ORIGINAL ARTICLE

Diagnosis of the Vertebral Level from Which Low Back or Leg Pain Originates. A Comparison of Clinical Evaluation, MRI and Epiduroscopy

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■ **Abstract:**

Background: The precise localization of painful structures in the spine of patients with low back pain and/or pain radiating (LBP/RP) to the lower extremities is important for targeted therapeutic intervention. The aim of the study reported here was to determine and compare the spinal segment(s) where pain was elicited via endoscopic evaluation vs. the vertebral level from where the pain was thought to originate as determined by clinical evaluation and by MRI.

Methods: Observational cohort study of 143 patients 19 to 88 years of age undergoing spinal canal endoscopy (epiduroscopy) in a combined academic and private practice setting January 2008 to December 2008. Patients were asked whether pain generated by pressure upon epidural structures with the tip of an endoscope was similar in character and distribution (concordant) to the pain for which patients sought treatment. Notes from clinical evaluation and MRI reports were reviewed, and segmental level determined to be the locus of pathology was tabulated.

Results: One hundred twenty-five (87%) patients reported maximal reproducible pain at a specific level during epiduroscopy. The most common level was at L4 to L5 (87 patients). The least common level was L5 to S1 (2 patients). In only 40 patients did the level determined by clinical evaluation correlate with the level at which pain could be reproduced during epiduroscopy. MRI indicated a specific vertebral level that corresponded to the level at which pain could be reproduced during epiduroscopy in 28 of 143 (20%) patients. The results of the 3 diagnostic methods were significantly different ($P < 0.01$).

Conclusion: Results of this study indicate that epiduroscopy is more reliable than is either clinical evaluation or MRI for determining the vertebral level where clinically significant spinal pathology occurs in patients with LBP/RP. ■

Key Words: low back pain, radiating pain, vertebral level, epiduroscopy, lumbar MRI, clinical evaluation

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INTRODUCTION

Despite the advancement of percutaneous pain management techniques and the use of rigid endoscopy in surgery of the spine, direct observation of spinal pathology other than through a standard surgical wound is still limited. Thus intervention at the correct spinal segment(s), even surgically, relies on accurate clinical examination and imaging such as with CT scan or magnetic resonance imaging (MRI). The diagnosis of the correct vertebral level through *clinical evaluation* often depends on dermatomal, myotomal, and sclerotomal distributions of the nervous system. Identification of these patterns in clinical practice is often ambiguous.[1–4] MRI is considered by many to be the gold standard for localization of common spinal pathology, but the accuracy of MRI has been questioned.[5–11] These limitations may make the choice of the correct level of therapeutic intervention challenging.[1,12]

Flexible endoscopy of the epidural cavity (epiduroscopy) can be used to evaluate the contents and visualize pathology of the lumbar spinal canal as well as locate tissue that when pressed elicits pain.[13,14] All segments in the lumbar canal can be examined bilaterally via a single entry through the sacral hiatus. Epiduroscopy is mostly performed under monitored anesthesia care allowing direct communication with patients. This permits evaluation of the patient's response to manipulation of epidural structures in distinct regions of the epidural cavity. If pain produced by contact with epidural structures is similar in nature and distribution to the pain for which the patient is seeking treatment (concordant pain), it can be assumed that this region of the spinal canal is directly or indirectly related to spinal pathology of interest.[2,4] The aim of the study reported here was to compare the clinically significant vertebral level identified through endoscopic evaluation with the level determined through clinical evaluation (history and physical examination) and the level determined with MRI and to obtain the frequency distribution of the vertebral levels at which a concordant pain response could be evoked through epiduroscopy.

METHODS

After approval from the Texas Tech University Health Sciences Center Institutional Review Board for the Protection of Human Subjects was obtained (IRB L05099), a prospective observational study of 143 patients was performed. Written consent was obtained from all subjects. Epiduroscopy was performed on patients, 19 to 88 years of age, median 55 years, 57 men and 86 women, with back pain and/or radiating pain. Patients were entered into the study if symptoms were chronic (> 6 months), if surgery on the spine was not indicated (eg, presence of intractable pain and/or neurologic deficit), and if conservative treatment, including epidural corticosteroid injections, failed to provide adequate pain relief. Patients with prior surgery on the lumbar or sacral spine were included in the study. Routine epiduroscopy assisted by fluoroscopy was performed under monitored anesthesia care as described previously.[13]

After infiltration of the access site with local anesthetic, epidural access was established by placing a sheath through the sacral hiatus using the Seldinger Technique. Then, a flexible epiduroscope (Storz, 2.7 mm) was advanced through the sheath into the posterior epidural cavity while saline was infused through the working channel of the scope. A defect was considered to be present if major obstruction to scope advancement was encountered. In the absence of such obstruction, posterior epidural, lateral recesses, neuroforamina, and the anterior epidural cavity were systematically evaluated visually and by touching epidural structures with the epiduroscope tip between the vertebral levels of L2 and S2 to identify the presence of painful regions.

