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Original Articles

Annular tear of a cervical intervertebral disc treated with spinal manipulation and intermittent axial traction: a case report

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Abstract

Purpose

Annular tears of intervertebral discs represent potential pain generators and have been implicated in the development of degenerative disc changes. Symptomatic, physiologic, diagnostic and therapeutic observations will be made related to a patient with an MRI confirmed cervical annulus fibrosus tear.

Methods

A 30-year-old female patient presented for chiropractic care with insidious onset discogenic cervical spine pain, scapular and radicular symptoms. Review of magnetic resonance images revealed a high intensity zone consistent with granulation tissue of a C6/7 annulus fibrosus tear. The patient was treated using spinal manipulation, intermittent axial traction and self care instructions. Clinical outcomes were measured using the Neck Bournemouth Questionnaire and numeric pain scales. A brief review of the related literature is provided.

Results

A patient exhibiting discogenic and radicular symptoms with an identified annulus fibrosus tear of the cervical spine reported relief of painful symptoms and improved activities of daily living via chiropractic spinal manipulation, intermittent axial traction and self-care recommendations.

Conclusion

The presence of an annular tear that was visualized on MRI may have been causally related to the patient's signs and symptoms. A regimen of spinal manipulation, intermittent axial traction and compliance to self-care recommendations led to the resolution of discogenic and radicular symptoms. The clinical relationship and relevance of symptoms, signs, known physiologic tenets, imaging findings and therapeutic measures may be best considered as multi-factorial and inter-related components.

Background

Recent articles have indicated that annular tears of intervertebral discs may bear a causal link to pain and degeneration [1,2]. Various presentations of annular tears have been described [3]. Magnetic resonance imaging (MRI) has the ability to visualize annular tears and vascularized granulation tissue as high intensity zones (HIZ) on T2 weighted images (T2WI) and on post-contrast T1 weighted images (T1WI) [4]. The recognition of MRI findings correlated to known discogenic and radicular pain referral patterns and response to clinical protocols may assist in the development of diagnostic and treatment strategies.

Case Presentation

The patient, a 30-year-old female complained of cervical and left scapular pain with associated left arm paresthesia following the C6 dermatome to the hand. She reported a severe exacerbation of one week's duration that was insidious and progressive in nature. She attributed the recent flare-up of pain to lifting heavy trays during her employment as a waitress. The cervical spine, scapular and radicular symptoms were aggravated by cervical extension that adversely affected daily activities, work and sleep.

She reported a history of periodic localized neck pain following a vehicular rear end collision ten years earlier. She reported prior benefit with chiropractic management for past episodes of pain. She indicated that the current episode was the worst thus far. Over the counter Ibuprofen was taken without benefit. A review of systems and past medical, social and familial histories were unremarkable.

At worst, pain was rated 8/10 on a numeric pain scale (0=no pain, 10=the worst pain of one's life). The Neck Bournemouth Questionnaire score was 50/70. Vital signs were normal. Palpation of the left upper trapezius revealed decreased compliance and tenderness. Cervical and left scapular pain with associated left arm paresthesia was elicited on active and passive extension, left rotation and left lateral flexion of the cervical spine. Flexion of the cervical spine and Bakody's sign (abduction of the ipsilateral arm) revealed decreased neck and scapular pain with a reduction in radicular arm symptoms. Valsalva maneuver produced localized neck pain. Neurologic examination revealed no focal deficits with the exception of 4/5 left triceps weakness. Passive end range intervertebral segmental motion was restricted in left rotation and right lateral flexion at C5/6 and right rotation at C6/7.

Due to the slight motor deficit, severity, distribution and history of pain, the patient was referred for a non-contrast magnetic resonance imaging study of the cervical spine. The MRI images revealed small posterior, left parasagital subligamentous disc protrusions of C4/5 and C6/7 traversing the anterior epidural space, without

mass effect upon the cervical cord or exiting nerve roots. In addition, a posterior annular tear of the C6/7 intervertebral disc was visualized (see Figures 1 and 2).

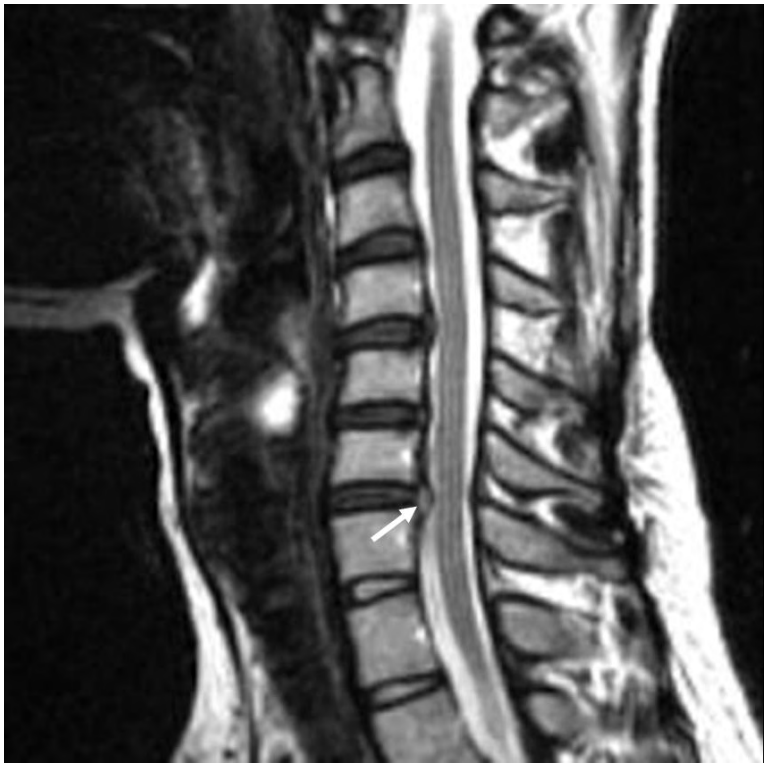

Figure 1. T2 weighted sagittal image of the cervical spine reveals three small subligamentous disc protrusions of the C4/5, C5/6 and C6/7 intervertebral discs. A posterior annular tear is noted as evidenced by increased signal intensity (white arrow).

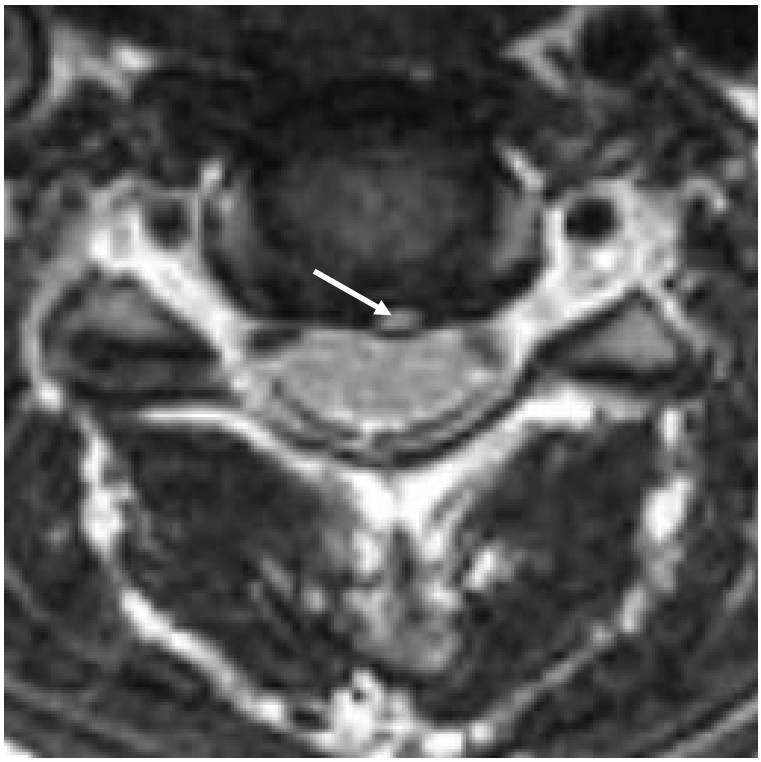

Figure 2. T2 weighted axial image of the C6/7 intervertebral disc reveals a posterior annular tear as evidenced by increased signal intensity (white arrow).

