Prospective observational study of acute postlumbar laminectomy MRI

Clinical article

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Object. Patients who develop a lower-extremity neurological deficit after lumbar laminectomy present a diagnostic dilemma. In the setting of a neurological deficit, some surgeons use MRI to evaluate for symptomatic compression of the thecal sac. The authors conducted a prospective observational cohort study in patients undergoing open lumbar laminectomy for neurogenic claudication to document the MRI appearance of the postlaminectomy spine and to determine changes in thecal sac diameter caused by the accumulation of epidural fluid.

Methods. Eligible patients who were candidates for open lumbar laminectomy for neurogenic claudication at a single neurosurgical center between August 2007 and June 2009 were enrolled. Preoperative and postoperative MRI of the lumbar spine was performed on the same MRI scanner. Postoperative MRI studies were completed within 36 hours of surgery. Routine clinical and surgical data were collected at the preoperative visit, during surgery, and postoperatively. Images were interpreted for the signal characteristics of the epidural fluid and for thecal diameter (region of interest [ROI]) by 2 blinded neuroradiologists.

Results. Twenty-four patients (mean age 69.7 years, range 30–83 years) were enrolled, and 20 completed the study. Single-level laminectomy was performed in 6 patients, 2-level in 12, and 3-level in 2. Preoperative canal measurements (ROI) at the most stenotic level averaged 0.26 cm² (range 0.0–0.46 cm²), and postoperative ROI at that same level averaged 0.95 cm² (range 0.46–2.05 cm²). The increase in ROI averaged 0.69 cm² (range 0.07–1.81 cm²). Seven patients (35%) had immediate postoperative weakness in at least 1 muscle group graded at 4+/5. The decline in examination was believed to be effort dependent and secondary to discomfort in the acute postoperative period. Those with weakness had smaller increases in ROI (0.51 cm²) than those with full strength (0.78 cm², p = 0.1599), but none had evidence of worsened thecal compression. On the 1st postoperative day, 19 patients were at full strength and all patients were at full strength at their 15-day follow-up. The T1-weighted epidural fluid signal was isointense in 19 of the 20 patients. The T2-weighted epidural fluid signal was hyperintense in 9, isointense in 4, and hypointense in 7 patients.

Conclusions. Immediately after lumbar laminectomy, the appearance of the thecal sac on MRI can vary widely. In most patients the thecal sac diameter increases after laminectomy despite the presence of epidural blood. In this observational cohort, a reduction in thecal diameter caused by epidural fluid did not correlate with motor function. Results in the small subset of patients where the canal diameter decreased due to epidural fluid compression of the thecal sac raises the question of the utility of immediate postoperative MRI.

Key Words • spine • laminectomy • MRI • lumbar

Abbreviation used in this paper: ROI = region of interest.
went single or multilevel laminectomies with or without a discectomy. No patient who underwent anterior, lateral, or “minimally invasive” approaches was included. To avoid the degradation of images due to artifact, no patients with instrumentation were included. All patients were evaluated at the outpatient clinics of Barrow Neurological Institute and were selected for surgery based on their clinical presentation and imaging findings.

The patients underwent MRI within 30 days of their surgery on a designated 1.5-T MRI scanner at our center. All postoperative MRI studies were performed within 36 hours of surgery on the same scanner, utilizing the same scanning protocol. Postoperative neurological examinations were recorded 1 hour, 24 hours, and 15 days after surgery.

Two neuroradiologists, blinded to the patients’ clinical condition, independently graded the MR images, and the results were averaged. Two methods were used to grade thecal sac compression. First, the cross-sectional area of the thecal sac at its most compressed preoperative level was calculated using the region of interest (ROI) function available on our radiology software system (DR Systems). The ROI at this same level was calculated on the postoperative image. Second, a subjective scoring system was devised to score compression at each disc space (0, minimal [0%–25% spinal canal compromise]; 1, mild [25%–50%]; 2, moderate [50%–75%]; and 3, severe [75%–100%]).

**Results**

**Patient Population**

Of the 24 patients enrolled in the study, 20 (15 men and 5 women; mean age 69.7 years, range 30–83 years) were included in the data analysis. The remaining 4 patients did not complete postoperative MRI. All patients were ready for discharge on the 1st postoperative morning before MRI could be performed. All patients presented with neurogenic claudication. One patient also had a radiculopathy, necessitating a discectomy in addition to the laminectomy. Preoperative coagulation studies and platelet counts were normal for all patients.

**Surgical Treatments and Complications**

All patients were treated for neurological claudication. Six patients underwent a single-level laminectomy (defined as covering 1 disc space, for example, L4–5 laminectomy), 12 patients underwent a 2-level laminectomy, and 2 patients underwent a 3-level laminectomy. Five patients had undergone previous decompressive lumbar procedures. One patient returned to surgery for repair of a CSF leak. One patient had a superficial wound infection that responded to oral antibiotics.

