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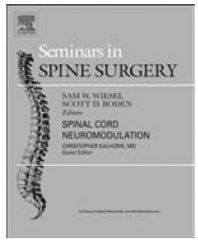

Considerations and approaches to revision discectomy

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ABSTRACT

Recurrent disc herniation is the most common complication following operative treatment for lumbar disc herniation. Surgical indications for recurrent disc herniation are similar to those for primary disc herniation, but the surgical decision-making process is complicated by several factors including the anatomic location of the disc herniation, the amount of bone removed in the index procedure, the presence of radiographic instability, and the degree of axial lower back pain versus radicular pain that drives the need for revision surgery. The surgeon must consider the unique aspects of revision laminectomy and discectomy when both planning for and carrying out this procedure.

1. Introduction

Lumbar disc herniation (LDH) is a common clinical entity, with lumbar laminectomy and microdiscectomy being the most commonly performed surgical procedure for patients undergoing surgery for this diagnosis.[1] Recurrent LDH is defined as a disc herniation causing new symptoms at the same anatomic level as a disc herniation previously treated with surgical discectomy, after an initial period of symptom improvement following the index procedure. The incidence of recurrent, symptomatic LDH has been reported to occur in approximately 5-18% of cases, representing a significant cause of pain, disability and lost work days.[2–5] There is some controversy regarding whether to include contralateral disc herniations or only ipsilateral herniations in the discussion, but most authors agree that only a repeat herniation at the same level and the same side should be considered a true recurrent disc herniation, as treatment implications are unique.[5–7] Recurrent disc herniations have been noted to contain granulation tissue which is not found in primary disc herniations, and contain large collagen bundles associated with a fibrillary network.[8] This raises the question of potentially different symptom characteristics in patients presenting with recurrent LDH as the pathophysiology is unique. Similar to primary LDH, both axial lower back pain and radicular pain in a dermatomal distribution matching the anatomic disc location can be present in a recurrence. Pain reproduced with Valsalva maneuvers (coughing or sneezing) and a positive straight leg raise have been found to be common in recurrent LDH, however, these findings are also found in many patients with epidural fibrosis alone, so imaging studies are necessary to make an accurate diagnosis.[9] It is important to note that in order to define a recurrent LDH, a pain-free interval (or at least significant reduction in symptoms) after the index operation must be present, as persistent symptoms would imply persistence of a disc herniation, inadequate disc removal, or potentially wrong site surgery. As in all cases of primary LDH, an initial conservative treatment protocol of nonsteroidal anti-inflammatory medication, physical therapy, and possibly epidural injections is appropriate for most cases of diagnosed recurrence in the absence of progressive neurologic deficit or cauda equina syndrome (CES). Once the decision to move forward with surgery is made, a

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variety of surgical procedures are available to the surgeon, with revision laminotomy or laminectomy and discectomy with limited fragment excision being the most common and most often appropriate choice. The purpose of the following review is to provide insight and guidance to the reader regarding the evaluation, work-up and technical features of revision discectomy surgery.

2. Recurrent disc herniations

2.1. Patient factors

As previously noted, recurrent disc herniation is the most common complication of primary discectomy surgery although can be considered part of the natural history of this disease process. Although the majority of recurrent LDH occur within one year of the index procedure, there are reports of recurrences up to 8 years following the index surgery, making a high index of suspicion necessary for patients seen at a variety of time points after discectomy surgery.[10–12] Risk factors for recurrent LDH have been reported to include smoking, disc protrusion (versus extrusion or other disc morphology), and diabetes.[13] Risk factors for reoperation following discectomy surgery, a similar but distinct outcome measure as not all patients with recurrent LDH require surgery, have also been identified, including younger age, higher baseline Oswestry Disability Index (ODI), lack of sensory deficit, and lack of motor deficit.[14] In this review of the intervertebral disc herniation arm of the Spine Patient Outcomes Research Trial (SPORT) smoking, diabetes, obesity, worker's compensation status, and diagnosis of clinical depression were not associated with risk of reoperation. Overall reoperation rate was 15%, not surprisingly with less improvement after reoperation noted than after index surgery. While smoking was not found to be a significant risk factor for recurrent LDH in this review of the SPORT data, nicotine has been found to produce vasoconstriction which is hypothesized to lead to diminished ability of the annulus to heal after surgery and has been implicated in other studies as an independent risk factor.[4,15,16] Increased disc height and increased segmental range of motion have been found to correlate with risk of recurrent LDH, with moderate radiographic disc degeneration also correlating with recurrent LDH, but not severe grades, possibly due to the relative biomechanical stability of collapsed discs at the end stages of disc degeneration.[11]

2.2. Surgical factors

While it has been established that the majority of patients with a symptomatic lumbar disc herniation will have acceptable clinical outcomes with nonsurgical treatment and that the benefits of surgery are greatest in the first 2 years postoperatively,[17,18] lumbar discectomy surgery remains a commonly performed operation. Surgical factors that may potentially influence the natural history of recurrent LDH include standard open laminectomy and discectomy versus micro-discectomy, limited fragment excision versus more aggressive subtotal discectomy, and open versus minimally invasive techniques including endoscopic discectomy. Although lumbar fusion is performed for primary lumbar disc herniation in select cases, indications generally include significant radiographic instability or spondylolisthesis and this is not routine.