The patient was provided a course of chiropractic care that included cervical spinal manipulation in pain free ranges of motion. While in the supine position, the patient's head was elevated in a flexed posture. This supported flexed posture provided relief of pain in rotation and lateral flexion. In this flexed posture, the patient was provided low amplitude, high velocity manipulations in pain-free ranges motion at C5/6 in coupled left rotation/right lateral flexion and at C6/7 in right rotation.

In addition, the patient was provided intermittent axial traction utilizing a Chattanooga Triton DTS table with the attached Saunders cervical unit (see Figure 3). In the supine position, the patient's head was elevated 12 degrees in flexion. The amplitude of traction was progressively increased up to 25 pounds of pull at which point the patient reported diminution of cervico-scapular pain and centralization of arm pain/paresthesias. The patient was provided 20 second intervals of traction at 25 pounds of pull with an intervening decrease in axial traction at 12 pounds for 10 seconds. The patient was provided a treatment duration of 8 minutes of intermittent axial traction.

Figure 3. Photo of a model on a Chattanooga Triton DTS table with the attached Saunders cervical device.

The patient was provided self-care information related to activities of daily living that included a decrease of her work schedule for a period of two weeks and a recommendation to avoid any activity including extension of the cervical spine that provoked neck or arm symptoms. Special instruction was given to the patient related to utilizing pillows during sleep that were dense enough to maintain a few degrees of flexion in the attempt to relieve night time radicular symptoms. The patient reported this simple recommendation provided her better sleep, rest and comfort.

The patient was treated utilizing the above protocols at a frequency of three visits per week for four weeks. The frequency of care was reduced to one visit per week when she reported a sustained reduction of pain to 2/10 on a numeric pain scale and reported improvement of upper extremity paresthesia. The patient was treated a total of 16 visits. At the conclusion of care, the patient reported 0/10 pain and a Neck Bournemouth Questionnaire score of 0/70. Cervical range of motion, tissue compliance and triceps weakness had normalized.

Discussion

Regarding annulus fibrosus tears and MRI visualized HIZ, the relationship and clinical relevance of these considerations is yet unclear. Questions persist related to the prevalence of annular tears, their role in the genesis of disc degeneration, mechanisms of the propagation of tears and healing, their role as pain generators and the clinical relevance of visualized HIZ in symptomatic and asymptomatic populations that continue to

confound this issue [3, 5-19]. When considered alone, MRI visualized HIZs may or may not reflect a pain generator. However, when considered and correlated with other clinical findings, perhaps the clinical relevance of HIZ may become more meaningful.

Peng et al. attempted to evaluate whether the HIZ was closely associated with a concordant pain response on awake discography, as well as its characteristic pathology [8]. They evaluated fifty-two patients with low back pain without disc herniation who underwent MRI and discography successively. Each disc with HIZ was correlated for an association between the presence of a HIZ and the grading of annular disruption and a concordant pain response. Eleven specimens of lumbar intervertebral discs which contained HIZ in the posterior annulus from 11 patients with discogenic low back pain were harvested for histologic examination to interpret the histologic basis of a nociceptive response during posterior lumbar interbody fusion (PLIF). The study found that in all of 142 discograms in 52 patients, 17 presented HIZ. All 17 discs with HIZ showed painful reproduction and abnormal morphology with annular tears extending either well into or through the outer third of the annulus fibrosus. The consecutive sagittal slices through the HIZ lesion showed that a notable histologic feature of the formation of vascularized granulation tissue in the outer region of the annulus fibrosus. Peng et al. suggested that the HIZ of the lumbar disc on MRI in the patient with low back pain could be considered as a reliable marker of painful outer annular disruption [8].

In asymptomatic and symptomatic populations, whether a visualized HIZ represents an annular tear that is a pain generator or contributor to degenerative sequelae may be reflective of active or inactive causality. When considering the active mechanisms of healing, it is conceivable that the annular tear debris field is under a state of constant modelling and re-modelling secondary to physical stressors that may vary dependent upon activities of daily living [3, 20, 21].

Mechanisms of healing annular tears may be the result of mast cells and macrophage release of growth factors and cytokines, cellular matrix remodelling of the fibrous debris field via metalloproteinases, ingrowth of vascularized granulation tissue and neoinnervation [3]. It has been hypothesized that active discogenic pain is related to the presence of cytokines released by mast cells and macrophage within annular tears [22].

Increased intra-annular tear hydrostatic pressures may cause mechanical and peripheral propagation of the tears [23]. Early neovascularization may be susceptible to mechanical stressors as newly formed blood vessels formed at the border of the annular tear have been reported to be composed only of a single layer of endothelial cells [3]. Physical stressors may disrupt immature endothelial cells leading to edema and local intra-discal hemarthrosis. This could conceivably account for increased proton population densities that permit visualization as a HIZ on MRI.

The utilization of spinal manipulation and intermittent axial traction has been shown to be effective in the treatment of neck pain and radicular symptoms [24-30]. The intersegmental motion achieved inherent to these therapies may have a beneficial effect on healing annular tears. Salter has made convincing arguments pertaining to the importance of motion to healing joints [31]. Decompressive forces inherent to intermittent traction have been shown to improve disc cellular RNA transcription and protein matrix synthesis [32, 33]. By evaluating MRI, gene and protein expression levels, Guerhing et al., report that disc distraction results in disc rehydration, stimulated extracellular matrix gene expression, and increased numbers of protein-expressing cells. The authors reported that distracted discs showed histologic signs of tissue recovery [33].

In our case, the relationship of discogenic and radicular symptoms, clinical signs, MRI findings and reduction of pain were both diagnostic and therapeutic. Perhaps when each of these components are considered separately, their clinical relevance are non-specific and of uncertain clinical value. However, when HIZ and clinical indicators are considered in conjunction with inherent injury and healing mechanisms, perhaps improved clinical relevance and specificity can be better appreciated.

Conclusion

The utilization of chiropractic spinal manipulation, intermittent axial traction and alteration of biomechanic stressors led to a favourable resolution of cervical discogenic/radicular pain that may have been related to an annular tear. When one considers annular tears, the proposed mechanisms of healing, pain referral patterns and MRI findings, perhaps the best means to consider complex issues related to clinical relevance is to assess the sum of the parts rather than the integral components. Additional research is needed to assess these relationships.

Competing interests

The author declares no competing interests.

Acknowledgements

Written informed consent was obtained from the patient for publication of this case report and for the use of accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

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Spine 2006, **31(15)**:1658-1665.

