The notion of a herniated disc fragment causing neural compression in the lumbar spinal canal was first reported by Mixter and Barr in 1934. Today, lumbar discectomy is the most commonly performed spinal procedure in the US, with ~ 300,000 cases each year. Multiple studies have revealed that lumbar discectomy improves pain, physical function, and disability in the majority of patients; however, 10–30% of patients may experience long-term back pain following primary discectomy for radiculopathy.

Progressive disc degeneration and height loss at the level of discectomy occur in most patients and, in fact, contribute to postdiscectomy mechanical back pain in a subset of them. Yorimitsu et al. have found a 25% loss of disc height in most patients 1 year after lumbar discectomy, a phenomenon associated with worsened back pain. Barth et al. have reported a significant increase in endplate degeneration and disc dehydration following discectomy, phenomena that were associated with worsened back pain in that study.

Conservative therapy for postdiscectomy back pain includes epidural steroid injection, nerve or facet blocks, radiofrequency ablation, and/or physical therapy. For patients whose condition is refractory to these measures or who demonstrate segmental instability, fusion may be required. While the incidence of postdiscectomy fusion remains unclear, multiple studies have documented the successful treatment of refractory postdiscectomy back pain with spinal fusion.

The incidence of mechanical back pain following discectomy varies widely in the literature, and its associated health care costs are unknown; therefore, we set out to identify the incidence of and the health care costs associated with mechanical back pain attributed to segmental degeneration or instability at the level of a prior discectomy performed at our institution.
Long-term back pain following single-level discectomy

Methods

Data Collection

Subsequent to obtaining approval from The Johns Hopkins Institutional Review Board, we reviewed all single-level, first-time lumbar discectomies performed by a single spine neurosurgeon (D.M.L.) between January 1, 1997, and January 1, 2007. All of these patients underwent lumbar discectomy only if they had 1) preoperative imaging clearly demonstrating lumbar disc herniation, 2) radicular symptoms ascribable to a disc level, and 3) symptoms refractory to at least 6 weeks of conservative treatment. Patients undergoing bilateral laminectomy or concomitant fusion or presenting with additional spinal pathologies were excluded from our analysis. Patient's lost to follow-up prior to the first clinic visit at 1 month postoperatively were also excluded from the study.

Medical records were reviewed and patient demographics, presenting symptoms, preoperative radiographic findings, operative variables, perioperative morbidity, duration of hospitalization, and clinical outcomes were recorded. For patients who experienced postdiscectomy mechanical back pain, all diagnostic studies (MR imaging, CT, radiography, electromyography, or discography), conservative treatments (epidural steroid injections, nerve blocks, radiofrequency nerve ablation, or physical therapy), and details of subsequent surgeries for back pain were noted. It was not our aim to assess symptomatic recurrent disc herniation, but rather the back pain associated with same-level disc degeneration, spondylolisthesis, or instability.

To assess the health care costs associated with the treatment of mechanical back pain following single-level discectomy, institutional billing and accounting records were reviewed to determine the billed costs of all diagnostic and therapeutic measures used for patients experiencing recurrent mechanical back pain. Such measures included the diagnostic and conservative treatments listed above, hospitalization for subsequent same-level fusion, and any physical therapy required after subsequent fusion surgery. For the purposes of this study, “health care cost” was defined as the total amount billed for all procedures and health care services related to the management of postdiscectomy mechanical back pain.

Case Definition

Postdiscectomy back pain was defined as same-segment, degenerative, disc-associated axial back pain that was mechanical in nature and demonstrated both decreased disc height and decreased T2 signal intensity from the time of primary discectomy. Patients were stratified into 3 categories according to their postdiscectomy back pain status: 1) minimal to none, 2) moderate, or 3) severe. Minimal to none refers to no back pain postoperatively or to back pain that was amenable to narcotics and/or antiinflammatory drugs. Moderate describes back pain that required and was successfully managed with conservative treatments such as nerve blocks, facet blocks, and/or epidural steroid injections. Severe indicates back pain that was refractory to conservative treatments and therefore required surgical management.

