Lateral exit-zone stenosis and lumbar radiculopathy

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Object. Hypertrophy of the superior facet of the inferior vertebra, resulting in a compression of the nerve root at the lateral foraminal exit, is a recognized cause of radicular symptoms, particularly in patients in whom previous lumbar spine surgery has failed. The lesion-specific presenting symptoms, imaging findings, and surgical treatment of this lesion, however, have received little attention. The authors prospectively studied a series of eight consecutive patients, in whom a diagnosis of lumbar stenosis at the lateral foraminal exit had been made, to elucidate the common presenting signs and symptoms of this disorder, as well as to evaluate the success of the operative treatment.

Methods. The eight patients were selected from a group of 250 consecutive patients who presented to a tertiary-care hospital and in whom a diagnosis of long-standing lumbar radiculopathy had been made. In all cases the diagnosis was confirmed by imaging studies and by intraoperative findings. The authors performed decompressive procedures on the nerve root via a medial facet-sparing approach.

Conclusions. The authors conclude that this lesion presents with characteristic physical findings and on imaging studies that distinguish it from other causes of radiculopathy, and they propose a lesion-specific, facet-sparing surgical technique that has yielded excellent results.

KEY WORDS • lumbar radiculopathy • exit zone • intervertebral foramen • facet hypertrophy • lumbar spine

THE nomenclature that describes the location of nerve root compression in the spine is inconsistent. Lee, et al.,27 divided the lateral lumbar spinal canal into three zones. Using this terminology, the entrance zone refers to the lateral recess; the midzone refers to the area of the intervertebral canal beneath the pedicle and the pars interarticularis;33 and the exit zone to the intervertebral foramen, which is bound superiorly and inferiorly by the pedicles. The extraforaminal zone, as defined by Kanogi and Hasue,25 lies outside the lateral border of the pedicle. In this communication, we are concerned with compression of the nerve root as it exits the intervertebral foramen. Root compression occurs in the lateral region of the exit zone and, to some extent, in the extraforaminal zone. Because no current anatomical definition consistently identifies the location of this compression, we have chosen to refer to nerve root compression as it exits the foramen as "lateral exit-zone stenosis."

Key23 and Danforth and Wilson6 first described facet hypertrophy as a cause of nerve root compression. Facet hypertrophy is a well-established cause of lumbar nerve root compression at more proximal locations along the path of the nerve root.2,3,6–8,10,17,22,23,28,29,32 These authors discuss superior facet hypertrophy as a cause of lateral recess stenosis. In this communication, however, we are concerned with hypertrophy of the superior facet of the vertebra that is below the exiting nerve root in relation to lateral exit-zone stenosis. In lateral exit-zone stenosis, the L-5 root is compressed by degenerative changes in the S-1 superior facet, the L-4 root by degenerative changes in the L-5 superior facet, and so on (Fig. 1).

Macnab28 noted intraoperatively a subset of patients whose superior facet had dislocated in an upward direction and caused root entrapment. He did not discuss patient presentation. He proposed performing facet joint removal and fusion of the two levels as the standard treatment of this lesion. Other authors, recognizing the importance of extraforaminal stenosis, have recommended “lateral fenestration” (removal of the pars interarticularis and tip of the superior facet), osteoplastic hemilaminectomy (with screw and wire), or total foraminotomy followed by fusion.25

We present a series of eight consecutive patients with lateral exit-zone stenosis, in whom previous diagnoses...
were based on clinical findings, as well as x-ray film and imaging studies. We believe it is important to draw attention to this small group of patients in whom the diagnosis is frequently overlooked. These patients present with characteristic clinical and imaging features. We propose a simple pars and facet-sparing medial-to-lateral surgical approach, which has been very effective in our patients.