While the gold standard surgical procedure for symptomatic LDH has traditionally been open laminectomy and discectomy through a midline approach, microscopically assisted techniques (microdiscectomy) as described by McCulloch have largely replaced this in many centers and are thought to provide similar benefits and outcomes but with less morbidity, smaller incisions and greater potential for outpatient care.[19,20] However, despite the obvious advantages of microdiscectomy over standard open techniques, superior long-term clinical results have not been shown, with 80-96% of patients having successful result regardless of technique.[19] In addition, when compared to traditionally accepted complication rates of open lumbar laminectomy and discectomy, no significant difference in the rates of complications, including recurrent disc herniations, dural tear, and postoperative discitis, have been noted in reports of surgical microdiscectomy.[21]

A commonly debated technical point in lumbar discectomy surgery is whether to perform excision of only the free fragment compressing the nerve root versus extensive nuclear curettage. Simple disc fragment excision (Williams sequestrectomy) was first described in 1978 and is thought to offer the potential benefit of fewer postoperative complications and potentially lower risk of future degenerative changes as the native disc is largely spared.[22] This technique has been shown to be safe and carry a low complication rate, however with some controversy surrounding the rate of recurrent disc herniation as it was noted to be 5.8% in one study[23] and 12.5% in another, compared to 11.6% in a control group undergoing more extensive disc space curettage.[24] In this report by Balderston et al., there was no significant difference in rates of recurrent disc herniation or radiographic disc space narrowing, however a higher rate of postoperative back pain was found in the nuclear curettage group at a minimum 2 year follow-up.[24] Although a higher rate of recurrent disc herniation was reported by Carragee et al. in the limited versus subtotal discectomy group in a randomized, controlled study (18% versus 9%), this difference was not found to be statistically significant.[25] Finally, McGirt et al. reviewed 54 studies and found a greater incidence of chronic back and leg pain in an aggressive discectomy group compared to a limited discectomy group, but a lower incidence of recurrent disc herniation.[26] In summary, aggressive nuclear curettage has a similar or marginally lower rate of recurrence and carries with it a greater chance of symptomatic disc degeneration and lower back pain, therefore does not appear to be routinely warranted, especially in cases of extruded or sequestered free fragment.

Both minimally invasive approaches utilizing tubular retractors and endoscopic approaches to lumbar disc herniations are available to spine surgeons. A Cochrane review of 11 studies performed by Rasouli et al. in 2014 concluded that there was low-quality evidence for inferior relief of leg and back pain in patients undergoing minimally invasive surgery, lower risk of postoperative infection, and higher risk of rehospitalization due to recurrent disc herniation, with similar outcomes with regards to functional disability and

persistence of motor and sensory deficits.[27] This technique has been found to be safe and effective in multiple case series and review articles, but further studies are needed to more appropriately define its role in treating symptomatic LDH.

In the endoscopic approach to lumbar discectomy, an endoscope is passed percutaneously under radiographic guidance to Kambin's triangle, defined as the right angle over the dorsolateral disc lying between the exiting nerve root in the neural foramen superolaterally, the superior endplate of the caudal vertebra inferiorly, and the traversing nerve root medially.[28] Proponents of this method report that it is a safe and less invasive alternative to traditional discectomy utilizing a mini-open midline incision, although due to concerns over decreased visualization and potential nerve root injury, many surgeons have resisted adopting this technique. Endoscopic procedures likely play a role, especially for far lateral disc herniations where traditional approaches have limited use, however, data is lacking in regards to any improvements in long-term outcomes over traditional surgical approaches.[29] Regardless of technique chosen, the authors believe that the single most important factor in maximizing the benefit of primary lumbar discectomy surgery is patient selection, not unlike the majority of elective spine procedures.

3. History

A detailed history is mandatory to properly evaluate patients with persistent or recurrent pain after lumbar discectomy. In addition to medical history, medications should be reviewed to rule out narcotic abuse, and social history including work history and motivation for return to work should be elicited, as well as involvement in litigation. This information can help predict functional outcome of revision surgery.[30] The patient's main symptoms before the index discectomy should be elicited, as well as details of their operative procedure. It is helpful to obtain the medical records and imaging studies that were performed before the previous surgical procedure to compare with the current situation. In some cases, after such careful analysis an incorrect initial diagnosis may be identified.[31]

The time frame over which the new or recurrent symptoms develop may suggest their underlying etiology. Failure to achieve any pain-free interval after the primary discectomy has been associated with incorrect preoperative diagnosis, wrong-level surgery, and inadequate decompression including retained disc fragment, particularly in herniations involving the lateral recess or foraminal region.[32–34] Early onset of new radicular pain after surgery may suggest nerve root injury. In the intermediate postoperative period (1 to 6 months), mild new or recurrent pain may develop as patients progress through rehabilitation. Symptoms that develop suddenly after a specific inciting event may be suggestive of recurrent disc herniation, whereas recurrent symptoms of gradual onset in the intermediate time frame are often related to the development of scar tissue such as epidural fibrosis or adhesive arachnoiditis.[35] In the late postoperative setting, recurrent back and leg pain may signal recurrent disc herniation, progressive foraminal stenosis from degenerative changes, or adjacent level pathology. For the surgeon who may evaluate patients initially treated elsewhere, this timeline regarding the recurrence of symptoms is crucial to establishing the proper diagnosis.

