGES OF THE LOWER CERVICAL SPINE. NO FRACTURE SEEN.

Plane

Lateral

Modality

XR - Plain Film

ACR Codes

3.4

Figure Part

1

(This image was added on 2024-08-23 and last edited on 2024-08-24)

Quiz OFF Info **Case** Topic Author

CASE

Functional Capacity Evaluation Correlated With Diagnostic Studies

History

The Patient is a 64-year-old male who presented to the chiropractor's office with back and neck pain following an alleged work-related injury occurring on 06/04/2021. He was employed as a maintenance supervisor for a recycling company. He was removing large old TVs from recycling bins when he began to experience lower back pain. Over the next week, his back pain became severe with significant pain to the left buttock distally located along the posterior thigh and calf with numbness to the lateral aspect of his left foot. He also had neck pain.

Of note, prior to the episode of 05/06/2023 he reports feeling good. After his injury, he presented to the Hospital on June 14 & 16 due to severe pain & inability to sleep, where they prescribed him a Lortab. He also attempted to schedule an appointment with an orthopedic surgeon, however there was a 2 month long wait period. He had an appointment with a neurosurgeon, who did not recommend surgery. He attended physical therapy (PT) for 2 weeks prior to his initial appointment. He reported the PT was not helpful.

At his initial appointment, he attributed all of his pain as a direct result of his work injury. His main areas of pain were his back, specifically mid-back, lower back and left buttock, and neck. Relative to his mid back, he reported a 3-4/10 pain, which he experienced about 30% of his awake time. Relative to his lower back, he reported a 5-6/10 pain, which he experienced about 40% of his awake time. Relative to left buttock and lower extremity pain, he reported a 6/10 pain, which he experienced about 45% of his awake time. All three symptoms were made worse by tilting at the waist, getting up from a sitting position and by lifting. His symptoms improved with rest, heat, exercise, massage, pain medication and by muscle relaxant medication.

He reported loss of sleep, with obtaining only 6 hours of sleep in an 8-hour time frame due to pain and discomfort. This results in daytime fatigue. He has low back pain w/ radiation and neck pain. He reports no loss of bowel or bladder control. ROS is otherwise negative.

PERTINENT PAST MEDICAL HISTORY:

PMH: No significant past medical history. He reports using 800mg Motrin for pain relief.

His past surgical history includes an emergent right inguinal hernia repair in 2002.

The patient denies other work episodes, other vehicular accidents, or slips, falls, athletic episodes where an injury was sustained. He denies rheumatoid arthritis, diabetes, allergies, tuberculosis, shortness of breath, hearing loss, heart disease, kidney stones, headaches, gout, seizures, asthma, ulcers, loss of sight, anemia, stroke, other surgeries, or any fractures.

Exam

EXAM:

The patient is 6' tall and weighs 205 pounds. Blood pressure of the left arm and the seated position was 150/102 mmHg.

Ranges of motion were measured by Dual Inclinometry. Findings were compared to "normal" from The AMA Guides to the Evaluation of Permanent Impairment 5th Edition.¹ For the purposes of this case, the patient's shoulder and neck will remain the focus as they had a previous ANCR for their lower back and was being evaluated to have the right shoulder and neck to be added to their ANCR.

Active range of motion of the cervical spine revealed relative to AMA "normal"⁽¹⁾:

- Flexion: 24°/50°
- Left rotation: 55°/80°
- Right rotation: 60°/80°
- Left lateral bending: 35°/45°
- Right lateral bending: 35°/45°
- Extension: 21°/60°

Of note, he reports neck pain with all ranges of motion.

The bicep and tricep reflexes are graded 2/4 bilaterally. Cervical compression testing was unremarkable. Active shoulder ROM was within normal limits. Muscle strength of the upper extremities showed normal strength and was without report of pain.

He is right hand dominant. Grip strength was assessed using a dynamometer. The right hand tested at 85 pounds and the left hand tested to 70 pounds. There are multiple articles on the normative values for grip strength depending on the equipment used and publication dates. We compared his grip strength to the 90 percentile data from Wang et. al 2018 normative data⁽²⁾. For grip testing, strength is compared to the 90th percentile as it is assumed that above the 90 percentile are people who are fit and the lower end of the curve signifies people who are ill.