Clinical Material and Methods

The medical records and radiological studies of eight consecutive patients in whom a diagnosis of lateral exit foraminal stenosis had been made and who underwent subsequent nerve root decompression at the lateral exit zone between 1995 and 1997 were reviewed. Pain was measured using a visual analog scale pre- and postoperatively. All patients underwent exit zone foraminotomies (see Surgical Technique). Seven foraminotomies were bilateral. One patient underwent concurrent L5–S1 fusion for spinal instability after prior surgery on the lumbar spine. The follow-up period ranged from 12 to 27 months postsurgery. During the final telephone interview a verbal rating scale was administered. The visual analog and verbal rating scales have been shown to correlate closely with one another.24,30 The mean follow-up interval was 19 months. All patients were under the care of the senior author (F.C.H.).

Surgical Technique

Our technique in the decompressive procedure performed in lateral exit-zone stenosis is unlike that of a standard foraminotomy.9 In a standard foraminotomy, the L-5 root foramen is approached from the L4–5 disc space and the L-4 root foramen from the L3–4 disc space. However, in the case of lateral exit-zone stenosis, we believe it is important to approach the foramen from the interlaminar space below the level of the root; that is, between the L-5 and S-1 laminae for an L-5 root compression (Fig. 2). The caudal aspect of the L-4 lamina is removed in the approach to a L-4 root compression. In concordance with Jane, et al.,21 and Abdullah, et al.,1 who advocate preservation of the facet joint in their approaches to far-lateral discs, we stress the preservation of the pars interarticularis and the facet joint. In cases of L-5 root compression, a linear midline incision is made over the L-5 spinous process. A subperiosteal exposure is made of the L-5 spinous process and lamina bilaterally. The caudal 40% of the L-5 lamina and the caudal 50% of the L-5 spinous process are removed, taking care to preserve the partes interarticulares bilaterally. The pars on the side of the radiculopathy is then undercut with a coated diamond burr to expose the L-5 nerve root. The lateral rim (4 mm) of the pars interarticularis is preserved for stability. To visualize the L-5 root as it passes through the midzone of the foramen, it is necessary to tilt the operating microscope 10° and to tilt the operating table 10° away from the surgeon. Through this narrow angle, the exiting L-5 nerve root is seen traversing inferiorly to the pedicle. The superior facet of the inferior vertebra, as well as chondrocartilaginous material can be palpated with a Woodson instrument but cannot be visualized. In cases of lateral exit-zone stenosis, a Murphy ball probe cannot be passed through the foramen. The Kerrison rongeur and small curettes are then used to undercut the tip of the superior facet and the associated chondro-
cartilaginous material. The angle of approach is ideal for biting away the superior tip of the facet. It is important to emphasize that the lateral extent of the exit zone cannot be visualized even when using a fully tilted microscope; the tip of the facet must be removed without use of direct visualization. The rongeur is always positioned perpendicularly to the exiting nerve root to avoid inadvertent injury to the root by the side of the jaws. The operation is complete when a Murphy ball probe can be passed through and beyond the foramen. The patient is mobilized the following day.

**Results**

There were five men and three women whose ages ranged from 31 to 85 years (mean 60 years). Five patients had undergone previous surgery of the lumbar spine: three underwent lumbar discectomy and two underwent more than one prior lumbar surgery (Table 1). All patients complained of back and leg pain for at least 1 year prior to presenting to the senior author. Seven patients experienced pain in an L-5 distribution and one experienced pain in an L-3 distribution. Three patients had pain that radiated to both lower extremities and five had pain that radiated primarily to one lower extremity. Four patients complained of lower-extremity sensory deficits and two complained of lower-extremity weakness. There were no instances of neurogenic bowel or bladder dysfunction. All patients described worsening of the pain with walking and lifting.

On physical examination, extension of the spine increased pain in the back and leg in all patients. Forward bending (flexion at the waist) exacerbated the back and leg pain in two patients; lateral bending exacerbated the back and leg pain in two patients. One patient was mildly scoliotic. Five patients were hypesthetic to pinprick (four in the L-5 dermatome and one in L-3). Five patients demonstrated mild-to-moderate weakness of the extensor hallucis longus. There were no Babinski’s signs or abnormal deep tendon reflexes. Remarkably, the straight leg raising sign was absent in all cases. A femoral stretch sign was positive in the patient with L-3 radiculopathy.