Reprints

Abstracts & Literature Review

Kienböck's disease

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Osteonecrosis of the lunate, Kienböck's disease, is a progressive, debilitating disease process that can lead to chronic pain and dysfunction. Despite its recognition almost 100 years ago, the etiology remains unidentified, although mechanical, vascular, and traumatic factors have been implicated. The natural history of this disease is poorly defined, and the radiographic appearance does not always correlate with the clinical findings. Some progress has been made in the identification and an understanding of the progression of the avascular process and its deleterious effects on wrist mechanics. Initial treatment is nonsurgical. Advances in surgical techniques with vascularized pedicled grafts from the distal radius may lead to an improvement in outcomes for patients in the earlier stages of disease, although much more work is needed to determine whether this surgical option represents an improvement over conventional treatment alternatives. Recent reports of long-term outcomes of radial shortening osteotomy for earlier stages of osteonecrosis and proximal row carpectomy for advanced Kienböck's disease reveal that these procedures provide reliable options for the long-term management of this difficult clinical problem.

Comments:

The etiologic factors behind this disease process remain unidentified. The chiropractic orthopedist should note that the process of staging must be considered. You may not have been taught this process when you were in training. The staging of Kienböck's disease depends primarily on the radiographic findings. Staging is a critical part of the evaluation and management of patients affected with this condition, as it dictates the various treatment options applicable in each case. The classification posed by Lichtman et al. is the most commonly used and one that has shown to have good reproducibility and reliability. [1]

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Knee Bracing in Sports Medicine: A Review

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ABSTRACT

Considerable controversy still surrounds the use of knee bracing in the sports medicine patient. Several recent randomized controlled trials have shed new light on the debate. This article reviews the current clinical and biomechanical evidence supporting the efficacy of 5 brace types: prophylactic, rehabilitative, functional, off-loader, and patellofemoral knee braces. A summary of evidence-based implications and techniques for selecting and fitting these braces will also be presented. Keywords: knee bracing, prophylactic, rehabilitation, functional, offloader.

Diagnosis: Osteochondritis Dissecans

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Madhura A. Desai, MD, PhD; Laura W. Bancroft, MD; Cedric J. Ortiguera, MD

AUTHOR'S ABSTRACT: Osteochondritis dissecans (OCD) is a non-acute osteochondral fracture in which a fragment of articular cartilage and subchondral bone separates from the underlying joint surface. The knee joint is most commonly affected, and classically the defect is located at the lateral aspect of the medial femoral condyle (70%-80% of lesions). The lateral femoral condyle (15%-20%) and patella (5%-10%) are less commonly involved. Osteochondritis dissecans is most frequently encountered in adolescents and young adults. The status of the physes allows for classification of the lesion as juvenile OCD (open physes) or adult-form OCD (closed physes). Men are affected more commonly than women, and up to 25% of cases may be bilateral. The spectrum of OCD includes 1) non-displaced subchondral lesion with intact overlying articular cartilage, 2) osteochondral defect connected via an osteocartilaginous flap, 3) detached in situ osteochondral body, and 4) dislodged osteochondral loose body. An OCD lesion that detaches to form an intra-articular loose body has the potential to cause additional injury to the remainder of the articular surface. Even in the absence of a loose body, articular surface incongruity can eventually lead to mechanical joint dysfunction, further cartilage destruction, and premature osteoarthritis.

EDITORIAL SUMMARY: This is an excellent summary of the evaluation and management of a knee injury that the Chiropractic Orthopedist is likely to encounter during the course of practice. Several clinical pearls for the evaluation and management are described:

- The knee joint is most commonly affected, and classically the defect is located at the lateral aspect of the medial femoral condyle.
- The classic medial femoral condyle lesion most likely results from chronic microtrauma caused by repetitive impingement of the tibial spine against the lateral aspect of the medial femoral condyle during internal rotation.
- Patients usually present with nonspecific symptoms including pain, swelling, and decreased range of motion.
- As expected, computed tomography (CT) provides better characterization of OCD defect size compared to plain radiographs.

- Conservative management is generally effective for non-displaced lesions in juvenile OCD. Conservative management is less effective after closure of the physes, where recurrent or persistent symptoms necessitate surgical intervention.
- Loose bodies or unstable lesions should undergo operative treatment regardless of age

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Book Review

Case Report

Free Fragment Resorption at L4-5 Following Chiropractic Treatment

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HISTORY

A 38-year-old female chiropractor with insidious onset of severe pain and numbness in the left low back, left gluteal and down the lateral leg to the left foot. Numbness was present on the plantar surface of the left foot when standing or walking. Decreased proprioception was noted in the left foot upon heel strike.

There was no history of prior lower back pain or numbness. No bowel or bladder disturbances. Pain and numbness varied from a 4-8 on a scale of 1-10. The pain increased with sitting, standing or lying on her back and is constant in nature. There was disturbance in sleep as the patient cannot get into a pain free position.

No recent accident, injuries or falls. Previous traumas include being dropped on her head when she was 16 years old from about 3 feet in the air. She was taken to the ER; her examination was essentially normal. There were no x-rays or advanced imaging performed.

EXAMINATION

Kemps sign (seated) was (+) on the left increasing the pain in the lower back and down the left leg. Straight Leg Raise test on the left was (+) at 40 degrees reproducing left sided leg pain and tingling. Bragard's sign was (+) for a neural response. Dejerine's sign was (+) with coughing or sneezing reproducing left sided referred pain and numbness.

FABERE Test increased the left sided lower back pain when performed on the left leg.
Range of motion was severely guarded in all planes intensifying her back and leg pain and tingling. Muscle hypertonicity was noted in the left lumbar paraspinals of 6/10, right 5/10; left gluteal 6/10, right 4/10; left piriformis 7/10 and right 3/10. There was hypoesthesia on pinwheel testing over the left lateral leg and dorsum of the left foot. Muscle strength was within normal limits in both left and right legs, feet and toes.
AP and Lateral Lumbar radiographs were ordered (see Figure 1).

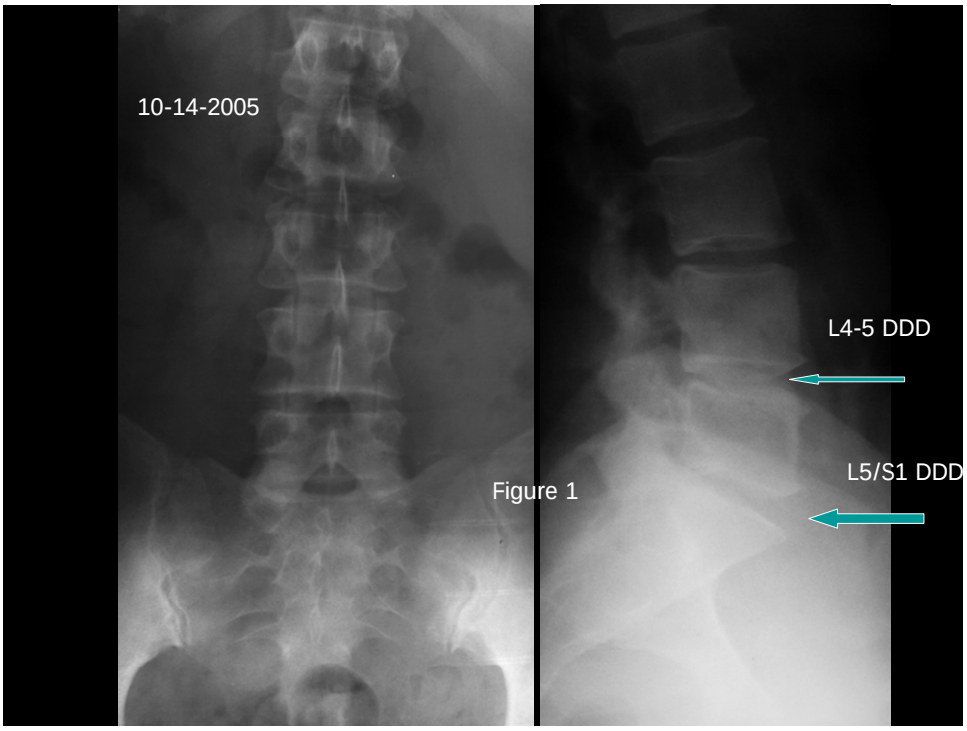

Figure1. AP and Lateral Lumbosacral views dated demonstrating Degenerative disc disease, including disc narrowing and spondylosis at the L4-5 and L5/S1 levels (See arrows above). Also noted is a mild right lateral antalgia.

