Management of incidental durotomy in minimally invasive spine surgery

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Object. Unintended durotomy is one of the most common complications in spine surgery that may lead to serious complications if not recognized or treated properly. There are few reports on the management of durotomies incurred during minimally invasive spine surgery (MISS). The authors describe their experience in a series of consecutive MISS patients with unintended durotomies.

Methods. All patients who underwent MISS by the senior author between August 2006 and February 2011 were retrospectively reviewed, and cases with unintended durotomies were identified. A case-control study was carried out comparing patient demographics and perioperative data between patients with and without durotomy. Surgical technique, including a proposed algorithm for management of durotomies, is described.

Results. Unintended durotomy occurred in 53 (9.4%) of 563 patients. The mean age at surgery was 60.7 years (range 30–85 years). Previous surgery at the same level was performed in 5 patients (9.4%). Two patients underwent posterior cervical surgery, and 51 patients underwent posterior lumbar surgery. Decompression alone was performed in 32 patients (60.4%), and fusion was performed in 21 patients (39.6%). The mean operative time was 105 minutes in the decompression group and 310 minutes in the fusion group (p < 0.001). Estimated blood loss was 60 ml in the decompression group and 381 ml in the fusion group (p < 0.001). The hospital length of stay was 52 hours in the decompression group and 106 hours in the fusion group (p < 0.001). The mean follow-up was 310 days, and there were no cases of cutaneous CSF fistula, pseudomeningocele, or other complications referable to durotomy in either group. Risk factors identified for durotomy included previous operation at the same level (p = 0.019) and operation in the lumbar spine region (p = 0.001).

Conclusions. In the authors’ consecutive series of patients undergoing MISS, an unintended durotomy was associated with fewer complications than previously reported for open spinal surgery. The authors propose a simple management algorithm that includes early mobilization and results in excellent clinical outcomes with no incidence of postoperative cutaneous CSF fistula or other complications. (DOI: 10.3171/2011.7.FOCUS11122)

Key Words • durotomy • minimally invasive spine surgery • complication

Unintended durotomy is one of the most common complications in spine surgery, with a reported incidence ranging from 1.6% to 17.4%.14,11,12,19,21,30,31,35–40 If not recognized or properly treated, it may lead to a persistent CSF leak and formation of a pseudomeningocele or cutaneous CSF fistula, with the resultant symptoms of postural headache, nausea, and back pain.3,4,7,11,21,31,39 More serious complications include neurological deficit, meningitis, and intracranial hemorrhage.4,5,7,11,14,20,23–28,34,42

Although there have been several reports on perioperative management of durotomy in open spinal procedures,3,4,11,15,21,36,39 there is a paucity of similar invasive reports in MISS.6,37 It has been hypothesized that the decreased dead space from smaller incisions and the muscle-splitting approach used in MISS creates less potential for formation of pseudomeningocele and persistent CSF leak in cases complicated by a durotomy.37 Therefore, it is important to examine whether MISS results in lower rates of complications after a durotomy and whether any modifications need to be made in the perioperative management of durotomy in MISS cases.

In this report, we present our series of patients who underwent MISS with unintended durotomies and propose a management algorithm for this complication.

Methods

All patients who underwent MISS performed by the senior author (J.E.O.) between August 2006 and February 2011 were identified from a prospectively collected database that includes all perioperative complications. Approval for the study was obtained from the Rush Uni-
University Institutional Review Board. Patient demographics, preoperative records, operative notes, and postoperative records were reviewed. For the purposes of the case-control analysis, all patients with a durotomy were identified as cases and those without a durotomy were identified as controls. Variables included in the analysis were patient age, patient sex, history of previous surgery at the same level (“reoperation status”), fusion procedure, presence of synovial cyst at the operative level, spine region (cervical, thoracic, or lumbar), diagnostic category (degenerative, traumatic, neoplastic, infectious, congenital, or other), and size of retractor tube (16–18 mm, 20–22 mm, or 26 mm–expandable). Univariate chi-square and multiple logistic regression analyses were performed.