In seven patients, sagittal magnetic resonance (MR) imaging performed in the lateral spinal column demonstrated compression of a lumbar nerve root at the lateral exit zone (Fig. 3). In five patients, there was unilateral stenosis at the lateral exit zone (Fig. 3 upper). In three patients, there was bilateral stenosis at the lateral exit zone (Fig. 3 lower). In the seven patients, we observed com-

<table>
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<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Prior Surgery</th>
<th>Duration (yrs)</th>
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<th>Provocative Posture†</th>
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* Disc = discectomy; lam = laminectomy; SLR = straight leg raising sign. † The provocative activity was walking in all cases.

![Fig. 3. Sagittal MR images obtained in two patients demonstrating findings typical of L-5 lateral-exit stenosis. Upper: Unilateral stenosis on the right; note the presence of fat signal around the L-5 nerve root on the left. Lower: Bilateral stenosis; note the absence of fat signal around both exiting L-5 roots.](attachment:image)
pression due to degenerative osteoarthritic changes in the superior facet of the vertebrae lying below the level of the radiculopathy. Mild L4–5 spondylolisthesis was noted in one case. Imaging studies revealed that the S-1 superior facet compressed the L-5 root in seven cases; in one case plain x-ray films demonstrated that the L-4 superior facet compressed the L-3 root (Figs. 4 and 5). Standard computerized tomography (CT), three-dimensional computerized tomography (3-D CT) scanning and CT myelography failed to demonstrate the lateral exit stenosis seen on sagittal MR imaging.

**Follow-Up Examination**

Every patient reported good or excellent relief of pain and rated their pain as three or less (mean 1.6, standard deviation 1.95) on a visual analog scale 3 months postsurgery (Fig. 6). All patients were then contacted by phone, at a mean postoperative interval of 19 months, and were again asked to rate their pain on a scale from 0 to 10 (mean 1.8, standard deviation 2.37). At that time, six patients reported significant and sustained improvement of their pain, rating their pain less than 2 on the same scale. One patient, who initially reported significant improvement, complained of “moderate” (a rating of 6) recurrent radicular pain in an identical distribution 18 months after surgery. This patient is currently receiving workers’ compensation. Six patients had resumed their usual activities at the time of extended follow-up contact. No patients complained of residual weakness; however, one complained of “insignificant” numbness in the medial foot. One 88-year-old patient (Case 7; Table 1) with L-5 radiculopathy had enjoyed complete pain relief postsurgery, but returned 5 months later with the new onset of a severe L-4 radiculopathy. An MR image confirmed a widely patent foramen around the L-5 root while also demonstrating severe stenosis at the L-4 lateral exit zone. The patient then underwent a left L-4 exit foraminotomy. Unfortunately, while removing the medial aspect of the pars interarticularis with a Kerrison rongeur, the pars was fractured. We then believed it prudent to perform a complete facetectomy to decompress the nerve root completely. The patient experienced complete relief of pain postoperatively. This latter surgery (the second surgery in the patient in Case 7) is not included in our data because of an inadequate follow-up interval.

**Illustrative Case**

**Case 8**

This 59-year-old woman secretary presented with a 1-year history of severe pain in her right buttock, lateral calf, and medial foot as well as intermittent left-sided pain in the same distribution. She rated the pain as a “10” on a scale from 0 to 10 at another institution 1 year before we assumed her care, she had undergone a bilateral L5–S1 hemilaminectomy with medial facetectomies and foraminotomies (in the midzone). After the first surgery, she experienced worsening of her pain. She presented to the senior author (F.C.H.) complaining of pain that was exacerbated by prolonged standing and walking and relieved by sitting and bending forward. On physical examination, she was obese, with a decrease in pinprick sensation in the right L-5 dermatome and mild weakness of the right ex-
tensor hallucis longus. Deep tendon reflexes were normal. Extension of her back worsened the leg pain. The straight leg raising sign was notably absent. The results of electromyography suggested a right L-5 radiculopathy. Sagittal MR imaging sequences of the lumbar spine revealed marked stenosis of the L-5 lateral exit zones bilaterally, with loss of the fat signal around the L-5 roots. Because she complained of intermittent left-sided pain, we elected to perform a bilateral microsurgical lateral exit-zone decompressive procedure. Postoperatively, the patient was significantly improved and, 2 months following surgery, rated her pain as a “2 to 3” on a 0 to 10 scale. At 14 months postoperatively, the patient rated her pain as a “0 or 1” on the same scale.