TREATMENT

Over the course of the initial two weeks she was treated three times a week with flexion distraction at L4-5 and L5/S1 disc levels. Interferential therapy was applied to L4, the left gluteal and popliteal fossa. Active Release Technique (ART) was administered to the left gluteal and piriformis muscles. Acupuncture was performed at L4-5, left gluteal, left lateral leg regions and the popliteal fossa. Symptoms were not substantially altered therefore a referral was made to obtain an MRI of the lumbar spine (see Figures 2 and 3).

Treatment resumed after the MRI was obtained and increased to 4-5 days per week for four weeks, using the same treatment modalities listed above. Additionally, lumbar traction was added. Numbness in the posterior leg and foot were slowly diminishing after one month of additional treatment.

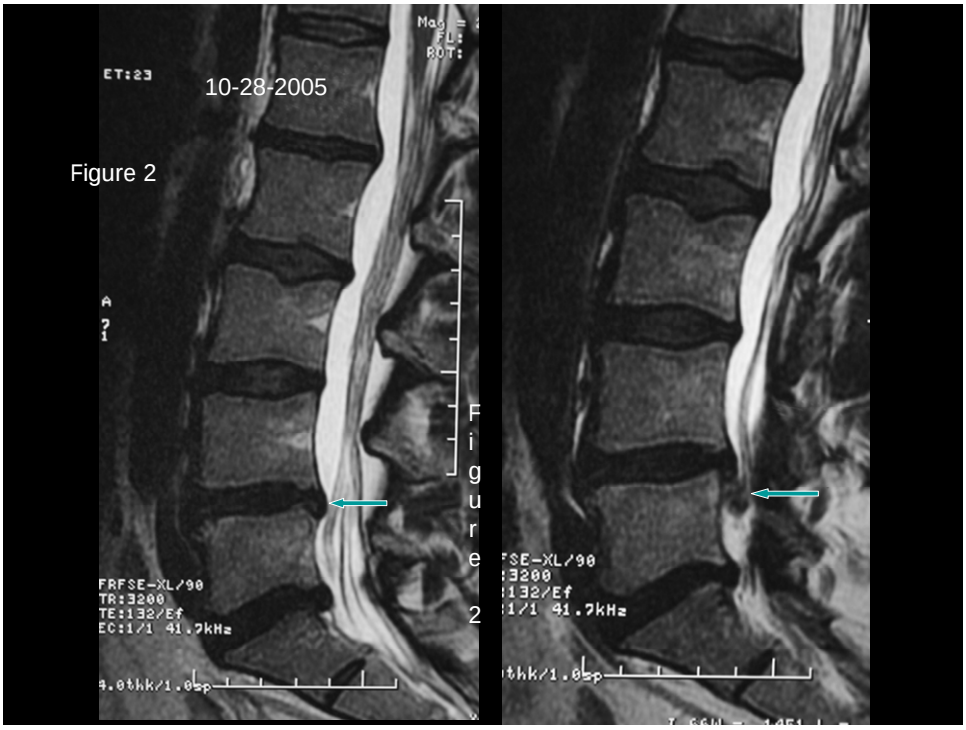

Figure2. T2 weighted sagittal images of the lumbar spine.
The left image reveals a moderate sized left posterior annular bulging (see left arrow). The image on the right demonstrates a large caudally extruded disc fragment (right arrow).

INITIAL MRI FINDINGS

Figure 2 on the left is a T2 weighted sagittal image of the lumbar spine revealing a moderate sized left posterior annular bulging. The right sided figure is also a T2 weighted sagittal image that demonstrates a caudally extruded disc fragment measuring 5-6 mm in the AP diameter and extends 11 mm caudal to the inferior margin of the intervertebral disc impinging upon the left L5 nerve root at the level of the left L5 lateral recess.

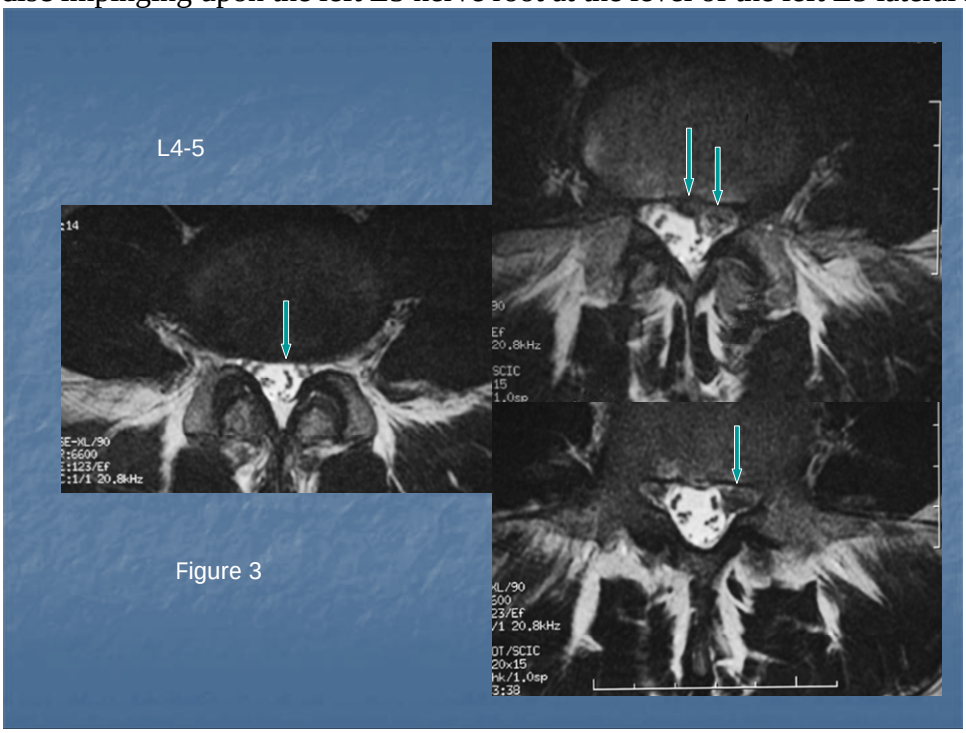

Figure 3. The left view is an axial T2 weighted image revealing annular bulging of the L4-5 disc annulus. The right top view is a T2 weighted image that reveals a disc herniation as well as a free fragment at the level of L4-5.The right lower view also demonstrates the L4-5 free fragment.