**Surgical Technique**

All cases were performed with tubular dilator systems (Medtronic Sofamor Danek and Globus Medical) under loupe or microscope magnification. Typically, an 18-mm-diameter tube was used for discectomies, a 20- to 22-mm tube was used for laminotomies, and a 22- to 26-mm tube was used for fusions. The technique for MISS decompression and fusion has been described in detail elsewhere.\(^1\)\(^7\), \(^2\)\(^2\)

When a durotomy was recognized, the defect was covered by a small piece of Gelfoam (Johnson & Johnson) and cottonoid and definitively treated as described below, or alternatively the primary procedure was completed and the durotomy was subsequently addressed. Our treatment algorithm is presented in Fig. 1. All patients with only partial-thickness durotomies and intact arachnoid were treated with fibrin glue only. For full-thickness durotomies, the possibility of primary repair was assessed. For durotomies located at the edge or undersurface of the bony opening or the ventral surface of the dura, primary repair was often not possible. More dorsally or dorsolaterally located durotomies were typically suitable for primary repair, which was performed using interrupted 4-0 Nurolon sutures (Ethicon). In each case, a commercially available, specialized set of dural repair instruments was used that includes 2 modified needle drivers and a bayoneted Chitwood Knot Pusher (Scanlan International; Fig. 2). If the repair was not watertight to Valsalva maneuver, a small piece of locally harvested paraspinal muscle was sutured in as a buttress graft. In either case, the repair was followed with application of fibrin glue. For cases in which primary repair was not possible, a small blood-soaked piece of Gelfoam was laid over the dural defect (often gently tucked under the bony edge to secure it in place), followed by fibrin glue.

After allowing the fibrin glue to congeal, the tubular retractor was slowly removed, and meticulous hemostasis in paraspinal muscles was achieved with bipolar coagulation. Interrupted 0 Vicryl sutures were used to close fascia, and skin was closed with interrupted 2-0 Vicryl subcutaneous sutures followed by Dermabond (Ethicon). No lumbar or subfascial drains were used. The patients were kept on strict bedrest overnight and were allowed to fully mobilize on the morning of postoperative Day 1. No additional antibiotics were administered.

**Results**

The cases of 563 consecutive patients were reviewed. Durotomies occurred in 53 patients for an overall unintended durotomy incidence of 9.4%. The demographics and operative details for the durotomy cases are presented in Table 1. Twenty-three patients were men (43%) and 30 patients were women (57%). The mean age at surgery was 60.7 years (range 30–85 years). Previous surgery at the same level was performed in 5 patients (9.4%). Two of the patients underwent posterior cervical surgery, and 51 patients underwent posterior lumbar surgery. Decompression (most commonly 1- or 2-level laminotomy for spinal stenosis) was performed in 32 patients (60.4%), and decompression with fusion was performed in 21 patients (39.6%). The mean operative time was 105 minutes in the decompression group and 310 minutes in the fusion group.
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(p < 0.001). Estimated blood loss was 60 ml in the decompression group and 381 ml in the fusion group (p < 0.001). Length of stay was 2.2 days in the decompression group and 4.4 days in the fusion group (p < 0.001). In control patients without durotomies, the length of stay was 1.3 days in the decompression group (p = 0.01) and 4.0 days in the fusion group (p = 0.69). Follow-up data were available in 48 patients. The mean follow-up was 310 days (range 25–1208 days) overall: 182 days (range 25–917 days) in the decompression group and 489 days (range 95–1208 days) in the fusion group.

Risk Factors

Of the risk factors studied, the variables that achieved statistical significance on univariate chi-square analysis were previous surgery at the same level (p = 0.019) and location in the lumbar spine (p = 0.001). On multiple regression analysis (Table 2), location in the lumbar spine remained statistically significant (p < 0.001), while reoperation status showed a trend toward significance (p = 0.088).