4. Physical examination

The physical examination of patients with recurrent axial pain and radicular complaints is similar to the initial examination for non-operated patients. Posture, gait, and alignment including sagittal balance while standing and sitting should be observed. Range of motion, tenderness, and nerve root tension signs should be elicited and a thorough neurologic examination should be performed. A common clinical conundrum is determining which patients have recurrent LDH versus fibrosis, as only the former will benefit from revision surgery in the majority of cases. Although both conditions can present with similar symptoms, pain upon coughing, severely reduced walking capacity, and a positive straight leg raise have been found to be more common in those with recurrent HNP.[9] Although the physical examination findings of this condition may be nonspecific otherwise, a thorough examination may be helpful to exclude other conditions that may have similar presentations. In patients with leg pain, thorough examination of the hip and knee and assessment of distal pulses may reveal other potential causes of their symptoms and generate a referral to general orthopedic or vascular specialists. Nonorganic physical findings should be recorded, as described by Waddell.[36] More than two Waddell findings strongly predict poor outcome, regardless of spinal pathology.

5. Imaging

5.1. *Plain radiography*

Plain radiographs of the lumbar spine should include bi-planar standing films (Fig. 1A, B). A coned-down lateral of the lumbosacral junction and an antero-posterior (AP) Ferguson view may be particularly helpful in evaluating patients who have had previous surgery at the L5-S1 level. Patients with pain after a discectomy should be evaluated for iatrogenic pars fracture and the extent of previous bone resection is often clearly visible. Endplate rarefaction suggests a postoperative discitis and requires further workup. In addition to evaluation of the disc height, endplate characteristics, and alignment, anterolisthesis or retrolisthesis at the operated level should be noted. Flexion-extension radiographs should be scrutinized for hypermobility involving the operated motion segment (Fig. 2A, B). The overall sagittal balance should be assessed on standing 36-inch radiographs with the hips and knees fully extended to eliminate any compensatory flexion that may mask deformity, especially when fusion is contemplated in the surgical plan. An AP pelvis radiograph should be ordered for any patient presenting with primary complaints of groin or anterior thigh pain, or those with pain or crepitus with passive hip range of motion.

5.2. *Advanced imaging*

Magnetic resonance imaging (MRI) with and without gadolinium enhancement is the most sensitive test for evaluating neurologic

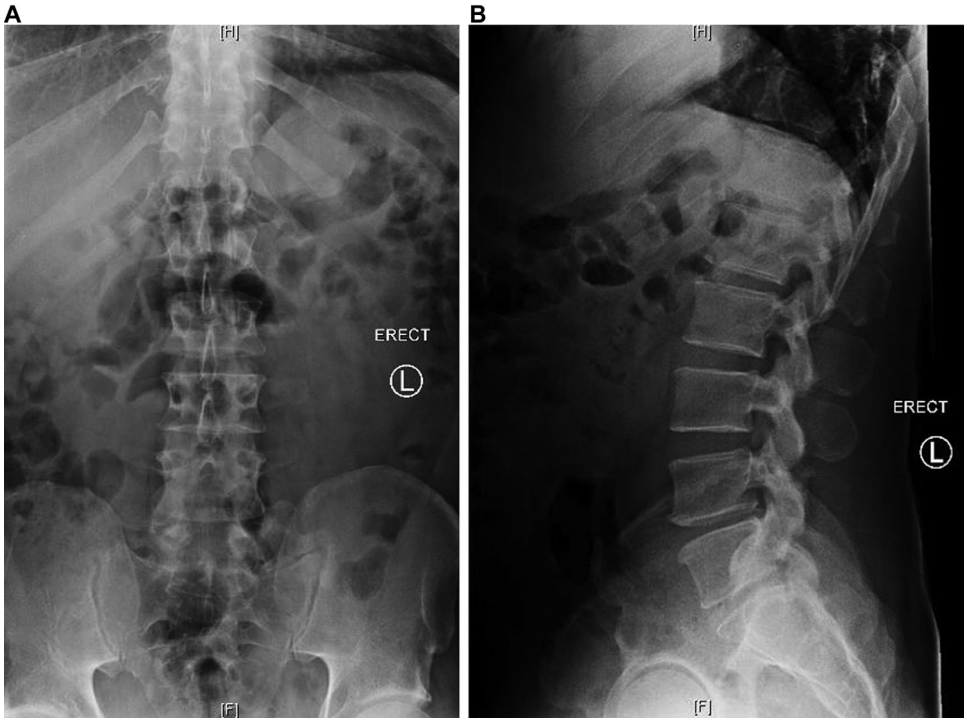

Fig. 1 – AP (A) and lateral (B) radiographs of a patient who previously underwent full laminectomy and right L4-L5 discectomy for cauda equina syndrome and right lower extremity radiculopathy, presenting with recurrent right leg pain 6 months postoperatively. Note disc space narrowing and facet arthropathy at L4-L5 with bony foraminal stenosis evident, without deformity.

