Perioperative results following lumbar discectomy: comparison of minimally invasive discectomy and standard microdiscectomy

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Object. Minimally invasive lumbar discectomy is a refinement of the standard open microsurgical discectomy technique. Proponents of the minimally invasive technique suggest that it improves patient outcome, shortens hospital stay, and decreases hospital costs. Despite these claims there is little support in the literature to justify the adoption of minimally invasive discectomy over standard open microsurgical discectomy. In the present study, the authors address some of these issues by comparing the short-term outcomes in patients who underwent first time, single-level lumbar discectomy at L3–4, L4–5, or L5–S1 using either a minimally invasive percutaneous, muscle splitting approach or a standard, open, muscle-stripping microsurgical approach.

Methods. A retrospective chart review of 172 patients who had undergone a first-time, single-level lumbar discectomy at either L3–4, L4–5, or L5–S1 was performed. Perioperative results were assessed by comparing the following parameters between patients who had undergone minimally invasive discectomy and those who received standard open microsurgical discectomy: length of stay, operative time, estimated blood loss, rate of cerebrospinal fluid leak, post-anesthesia care unit narcotic use, need for a physical therapy consultation, and need for admission to the hospital.

Results. Forty-nine patients underwent minimally invasive discectomy, and 123 patients underwent open microsurgical discectomy. At baseline the groups did differ significantly with respect to age, but did not differ with respect to height, weight, sex, body mass index, level of radiculopathy, side of radiculopathy, insurance status, or type of preoperative analgesic use. No statistically significant differences were identified in operative time, rate of cerebrospinal fluid leak, or need for a physical therapy consultation. Statistically significant differences were identified in length of stay, estimated blood loss, postanesthesia care unit narcotic use, and need for admission to the hospital.

Conclusions. In this retrospective study, patients who underwent minimally invasive discectomy were found to have similar perioperative results as those who underwent open microsurgical discectomy. The differences, although statistically significant, are of modest clinical significance. (DOI: 10.3171/FOC/2008/25/8/E20)

KEY WORDS • discectomy • hospital stay • lumbar spine • minimally invasive surgery • narcotic use

Lumbar discectomy was first described in 1934 by Mixt- er and Barr. Since the original description, the procedure has undergone continued refinement to limit complications and improve patient outcome. Most recently, the use of a percutaneous, muscle-splitting, minimally invasive approach rather than a standard open, muscle-stripping approach has been described in an effort to limit approach-related complications. This latest refinement was described by Foley and Smith in 1997 as a means to reduce approach-related complications associated with open discectomy. Although proponents of this approach suggest that patient outcome may be improved over a standard microsurgical discectomy, little comparative data has been provided to show that the differences in clinical outcome are indeed different. To date, the largest studies of minimally invasive discectomy have described an initial surgical experience without extensive comparison to a standard microsurgical discectomy group. Given the potentially significant learning curve associated with the use of a minimally invasive approach many surgeons have been reluctant to embrace these techniques without more substantial evidence of clinical benefit. Indeed, the current literature concerning minimally inva-

Abbreviations used in this paper: CSF = cerebrospinal fluid; PACU = postanesthesia care unit.
sive lumbar discectomy has been criticized for not emphasizing adverse results and complications.\(^3\)

The present study was undertaken to further clarify the effects of minimally invasive discectomy on short-term patient outcome, and includes an analysis of 172 patients treated by 6 board-certified neurosurgeons over a 3-year period.

**Methods**

After institutional review board approval was received, the divisional financial database at Albany Medical Center was used to identify all patients who had undergone a lumbar discectomy (CPT code 63030) for radiculopathy between November 1, 2002 and March 1, 2006. One hundred seventy-two patients who had undergone a first-time, single-level discectomy at L3–4, L4–5, or L5–S1 were identified. These records were then reviewed for patient demographics (age, sex, height, weight, and body mass index), type of radiculopathy (level and side), type of preoperative analgesic use (none, nonsteroidal antiinflammatory, or narcotic), insurance status (workers’ compensation or not), type of surgical approach (minimally invasive or open microsurgical), operative time (in minutes), estimated blood loss (in milliliters), percentage of patients with intraoperative CSF leakage, percentage who required conversion to an open procedure, postoperative narcotic use (in milligram morphine equivalents), percentage of patients who required physical therapy evaluation, percentage who required hospital admission, and length of stay (in days).