TREATMENT CONTINUED

Treatment was decreased to three times a week for three weeks then twice weekly, with positive results. The patient's hypertonicity/ spasms and numbness were gone within two months time. The patient was able to work to full capacity and regained normal proprioception in the left foot.

FOLLOW UP MRI

With the significant progress made by the patient over the 6 weeks a limited MRI of the lumbar spine was performed for comparative purposes (see Figures 4, 5 and 6).

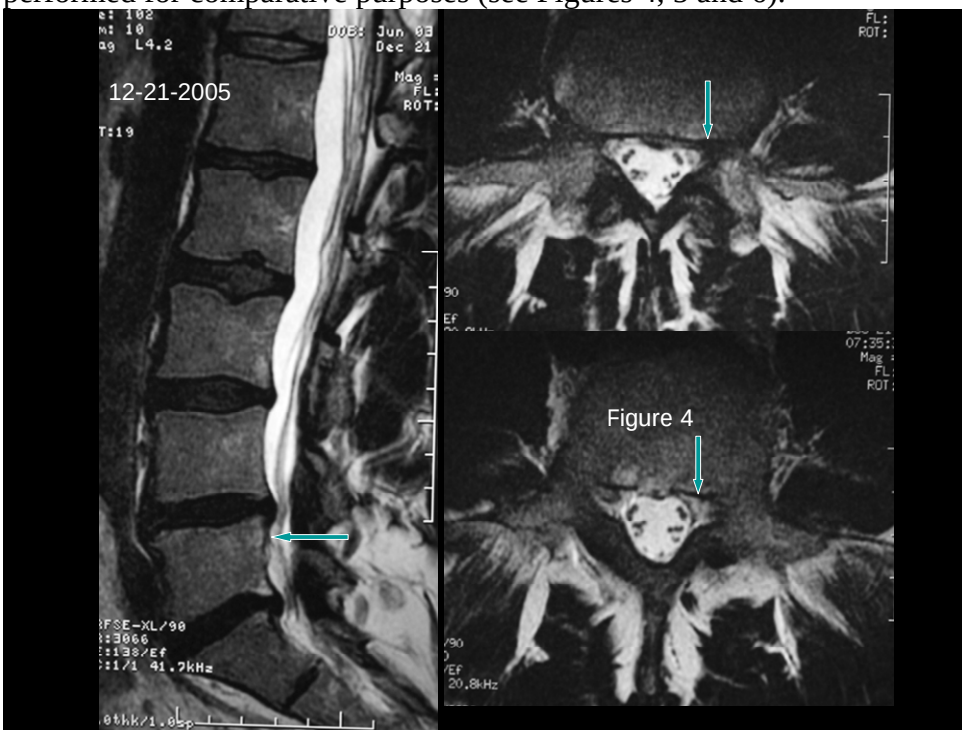

Figure 4. This figure shows both sagittal and axial views that are T2 weighted images approximately 7 weeks after the initial MRI demonstrating a significant reduction in the size of the L4-5 disc herniation and almost complete resorption of the free fragment.

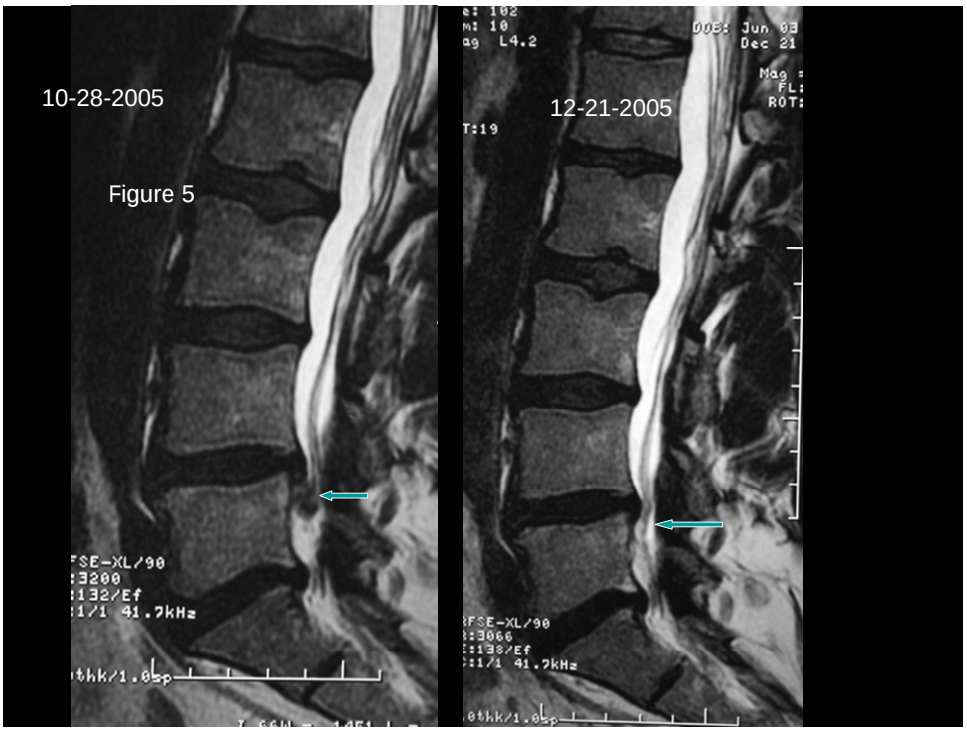

Figure5. T2 weighted sagittal images contrasting the large extruded disc herniation on the left with the absence of this fragment on the right. (see arrows).

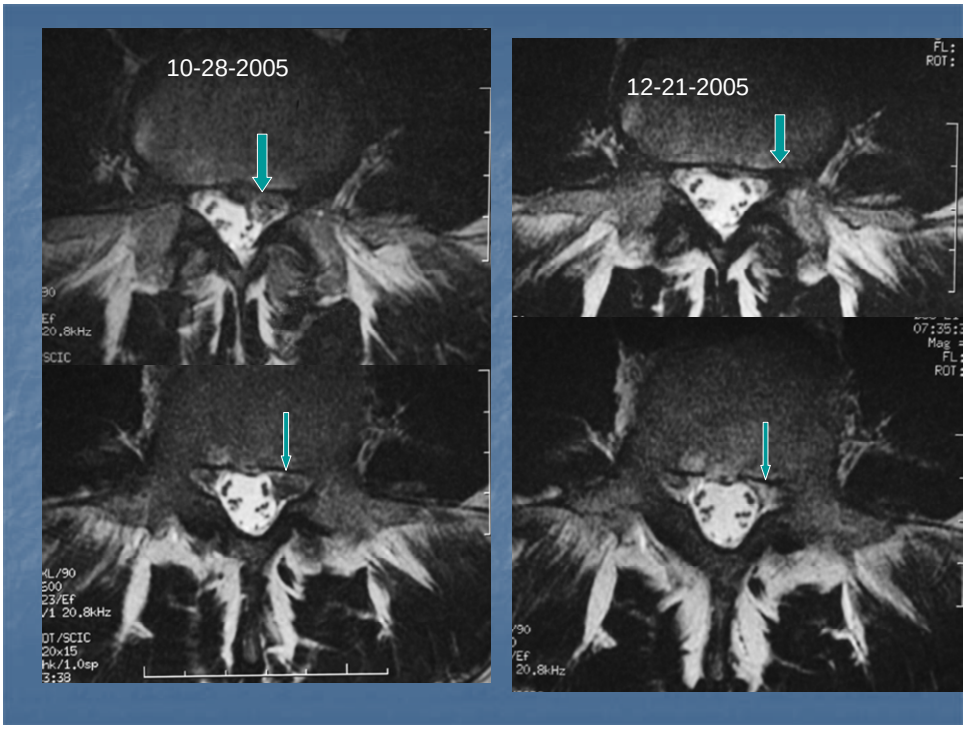

Figure6. The left and right images are T2 weighted axial images These four images compare and contrast the presence of a large extruded disc herniation on the left with its resorption being evident on the right (see arrows).