Diagnosis and Repair

All durotomies were recognized intraoperatively. In 46 patients, egress of CSF was noted through a full-thickness dural opening, and in 7 patients arachnoid herniation through a partial-thickness dural defect was seen. Eight of the full-thickness dural violations were deemed appropriate for primary repair. Of these, one required a muscle buttress to achieve a watertight closure. All patients were maintained on bedrest until the morning after surgery (< 24 hours).

Complications

No patient developed a postoperative cutaneous CSF fistula or pseudomeningocele. No patient complained of persistent headaches or nausea. There were no new neurological deficits or any other complications attributable to durotomy after surgery. A superficial wound infection developed in 1 patient following a 1-level fusion that required a return to the operating room for irrigation and debridement, followed successfully by a short course of antibiotics. No evidence of subfascial infection or pseudomeningocele was identified in this patient at revision surgery.

Discussion

Unintended durotomy remains a frequent complica-

<table>
<thead>
<tr>
<th>Variable</th>
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<tbody>
<tr>
<td>no. of patients</td>
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<tr>
<td>male</td>
<td>23 (43%)</td>
</tr>
<tr>
<td>female</td>
<td>30 (57%)</td>
</tr>
<tr>
<td>mean age at op (yrs)</td>
<td>60.7 (range 30–85)</td>
</tr>
<tr>
<td>previous op</td>
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</tr>
<tr>
<td>op type</td>
<td></td>
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<tr>
<td>decompression</td>
<td>32 (60.4%)</td>
</tr>
<tr>
<td>fusion</td>
<td>21 (39.6%)</td>
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<tr>
<td>mean op time (minutes)</td>
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<tr>
<td>decompression</td>
<td>105</td>
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<tr>
<td>fusion</td>
<td>310 (p &lt;0.001)</td>
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<tr>
<td>mean estimated blood loss (ml)</td>
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<tr>
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<td>60</td>
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<tr>
<td>fusion</td>
<td>381 (p &lt;0.001)</td>
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<td>mean length of stay (days)</td>
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<td>4.4 (p &lt;0.001)</td>
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<tr>
<td>mean follow-up (days)</td>
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<tr>
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<td>182 (range 25–917)</td>
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<tr>
<td>fusion</td>
<td>489 (range 95–1208)</td>
</tr>
<tr>
<td>overall</td>
<td>310 (range 25–1208)</td>
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* Statistically significant.
tion of spinal surgery, occurring in 1.6%–17.4% of cases. In the largest series of consecutive lumbar decompression and/or fusion cases to date, Khan et al. reported an overall durotomy incidence of 10.6%, with an increased incidence (15.9%) in the revision group. Our incidence of 9.4% is thus in line with previously reported numbers.

Multiple risk factors for durotomy have been previously reported, including older age, thin dura due to chronic compression, ossification of the ligamentum flavum, synovial cysts, scar from prior surgery, and surgeon inexperience. In our case-control study, the only risk factors that were statistically significant were previous operation at the same level and lumbar spine region. Although reoperation status did not maintain significance in multiple regression analysis, this is most likely due to a small number of reoperations in our series and would likely reach significance with a larger sample size. The importance of lumbar spine region as a risk factor is unclear, as we had significantly more lumbar than cervical or thoracic cases, which could bias the results.

Primary repair of incidental durotomy is considered to have the highest rate of success, although this is not always technically feasible due to thin dura or inaccessible location of the durotomy. This is particularly true in minimally invasive cases, in which a small tubular retractor may not allow the necessary manipulation of instruments to attain primary closure of the dura. In our series, the durotomy warranted primary closure in 8 patients; in all of these patients we were able to suture the dura using a specialized set of instruments designed for MISS dural repair. To our knowledge, there is only 1 other report of durotomy repair in MISS in which the authors successfully repaired a dural tear in a patient by using a standard pituitary rongeur and a laparoscopic knot pusher.