compression at both the previously operated site and the adjacent levels.[37] Comparison of the enhanced and non-enhanced sequences can help differentiate epidural scar (enhancing) from recurrent HNP and hypertrophic ligamentum flavum (non-enhancing or rim-enhancing only) (Fig. 3A-D). In addition, gadolinium enhancement in the intervertebral disk and vertebral bodies may demonstrate the presence of postoperative infection, although differentiating Modic changes from discitis on imaging alone can be challenging.[30] With the advent of MRI, CT myelography is less commonly required, but is still helpful in certain specific clinical situations, such as patients with indwelling dorsal column stimulators, aneurysm clips or cardiac stents, pronounced scoliosis, and known stainless steel implants at adjacent levels. It is important to note that the findings on advanced imaging must be closely correlated with the clinical impression obtained from the interview and physical. One prospective study of patients undergoing lumbar discectomy found that 23% of patients had MRI evidence of recurrent herniation at 2 years, with the majority being asymptomatic.[38] Therefore, other causes of leg pain should be excluded prior to initiation of treatment if the symptoms are of questionable correlation.

6. Nonoperative treatment

Axial back pain and leg symptoms due to recurrent disc herniation or stenosis can be treated initially with physical therapy and nonsteroidal anti-inflammatory pain medication in the absence of neurological deficit. Epidural injections may be offered as a treatment option; however, their effectiveness in patients with recurrent herniation can be less predictable. Transforaminal and caudal injections have some reported therapeutic success in uncontrolled studies.[39–41] Some have theorized that the presence of postoperative scar tissue interferes with dispersion of the injectate and leads to diminished effectiveness.[42] The overall success of nonoperative treatment for symptomatic recurrent lumbar disc herniation appears less promising than for primary herniations. Ambrossi reported that only 35% of such patients were able to avoid a reoperation with conservative treatment in a retrospective single institution study.[43]

When MRI is more suggestive of epidural scar formation and no definitive recurrence is found, the degree to which a patient's symptoms can be attributed to this condition is unclear. Epidural scar is an incidental finding in many patients who do not develop symptoms, and most feel that the scar tissue will inevitably return to some degree after attempted removal, making surgical intervention for these patients less desirable.[44] As new agents to help prevent proliferative epidural scarring are developed, the overall management of such patients may continue to evolve.

7. Surgical treatment

7.1. Indications for revision discectomy versus fusion

Despite the overall success of lumbar disc herniation as a treatment for symptomatic LDH, such patients are at risk for recurrent herniation at rate of 9.1% in a post hoc analysis of