DISCUSSION

The resorption of extruded disc material has been well documented previously in the literature.

Cowan et al did a prospective study which was set up to record the changes in the intervertebral disc accompanying resolution of sciatica following conservative treatment [1]. Patients presenting with sciatica (n = 165) were examined by computed tomography (CT) of the lumbar spine. Disc lesions were classified into the following groups: herniation, sequestration, generalized bulge and focal bulge. Follow-up CT of the pathological disc was performed in 106 of the 165 patients after 1 year and identical anatomical sections were compared. All patients were initially treated conservatively by the injection of steroid and local anesthetic at the intervertebral disc/nerve root interface. Of 84 cases of disc herniation and sequestration 64 (76%) showed either complete or partial resolution on follow-up CT examination. Of 22 cases with either a generalized or focal bulge of the disc 18 (82%) were unchanged on follow up.

Ahn et al, outlined in their abstract magnetic resonance imaging of symptomatic herniated lumbar discs was investigated longitudinally and prospectively for the presence of tear in the posterior longitudinal ligament (PLL). 1. Greater regression of the herniated fragment was noted with larger initial disc herniations. 2. The exposure of herniated disc materials to the epidural vascular supply through the ruptured PLL has been suspected to play a part in the mechanism of disappearance of the herniated nucleus pulposus. Clinical outcomes and magnetic resonance images of 36 patients with symptomatic lumbar disc herniations, treated conservatively, were analyzed. Patients were divided into three groups: subligamentous, transligamentous, and sequestered herniations. The size of the herniated disc was measured by herniation ratio, which is defined as the ratio of the area of herniated disc to that of the thecal sac on the axial view. Of the 36 herniated discs, 25 decreased in size. Ten (56%) of 18 subligamentous herniations, 11 (79%) of 14 transligamentous herniations, and all 4 (100%) sequestered herniations were reduced in size. The average decreases in herniation ratio of the subligamentous, transligamentous, and sequestered disc groups were 17%, 48%, and 82% respectively. The decrease in herniation ratio was related to the presence of transligamentous extension but was not related to the initial size of herniation. Successful outcome correlated with a decrease in herniation of more than 20%. Transligamentous extension of herniated disc materials through the ruptured PLL was more important to its reduction in size than is the initial size of the herniated disc. Decrease in herniation ratio of more than 20% seems to correspond to successful clinical outcome.

Maigne et al, prospectively followed the natural evolution of lumbar disc herniation in 48 patients treated by conservative measures. The initial computed tomographic scan was obtained during the acute phase of the disc herniation and the second was performed 1-48 months after healing. The initial computed tomographic scan allowed classification of the herniations according to size: 13 were considered small, 20 medium and 15 large. Comparison with follow-up computed tomographic scans showed that 9 of the herniations decreased by at least 25%, 8 decreased between 50 and 75% and 31 decreased between 75 and 100%. In the latter group, a few had disappeared even though the second computed tomographic scan was performed as early as the month immediately after successful treatment. The largest herniations were those which had the greatest tendency to decrease in size. It is postulated that this could be secondary to the herniation breaking through the outer fibers of the anulus and entering the epidural space.

CONCLUSION

It is apparent from the literature that there are several factors which may determine if an extruded disc herniation may resorb. When the disc material is located in the epidural space[3], which is an area of greater vascularization triggering an assault on this “foreign body” by the macrophages. The herniations with the greatest tendency to resorb were larger herniations[3]. 79% of all transligamentous herniations and 100% of all sequestered herniations were reduced in size[2].

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Advanced Imaging was performed at the Center for Diagnostic Imaging (CDI) in Mendota Heights, Minnesota.

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Imaging the Adolescent Low Back: Spondylolysis in the Adolescent Athlete

Thomas J. Gilbert M.D., M.P.P.

INSIDE THIS ISSUE

Thomas J. Gilbert, M.D. presents a case study, peer-reviewed research, and a review of the CDI experience with imaging techniques in the diagnosis and treatment of spondylolysis in the adolescent patient. Dr. Gilbert emphasizes early detection in order to promote healing, to prevent the development of chronic spondylolysis, and to limit the long-term risks of symptomatic degenerative disc disease.

Thomas J. Gilbert, M.D., M.P.P., Spine Radiologist

Case Presentation

A 13-year-old female gymnast presents with a 10-week history of activity-related left low back pain. She recalls no specific injury, however, practices gymnastics 15 hours a week. She has been limiting her activities; however, her pain has persisted. The patient denies any sensory changes or weakness, bowel or bladder problems, or fevers or night sweats. Both mother and daughter are concerned, as the daughter is scheduled to compete in a state gymnastics meet in two weeks. A spine radiologist was consulted over the telephone and recommended that MRI be obtained to evaluate for spondylolysis, a herniated disc, or symptomatic disc disease.

The MRI of the lumbar spine was performed with sagittal STIR images and showed marrow edema within the L5 pedicles and pars interarticularis bilaterally. On the right, minimal marrow edema was seen and associated with a defect within the pars interarticularis (Figure 1). On the left, prominent marrow edema was seen with loss of definition of the inferior pars cortex (Figure 2 on page 2). The diagnosis of subacute bilateral L5 spondylolysis was made with an early symptomatic lesion on the left, and a more chronic subacute lesion on the right.

Background

Spondylolysis is defined as a defect of the pars interarticularis and occurs most commonly at L5.[9,11,36,45] Symptomatic spondylolysis occurs almost exclusively in children and adolescents and most likely represents a stress fracture, the sequela of chronic repetitive injury.[15,22,23,27,31,38,49,50,55] Previous clinical research has revealed:

- Spondylolysis is a common cause of back pain in childhood and adolescence,[29] and is commonly seen in athletes.[22]
- The incidence of spondylolysis had been reported to be 4.4% at age 5, and 6% in the adult.[11,36,54]
- It is more common in males,[11,28,36,45] and has a familial incidence of between 19 and 31%.[1,11,30,57,59]

(continued on page 2)

FIGURE 1a

FIGURE 1b

FIGURE 1c

Figure 1: Right L5 late subacute spondylolysis. Marrow edema is minimal with a mild decrease in signal within the pedicle and pars interarticularis on T1-weighted images (1a), relative increase in signal intensity on T2-weighted images (1b), and a slight increase in signal intensity on STIR images. This is associated with a complete defect within the pars interarticularis (1c arrow).

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(continued from page 1)

The different appearances of spondylolysis on plain radiographs and computed tomography (CT) most likely represent the orderly progression of a stress-related injury of the pars interarticularis.[31,49] As with stress fractures within the long tubular bones, the earliest lesions show a localized area of cortical rarefaction. In our experience, this localizes almost exclusively to the inferior pars cortex. A thin fracture line subsequently develops within the inferior pars cortex, and with progression, may extend cephalad or dorsally through the pedicle, superior articular facet, or lamina. The completed fracture line may widen, and may become irregular or fragmented. Chronic end-stage fractures with nonunion will show cortication of bone on the margins of the fracture line.[33] Early lesions show rarefaction of bone on the margins of the defect. Both subacute complete lesions and chronic lesions may be associated with variable degrees of spondylolisthesis.