Active thoracic spine ROM revealed flexion to be accomplished to 4°/30°, with a report of lower back pain.

Active range of motion of the lumbar spine revealed relative to AMA "normal"⁽¹⁾:

- Flexion: 28°/60°
- Left lateral bending: 7°/25°
- Right lateral bending: 11°/25°
- Extension: 6°/25°

Of note, he reported lower back pain and discomfort with extension into the left thigh during left lateral bending, flexion and extension.

The subpatellar reflexes were graded 2/4 bilaterally. The Achilles reflex was graded 0/4 bilaterally. He was able to toe walk and heel walk. He was able to perform a squat.

His left and right straight leg raise tests were positive. His left leg straight raise went to 34° with a report of low back pain extending through the left lower extremity to the heel. His right leg straight raise to 55° with a report of low back pain extending to the left heel. Of note, when muscle strength of the lower extremities was assessed he exhibited weakness of the left extensor hallucis longus, which rated 4/5. Posterior to anterior compression of the spine produced reported pain over the lumbosacral and left lumbopelvic regions. Deep palpation produced reported pain over the left buttock.

Additionally, hypomobility was noted at C2-6, T1-4, T7-10, T12-L5, sacrum base, and bilateral Ilium. Muscle spasm was noted over the cervicothoracic and lumbar regions paraspinally. Pain/tenderness, asymmetry/misalignment, abnormal range of motion, and tissue/tone changes

were associated with the areas of hypomobility.

Findings

FINDINGS ON IMAGING:

X-ray Cervical Motion 10/05/2021:

Findings: The study reveals no acute fracture seen. There is degenerative disc narrowing between C5 and C7 with anterior spondylitic changes between C4 and C7. No evidence of instability on the flexion and extension views. Bone density appears unremarkable.

Impression:

1. Degenerative changes of the lower cervical spine. No fracture seen.

X-ray Lumbar Motion 10/05/2021:

Findings: Six views of the lumbar spine including flexion and extension as well as bending views were obtained. The study reveals no acute fracture seen. No evidence of instability. There are diffuse degenerative spondylitic changes throughout. Bone density appears unremarkable.

Impression:

1. Degenerative changes. No fracture or Instability seen.

MRI Lumbar 10/05/2021:

Findings: No fractures, dislocations, destructive bony changes or acute bone abnormalities are seen. Schmorl's node at multiple levels are noted without surrounding bone marrow edema or resulting loss of vertebral height is seen. The vertebral bodies are maintained in height. The pedicles are intact. No spondylolysis is seen. The conus medullaris is unremarkable. There is prominent straightening of the lumbar lordosis likely due to muscle spasm from patients injury.

Large bilateral renal cysts are incompletely visualized. The largest on the right measures approximately 9.7 cm in maximum diameter. Findings could be further evaluated with renal sonography or CT of the abdomen if clinically warranted.

The T11-12 and T12-L1 disc levels are unremarkable.

L1-2: Mild disc space narrowing with ventral spurring and bulge/protrusion, minimal posterior ridging with diffuse posterior annular tear and broad based herniation most severe left paracentrally encroaching approximately 4 mm into the spinal canal with impingement on the ventral thecal sac and borderline central spinal stenosis.

L2-3: Circumferential bulge encroaching posteriorly 3 mm into the spinal canal with associated posterior ridging with facet arthrosis, hypertrophy of the ligamentum flavum, developmental foreshortening of the pedicles and posterior epidural lipomatosis resulting in central spinal stenosis. Bilateral foraminal ridging and bulges/subligamentous protrusion asymmetric on the left are noted.

L3-4: Spondylosis and disc space narrowing with circumferential bulge and spurring encroaching posteriorly approximately 4 mm into the spinal canal with associated hypertrophic facet arthrosis and hypertrophy of the ligamentum flavum, developmental foreshortening of the pedicles and posterior epidural lipomatosis resulting in moderate central spinal stenosis. Bilateral foraminal ridging and bulges mildly encroach on and narrow the foramina.

