Computed tomography–guided epidural patching of postoperative cerebrospinal fluid leaks

Clinical article

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Objective. Cerebrospinal fluid leaks due to unrecognized durotomy during spinal surgery are often managed with a second surgery for dural closure. CT-guided percutaneous patching targeted to the dural defect offers an alternative to surgery since it can be performed in a minimally invasive fashion without the need for general anesthesia. This case series describes the authors’ experience using targeted CT-guided percutaneous patching to repair incidental durotomies incurred during spinal surgery.

Methods. This investigation is a retrospective case series involving patients who underwent CT-guided percutaneous patching of surgical incidental durotomies and were referred between January 2007 and June 2013. Their presenting clinical history, myelographic findings, and clinical outcomes, including the need for eventual surgical duraplasty, were reviewed.

Results. Nine cases were identified, including 7 durotomies incurred during lumbar discectomy, one due to a medial transpedicular screw breach, and one incurred during vertebrectomy for spinal osteosarcoma. All patients who had favorable outcomes with percutaneous intervention alone had 2 common features: dural defect of 4 mm or smaller and absence of a pseudomeningocele. Patients with CSF leaks complicated by pseudomeningocele and those with a dural defect of 6 mm or more all required eventual surgical management.

Conclusions. The authors’ results suggest that findings on CT myelography may help predict which patients with postsurgical durotomy can be treated with percutaneous intervention. In particular, CT-guided patching may be more likely to be successful in those patients with dural defects of less than 5 mm and without pseudomeningocele.

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KEY WORDS • epidural patch • fibrin glue • incidental durotomy • CT-guided • CSF leak • spine surgery • pseudomeningocele

Incidental durotomy during spine surgery occurs in approximately 3%–13% of lumbar spine surgeries, with rates that vary depending on the type of surgery performed. Often these dural tears are immediately detected and repaired intraoperatively. In a subset of cases, the durotomy is not detected intraoperatively, and the patient develops either a pseudomeningocele or symptoms of CSF hypotension. These dural tears are usually initially managed conservatively, but some may ultimately require surgical repair.

Although surgical repair is effective, the drawbacks include the generic risks and morbidities associated with reoperating on a recently postoperative spine. CT-guided percutaneous epidural patching targeted to the dural defect offers an alternative to surgery and can be performed without general anesthesia and with minimal risk and discomfort to the patient. This article is a case series reporting the Duke neuroradiology experience using targeted CT-guided percutaneous epidural patching to repair incidental durotomies incurred during spinal surgery.

Methods

This investigation is a retrospective case series involving patients who underwent CT-guided epidural blood or fibrin glue patching for a symptomatic postoperative CSF leak at a single center between January 2007 and June 2013. Patient history, procedural outcome, and clinical follow-up were determined by chart review. Myelographic and procedural images were reviewed in our institution’s PACS (picture archiving and communication system). The study was approved by our local institutional review board and is compliant with the Health Insurance Portability and Accountability Act.
In patients without a pseudomeningocele, a standard CT myelogram was performed after 10 ml of Isovue-M 300 contrast (Bracco Diagnostics) was injected into the thecal sac via lumbar puncture at a nonsurgical level. The CT imaging was reviewed to determine the location and size of the dural defect.

In the patients in whom a pseudomeningocele was present, Isovue-M 300 was injected under CT fluoroscopy (CTF) into the pseudomeningocele to determine the location and size of the dural defect as evidenced by the point at which the contrast medium passed from the pseudomeningocele into the thecal sac.

Once the dural defect was localized, autologous blood was collected from a peripheral vein in sterile fashion. In 1 case, fibrin glue (Tisseel, Baxter AG) was used in addition to autologous blood. Under CT-fluoroscopic guidance, a 22-gauge spinal needle was advanced to a position immediately adjacent to the dural defect usually using a translaminatecary, interlaminar, or transfaraminal approach. Once the needle was in position, a small volume (1–2 ml) of Isovue-M 200 contrast was injected to assess the pattern of epidural spread and to confirm extravascular placement of the needle. This was then followed by injection of 3–5 ml of autologous blood under CTF. In the case in which fibrin glue was used, 1–3 ml of glue was injected, followed by 3 ml of autologous blood in the same location. If necessary, multiple approaches (transforaminal and interlaminar) were used during the same procedure to ensure adequate coverage of patching material over the dural defect. Because pseudomeningoceles represent persistent communications with the CSF space, and in our experience drainage without occlusion of the neck results only in intracranial hypotension, the pseudomeningoceles in this series were not managed with drainage alone.

The primary outcome measure was clinical resolution of symptoms. Success of the percutaneous patching procedure was defined as symptom resolution without the need for surgical duraplasty. If the initial procedure failed, as evidenced by persistent symptoms, sometimes a second CT-guided blood patch procedure was performed. In cases in which CT-guided patching ultimately failed to relieve the patient’s clinical symptoms, the patient underwent definitive surgical duraplasty.

Results

Nine patients referred for percutaneous management of incidental durotomy were identified. Seven of these referrals were for durotomies incurred during lumbar discectomies, one was for a durotomy incurred during removal of a transpedicular screw that traversed the spinal canal, and one for a durotomy incurred during T-9 vertebrectomy for recurrent primary spinal osteosarcoma.