Discussion

Lateral exit-zone stenosis is an important and, we suspect, frequently missed cause of the failed back syndrome. We identified and treated eight consecutive patients who presented with lateral exit-zone stenosis and who were characterized by prior failed back surgery, severe radicular pain worsened with back extension and walking, mild neurological deficits, the absence of the straight leg raising sign, and MR images that demonstrated loss of perineural fat in the lateral exit zone.

The anatomy of the neural foramen has been discussed in detail by Hasegawa, et al., Schneck, and others. Ste- nosis in the entrance zone is also termed lateral recess stenosis (Fig. 7). Compression of the nerve root in the middle zone is commonly referred to as foraminal stenosis. Whereas the anatomy of the exit zone has been described, no clinical correlations have been established. In this report, we have been concerned only with the lateral portion of the exit zone where the superior facet of the lower vertebra impinged on the exiting nerve root.

In this series, MR imaging with standard sagittal views through the lateral exit zone was the diagnostic tool of choice for visualizing lateral exit-zone stenosis. As with more proximal stenosis, a loss of the perineural fat signal is a characteristic finding. The utility of coronal MR imaging for the assessment of extraforaminal stenosis has been described by Hashimoto, et al. Although their study concerned extraforaminal stenosis between the transverse process and sacral ala, it is possible that coronal MR imaging may be of value in diagnosing lateral exit-zone stenosis. Coronal MR imaging was not performed in this series.

Standard CT slices in six of our patients were of limited use in guiding the diagnosis of lateral exit-zone stenosis in our series. Evaluation of CT scans, however, was limited to the observation of spondylotic changes, facet arthropathy, alignment, and the presence of stenosis beneath the facet joint (lateral recess stenosis) and in the middle zone (foraminal stenosis). Computerized tomography scanning did not reveal stenosis within the lateral exit zone. Standard CT views do not clearly demonstrate lateral exit-zone stenosis because of the obliquity of the neural foramen. Although CT scanning with sagittal reconstruction may be useful in demonstrating the degenerative changes of the lateral exit zone, it does not demonstrate the nerve and perineural tissue and was not useful in making this diagnosis. Computerized tomography myelography was the primary diagnostic tool in only one patient in this series (Case 2). In our opinion, MR imaging more clearly demonstrates nerve root compression at the lateral exit zone.

There are three ways in which the superior facet of the lower vertebrae may cause radicular pain in the level above (that is, the S-1 superior facet causing L-5 pain): 1) by upward migration of the facet, a phenomenon referred

![Fig. 6](image6.png)  
**Fig. 6.** Graph depicting patients’ self-graded pain scores, preoperatively (mean 8.1, standard deviation [SD] 0.93), at 3-months (mean 1.6, SD 1.95), and at extended (average 19 months) follow up (mean 1.8, SD 2.37).