Primary Discectomy Technique and Postoperative Management

Patients underwent surgical intervention while in the prone position under general anesthesia. Preincision plain radiographs were obtained to identify the correct spinal level. A midline skin incision was made, followed by unilateral subperiosteal dissection of the lumbar paraspinous muscles for exposure of the laminae. A portion of the caudal aspect of the superior lamina and the rostral aspect of the inferior lamina were removed, followed by a partial medial facetectomy to unroof the lateral recess if needed. The herniated disc was removed, and a nerve hook was used to free any migrated fragments. In cases of minimal anular defect, disc curettage was not performed. In cases with a sizable anular defect, however, a subannular discectomy with curettage was undertaken. The compressed nerve root was always examined along its course to the foramen inferior to the pedicle and, if necessary, a foraminotomy was performed prior to closure.

Routine postoperative follow-up consisted of evaluation at 1, 3, 6, and 12 months and annually thereafter. Patients experiencing mechanical axial back pain that was believed to interfere with their quality of life underwent flexion and extension radiography to rule out overt instability and were started on various conservative treatment modalities. Those continuing to experience mechanical back pain beyond 1 year postoperatively routinely underwent MR imaging to assess for disc degeneration, spondylolisthesis, or facet and ligamentous hypertrophy. If severe back pain remained refractory to nonsurgical treatment in the presence of radiographically confirmed degeneration or instability, a fusion procedure was then considered. Patients who experienced continual back pain without radiographic signs of segmental instability or degeneration of the prior discectomy segment were treated with prolonged conservative (nonsurgical) therapy.

Results

Patient Population

One hundred eleven consecutive patients meeting the inclusion criteria underwent first-time, single-level lumbar discectomy over the reviewed period. The average age was 52 years (range 17–89 years), and 64 patients (58%) were male. Patient symptoms before primary discectomy consisted of radicular pain (90%), mild motor weakness (49%), numbness (46%), and lower extremity paresthesias (19%). Fifty-six patients (50%) had left-sided symptoms and 55 (50%) had right-sided symptoms. The level of disc herniation was L1–2 in 4 patients (4%), L2–3 in 7 (6%), L3–4 in 16 (14%), L4–5 in 47 (42%), and L5–S1 in 37 (33%). The median duration of symptoms prior to surgery was 7 months (IQR 1–18 months; Table 1).

Perioperative Outcomes

No perioperative death was associated with any of the 111 first-time discectomies. The median duration of hospitalization was 2 days (IQR 1–5 days). Perioperative complications included deep vein thrombosis (1 case [0.9%]) and surgical site infection (1 case [0.9%]).
hundred nine patients (98%) were discharged home following surgery, whereas 2 (2%) required inpatient rehabilitation because of persistent preoperative motor weakness.

Incidence and Management of Postoperative Mechanical Back Pain

The mean duration of follow-up after the primary discectomy procedure was 37.3 months (range 1 month–12.2 years). Seventy-five percent of patients were in active follow-up at 3 months postoperatively, 68% at 6 months, and 63% at 1 year. At the last follow-up, 75 patients (68%) had minimal to no back pain, 26 (23%) had moderate back pain requiring conservative therapy, and 10 (9%) had severe back pain that required a subsequent fusion surgery at the site of the primary discectomy because of segmental instability (Table 2). Radiographically identified disc degeneration was present in all 36 patients with back pain requiring conservative or operative management. Additionally, posterior ligamentous hypertrophy and vertebral hypermobility were found in 22 (61%) and 5 (14%) cases, respectively. A review of radiographic images obtained before the primary discectomy revealed that 19 patients (53%) who would later experience clinically significant postdiscectomy back pain actually had signs of same-level degenerative changes preoperatively. Similarly, 39 patients (52%) who did not experience postdiscectomy back pain had signs of same-level degenerative disease preoperatively. The median time from the initial discectomy to the subsequent fusion procedure was 14 months (IQR 11–19 months). The fusion procedures consisted of 3 in situ fusions (30%), 5 transpedicular instrumented fusions (50%), and 2 transforaminal lumbar interbody fusions (20%).