Both groups of patients underwent lumbar discectomy with either an open\(^2,11,22\) or minimally invasive technique\(^4\) as previously described. The main difference between the techniques lies within the treatment of the paraspinous muscles and the type of retractor used (Fig. 1). Briefly, patients in the open group underwent a standard midline incision ~4–5 cm in length with a muscle-stripping approach to the interspace. A bladed retractor was then inserted to maintain surgical access. In contrast, the patients in the minimally invasive group underwent a paramedian incision ~1.8 cm in length with a transmuscular approach to the interspace using serial soft-tissue dilators. A tubular retractor was then inserted to maintain surgical access. Both groups received similar perioperative care with respect to general anesthesia, local anesthetic, postoperative pain medications, and early mobilization.

The data are presented as means ± standard errors of the means. The groups were compared using the Student t-test for continuous variables and the chi-square test for categorical variables. A probability value of 0.05 was considered statistically significant.

**Results**

Baseline demographics including age, sex, height, weight, body mass index, insurance status, type of preoperative analgesia, level and side of radiculopathy are presented in Table 1. A statistically significant difference between the groups was identified with respect to age (minimally

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*Fig. 1. Photograph of the bladed retractor (left), used in the microsurgical group, and the tubular retractor (right), used in the minimally invasive surgical group.*
Short-term outcomes after lumbar discectomy

**TABLE 1**
Summary of baseline characteristics of patients in minimally invasive and standard microsurgical groups

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Minimally Invasive Discectomy (49 patients)</th>
<th>Standard Microsurgical Discectomy (123 patients)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>age (yrs)*</td>
<td>47.45 ± 1.98</td>
<td>41.75 ± 1.11</td>
<td></td>
</tr>
<tr>
<td>male sex (%)</td>
<td>44.9</td>
<td>61.0</td>
<td></td>
</tr>
<tr>
<td>body mass index</td>
<td>29.60 ± 0.66</td>
<td>29.53 ± 0.59</td>
<td></td>
</tr>
<tr>
<td>no. on workers’ comp (%)</td>
<td>8.0</td>
<td>7.4</td>
<td></td>
</tr>
<tr>
<td>no. w/ preop medications (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>narcotics</td>
<td>62</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>NSAID</td>
<td>16</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>none</td>
<td>22</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>discectomy side (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>right</td>
<td>56.0</td>
<td>44.3</td>
<td></td>
</tr>
<tr>
<td>left</td>
<td>44.0</td>
<td>55.7</td>
<td></td>
</tr>
<tr>
<td>discectomy level (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L3–4</td>
<td>12.0</td>
<td>7.4</td>
<td></td>
</tr>
<tr>
<td>L4–5</td>
<td>38.0</td>
<td>40.2</td>
<td></td>
</tr>
<tr>
<td>L5–S1</td>
<td>50.0</td>
<td>52.4</td>
<td></td>
</tr>
</tbody>
</table>

* Statistically significant difference, p = 0.021. Abbreviations: comp = compensation; NSAID = nonsteroidal antiinflammatory drug.

invasive: 47.45 ± 1.98 years; open microsurgery: 41.75 ± 1.11 years; p < 0.05). The groups did not differ significantly with respect to height, weight, body mass index, level or side of radiculopathy, insurance status, or type of preoperative analgesic use.

The percentage of patients who incurred a CSF leak was not statistically different between groups. Two patients who underwent a minimally invasive approach required conversion to a standard, open microsurgical discectomy. Due to insurance issues the first patient remained in the hospital for 6 days before returning to the operating room for an open microsurgical hemilaminectomy to address a heavily calcified intradural disc herniation. In the second case, access could not be maintained using a minimally invasive approach, and conversion to an open procedure was performed at that time. The reason for the conversion was a mechanical failure of the reticulated arm, which holds the tubular retractor in place. One patient in the minimally invasive group sustained an iliac vein injury requiring emergency vascular surgery for repair.