![Fig. 7](image7.png)  
**Fig. 7.** Illustration (posterolateral perspective) showing the anatomical location of potential foraminal stenoses. The site of lateral recess stenosis, the entrance zone (aa), is beneath the medial aspect of the superior facet (a). “Foraminal stenosis” occurs in the middle zone (bb) when the nerve root passes around the pedicle (b). Lateral exit-zone stenosis occurs in the exit zone (cc) when the nerve root passes ventrally and superiorly to the superior facet of the lower vertebra (c).
Lateral exit-zone stenosis
to as “facet impingement”28 2) by degenerative osteoarthritic changes of the facet; and 3) by the enroachment of chondrocartilaginous material from the facet joint on to the nerve. Other authors have addressed radiculopathy caused by spondylosis, spondylolisthesis, lateral discs, pedicular kinking, and migration of the disc into the foramen.4,11,15,20,28

How frequently is lateral exit-zone stenosis seen? Macnab28 from a consecutive series of 842 patients, reported on 68 patients whose radicular pain could not be ascribed to disc-related disease.28 Intraoperatively 19 of these patients were found to have a nerve root “tightly gripped between the superior articular process and the pedicle above.” Macnab sacrificed the pars interarticularis and facet joint in these cases. In most cases, he then performed a transverse process fusion across the destabilized joint. Our eight patients were selected from a larger group of 250 patients in whom lumbar degenerative disease had been diagnosed. These numbers suggest that, in the population we see, approximately one in 30 patients with lumbar radicular pain has lateral exit-zone stenosis.

Other authors have emphasized the importance of sparing the facet joint and the pars interarticularis to prevent delayed instability and the need for fusion.7,25,26,29 We also are concerned with preserving the facet joint and the pars interarticularis, and we believe that most of these patients can be successfully treated without undergoing fusion. We have recommended that the surgical approach to the lateral foraminotome exit should involve removal of the caudal portion of the lamina; thus, the L-5 root exit zone is approached by removing the caudal L-5 lamina and undercutting the pars interarticularis. We do this for two reasons: first, to preserve the cephalad portion of the lamina, most of the spinous process, and the pars interarticularis bilaterally; second, to the opening of the intervertebral foramen, with the table and the operating microscope angled appropriately, the surgeon can be more easily able to visualize and reach the foramen, approximately 25 to 30 mm from the midline. The lateral extent of the resection, however, is performed without direct visualization.

Hood44 has advocated removal of the lateral foramen and the lateral margin of the adjacent facet for the treatment of far-lateral discs. This procedure spares the medial facet joint and would potentially relieve the lateral exit-zone stenosis that is caused by degenerative arthritic changes. We choose to perform the medial, interlaminar approach over Hood’s lateral approach for the following reasons: 1) we choose to establish the normal anatomy of the root passing around the pedicle before proceeding to the region of abnormal anatomy; 2) the dissection medially does not require the tedious dissection through the intertransverse muscles and fascial planes; 3) the medial approach allows confirmation that there is no stenosis more proximal to the lateral exit zone; and 4) the approach we propose allows the surgeon to position the jaws of the rongeur parallel to the nerve root, thus lessening the risk of dural or root injury. Thus, although the lateral exit zone is not directly visualized, we believe that an interlaminar approach is safe and effective.

Conclusions
In summary, lateral exit-zone stenosis is an important cause of the failed back syndrome. Authors of prior reports have implicated spinal stenosis, peripheral fibrosis, arachnoiditis, and recurrent disc herniation as the most frequently encountered anatomical causes of persistent pain after surgery of the lumbar spine.31 Burton, et al.,5 have implicated lateral stenosis of the lumbar spine as the major cause of surgical failure. We agree with Hasegawa, et al.,12 that the superior facet of the inferior vertebra that causes a compression of the nerve root at the foraminar exit is an important subcategory of lateral stenosis. A decrease in disc height caused by degenerative disc disease or dissection causes osteoarthritic changes of the superior facet which, in turn, compress the nerve root exiting from the level above. Facet hypertrophy and osteophytic changes in five of the eight patients presented here may have been accelerated by lumbar discectomies, which may have been inappropriately performed on the basis of degenerative disc disease observed on MR images; these five patients experienced exacerbation of their original pain after undergoing discectomy. We reemphasize what Macnab28 had described in the generation prior to modern imaging techniques and propose a characteristic clinical presentation, consistent imaging findings, and a simple surgical technique for radicular decompression via a medial approach, without need for resection of the facet joint and fusion.

References

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