L4-5: Disc space narrowing and large diffuse herniation of the protrusion type asymmetric to the right encroaching approximately 6.5 mm into the spinal canal severely impinging on the ventral thecal sac with associated facet arthrosis and hypertrophy of the ligamentum flavum resulting in severe central spinal stenosis, moderate left lateral recess stenosis and severe right lateral recess stenosis with bilateral foraminal bulges/protrusions slightly effacing the undersurfaces of the exiting L4 nerve roots.

L5-S1: Posterior annular tear and broad based subligamentous protrusion encroaching approximately 3.5 mm into the spinal canal indenting the ventral thecal sac and effacing the traversing S1 nerve roots with associated facet arthrosis with encroachment on the lateral recess resulting in moderate bilateral lateral recesses stenoses. The neural foramina are patent bilaterally.

Impression:

1. Straightening of lumbar lordosis and multifocal spondylosis, disc herniations, annular tears, central and foraminal stenoses as described above. Large Left paracentral herniation at the L1-2 disc level with associated acute annular tear is noted likely representing acute change sequelae of known recent injury.
2. Multiple large bilateral renal cysts are incompletely visualized and evaluated. Findings could be further evaluated with CT and/or Sonography of the abdomen and kidneys.
3. These findings are consistent with phase II pathophysiology of the chiropractic clinical diagnosis of vertebral subluxation complexes. Clinical correlation is recommended.
4. If further evaluation of radicular symptoms of foraminal pathology is required correlation with EMG and/or nerve conduction studies would be helpful.

MRI Cervical 09/20/2022:

FINDINGS: No fractures, dislocations, destructive bony changes or acute bone abnormalities are seen. Prominent straightening of the cervical lordosis is noted likely due to muscle spasm from patient's injury. The vertebral heights are maintained. No facet malalignment is seen. The pedicles appear intact. The craniocervical alignment and atlantoaxial articulation are unremarkable. The visualized structures within the cranial fossa are grossly unremarkable. Minimal spinal cord myelopathy at upper C4 vertebral level cannot be excluded. Otherwise, the remainder of the visualized spinal cord is unremarkable.

C2-3: Grade 1 retrolisthesis with posterior ridging and 2 mm diffuse bulge partially effacing the anterior arachnoid space without focal herniation or foraminal stenosis.

C3-4: There is diffuse posterior herniation asymmetric to the left side encroaching approximately 4 mm into the spinal canal with slight superior and inferior extension moderately impinging on and flattening the spinal cord resulting in moderate central spinal stenosis and moderate to severe left lateral recess stenosis with associated hypertrophy of the uncovertebral joints and foraminal stenoses more severe on the left.

C4-5: Minimal spondylosis with ventral spurring with evidence for central posterior annular tear and central posterior subligamentous protrusion

encroaching approximately 2.8 mm into the spinal canal effacing the anterior arachnoid space.

C5-6: Moderate spondylosis with disc space narrowing, Grade 1 retrolisthesis, ventral spurring, posterior ridging, and 3.5-4 mm bilobed central and right posterior herniation partially effacing the anterior arachnoid space and mildly encroaching on and narrowing the right lateral recess with associated right posterior ridging, hypertrophy of the right uncovertebral joint and right foraminal stenosis. There is hypertrophy of the left uncovertebral joint and left foraminal stenosis.

C6-7: Mild-to-moderate disc space narrowing with spondylosis, ventral spurring and posterior ridging with 2.5 mm diffuse bulge/subligamentous protrusion partially effacing the anterior arachnoid space without central spinal stenosis. There is hypertrophy of the uncovertebral joints and bilateral foraminal stenoses.

C7-T1: There is 3.5 mm diffuse herniation with mild inferior extension partially effacing the anterior arachnoid space.

The T1-2 and T2-3 disc levels are unremarkable.

Impression:

1. Straightening of the cervical lordosis is likely due to muscle spasm with multilevel spondylosis, spondylolisthesis, posterior ridging and herniations, central and foraminal stenoses. Central spinal stenosis is worse at C3-4 disc level with associated cord compression and questionable minimal myelopathy of the spinal cord at upper C4 vertebral body level.

MRI Lumbar 05/08/2023:

FINDINGS: There is no fracture. Lumbar vertebra maintain their height. There are Schmorl's nodes at several levels. STIR images demonstrate no evidence of bone marrow edema or marrow infiltrating lesion.