Other methods described for repair of durotomies include using muscle or fat graft, blood-soaked Gelfoam or Surgicel (Ethicon), collagen matrix, fibrin glue, and metallic clips. In our series, we used fibrin glue alone for partial-thickness durotomies, blood-soaked Gelfoam with fibrin glue for small full-thickness durotomies, and muscle graft or collagen matrix with fibrin glue to reinforce nonwatertight primary closure of larger durotomies. Using this strategy, summarized in Fig. 1, we were able to achieve a 0% incidence of CSF leaks or any other complications attributable to the durotomy.

Traditionally, a period of bedrest anywhere from 1 to 7 days has been recommended after a durotomy occurs during open spinal surgery. In the only study of durotomy after MISS procedures, the authors evaluated 5 patients with unintended durotomies and recommended mobilization within 48 hours of surgery. In our series, all patients were mobilized less than 24 hours postoperatively without any complications, suggesting that MISS may allow for faster mobilization after a durotomy than open spine surgery.

Although the length of stay was longer for patients with a durotomy undergoing decompressive procedures, no such difference was found in patients undergoing fusion procedures. The likely explanation is that—in absence of durotomy—a high proportion of patients undergoing decompressive procedures were discharged on the day of surgery, whereas durotomy patients were kept bedrest overnight, thus prolonging the average length of stay. Durotomy did not increase the length of stay in fusion patients, likely due to our early mobilization protocol, which enabled the patients to meet usual discharge criteria.

The use of drains after unintended durotomy has been controversial. Despite the classic teaching that drains may increase the risk of cutaneous CSF fistula formation, several authors have described the routine use of subfascial drains after primary repair of durotomies without increased incidence of fistulas or other complications. Lumbar subarachnoid drains have also been used, primarily in the management of postoperative CSF leak and pseudomeningocele. We do not routinely use drains for MISS cases, and thus no subfascial or lumbar drains were placed in any of the patients in this series. We believe that one of the benefits of MISS in the setting of durotomy is the decreased dead space resulting from a smaller incision and muscle-splitting approach. Compared with the open approach, this decreases the potential space for CSF accumulation and formation of pseudomeningocele, thus obviating the need for a drain.

Most previously published studies have reported few long-term consequences after unintended durotomy. However, serious complications, such as neurological deficit, pseudomeningocele, meningitis, and intracranial hemorrhage, have been reported. In addition, rates of persistent CSF wound leak and pseudomeningocele formation have been reported to be as high as 17.6%. In our series of patients with a mean follow-up of 310 days, there were no complications referable to durotomy, which compares favorably with the current literature on durotomies after open cases.

The limitations of this study are small sample size and lack of either an open spinal surgery control group or comparison with disparate durotomy repair strategies. A large randomized trial comparing open to minimally invasive surgery would be necessary to confirm or refute our findings of decreased complications in the MISS durotomy group. In addition, longer follow-up may be necessary to elucidate whether durotomy impacts long-term clinical outcome in patients after MISS procedures. Finally, the algorithm that we suggest here may have several other viable alternatives that we did not use but that could result in equally good outcomes.

**Conclusions**

We report here the most comprehensive review of unintended durotomy incidence and management during MISS. In our consecutive series of patients undergoing MISS, we found that an unintended durotomy was associated with fewer complications than previously reported for open spinal surgery. Our case-control study using multiple logistic regression analysis revealed lumbar spine region and possibly reoperation status as risk factors for durotomy. We propose a simple management algorithm for durotomy repair that includes early mobilization, primary closure of durotomies using available resources, and mobilization within 48 hours of surgery.
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zation and results in excellent clinical outcomes with no incidence of postoperative cutaneous CSF fistula or other complications.

Disclosure
Dr. O'Toole is a consultant for Globus Medical, Inc.

Author contributions to the study and manuscript preparation include the following. Conception and design: both authors. Acquisition of data: both authors. Analysis and interpretation of data: both authors. Drafting the article: Ruban. Critically revising the article: O'Toole. Statistical analysis: both authors.

References


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