**Perioperative Parameters**

Perioperative outcome parameters are summarized in Table 2. No statistically significant differences were identified in operative time, rate of CSF leak, or need for physical therapy consultation. Statistically significant differences were identified in length of stay (minimally invasive group: 0.82 ± 0.28 days; open microsurgical group: 1.44 ± 0.09 days; p < 0.05), estimated blood loss (minimally invasive group: 59.3 ± 12.0 ml; open microsurgical group: 90.4 ± 8.1 ml; p < 0.05), PACU narcotic use (minimally invasive group: 9.1 ± 1.56 mg morphine equivalents; open microsurgical group: 14.2 ± 1.1 mg morphine equivalents; p < 0.05), and the need for hospital admission (minimally invasive group: 34.7% admitted; open microsurgical group: 90.2% admitted; p < 0.0001).

**Discussion**

**Criticism of Present Study**

The goal of this study was to compare the perioperative outcomes after lumbar discectomy among patients who have undergone the minimally invasive muscle-splitting approach and those who had the open microsurgical approach. The surgical care provided was similar between the groups with the patients in both groups having received general anesthesia. Postoperative pain was controlled with an extraforaminal, intradiscal procedure as described by others.

While several large series have described clinical results using a minimally invasive approach, there are more limited clinical data comparing these surgical techniques. It should be emphasized that the patients who underwent the minimally invasive approach still had the benefit of an intralaminar exposure and were not treated with an extrarofaminal, intradiscal procedure as described by others.

The baseline characteristics between the groups are not statistically similar with respect to age. We believe that the observed difference in age between the groups is not very likely to have a significant effect on the short-term outcomes observed in this study. The fact that no statistically significant differences were noted with respect to height, weight, body mass index, preoperative medication use, or workers’ compensation status suggests that the 2 surgeons offering the minimally invasive approach were not biased towards younger, leaner, or noncompensation patients.

**TABLE 2**
Summary of results*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimally Invasive Discectomy (49 patients)</th>
<th>Open Microsurgical Discectomy (123 patients)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>operative time (min)</td>
<td>165.5 ± 5.75</td>
<td>169.8 ± 4.37</td>
<td>NS</td>
</tr>
<tr>
<td>estimated blood loss (ml)</td>
<td>59.3 ± 12.0</td>
<td>90.4 ± 8.1</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>CSF leak (%)</td>
<td>8.2</td>
<td>4.9</td>
<td>NS</td>
</tr>
<tr>
<td>pain med (mg morphine equivalents)</td>
<td>9.1 ± 1.6</td>
<td>14.2 ± 1.1</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>PT evaluation (%)</td>
<td>8.2</td>
<td>13.0</td>
<td>NS</td>
</tr>
<tr>
<td>LOS (days)</td>
<td>0.82 ± 0.28</td>
<td>1.44 ± 0.09</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>hospital admission (%)</td>
<td>34.7</td>
<td>90.2</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

* LOS = length of stay; med = medicine; PT = physical therapy; NS = not significant.
An important variable that was not controlled in our study was the attitude of the treating surgeon towards hospital discharge after lumbar discectomy. This attitude is most often shaped by hospital policies, hospital reimbursement, insurance status, and nursing care than by any actual clinical data. The effect of the surgeon’s attitude on clinical outcome is not well-described, but there is some literature to support its effect on clinical outcome.

The importance of the present study lies in its size: this is the largest comparative analysis of minimally invasive versus open microsurgical discectomy to be presented to date. Data from 6 board-certified, practicing neurosurgeons are incorporated. Previous series of minimally invasive discectomy cases have largely been limited to single- or 2-surgeon experience.