**MRI Appearance**

All pre- and postoperative MR images were deemed interpretable and without artifact. Preoperative measurements of the spinal canal or ROI at the most stenotic preoperative level averaged 0.26 cm² (range 0.0–0.46 cm²); the postoperative ROI at that same level averaged 0.95 cm² (range 0.46–2.05 cm², Figs. 1 and 2). The increase in ROI averaged 0.69 cm² (range 0.07–1.81 cm²). No patient had a decreased ROI at the most stenotic level, although the ROI did change at other levels. Seven patients had immediate postoperative weakness in at least 1 muscle group graded at 4+/5. Those with weakness had smaller increases in ROI (mean 0.51 cm²) than those with full strength (mean 0.78 cm²), but the difference was not significant (p = 0.1599). Nineteen patients had full strength on postoperative Day 1, and all had full strength at their 15-day follow-up. The patient with an abnormal examination on postoperative Day 1 had a preoperative ROI of 0.0 cm² and a postoperative ROI of 0.46 cm².

Compression at the operative site was graded “moderate” or “severe” in 5 patients. Seven patients had worsened compression at an adjacent or distant nonoperative site. Three of these 7 cases were graded “severe” and were as far as 2 levels away from the operative site.

The T1-weighted epidural fluid signal was isointense to CSF in 19 of the 20 patients and hyperintense in the remaining patient. The T2-weighted epidural fluid signal was hyperintense in 9, isointense in 4, and hypointense in 7 patients.

![Fig. 1. Preoperative (A) and postoperative (B) sagittal T2-weighted images and pre- (C) and postoperative (D) axial images obtained in the patient with the largest increase in ROI. Preoperative ROI at the L3–4 disc space was 0.24 cm². Postoperative ROI at the same level was 2.05 cm².](image-url)
Discussion

There have been few reports of postoperative lumbar findings on MRI correlated with clinical data. In a prospective series of 30 patients undergoing minimally invasive discectomies, MRI was performed 1 week after surgery. The authors found that 33% of their patients had significant hematomas, but there was no correlation between the presence of a hematoma and neurological status. However, compared with patients without hematomas, patients with hematomas reported more back pain in the postoperative period and recorded smaller long-term improvements on standardized scoring.

Another prospective study of MRI performed 2–5 days after lumbar spine surgery included both anterior and posterior approaches and included patients in whom instrumentation was placed. Fifty-seven patients were investigated and were neurologically intact after surgery. The authors compared the images from these patients with images from patients in their database who were noted to have severe pain or cauda equina syndrome and who had returned to surgery. A critical ratio (defined as the postoperative cross-sectional area/preoperative cross-sectional area) < 0.25 was predictive of cauda equina syndrome. The authors also reported a wide range of MRI appearances in unaffected patients. In a separate paper by the same group, significant compression at the decompressed levels and worsened compression at levels distant from the operative site were noted to be similar to our findings.

A postoperative epidural hematoma must be considered in patients who awake after lumbar spine surgery with unanticipated findings on their neurological examination. If patients are neurologically compromised, urgent decompression is warranted. Sometimes it is not clear whether an unanticipated finding is real or the product of oversedation, pain limitation, or confusion in these often elderly patients. In such questionable cases, it may be helpful to obtain an MR image to evaluate whether the patient needs to return to surgery. Because all of our patients awoke with a reasonable neurological status, we were unable to include any patients with unanticipated findings in this prospective study.

Risk factors for postoperative hematomas include preoperative nonsteroidal drugs, age older than 60 years, Rh-positive blood type, multilevel procedures, anemia, intraoperative blood loss greater than 1 L, and an elevated pre- or postoperative international normalized ratio. Although not formally described, it is reasonable to assume that dual antiplatelet therapy is also a risk factor.

The findings of this prospective, acute postoperative period (< 36 hours) study indicate that the postoperative lumbar spine has a wide range of appearances on MRI. Every patient had some element of a postoperative hematoma, but only 12 of 20 patients had a hematoma that caused significant (worsened or Grade 2/3) compression at the operative site or at a site distant from it. In 5 of the 20 cases, the thecal sac appeared so severely compromised on MRI that we immediately returned to the patient’s bedside to reexamine the patient and confirm a good neurological examination. In each case, however, the patient exhibited full strength. Although there was a trend indicating that the more severely compressed thecal sac predicted mild, temporary weakness, it did not prove to be significant. Furthermore, no patient was weaker than 4+/5 in the postoperative period. We doubt whether this small difference in a subjective measure of patient strength had any clinical significance and interpret the entire cohort as within the expected norms of a clinical examination.

The outcome of the small subset of patients whose spinal canal diameter decreased due to epidural fluid compression of the thecal sac raises the question of the usefulness of MRI in postsurgical patients. Should a surgeon choose to obtain an MRI study after surgery to evaluate unexpected lower-extremity weakness, our findings may aid in the interpretation of such studies. It can be said with confidence that severe compromise seen on postoperative MRI does not necessarily predict that the patient will have a neurological deficit. Unfortunately, we cannot comment on the converse. Given the lack of prospective data regarding the postoperative appearance of the lumbar spine in the neurologically compromised patient, clinical judgment remains the best guide for determining whether to return a patient to surgery and explore for a clinically significant hematoma. We see no role for delaying return to the operating room to obtain a postoperative MR image in the acute period for a patient who has an unanticipated and unequivocal poor status on neurological examination.
Conclusions

The lumbar spine has a wide range of appearances on MRI immediately after laminectomy. The thecal sac may appear compressed at the operative site or distant from it. The severity of compression by epidural fluid (presumed hematoma) does not predict a patient’s neurological status. When confronted with a patient with poor neurological examination findings after decompressive surgery, we would recommend immediate return to the operating room for exploration.

Disclosure

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