Plain radiographs

AP and lateral radiographs are often the initial study in these patients, however, may be misleading. Plain radiographs are frequently normal in patients with early stress fractures,[15,22,23,49,55] and normal plain radiographs may lead to a false diagnosis of lumbosacral strain without underlying bony abnormality.[35,37] Lumbosacral strain is a less common diagnosis in adolescents, accounting for only 6% of patients, while spondylolysis is present in up to 47% of patients.[29] Early spondylolysis is typically not detected on plain radiographs. When spondylolysis is seen, it is more likely to represent a chronic lesion, which is often asymptomatic, and may be incidental to patients' symptoms.[22] Low back pain, when present in patients with chronic spondylolysis, is more likely secondary to microinstability, a disc herniation, or to symptomatic disc degeneration.[16,17,38,41,52]

Bone scintigraphy with SPECT

Early spondylolysis is readily detected on bone scintigraphy as are stress fractures in the tubular bones.[22,23,33] A positive bone scan indicates that a stress fracture or spondylolysis is the source of pain.[5,21,24,34] Increased uptake on radionuclide bone scan also indicates that the lesion is active and retains some potential for healing. Bone scintigraphy can distinguish actively healing fractures from chronic spondylolysis with nonunion.[5,10,24,32,33,48]

Patients with a positive bone scan and negative x-ray show resolution of pain and a subsequent decrease in uptake with immobilization.[4,21,48] Raby and Mathews also showed a correlation between abnormal uptake and resolution of pain with lumbar fusion in patients with spondylolysis.[34] Resolution of activity on bone scintigraphy does not necessarily indicate healing however. Abnormal uptake reverts to normal both with healing and with development of a chronic non-union.[25,48]

The sensitivity and specificity of scintigraphy for stress fracture and spondylolysis are increased significantly with single photon emission computed tomography (SPECT).[3,4,5,12,21,40] SPECT can detect stress injuries not seen with planar bone scan or with radiography,[2,3,4,5,12,21,37,39,40] and it allows more accurate localization of scintigraphic abnormalities than does planar bone scanning.[3,5,39,40] Bellah reported the results of SPECT scanning in a series of 162 young patients with back pain exacerbated with hyperextension and noted abnormal SPECT scans in 71 (44%) of patients. Planar bone scans detected abnormalities in only 39 of these 71 patients.[3] Ryan et al. noted abnormal planar scans in 28 of 48 patients with abnormal SPECT scans, and found that planar scans detected only 49% of all lesions noted on SPECT scans.[40]

Magnetic Resonance Imaging (MRI)

MRI can also detect early or subacute spondylolysis and may be preferable to bone scintigraphy with SPECT. Several authors have reported signal changes within pedicles of lumbar vertebrae in association with a stress fractures or spondylolysis.[14,18,42,46,47,56,58] Ulmer and colleagues observed abnormal signal intensity within the pedicles of 36-40% of patients with spondylolysis, and noted that these changes were similar to those described within vertebrae adjacent to degenerating discs by Modic et al.[8,30,46,47] Yamane et al. reported that in a group of young patients with pain on extension, abnormal low-signal intensity appeared within the pedicles on T1-weighted images prior to the development of a fissure on plain x-ray or CT. They suggested that this may be useful in the diagnosis of early spondylolysis.[58] Stabler et al. reported bone marrow edema within the pedicles and pars interarticularis in nine patients with back pain on hyperextension.[42]

Patients with chronic spondylolysis have either normal marrow or fatty replacement of marrow adjacent to a cortical discontinuity within the pars interarticularis. Chronic lesions

(continued on page 3)

FIGURE 2a

FIGURE 2b

FIGURE 2c

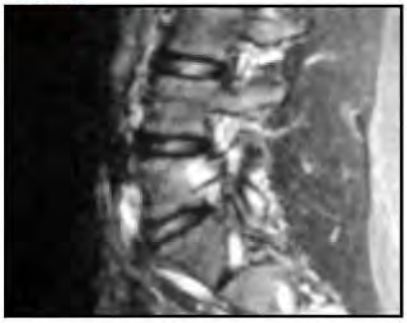

Figure 2: Left L5 early spondylolysis. Marrow edema is noted in the pedicle and pars interarticularis and shows low signal intensity on T1-weighted images (2a), a relative increase in signal intensity on T2-weighted images (2b), and high signal intensity on STIR images (2c). This is associated with an incomplete defect within the inferior pars cortex (arrow).

TABLE 1: CT Findings in Patients with Marrow Edema on MRI							
	Early Incomplete Spondylolysis on CT	Subacute Complete Spondylolysis on CT	Pedicle Stress Fracture on CT (Complete or incomplete)	Facet Fracture/Avulsion on CT	Chronic Spondylolysis on CT	No fracture (Facet arthropathy or endplate erosions)	Total for pedicles with MRI findings
Marrow edema with no discontinuity on MRI	25	2(6%)	3(9%)	2(6%)	0(0%)	3(9%)	**35**
Marrow edema with discontinuity on MRI	10	9(45%)	1(5%)	0(0%)	0(0%)	0(0%)	**20**
Total for pedicles with CT findings	**35(64%)**	**11(20%)**	**4(7%)**	**2(4%)**	**0**	**3(5%)**	**55**

can be distinguished from early and subacute lesions on T1-weighted images and on STIR images. On T1-weighted images, marrow will show either normal or high signal adjacent to chronic lesions, and low-signal intensity adjacent to early lesions. On STIR images, marrow will show low signal adjacent to chronic lesions and high-signal intensity adjacent to early and subacute lesions.

In a retrospective study at CDI, we reviewed MRI reports from a two-year period, January 2000 through December 2002, and found reports of abnormal high-signal intensity on T2-weighted images in 109 pedicles from 79 patients (Table 1).[18] Thin section CT was available for comparison for 55 pedicles with marrow edema on MRI, and showed early incomplete spondylolysis in 35 patients (64%), subacute complete spondylolysis in 11 (20%), subacute pedicle fractures in four (7%), and facet fractures in two (4%). Each of these patients was 18 years of age or less. Marrow edema was seen with bilateral facet arthropathy in a 20-year-old, and with inflammatory spondyloarthropathy in a second 20-year-old. CT showed chronic spondylolysis in 12 of 12 cases with either normal or fatty marrow adjacent to a cortical defect within the pars interarticularis.

Hollenberg et al. have developed a five-stage, classification system based on the presence of high-signal intensity within the pars and adjacent pedicles on T2-weighted, fat-saturation images, and on the integrity of the pars interarticularis on T1 or T2 images.[18] In Hollenberg's classification scheme, grade 0 patients show normal signal within an intact pars interarticularis. Grade 1, 2, and 3 patients all show increased signal on T2 fat saturation images with an intact pars interarticularis (grade 1); thinning, fragmentation, or irregularity of the pars interarticularis (grade 2); or a visible spondylolytic defect (grade 3). Grade 4 patients show a spondylolytic defect and normal signal. In our experience, the differentiation between Hollenberg grade 1, grade 2, and grade 3 lesions can be difficult on routine clinical MRI. In the CDI study described above, we did find that early incomplete spondylolysis was more common on CT in pedicles with marrow edema and no cortical defect on MRI, while subacute complete spondylolysis was more common on CT in pedicles with marrow edema and a discreet cortical defect on MRI.