Complications of Minimally Invasive Spinal Surgery

The present study highlights the fact that the adoption of minimally invasive techniques does not limit the potential for complications. Although the percent of patients who developed a CSF leak was similar between the groups, our anecdotal experience suggests that most patients who undergo a minimally invasive approach fare better because they do not require bed rest, may be discharged home on the day of surgery, and do not require further intervention for symptomatic headaches or poor wound healing. This analysis also demonstrates that the potential for major complications is not avoided with a minimally invasive approach as 1 patient in this group required surgical repair of an iliac vein laceration. Longer term complications such as wound infections, recurrent disc herniation, and symptomatic spinal instability were not addressed in the present study. To date the reported literature regarding minimally invasive spine surgery has been criticized as being overly optimistic. The continued review and reporting of adverse events is essential to a full understanding of the effectiveness of these procedures.

Effect of a Minimally Invasive Approach on Perioperative Outcome

In our analysis, the minimally invasive approach demonstrated statistical differences from the standard microsurgical approach with respect to length of stay, estimated blood loss, PACU narcotic use, and the need for hospitalization. Although statistically significant, these differences are of dubious clinical significance. For example, the observed difference in estimated blood loss between the groups is minimal and would seem unlikely to affect the need for a transfusion (a rare event in lumbar disc surgery). Similarly the difference in PACU narcotic use is also negligible, and would not seem to affect the need for more aggressive pain control such as extended intravenous narcotics or a patient-controlled analgesic pump. The medicoeconomic impact of the difference in length of stay and the need for hospital admission is not the subject of the current study. Such differences may have different implications when analyzed from the perspective of the patient, surgeon, hospital, or insurance provider. Lorish et al. have suggested that, from the perspective of the insurance provider, the cost savings of a 1-day versus a 2-day hospitalization after lumbar discectomy is ~ $781. A prospective, randomized clinical trial has been proposed to specifically address the issue of cost-effectiveness.

The largest benefit of a minimally invasive approach may rest in the psychological effect afforded some patients by allowing and encouraging a faster return to normal activities and deemphasizing sickness behavior. Again this benefit is not the subject of the current study.

Our results in the present study also demonstrate that a minimally invasive approach does not add safety to the surgical procedure. The rate of CSF leakage was numerically but not statistically higher in the minimally invasive group compared to the open microsurgical group. The only iliac vein injury observed occurred in the minimally invasive group.

Comparison with Other Series of Minimally Invasive Discectomy

A review of the reported studies of minimally invasive discectomy is provided in Table 3. Huang et al. and Nakagawa et al. have suggested that, from the perspective of the insurance provider, the cost savings of a 1-day versus a 2-day hospitalization after lumbar discectomy is ~ $781. A prospective, randomized clinical trial has been proposed to specifically address the issue of cost-effectiveness.

Table 3

<table>
<thead>
<tr>
<th>Authors, Year</th>
<th>No. of Patients</th>
<th>Analgesia (mg morphine)</th>
<th>EBL (ml)</th>
<th>OR Time (min)</th>
<th>LOS (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MI</td>
<td>Open</td>
<td>MI</td>
<td>Open</td>
<td>MI</td>
<td>Open</td>
</tr>
<tr>
<td>Smith &amp; Foley, 1997†</td>
<td>43</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Muramatsu et al., 2001‡</td>
<td>70</td>
<td>15</td>
<td>52%</td>
<td>100%</td>
<td>30</td>
</tr>
<tr>
<td>Grenier-Perth et al., 2002</td>
<td>135</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>22</td>
</tr>
<tr>
<td>Perez-Cruet et al., 2002</td>
<td>150</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Nakagawa et al., 2003§</td>
<td>30</td>
<td>30</td>
<td>NR</td>
<td>NR</td>
<td>92.9</td>
</tr>
<tr>
<td>Huang et al., 2005</td>
<td>43</td>
<td>86</td>
<td>NR</td>
<td>NR</td>
<td>87.5</td>
</tr>
<tr>
<td>Righesso et al., 2007</td>
<td>21</td>
<td>19</td>
<td>NR</td>
<td>NR</td>
<td>50</td>
</tr>
<tr>
<td>Ryang et al., 2008</td>
<td>30</td>
<td>30</td>
<td>NR</td>
<td>NR</td>
<td>26.2</td>
</tr>
<tr>
<td>current study</td>
<td>49</td>
<td>123</td>
<td>9.14</td>
<td>14.18</td>
<td>59.3</td>
</tr>
</tbody>
</table>