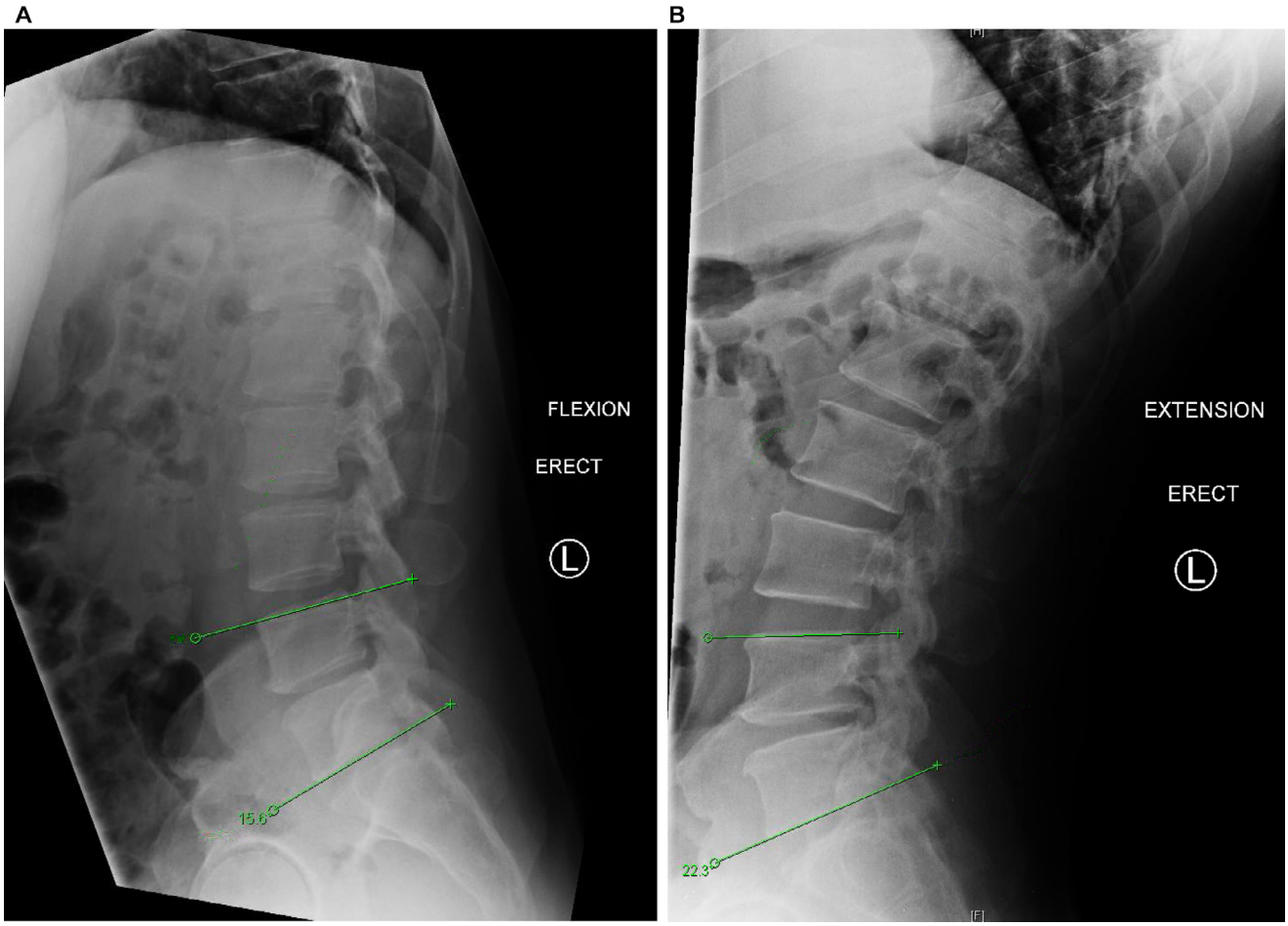

Fig. 2 – Flexion (A) and extension (B) lateral radiographs of the same patient. Note relative stability in flexion and extension, no spondylolisthesis noted. Patients may demonstrate dynamic instability or anterolisthesis that is not present on neutral film.

prospectively collected data from the Spine Patient Outcomes Research Trial (SPORT).[45] Despite the relative frequency of this occurrence, there is a paucity of high quality evidence regarding the optimal surgical treatment strategy. While multiple surgical treatment options exist, the main two options are revision lumbar discectomy alone versus one accompanied by an instrumented fusion.

From a theoretic standpoint, the primary concern regarding revision discectomy without fusion involves stability. In some regard, inherent instability could be an underlying factor that contributed to the re-herniation. Any such instability could be compounded by the revision discectomy as additional facet must be resected in order to identify normal tissue planes in an effort to avoid incidental durotomy or nerve root injury. Conversely, the addition of an instrumented fusion to revision discectomy involves additional operative time, higher blood loss, longer length of stay and recovery time, as well as dramatically higher cost.[46] Several recent studies have compared clinical outcomes of the two strategies. Guan and colleagues compared 25 repeat discectomy patients with 12 patients treated with revision discectomy and fusion at 3 and 12 month follow up.[46] Both groups had similar Oswestry Disability Index (ODI), visual analog scale (VAS) scores and comparable quality-adjusted life years (QALY) measures at both follow up points. Fu et al performed a retrospective study comparing long term outcomes of repeat discectomy alone versus repeat discectomy and instrumented fusion for recurrent lumbar disc herniation.[47] At a mean follow up of 88 months, they reported excellent or good clinical outcome in 78.3% of the revision discectomy alone group versus 83% in the fusion group, a difference which was not statistically significant. Dower and colleagues performed a recent systematic review on this topic, finding 37 studies that fit their inclusion criteria, generating 1483 patients for analysis.[48] The rate of satisfactory outcome was found to be statistically similar between the patients undergoing revision discectomy alone (79.5%) versus those undergoing concomitant fusion (77.8%). Given the above findings, the authors typically recommend revision discectomy alone for patients with leg predominant symptoms when no evidence of instability is seen on upright and flexion-extension radiographs. Additional considerations include the amount of facet resection performed at the original surgery, the location of the recurrent herniation (posterolateral versus foraminal), and whether substantial foraminal stenosis due to disc height loss is potentially contributing to radicular symptoms. If