Concordancy

Patients were asked whether the pain generated by pressing upon discrete areas in the epidural cavity with the tip of the epiduroscope was similar in distribution and character to the pain for which the patient was seeking treatment. (Figures 1, 2, 3) This was compared with the nonpainful response to touch when an anatomical structure such as a nerve root in a different region of the epidural cavity was touched.

Level Definition

The vertebral level was defined as the region between the mid points of 2 subsequent pedicles, for example, L5 equals the midpoint between L4 and L5 pedicles, as observed through fluoroscopy or MRI where the concordant pain could be generated. The following 5 regions were included in the study: the region corresponding to the level of L3 to L4, L4 to L5, or L5 to S1 and the region above L3 or below the pedicle equiv-

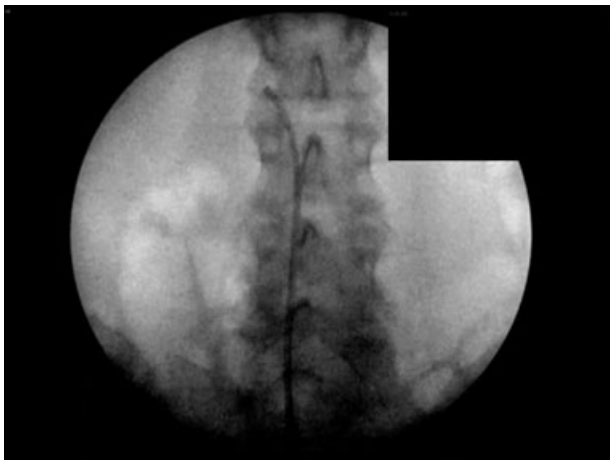

Figure 1. A flexible fiberoptic endoscope is placed in the neuroforamen at L2 to 3. If back and leg pain can be reproduced with respect to character and distribution, the level is considered to be of clinical significance.

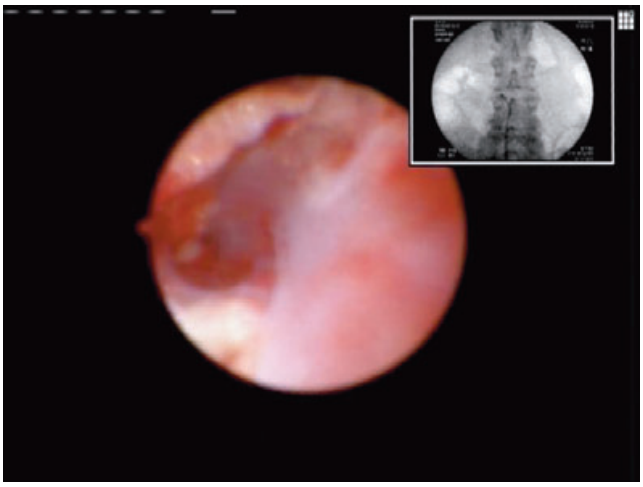

Figure 3. The posterior longitudinal ligament is hyperemic (left L4 lateral recess). This suggests the presence of clinical significant pathology.

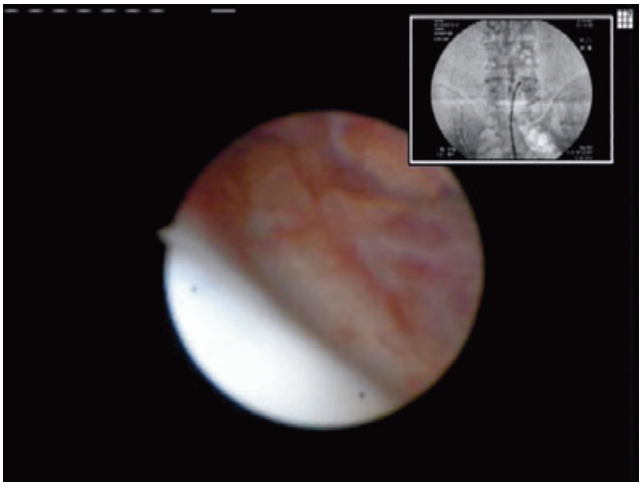

Figure 2. The nerve root of L5, posterior longitudinal ligament and Batson's plexus are visible in the lateral recess just cephalad to the pedicle of L5. Each structure can be touched and evaluated for the presence of *concordant* pain.

alent of S1. If more than 1 level was identified where the response was concordant to a component of the pain, more than 1 level was considered to contain clinical significant pathology.