The lower thoracic spinal cord, conus and cauda equina are normal. There is no paraspinous or intraspinal soft tissue mass, hematoma or fluid collection. There are large bilateral renal cysts. These appear to be simple cysts but cannot be further evaluated as they are only partially included on the scan. No gross change in appearance from prior scan.

T12-L1: No disc bulge. No central or foraminal stenosis.

L1-L2: Annular fissure and 4 mm left paracentral disc protrusion indenting the thecal sac and encroaching on the left lateral recess. No change from prior scan. There is posterior element hypertrophy with mild central stenosis.

L2-L3: 3 mm broad-based disc protrusion superimposed on facet and ligament hypertrophy and posterior epidural lipomatosis resulting in moderate central spinal stenosis. The disc protrudes in a left posterolateral direction encroaching on the inferior aspect of the left foramen.

L3-L4: 3 mm broad-based disc protrusion superimposed on facet and ligament hypertrophy. There is posterior prominent epidural lipomatosis. This results in moderate to severe central and moderate bilateral foraminal stenosis.

L4-L5: 6 mm broad-based disc protrusion superimposed on facet and ligament hypertrophy and prominent posterior epidural lipomatosis. There is severe central spinal stenosis. There is mild foraminal stenosis.

L5-S1: 4.5 mm right paracentral disc protrusion encroaching on the right lateral recess and impinging the descending right S1 nerve root. This has progressed compared with prior scan.

Impression:

1. Multilevel disc disease superimposed on posterior element hypertrophy resulting in segmental central spinal stenosis which is most severe at L4-L5. There is moderate to severe L3-L4, moderate L2-L3, and Mild L1-L2 foraminal stenosis. From L1-L2 to L4-L5 the appearance is stable since prior scan, details above.

2. L5-S1: Progressive Right Paracentral Disc Protrusion and Right S1 Nerve Root Compression.

Addendum:

At the L5-S1 level there is an apparent synovial cyst arising from the left facet joint medially creating additional encroachment upon the left lateral aspect of the thecal sac/lateral recess affecting the traversing left S1 nerve root as well as contributing to left foraminal stenosis which has progressed since previous examination of 10/5/2021. As described, severe central canal stenosis is present at the L4-5 level.

X-ray Cervical 2 months s/p Surgery (09/2023):

AP and lateral radiograph performed on a cervical spine again demonstrate single level plate and screw instrumentation with interbody fusion spacer stabilizing C3-4. His hardware appears to be well seated and there has been no interval change in position when compared with his last postsurgical x-rays. He does have advanced collapse and disc space height with uncovertebral hypertrophy in some slight sclerotic changes mainly noted at C5-6 and C6-7.

Differential Diagnosis

Mechanical back pain, Degenerative disc disease, Spinal Stenosis, Osteoporotic compression fracture, Spondylolysis, Kidney disease, Neoplasm, Osteomyelitis, Inflammatory arthritis, Cervical disc herniation, Cervical strain/sprain, Thoracic strain/sprain, Lumbar strain/sprain, Lumbar disc herniation, Lumbar radiculopathy, Impingement syndrome

Case Diagnosis

Functional Capacity Evaluation Correlated with Diagnostic Studies

Diagnosis By

History, Physical Examination, EMG, Radiographs, MRI, ROM-sEMG and FCE

Treatment & Follow Up

EMG/NCS studies were requested to evaluate for cervical and lumbar radiculopathy.

Electrodiagnostic Findings for lumbar evaluation (01/2023):

1. Evaluation of the left peroneal motor nerve showed reduced amplitude (1.8 mV).
2. All remaining nerves (as indicated in the following tables) were within normal limits.
3. Tibial H-reflexes are absent on the left.
4. All remaining H-Reflex latencies were within normal limits.

5. Monopolar needle EMG evaluation of the left anterior tibialis and the left extensor digitorum brevis muscles showed increased insertional activity, slightly increased spontaneous activity, and diminished recruitment. The left peroneus longus muscle showed increased insertional activity, moderately increased spontaneous activity, moderately increased polyphasic potentials, and diminished recruitment. The left gastrocnemius medius muscle showed increased insertional activity, slightly increased spontaneous activity, moderately increased polyphasic potentials, and diminished recruitment. The left lumbar paraspinals muscle showed increased insertional activity and moderately increased spontaneous activity. All remaining muscles (as indicated in the following table) showed no evidence of electrical instability.