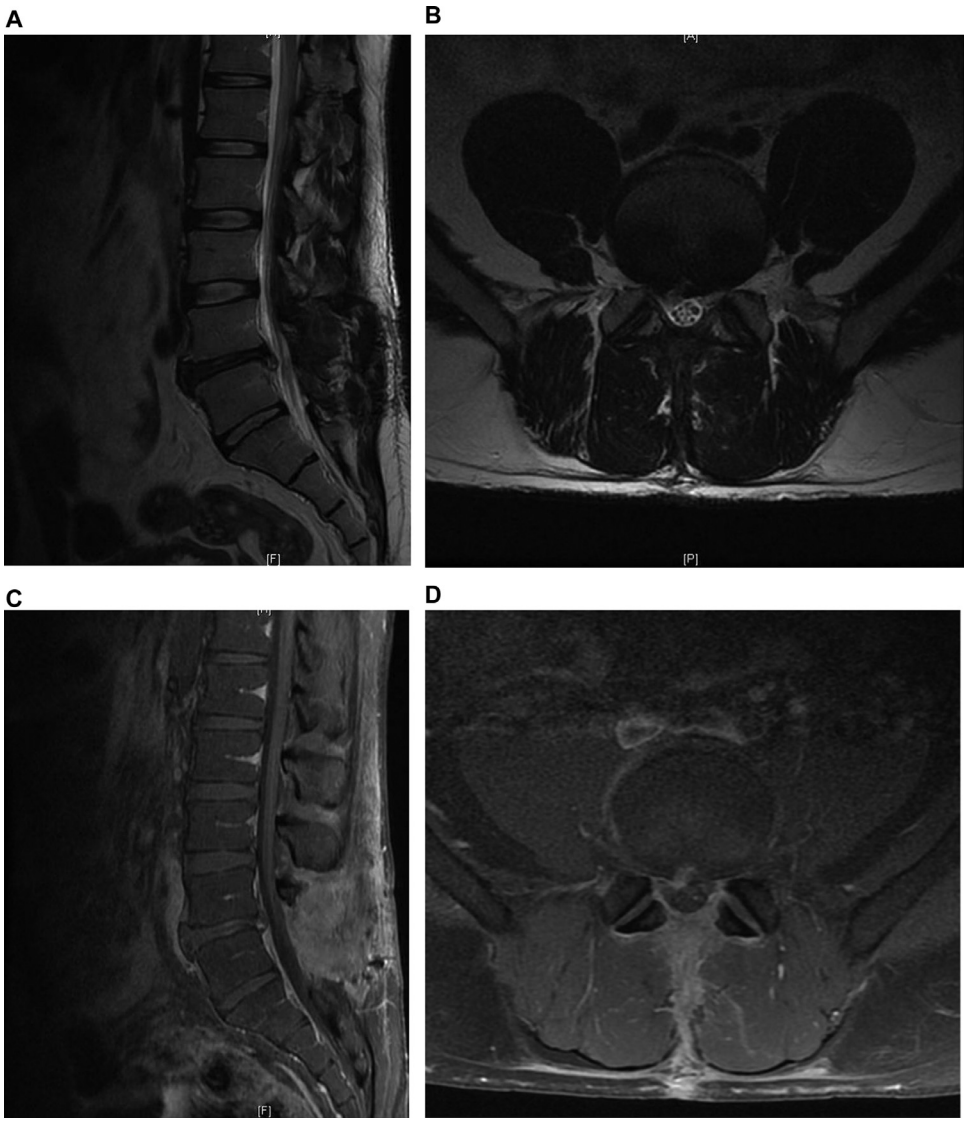

Fig. 3 – Sagittal (A) and axial (B) T2-weighted MRI images of this patient demonstrating a small recurrent right posterolateral disc herniation and bilateral foraminal stenosis at L4-L5 secondary to facet hypertrophy. Sagittal (C) and axial (D) T1-weighted post-gadolinium images demonstrate significant epidural fibrosis, small posterolateral recurrence within the enhancing region as well as evidence of previous discectomy at this level.

these conditions suggest that a more aggressive facetectomy would facilitate safer and more reliable decompression, then a transforaminal lumbar interbody fusion strategy is typically employed. Patients who develop a third-time herniation or those who report a significant component of back pain (in addition to leg pain) may be considered for interbody fusion at the time of revision discectomy. A transforaminal interbody approach is favored again because removing the facet and working more lateral to the traversing root requires less mobilization of the epidural scar.[49] An anterior and posterior combined approach is favored by some in this situation given the high fusion rate and restoration of lordosis associated with ALIF, but the authors rarely advocate a stand-alone ALIF if leg pain is a significant part of the symptom complex. Although some have reported successful removal of extruded disc fragments from an anterior lumbar retroperitoneal approach,[50] in most cases a direct posterior neurolysis and decompression allows better intraoperative confirmation that the root itself is mobile and the patient's leg pain will be adequately addressed.

8. Revision discectomy technical considerations

Once the decision has been made to move forward with revision laminectomy and discectomy either through a traditional open or minimally invasive tubular approach, there are several unique and similar challenges that must be considered. The prior surgical incision can often be utilized, but one must be cautious not to assume that the prior incision will be ideally suited for the approach, especially if the index surgery

was performed by a different surgeon. It can be helpful to identify the midline spinous process through palpation as well as the level of the involved interspace on lateral fluoroscopy and mark these prior to making incision, to allow a smaller incision and avoid unnecessary dissection after the incision is made. The area of previous surgery is generally obvious with scar tissue in the subcutaneous tissues and paraspinal muscles having a well demarcated appearance compared to surrounding tissues, and the superficial dissection is similar to that in an index procedure with a midline fascial incision followed by unilateral deep dissection on the side of the pathology. Once the interlaminar space is encountered, care must be taken not to cause an incidental durotomy by carefully studying preoperative plain films to assess for the extent of laminar and facet resection made in the previous surgery, and by using large caliber cobb elevators and curettes to peel back the pseudomembrane from the previous laminectomy defect.[51] The spinous process of the cephalad level (L4 in a L4-L5 revision laminectomy) can be used to identify the edge of the pseudomembrane if present, otherwise in the less common situation of performing a revision discectomy at the site of a previous full laminectomy, the caudal border of the cephalad lamina and the medial facet are the only bony landmarks and the dissection progresses from lateral to medial. The lateral pars above and below the level should be exposed so that excessive resection can be avoided later in the procedure (Fig. 4).