MRI Reports

Routine MRI evaluation of the lumbar spine reported by qualified radiologists was used to determine the vertebral level of pathology (eg, spinal stenosis, degenerative disk disease, etc.) from which the pain was thought to originate. The vertebral level was defined as the region between the mid points of 2 subsequent pedicles as identified by MRI. Only pathology reported as moderate or severe was considered to be significant. If moderate or severe pathology was identified at more than 1 level, more than 1 level was considered to be of clinical significance.

Clinical Evaluation

As in most instances, back pain and accompanying pain that radiates down the leg do not follow a precise dermatomal distribution, referred pain patterns and associated spinal segments as described by Feinstein, Inman, and Kellgren were used in the clinical evaluation.[15–17] Thus, the vertebral level was defined as the region between the mid points of 2 subsequent pedicles at which the pathology was *presumed* to be present based on the following radiating patterns: Pain at the lateral posterior thigh, lateral calf, and dorsum of the foot was considered to be associated with the segment of L5 and pathology located in the region of the L4 to 5 vertebral level. Pain radiating over the anterior lateral thigh and anterior medial shin was considered to be associated with the segment of L4 and pathology located at the region of the L3 to 4 vertebral level. Pain at the anterior thigh or the groin was considered to represent pathology above the pedicle of L3, while pain referring down the posterior thigh, calf, or heel was associated with pathology at the region of L5 to S1 or below.

Comparison

The vertebral level as identified by each method was compared as follows: (1) If 2 methods identified the same levels as clinically significant, the findings were considered to be in agreement. (2) If methods identified different single or multiple levels, the findings were considered to be in disagreement.

Statistics

Results were evaluated using chi-squared test on binomial distributions and Bonferroni correction ($P < 0.05$ significant).

RESULTS

In 18 of 143 patients, no painful region in the lumbosacral spinal canal could be identified by epiduroscopy (Figure 4). In 8 of these patients, clinically significant pathology (spinal stenosis, degenerative disk disease, disk herniation, etc.) was identified on MRI.

In 125 of 143 patients, pain could be reproduced in a discrete area of the spine using epiduroscopy. The most frequent levels of pain reproduction were L4 to 5 (87 patients) followed by L3 to 4 (14 patients), combined accounting for 93% of patient in whom pain could be reproduced and 81% of all patients in the study. The levels of clinically significant pathology from which pain was thought to originate as determined by clinical examination were most frequently L3 to 4 and L4 to 5 (54 patients). In contrast, when evaluated with MRI, no clinically significant lesions were reported in the majority of patients (87) (Figure 4).

Radiating pain corresponding to pathology at a level below S1 was not diagnosed in any patient through clinical evaluation, lumbar MRI, or epiduroscopy.

Clinical evaluation diagnosed a different region at which spinal pathology was thought to be present than did through touch with epiduroscopy in 103 of 143 (72%) patients. This difference was statistically significant ($P < 0.01$). MRI diagnosed a different vertebral level compared with epiduroscopy in 115 of 143 (80%) patients. This difference was also statistically different ($P < 0.01$) In only 5 patients (3.5%) did epiduroscopy, MRI, and clinical evaluation agree on the same vertebral level(s).