Electrodiagnostic Impression:

1. Acute left L5-S1 radiculopathy.
2. No electrodiagnostic evidence of a focal lower extremity entrapment neuropathy, peripheral polyneuropathy, or lumbosacral plexopathy.

Electrodiagnostic Findings for cervical evaluation (01/2023):

1. All nerve conduction studies (as indicated in the following tables and graphs) were within normal limits.
2. Median H Reflex latencies were within normal limits.
3. Normal monopolar needle EMG examination (of muscles indicated in the following table), there was no evidence of electrical instability.

Electrodiagnostic Impression:

1. No electrodiagnostic evidence of cervical radiculopathy, upper extremity entrapment neuropathy, peripheral polyneuropathy, or brachial plexopathy.

Though EMG showed no evidence of cervical radiculopathy that doesn't mean it isn't there. For cervical radiculopathies, EMG sensitivities range from 50 to 71% (3). The patient is experiencing clinical signs of cervical radiculopathy on exam evidenced by his grip weakness and referred shoulder pain (4).

DynaROM was performed for cervical and lumbar ROM to further characterize any potential involuntary muscle guarding or muscular compensation in response to pain in the regions impacted by the injury (5).

DynaROM cervical summary (01/2023):

- Cervical flexion: The patient demonstrates a pattern of muscle guarding which correlates with a severe degree of pain and soft tissue injury in this motion. ROM: AMA: 50°, Patient: 30°
- Cervical extension: The patient demonstrates a pattern of muscle guarding which correlates with a moderate degree of pain and soft tissue injury in this motion. ROM: AMA: 60°, Patient: 20°
- Cervical left lateral flexion: The patient demonstrates a pattern of muscle guarding and range of motion which correlate with a moderate level of soft tissue injury and pain in this motion. ROM: AMA: 45° Patient: 31°
- Cervical right lateral flexion: The patient demonstrates a pattern of muscle guarding and range of motion which correlate with a moderate level of soft tissue injury and pain in this motion. ROM: AMA: 45° Patient: 31°
- Cervical left lateral rotation: The patient demonstrates a pattern of muscle guarding and range of motion which correlate with a moderate level of soft tissue injury and pain in this motion. ROM: AMA: 80° Patient: 51°
- Cervical right lateral rotation: The patient demonstrates a pattern of muscle guarding and range of motion which correlate with a moderate level of soft tissue injury and pain in this motion. ROM: AMA: 80° Patient: 47°

DynaROM lumbar summary (01/2023):

- Lumbar flexion: The patient demonstrates a moderate lack of flexion relaxation, indicating a possible chronic lumbar issue and moderate muscle guarding in motion. ROM: AMA: 50° Patient: 37°
- Lumbar extension: The patient demonstrates a pattern of muscle guarding and range of motion which correlate with a moderate level of soft tissue injury. ROM: AMA: 20° Patient: 10°
- Lumbar left lateral flexion: The patient demonstrates a pattern of muscle guarding and range of motion which correlate with a moderate level of soft tissue injury and pain in this motion. ROM: AMA: 30° Patient: 16°
- Lumbar right lateral flexion: The patient demonstrates a pattern of muscle guarding and range of motion which correlate with a moderate level of soft tissue injury and pain in this motion. ROM: AMA: 30° Patient: 18°
- Lumbar right rotation: The patient shows no bracing or guarding: Left and right sides fire independently, with little or no firing from the opposite side.
- Lumbar left rotation: The patient shows no bracing or guarding: Left and right sides fire independently, with little or no firing from the opposite side.

Patient was treated with chiropractic care, inclusive of Chiropractic Decompressive Mobilization, Adjustments, Ultrasound Therapy, Soft Tissue Mobilization and Electrical muscle Stimulation, which is considered to be supportive and relieving of pain and discomfort on a maintenance basis. Patient underwent a Post Anterior Discectomy and Interbody fusion with instrumentation (ACDF surgery) in July 2023, of which the two month follow up x-ray is listed above.