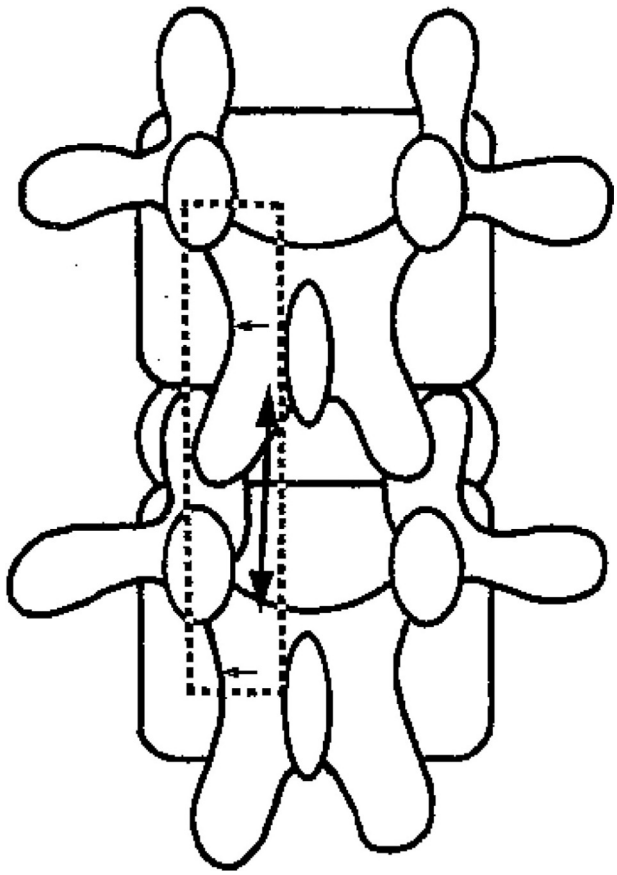

Fig. 4 – Extent of bone exposure necessary in a revision left laminectomy and discectomy. Note visualization of the lamina and pars above and below the level of interest and clear identification of the superior and inferior articular facet. (Reprinted, with permission, from McCulloch J, Young P: Microsurgery for lumbar disc herniations, in Essentials of Spinal Microsurgery, Philadelphia, PA, Lippincott-Raven, 1998, pp. 329-82.)

At this point once bony landmarks are established, curved curettes are used to detach the underlying epidural scar tissue and ligamentum flavum from the undersurface of the lamina and inferior articular facet. A high-speed burr can be helpful at this stage to thin the remaining lamina and medial facet, to allow a thinner rim of bone to resect with kerrisons. It is often necessary to advance the edge of bony resection greater than that in a primary lumbar discectomy in both a cephalad and caudal direction, so that normal dura can be encountered on both sides of the disc space and a clear tissue plane can then be established in the direction of the disc space (as McCulloch stated, “don’t operate through epidural scar; operate around it”[52] (Fig. 5). Although minimal bone resection is often advocated in a primary lumbar discectomy especially at L5-S1 where the interlaminar space is wide,[22] this often does not apply to a revision situation where adequate visualization of the traversing nerve root and safe exposure of the disc space takes precedence. Once exposure of the traversing root has been established by undercutting the above structures in addition to the pars and superior articular facet as necessary, the next step is to clearly identify the pedicle with a Woodson elevator, blunt nerve hook, or Penfield. In contrast to a primary discectomy, scar tissue will generally limit the amount of disc fragment migration to either the level of the disc space or just caudal to the disc space at the pedicle level.[52] If review of preoperative imaging demonstrates a significant amount of facet or pars resection already present, a preoperative discussion with the patient regarding the possible need for fusion is prudent to avoid postoperative instability and recurrent symptoms.

At this point, attention is then turned to excision of the recurrent disc herniation. First, dural adhesions between the traversing nerve root and the ventral disc herniation and any surrounding scar tissue must be carefully removed prior to attempting any medial retraction of the nerve root. Incidental durotomies occur in approximately 15-25% of revision laminectomy surgeries due to the loss of anatomic landmarks and increased technical difficulty of separating neural elements from the surrounding scar tissue and bone edge, and a meticulous technique and experienced surgeon are helpful in safely completing the exposure.[53,54] A blunt nerve hook or down-angled curette can be helpful to accomplish this, and the dissection can then progress close to the midline at which time the nerve root can then be safely retracted. It is then possible to excise the recurrent disc fragment in standard fashion, but only after it has been isolated on all sides in order to avoid incomplete resection and retained disc fragments.[52] Irrigation of the disc space with saline under pressure can be helpful to flush out small loose remaining disc fragments, and a blunt probe is then used to ensure that the disc space, proximal and distal root as well as the exiting and traversing foraminal zones are free of compression. Once hemostasis is obtained using thrombin-soaked gelfoam, cottonoid pledgelets or a commercially available hemostatic matrix, it can be