Health Care Costs Associated With Recurrent Back Pain

The total cost associated with the diagnosis and management of postoperative mechanical back pain for the 36 patients in this study was $547,655: diagnostic testing $109,798; conservative therapy $120,881; and subsequent fusion surgery $316,976. The mean cost per patient treated with conservative therapy alone was $4696, whereas the mean cost per patient requiring operative treatment was $42,554 (Table 3). In this study, the estimated cost for patients with mechanical back pain was $493,383 per 100 cases of first-time, single-level lumbar discectomy ($4934 per primary discectomy).

Discussion

In our experience with 111 patients undergoing primary single-level lumbar discectomy, the majority of patients experienced minimal to no back pain by 3 years postoperatively. The patients who had clinically significant low-back pain included 26 (23%) who responded to conservative therapy and 10 (9%) whose symptoms were refractory to conservative treatment and required spinal fusion; hence, the majority of patients with clinically significant back pain responded to conservative therapy alone. While 25% of patients in the study were lost to follow-up between 1 and 3 months postoperatively, this rate of attrition is not uncommon following a single-level discectomy procedure. We believe the majority, if not all, of these patients experienced complete resolution of their back pain.

### TABLE 1: Summary of characteristics in 111 patients who underwent discectomy

<table>
<thead>
<tr>
<th>Parameter</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>111</td>
</tr>
<tr>
<td>Age in yrs</td>
<td>51 (56)</td>
</tr>
<tr>
<td>Male sex</td>
<td>42 (56)</td>
</tr>
<tr>
<td>Duration of symptoms prediscetomy (mos)</td>
<td>16 (18)</td>
</tr>
<tr>
<td>Level of discectomy</td>
<td></td>
</tr>
<tr>
<td>L1–2</td>
<td>4 (6)</td>
</tr>
<tr>
<td>L2–3</td>
<td>6 (8)</td>
</tr>
<tr>
<td>L3–4</td>
<td>10 (13)</td>
</tr>
<tr>
<td>L4–5</td>
<td>31 (41)</td>
</tr>
<tr>
<td>L5–S1</td>
<td>24 (32)</td>
</tr>
<tr>
<td>Same-level degenerative changes prediscetomy</td>
<td>39 (52)</td>
</tr>
<tr>
<td>Time to recurrent pain postdiscectomy (mos)</td>
<td>— (9)</td>
</tr>
<tr>
<td>Time to fusion postdiscectomy (mos)</td>
<td>— (7)</td>
</tr>
</tbody>
</table>

### TABLE 2: Outcome after first-time single-level discectomy for lumbar disc herniation and radiculopathy

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients w/ minimal to no back pain (%)</td>
<td>75 (68)</td>
</tr>
<tr>
<td>Patients w/ moderate back pain (%)</td>
<td>26 (23)</td>
</tr>
<tr>
<td>Patients w/ severe back pain (%)</td>
<td>10 (9)</td>
</tr>
<tr>
<td>Median no. of mos from discetomy to subsequent fusion (IQR)</td>
<td>14 (11–19)</td>
</tr>
</tbody>
</table>
Long-term back pain following single-level discectomy

The diagnosis and management of postdiscectomy back pain was associated with substantial health care costs. The total cost associated with the diagnosis and management of the 36 cases of postdiscectomy back pain in our series was $547,655. This total cost suggests an additional estimated $493,383 per 100 cases of primary single-level discectomy was required for postdiscectomy mechanical back pain at our institution. For the purposes of this study, cost was defined as the total amount billed, rather than collected, for all procedures related to postdiscectomy back pain. The percent collected varies as a function of hospitals and individual patients, but is always less than the amount billed. As a result, the total health care cost paid was probably less than the total amount billed per patient with postdiscectomy back pain. Note that the indirect socioeconomic costs associated with missed work and the cost of outpatient pain medications were not assessed in our analysis, suggesting that the overall cost per patient with postdiscectomy back pain may be higher than the hospital costs estimated here. Nevertheless, our results suggest that postdiscectomy back pain is not uncommon and is associated with significant health care costs in affected patients.