MRI may be preferable to bone scintigraphy with SPECT in children and adolescents with activity-related back pain. MRI does not expose the child to ionizing radiation. In addition, MRI can detect associated abnormalities and is more accurate than CT and SPECT in the detection of disc degeneration, annular tears (HIZs), disc herniations, and stenosis. Up to 56% of adolescents with back pain will have no abnormalities on bone scan with SPECT.[3] Disc degeneration, disc herniations, and lumbosacral Scheuermann's disease will remain differential considerations in these patients.

MRI, on the other hand, offers a comprehensive look at the spine, and a negative MRI of the spine will assure the referring physician that no significant structural pathology is present in these patients.

Computed Tomography (CT): Staging and Prognosis

CT is more accurate than plain radiographs in the diagnosis of spondylolysis, and can confirm the presence of a lesion in patients with abnormal SPECT scans and abnormal MRI scans.[6,39,44] The majority of positive lesions on SPECT and MRI will have an identifiable lesion on CT.[6,13,39]

CT can characterize spondylolytic lesions and may assist in determining prognosis in patients with a positive bone scan or SPECT scan.[6,31,58] The rate of healing is much higher in patients with early lesions. Yamane et al. classified abnormalities on CT as prefissure, fissure, and pseudarthrosis.[58] Prefissure lesions showed no defect on initial CT images, however, developed a defect on subsequent follow-up examinations. All seven of the prefissure cases went on to heal at a mean follow-up of 3.9 months. Of the patients with a discreet fissure on CT, 58% went on to heal at an average of 4.9 months. None of the 42 patients with a pseudarthrosis-type of abnormality went on to heal.

In a similar study, Morita and coworkers reported on 185 adolescents under the age of 19 with back pain and spondylolysis on CT.[31] Lesions on CT were classified as "early" if they showed focal bony absorption or a hairline defect; "progressive" if the defect was wide and small fragments were present; and "terminal" if sclerotic changes were noted. All patients were advised to discontinue sports and to use a lumbar corset for three to six months. Healing was noted in 87 (73%) of 119 early defects, in 42 (38.5%) of 109 progressive defects, and in none of the 118 terminal defects at three to six months. Early detection and immobilization may increase the chances of healing and may prevent progression of disease and the development of spondylolisthesis.[10, 22, 23, 31, 51, 55, 58] Healing may limit the lifetime risk of degenerative disc disease and low back pain in these patients.

Several authors have reported an increase in the incidence of disc degeneration at the level of the defect in patients with chronic spondylolysis and spondylolisthesis, while others have reported an increased incidence of disc herniation at the level above the spondylolysis.[7,17,26,41,43,51] Degenerative disc disease in these patients appears to be proportional to the degree of spondylolisthesis and is greater in patients with high-grade spondylolisthesis.[20,41] Patients with chronic spondylolysis and spondylolisthesis have been shown to have an increased incidence of low back pain over their lifetime.[19,41,59] Hult reported that subjects with spondylolysis have a 24% greater likelihood of eventually developing significant back pain over their lifetime.[19]

(continued on page 4)

Summary

Spondylolysis is a common diagnosis in young patients with activity-related back pain, and may be amenable to healing if detected early. With respect to imaging, the following points can be made:

- Plain radiographs are often the initial imaging study in patients, however, can be misleading.
- A radionuclide bone scan or SPECT will show abnormal increased uptake with early or subacute spondylolysis. In these patients, increased uptake indicates that the spondylolysis is the source of pain, and that the lesion retains some potential healing. The integrity of the intervertebral discs and facet joints is not assessed on SPECT scans.
- MRI can detect early or subacute spondylolysis and can also detect disc herniations, disc degeneration, and facet derangement. MRI does not expose the patient to ionizing irradiation. At CDI, we have found that marrow edema within the pedicle is typically associated with stress fractures or chronic repetitive injuries of the posterior elements in adolescents and children.
- CT can be used to confirm the presence of these abnormalities whether detected on SPECT or MRI, can characterize or stage lesions, and can assess for healing in patients undergoing treatment.

Early detection and healing is important in patients if one is to limit the development of spondylolisthesis and the lifetime risk of symptomatic degenerative disc disease.

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Editorial Comments

Current Events

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ACADEMY *e-Journal*

CURRENT ADVANCES IN ORTHOPEDIC SPECIALTY EDUCATION AND ACADEMY PUBLICATION

Stephen D. Capps, DC, FACO
Current Events Editor

With current trends of educational opportunities incorporating the internet learning experience along with live sessions, the orthopedic specialty will soon utilize the internet medium to accelerate the orthopedic diplomate program and offer the student the opportunity to complete the program in as little as two years. This venue will not only shorten the duration of study but will reduce the overall cost to the student by providing fewer sessions that require travel and hotel expense. Palmer College of Chiropractic is the first to offer such an educational experience in the orthopedic diplomate program area.

As the profession advances along post graduate and graduate level study pathways the computer and internet will prove to be a key cost reducing benefit to those educational areas of the profession. Post graduate and graduate education will be more attainable and more cost effective than in years past.

The public, our patients and other health care professionals are aware of and respect a doctor of chiropractic's credentials in the same way they respect other medical professionals' advanced designations. With this increasing need to maintain a higher level of academic credential, the chiropractic physician will directly benefit from a specialty diplomate and advanced degree. The post graduate orthopedic diplomate program and the Masters of Science (PM&R) program developed for the orthopedic specialty both offer the pathway to orthopedic specialty board certification.

The orthopedic specialist and the chiropractic physician can find other opportunities to enhance their professional credentials and standing in the community through publication of peer reviewed articles. It is not necessary to always publish in the most elite professional journals. Scholarly journals of the profession and specialty offer an excellent venue for publication of material that otherwise would initially be rejected not because of content but due to the inexperience of the author.

The Academy of Chiropractic Orthopedists *e-Journal* offers the profession and orthopedic specialty the opportunity to publish various types of scholarly articles through a peer review process. The Academy *e-Journal* is dedicated to developing the orthopedic specialty of the chiropractic profession through scholarly peer reviewed publication. The editorial board of the *e-Journal* offers a mentoring process to help aspiring authors develop their authoring skills in a supportive environment.

The Academy *e-Journal* with DCConsult of the Foundation of Chiropractic Education and Research (FCER) have partnered in a unique program to have case reports, clinical topics and other chiropractic orthopedic investigative/research work promulgated on DCConsult. Recently FCER undertook moving DCConsult, a site designed to meet the evidence-based information needs of the chiropractic profession, into the free-access domain. The content has changed and the search engines are more powerful. The DCConsult website is now

available to Google searches and “clicks,” both activities earning the orthopedic specialty and chiropractic profession valuable exposure, far beyond the usual profession-only users.

This partnership program between the Academy *e-Journal* and DCConsult offers authors of articles published through the Academy *e-Journal* the opportunity to present to a larger audience of both professional and lay readers than ever before. Those doctors published through the Academy *e-Journal* will have a distinct advantage. That is, their patients (and prospective patients) can simply Google the doctor’s name to read these published articles. The published doctor will appreciate the added credential and exposure associated with being a published author as a true benefit, not only for the publicity to their practice but also for the respect accorded to a published author by the entire health care community.

Attribution

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