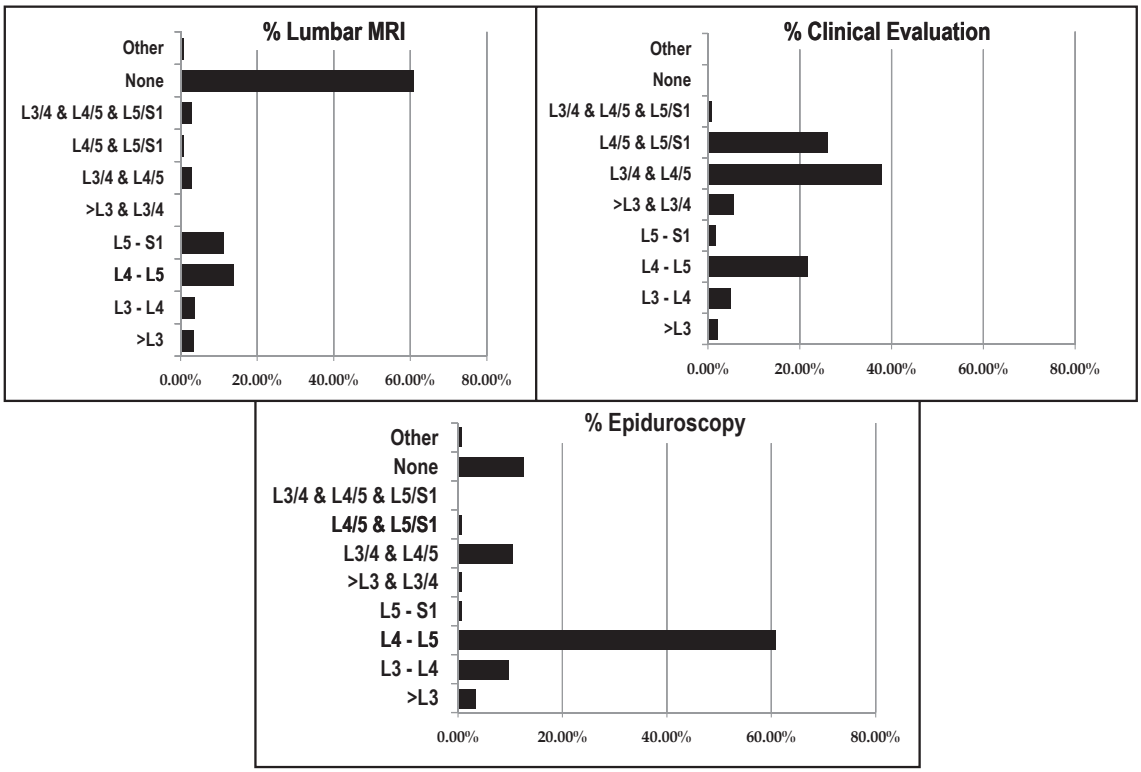

Figure 4. Distribution of the vertebral levels at which clinical significant pathology was diagnosed via clinical evaluation, lumbar MRI, and epiduroscopy.

DISCUSSION

The most significant finding of this study is that there is poor correlation between the spinal segments at which clinically significant pathology is determined to be present by epiduroscopy vs. the level determined by clinical evaluation and by MRI. Important questions are (1) Why are the levels of pathology determined by the 3 different techniques not in agreement? (2) Which level determined by each technique is important for guiding targeted treatment? We believe the levels differ because the 3 assessment techniques assess different indicators and that levels determined by epiduroscopy are the best for guiding targeted treatment.

The problems of identifying the segment(s) of significant pathology by clinical evaluation are familiar to the pain physician. Pure segmental distribution of pain is frequently not found.[1–7] To explain the inconsistent results from clinical evaluation, MRI findings, and epiduroscopy, 3 possible pathophysiological mechanisms should be considered. (1) The nerve root and dorsal root ganglion (DRG) are directly involved in local pathology of the spine (eg, disk protrusion with compression of DRG) and cause dermatomatal distribution of pain, loss of sensation, and loss of motor strength in the associated muscle groups. (2) The nerve root and dorsal root ganglion are directly involved but cause a mixture of dermatomal, sclerotomal, and myotomal components in the distribution of pain, loss of sensation, and motor weakness, and (3) The nerve root and dorsal root ganglion are not directly involved. In this case, back pain and radiating pain down the leg are caused by an alternative pathophysiological mechanism.

The first mechanism is important in the patient with verifiable nerve root compression leading to *neuropathic* pain. Direct compression of a nerve root or its blood supply leads to a *dermatomal* distribution of radiating pain.[18] These patients are often surgical candidates and are unlikely to present with *chronic* back and leg symptoms such as the patients in our study.[1]

The nature of the second pathophysiological mechanism is more obscure. Radiating pain may be explained by alternative radiating patterns such as a described with a sclerotome or the nondermatomal patterns obtained through stimulation of deep somatic structures of the spine.[15–17] An attempt to use a combination of dermatomal, myotomal, and sclerotomal referral patterns instead of just dermatomal to localize the segment of clinically significant pathology by clinical evaluation did not result in significant improved specificity in the diagnosis as compared to epiduroscopy in our study. Indeed, the very existence of a sclerotomal pain referral pattern has been questioned.[19]