A principle etiology of disc-associated mechanical back pain is disc degeneration (Fig. 1). In the present study, disc degeneration was radiographically demonstrated in all 36 patients with clinically significant back pain. Yo-rimitsu et al.22 have shown a ≥25% loss of disc height in a majority of patients following lumbar discectomy, a phenomenon associated with worsening back pain. Barth et al.1 have reported a significant increase in endplate degeneration and disc dehydration following discectomy, phenomena also associated with worsening back pain. Data from both of these studies indirectly suggest that minimal endplate injury and subanular disc removal should be the goal of discectomy for radiculopathy.

Although the present analysis is based solely on the experience of a single surgeon at one institution, our results fall within the expected norm and can be considered representative. Consistent with the findings described here, a 5% incidence of postdiscectomy back pain requiring operative treatment has been reported by Ruetten et al.18 Other studies have documented postdiscectomy back pain in 10–30% of patients by using subjective pain scales and mailed questionnaires.3–6,9,10,14,20 Because surgical techniques differ and pain assessment scales vary, the reported incidence of postdiscectomy back pain is difficult to objectively compare. While the outcomes following primary single-level discectomy in the present study are consistent with prior reports, it remains unclear how different management strategies may affect costs associated with postdiscectomy back pain. In our practice, we attempt to conservatively treat all patients experiencing postdiscectomy back pain, prior to imaging. Such treatment includes 2 days of bed rest, nonsteroidal antiinflammatory medications, and physical therapy. Radiological studies are pursued only after these acute measures have failed. Even in cases with a radiographically confirmed etiology for back pain, a prolonged course (>3 months) of conservative therapy will be attempted in the absence of acutely worsening motor deficits, prior to operative treat-

### Table 3: Health care costs associated with the management of back pain attributed to segmental instability or degenerative disc disease at the level of prior discectomy in 36 patients*

<table>
<thead>
<tr>
<th>Therapy Required</th>
<th>No. of Patients</th>
<th>Diagnostic Testing†</th>
<th>Conservative Therapies‡</th>
<th>Op Treatment§</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>conservative therapy alone</td>
<td>26</td>
<td>$2,291</td>
<td>$2,405</td>
<td>$0</td>
<td>$4,696</td>
</tr>
<tr>
<td>op treatment</td>
<td>10</td>
<td>$5,022</td>
<td>$5,834</td>
<td>$31,698</td>
<td>$42,554</td>
</tr>
</tbody>
</table>

* All monetary values expressed in US dollars.  
† Includes MR imaging, CT, radiography, and discography.  
‡ Includes physical therapy and injections.  
§ Includes the cost of surgery, all in-hospital charges, and postoperative rehabilitation.

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**Fig. 1.** A: Computed tomography scan showing extensive L3–4 disc degeneration 9 months after primary discectomy.  
B: Plain radiograph showing the same region after spinal stabilization using pedicle screws with interbody fusion at L3–4. This patient originally underwent L3–4 microdiscectomy after presenting with right lower extremity radiculopathy and a large herniated L3–4 disc fragment. The patient fared well postoperatively but returned months later with severe mechanical back pain. Three months of conservative therapy failed, and the patient was eventually offered an instrumented fusion. The patient experienced a significant reduction in low-back pain 9 months after fusion.
ment. Practices that are more aggressive in pursuing operative treatment may incur even greater health care costs associated with the management of postdiscectomy back pain compared with those reported in this study.

Our experience with primary single-level lumbar discectomy highlights the importance of postdiscectomy back pain as a significant contributor to unsatisfactory patient outcomes and excessive health care costs. In an attempt to reduce the costs associated with postdiscectomy back pain, the application of prolonged conservative therapy may be prudent.

Conclusions

Postoperative mechanical back pain associated with same-level degeneration is not uncommon in patients undergoing single-level lumbar discectomy. The majority of postdiscectomy back pain can be successfully managed with conservative treatments. Nonetheless, the diagnosis and treatment of postdiscectomy back pain is associated with substantial health care costs.

Disclosure

Dr. McGirt is a consultant for Intrinsic Therapeutics, Inc.

References


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