Patient also had a Functional Capacity Evaluation (FCE) completed utilizing JTECH Northstar software.

Summary of FCE Report:

1. Pain: Bob has a low soft tissue tolerance compared with the average male (measured via algometry). He has an increased sensitivity to pain compared with the average male.
2. Range of Motion: He has definite lumbar and cervical ROM motion limitations and did pass the Validity Test, so these motions were valid for impairment rating
3. Strength: He had demonstrable left sided motor strength loss. He had bilateral grip strength weakness compared to normal individuals his age.
4. Sensory: He has no demonstrable sensory losses.
5. Functional: He can lift 10 lbs in material handling from the floor on an occasional basis. "Occasional" refers to the Federal DOT values of up to 1/3 of a work day. He was able to lift 20 lbs from the floor but had to cease due to back pain. He displayed facial grimace, used Valsalva procedure and

postural modifications to make the lift. He displayed whitening of the knuckles during the grip strength. He is unable to return to his previous job duties described. He is capable of 15 lbs from the floor of lifting on an occasional basis. He can push and pull between 15-20 lbs on an occasional basis. He can sit and stand normally.

6. Impairment Rating: He has an impairment rating D for the cervical region and an F for the lumbar region.

7. Return To Work: He is unable to return to his usual employment.

8. Validity of Effort: Overall, he demonstrated very good validity of effort as noted in CV assessments and physiological components associated with his painful activity.

He also had a C4.3 completed, which is a Doctor's report of permanent partial impairment or maximum medical improvement. His permanency was calculated based on New York State Impairment Guidelines 2012, chapter 11 on the back table 11.2 for surgically treated conditions relative to the cervical area and 11.1 for non-surgically treated areas (6). For the scoring of his cervical region, he had positive MRI findings which equate to a score of 16 points, which equates to a severity rating of D. His lumbar scoring includes positive lumbar MRI findings (16 points), positive straight leg testing during physical exam and functional testing (4 points), positive EMG finding of Left L5-S1 radiculopathy (6 points), and negative Achilles reflex (6 points). This totaled to 32 points for the lumbar region which equates to a severity rating of F. Ultimately his ratings equate to a permanent 67% marked partial disability.

Patient is currently undergoing legal proceedings for workers compensation.

Discussion

This patient had a workup and workers compensation case which spanned almost three years from initial accident (2021) to his final C4.3 report (2024). The benefit of a lengthy workup is that the chronicity of his symptoms are evident.

From his first NDI and Oswestry score during his initial exam in 2021, to his functional capacity evaluation questionnaire scores in 2023, both scores worsened (NDI from 24% to 44% and Oswestry from 46% to 58%), indicating that his self assessed disability has not improved over the intervening years though he was treated with the best modalities available including NSAIDS, PT, epidural steroids and ACDF surgery on C3-4.

For this discussion, his cervical symptoms and lumbar symptoms will be divided to better showcase how the FCE and DynaROM studies helped correlate his symptoms with his imaging findings over the course of his workup.

Throughout the 3 years, our patient experienced neck pain radiating down his shoulders. He also had worsening grip strength as evidenced by his decreased strength measurement from his initial to the FCE (2). For grip strength, age is also a factor in the amount of strength lost, however the amount of difference in his grip testing was more than the typical age drop over two years (2). Some of this loss is likely due to disuse, from not performing his usual lifting functions with his continuing neck pain. His neck pain, which radiated to the shoulders corresponds with referred neck pain from irritation of C3/4, C4/5 and C5/6. It is difficult to precisely map referred areas to specific spinal nerve roots because referred pain of different origins often overlaps (7). We can correlate this with the significant diffuse cervical spinal stenosis with multiple herniations from C4-5 to C7-T1, with C3-4 being the largest herniation with left lateral recess stenosis.

When he left rotates or left lateral bends his head, this causes the left-sided intervertebral foramen space to become smaller in the presence of left lateral disc herniation to also become more painful, which was reflected in his ROM-sEMG (DynaROM) (5). During his DynaROM left lateral flexion, he exhibited a loss of motion with high level of right sided paraspinal activity and degree of pain. He also had limitation in left cervical rotation, which aligns with his cervical imaging, as when the left facet joint rotates in the cervical spine, it also makes the intervertebral foramen smaller and would contribute to pain from compression of the C4 nerve exiting at that level (8).