* EBL = estimated blood loss; MI = minimally invasive; NR = not reported; OR = operating room.
† All patients were discharged within 6 hours of surgery except the first, who was admitted for 48 hours for a CSF leak.
‡ Authors reported percentage who received morphine instead of milligrams of morphine. Estimated blood loss is given in grams.
§ Authors reported no significant difference in analgesic dosage on the day and night postoperatively. The number of patients who did not require analgesia postoperatively was significantly greater in the microendoscopic discectomy group.
historical controls in their studies documenting the effects of a minimally invasive approach to the spine. None of these authors attempted to compare the effects of the minimally invasive approach with a concurrent cohort of patients who underwent standard microsurgical discectomy. The differences we observed between the groups are in agreement with the findings of these previously published studies.

Righesso and colleagues and Ryang et al. recently reported the results of 2 prospective randomized trials of minimally invasive versus open microdiscectomy in patients with first-time lumbar radiculopathy caused by disc herniation. In both studies the investigators identified no differences in clinical outcome between the groups at a mean follow-up of 16 months as determined by Visual Analog Scale, Oswestry Disability Index, and Short Form-36 score. It should be noted that a power analysis was not included in either study, and it is possible that these studies were underpowered to identify small differences between groups.

The Importance of Minimally Invasive Lumbar Discectomy

The concept of minimally invasive spinal surgery is not new, and previous attempts at minimally invasive lumbar discectomy have often been viewed as less optimal than traditional open microsurgical discectomy. Most recently Foley and Smith introduced a percutaneous tubular retractor system as a means of limiting approach-related muscle damage during lumbar discectomy. In the present study all patients in the minimally invasive lumbar discectomy group underwent the access procedure as described originally by Smith and Foley to a final diameter of either 16 or 18 mm. After spinal access had been obtained, a standard lumbar laminotomy and discectomy were performed using traditional microsurgical techniques. As a result, all patients in the minimally invasive group had smaller incisions (16–18 mm in length) and underwent a muscle-splitting approach. In contrast, the patients in whom the standard open approach was performed had slightly larger incisions (25–35 mm in length) and underwent a muscle-stripping approach to allow placement of a McCollough retractor. Although the authors of some studies have suggested that there is a decrease in associated muscle injury with the use of the minimally invasive approach, the effect on patient outcome remains debatable and, indeed, is the subject of our retrospective review.

It should be emphasized that although this study demonstrates a very modest benefit of the minimally invasive approach over the standard open microsurgical approach, the potential benefits of such an approach should not be immediately dismissed. For all surgeons attempting to adopt minimally invasive approaches in clinical practice, lumbar discectomy remains the most important transition procedure. More involved procedures such as bilateral lumbar decompression, multilevel lumbar decompression, and instrumented lumbar fusion can all be performed through a minimally invasive approach. These procedures are technically more involved, of longer duration, and require more extensive soft tissue destruction. Accordingly, application of a minimally invasive approach to these procedures may very well demonstrate even greater therapeutic gains over the standard open approaches.

Conclusions

Minimally invasive discectomy provides some statistical advantages over open microsurgical discectomy with respect to the need for admission, length of stay, estimated blood loss, and PACU narcotic use. The clinical significance of these rather modest differences is unclear. Given the learning curve associated with the introduction of minimally invasive approaches to clinical practice, these modest clinical benefits probably do not warrant the transition from a standard microsurgical approach to a minimally invasive approach for surgeons whose lumbar spine practice is predominantly limited to laminotomy and discectomy.

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Disclaimer

The authors do not report any conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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