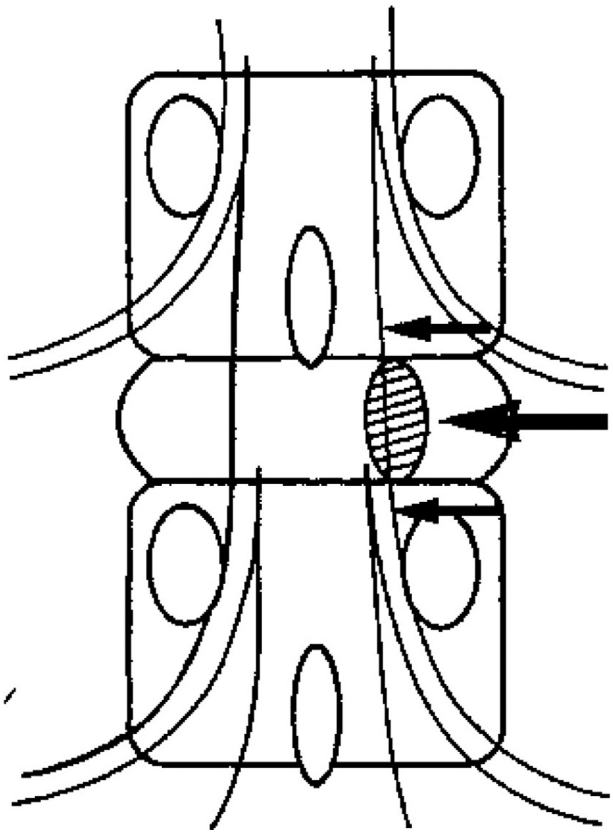

Fig. 5 – Area of scar tissue almost universally present between the disc space and the traversing nerve root at the site of a previous discectomy (large arrow) and areas of normal dura that need to be exposed proximal and distal to the nerve root (small arrows) in order to safely mobilize it. (Reprinted, with permission, from McCulloch J, Young P: Microsurgery for lumbar disc herniations, in Essentials of Spinal Microsurgery, Philadelphia, PA, Lippincott-Raven, 1998, pp. 329-82.)

helpful to have the anesthesiologist perform a Valsalva maneuver to 40 mm Hg in order to assess for spinal fluid leak, which can then be addressed prior to closure. The wound is then closed in standard layered fashion utilizing a watertight fascial closure with absorbable suture, and a drain can be placed if desired. The patient can be mobilized immediately as long as the integrity of the dura is maintained, and can be safely discharged home once adequate pain control and mobility are present.

9. Further approach related considerations for revision lumbar discectomy

While there is a paucity of level 1 evidence to guide specific surgical approaches to revision LDH, several studies have demonstrated differences between open and various minimally invasive techniques and have provided useful information on clinical outcomes. In a recent review of 22 patients undergoing revision microdiscectomy at a single institution, there was no difference between primary and revision surgery with regards to blood loss, length of hospital stay, and operative time, but not surprisingly the incidence of incidental durotomy was significantly greater in the revision group (16.7% vs 1.3%), with a greater portion of these located near the root shoulder than in the primary group.[55] A systematic review of 30 studies looking at revision surgery for recurrent LDH revealed an incidence of revision surgery of 1.4-11.4% and an overall complication rate of 0-34.6%, again with incidental durotomy being the most common complication.[56] However, despite the relatively high reported complication rates in this meta-analysis, a successful clinical outcome was noted in 60-100% of cases, similar to that in primary cases, supporting the notion that these procedures have value and are worth undertaking as long as appropriate indications and meticulous operative technique are followed. Likewise, Suk et al. performed a retrospective review of 28 patients undergoing traditional open laminectomy and discectomy for recurrent LDH and noted a longer operative time in the revision group, but no significant difference in hospital stay or clinical improvement.[57] Pain-free interval did not seem to affect clinical outcomes, indicating that patients with a relatively quick recurrence and those with a longer time to recurrence may benefit equally from revision surgery, although further studies with a greater sample size may be necessary to determine this. Finally, data on open versus minimally invasive techniques for recurrent LDH is limited, with one recent review demonstrating no superiority of either method, and the authors recommend that the surgical approach be driven by surgeon experience, available facilities, and equipment.[58]

In summary, revision discectomy surgery is a successful and reliable procedure in patients with recurrent leg and back symptoms following primary lumbar laminectomy and discectomy surgery after a pain-free interval. Once significant radiographic instability or spondylolisthesis has been ruled out, one can reliably choose this procedure and advise the patient that good outcomes are likely as long as appropriate planning and surgical technique are followed. Whether the surgeon chooses traditional open discectomy, open microdiscectomy or minimally invasive methods, the principles of careful scrutiny of preoperative imaging, meticulous dissection through scar tissue and establishing normal tissue planes in the spinal canal lead to a lower chance of neurologic injury, incidental durotomy, and a greater chance of patient success. No specific surgical approach has been shown to be superior with regard to overall clinical outcomes, therefore the surgeon should base this decision on their training, available equipment, and comfort level with minimally invasive versus open techniques.

Disclosures

Dr. Harris accepts consulting fees from Globus, Inc., not relevant to the content of this article. Dr. Vives reports no proprietary or commercial interest in any product mentioned or concept discussed in this article.

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