Why then, did he later complain of diffuse grip weakness instead of a specific motor function being affected, since C3-4 was specifically impacted? Of course he also has disc herniations at every level from C4-5 to C7-T1. The key issue in almost all cases of cervical radiculopathy is not only compression but also chemical inflammation, which may initially result from an acute herniation, of which he had several, but may go on to exacerbate already present degenerative changes, which was also present(4,9). Chemical radiculopathy occurs from the acute herniation releasing inflammatory cytokines, such as Phospholipase A2 and TNF-alpha, and is more common in injuries from heavy lifting, which corresponds with our patient's mechanism of injury. Chemical radiculopathy may contribute to neck pain and signs of radiculopathy without always being able to be diagnosed by EMG, as evidenced in our case, since his EMG reading was negative for radiculopathy. As previously mentioned, EMG is only sensitive 50-70% of the time in detecting radiculopathy. So though his EMG findings were negative, based on his grip muscle weakness and pain, as well as contributory imaging, he has a clinical cervical radiculopathy (4,10).

His lumbar symptoms of low back pain with shooting, tingling pain down his left buttock also persisted over 3 years. On his initial exam, he had positive left and right straight leg tests, which are commonly described as tests used to detect lumbar herniation or radiculopathy, but actually detect nerve root irritation (11). Nerve root irritation can be caused by a multitude of things, including herniation (11). Three years later, both straight leg raise tests were still positive on this FCE. He also had persistent weakness of left big toe dorsiflexion. Dorsiflexion of the great toe corresponds with left extensor hallucis longus weakness, which is supplied by L4-S1 nerves but primarily such is related to the L5 nerve root (12). The best test for looking at specific nerve damage is EMG, which in this case identified a left L5-S1 radiculopathy, aligning with his physical weakness (10).

His EMG demonstrated acute radiculopathy with multiple positive sharp waves and fibrillations and chronic changes with polyphasic potentials. With the multi-year span of symptoms with no improvement and both acute and chronic signs of damage, this suggests the development of a chronic radiculopathy from an acute injury and permanent loss of some of the axons (13). Tong et al. 2006 defined lumbosacral radiculopathy noted on EMG as abnormalities of two limb muscles plus abnormalities in the associated lumbar paraspinal muscles (13). This definition has a 100% specificity, meaning if a person meets this criteria, they have radiculopathy (13). Our patient had multiple nerves affected with two common roots affected, L5 & S1, as well as abnormal paraspinals, so he has a chronic left L5-S1 radiculopathy.

The initial imaging had noted a right paracentral herniation at L5-S1, which did not correlate with his left radiculopathy symptoms. Of course the presence of HIZ at the level of L5/S1 helps to causally-relate his injury to the work episode described. When we assessed his DynaROM studies, he had a lack of flexion relaxation, which corresponded with a possible chronic lumbar issue but was not side specific. (14)

Interestingly, our patient did not have any pain or limitation with back rotation on DynaROM. There are two possible reasons why his left and right rotations were normal. The first is that he was seated for his rotation measurements and it is possible this allowed him more comfort and less strain. The second is that the facets of the lumbosacral region are obliquely coronal and did not decrease the amount of space the nerves had to exit at the IVF on both sides (15).

Upon further examination of his lumbar MRI, development of a synovial cyst with worsening facet joint hypertrophy was identified, which severely impacting his left IVF, which explains his left L5-S1 radiculopathy. It was only through multimodal confirmation of his left radiculopathy, that we took a second look at his initial imaging and were able to determine the imaging correlating with his symptoms. It is also important to note that our patient had lumbar spinal stenosis and the chemical inflammation which can occur after acute herniation could also be a contributor to his residual back pain, though he clearly also has evidence of compressive radiculopathy (12,16).

This case study is a good example of using multiple testing modalities, including range of motion, EMG, imaging and the patient's reported symptoms to identify the processes and diagnoses causing the symptoms. In this case, the Functional Capacity evaluation and DynaROM exam were adjunctive tests which were of great benefit to describing a patient's disease burden and correlating their symptoms with their imaging.

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