The third mechanism by which nonradicular radiating pain can be explained may not depend on dysfunction of the nerve root or dorsal root ganglion. Instead, a wide variety of rather nonspecific radiating pain patterns in response to touch of painful epidural structures other than the nerve root or dorsal root ganglion during epiduroscopy was observed in this study. This agrees with similar observations by others.[2–6] This diversity may be better explained by *nociceptive* pain originating from sensitization (eg, through inflammation) of the nerve plexus that covers the inside of the spinal canal and not through pathology affecting the nerve root or dorsal root ganglion directly. This network is complex and has connections to nerve roots at multiple levels. Referred pain patterns to the back and lower extremities would therefore be highly sensitive to the precise location and extent of the lesion in the spinal canal and neuroforamina.[20]

MRI and epiduroscopy are different diagnostic tools. MRI describes *observable* spinal pathology often associated with compression of a nerve root or dorsal root ganglion. MRI is therefore more likely to diagnose the precise location of the pathology in patients with true radicular symptoms. Response to touch during epiduroscopy is *functional* and can identify painful areas more diffuse in nature and too small for the discriminative power of MRI. Epiduroscopy is more likely to diagnose disease that is not directly associated with compression of the nerve root or dorsal root ganglion. This may explain why MRI is a weak indicator of the vertebral level diagnosed through epiduroscopy in this study but not in studies of patients who presents with classic radiculopathy.[21]

The heterogeneity of pathology reported on MRIs may explain some of the discrepancies in diagnostic methods observed in this study as well. However, from the treating physician's point of view, the severity of the pathology is usually a major determinant in the diagnosis of the vertebral level of spinal pathology, not the nature of the pathology (eg, severe disk degeneration at L3 to 4 is considered more significant in the diagnosis than mild spinal stenosis at L4 to 5).

Precise description of radiating patterns and corresponding vertebral levels of pathology in clinical examination is a challenge for several reasons. Seg-

mental distribution of pain as described in radicular pain involves multiple types of afferent and efferent nerve fibers and secondary central pain processing resulting in primary and secondary hyperalgesia, each modality with its own topographical representation and overlap. For example, innervation of the bones, the sclerotome, rarely overlies a portion of the corresponding dermatome. Nonradicular referred radiating pain patterns, obtained through stimulation of the deep somatic tissues of the back or tissues in the epidural cavity, also lack consistency and suffer from the same limitations as radicular pain patterns. For these reasons, it is difficult to describe well-defined radiating pain patterns and the poor relationship between clinical evaluation and epiduroscopy in the evaluation of the vertebral level from which the radiating pain is thought to originate is not surprising.

Reproducibility of pain elicited when painful structures in the epidural cavity pressed upon with an endoscope may be questioned. But mechanical manipulation of structures in the normal epidural cavity is in general not painful. This can be confirmed easily on routine epiduroscopy and agrees with the findings by others.[14] In contrast, when pressure is exerted on a pathological region of the spinal canal, most patients report pain sensations with obvious similarity to character and distribution of the pain for which they sought treatment.

Distribution of lumbar spinal levels reported in the literature at which surgical intervention is performed (L3 to 4, L4 to 5, L5 to S1) differs somewhat from the distribution of clinically significant pathology determined by epiduroscopy in this study.[21,22] In addition to the arguments stated earlier, indications for surgery (intractable pain and/or neurologic deficit) vs. indications for epiduroscopy (moderate to severe back pain and radiating pain) may also lead to different patient selection and therefore to different level distributions.

The absence of significant spinal pathology at level of L5 to S1 in patient population we studied is remarkable considering the frequency of abnormalities diagnosed at this level based on MRI and the relative frequent spine surgery performed at this level in general.[22,23]

In conclusion, the pathophysiology of a ''posterior protruding disk'' and ''sciatica'' as described by Mixter and Barr may fit the patient with intractable pain and a strict dermatomal pain pattern but must be an oversimplification in patients with moderate to severe back pain and nondermatomal leg pain commonly seen in pain management institutions.[24]

The majority of clinically significant epidural pathology found by epiduroscopy in patients with low back pain and/or radiating pain down the leg in this study was located at the L4 to L5 vertebral level, followed by L3 to L4. Pathology at other levels was far less common. As compared to the pain response to direct touch using epiduroscopy, clinical evaluation and MRI were of low specificity in the diagnosis of the correct vertebral level of clinical significant spinal pathology.

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