Clinical characteristics, CT myelogram findings, procedural details, and outcomes are summarized in Table 1. All 7 of the dural defects secondary to lumbar discectomy were along the dorsal lateral aspect of the thecal sac, and the 2 other dural defects were along the ventral lateral aspect of the thecal sac. Pseudomeningocele was present in 2 of 9 cases. Eight of the cases were performed using solely autologous blood as the patching agent, and one of the cases was performed using fibrin glue in addition to autologous blood. No complications developed during any of the epidural patching procedures.

Four of 9 patients were successfully treated with CT-guided patching alone. The remaining 5 patients ultimately required surgical duraplasty for persistent symptoms. In all cases successfully managed with CT-guided patching alone, the dural defect was less than 4 mm, and no pseudomeningocele was present. All of the patients who ultimately required duraplasty demonstrated a dural defect of 6 mm or more (n = 3) or a pseudomeningocele (n = 2). Following definitive treatment, no patient had recurrent symptoms related to CSF leak, with clinical follow-up available over an average of 3.3 years (range 1–6 years) posttreatment.

Illustrative Cases

Case 2

This 22-year-old woman who had undergone a left L4–5 discectomy presented to the emergency department 5 days after the operation with a progressive severe headache that improved in the recumbent position and was accompanied by intractable nausea and vomiting. A CSF leak was diagnosed clinically, and the patient was admitted for epidural blood patching. CT myelography showed gross extravasation of contrast-opacified CSF through a nonmeasurable dural defect in the left dorsal lateral thecal sac at the level of the discectomy. Epidural blood patching was performed via transfaraminal and direct transhemilaminectomy approaches, and the patient’s headache had markedly improved by the next morning. She was discharged, then 2 days later returned with recurrent positional headaches. Repeat myelography again showed gross extravasation of contrast-opacified CSF from the left dorsal lateral thecal sac (Fig. 1A), and repeat transfaraminal (Fig. 1B) and transhemilaminectomy (Fig. 1C) approach epidural blood patching was performed. The patient’s symptoms resolved the day after the procedure, and she remained asymptomatic 4 years later.

Case 4

This 46-year-old man with a history of lumbar spine fusion presented with symptoms of positional headache, neck pain, and facial droop 5 days following removal of a transpedicular screw that traversed the spinal canal (Fig. 2A). CT myelography showed a 4-mm right ventral lateral dural defect (Fig. 2B) through which contrast medium leaked into the right screw channel. Injection of contrast into the left screw tract demonstrated that there was communication between the 2 tracts. To create a patch along the ventral surface of the thecal sac, fibrin glue and then autologous blood were injected through a needle advanced into the left screw channel (Fig. 2C) such that the patching agents flowed from the left screw channel in a retrograde manner through the right screw channel to spread across the right ventral surface of the thecal sac. Next, a needle was advanced through the right laminectomy defect into the right lateral epidural space (Fig. 2D),
<table>
<thead>
<tr>
<th>Case No.</th>
<th>Pt Age (yrs), Sex</th>
<th>Surgery</th>
<th>Interval Btw Surgery &amp; Clinical Presentation</th>
<th>Indication for Intervention</th>
<th>CT Myelogram Findings</th>
<th>Epidural Patching Agent</th>
<th>No. of CT-Guided Procedures</th>
<th>Duraplasty Required</th>
<th>Outcome &amp; Years of Follow-Up Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>52, M</td>
<td>L5–S1 discectomy</td>
<td>1 wk</td>
<td>persistent wound drainage &amp; infection</td>
<td>focal irregularity of thecal sac at operative site</td>
<td>blood</td>
<td>1</td>
<td>no</td>
<td>Sx resolved, 2.5 yrs</td>
</tr>
<tr>
<td>2</td>
<td>22, F</td>
<td>L5–S1 discectomy</td>
<td>5 days</td>
<td>positional headache</td>
<td>nonmeasurable dural defect, gross CSF leak</td>
<td>blood</td>
<td>2</td>
<td>no</td>
<td>Sx resolved, 4 yrs</td>
</tr>
<tr>
<td>3</td>
<td>40, F</td>
<td>T-9 vertebrectomy for recurrent osteosarcoma</td>
<td>immediate</td>
<td>CSF drainage from thoracostomy tubes</td>
<td>4-mm dural defect w/ leak into pleural space</td>
<td>blood</td>
<td>1</td>
<td>no</td>
<td>chest tubes dried &amp; were removed, 2 yrs</td>
</tr>
<tr>
<td>4</td>
<td>46, M</td>
<td>posterior lumbar fusion w/ medial screw breach</td>
<td>5 days</td>
<td>positional headache, neck pain, facial droop</td>
<td>4-mm dural defect</td>
<td>blood + fibrin glue</td>
<td>1</td>
<td>no</td>
<td>Sx resolved, 2.5 yrs</td>
</tr>
<tr>
<td>5</td>
<td>31, F</td>
<td>L4–5 discectomy</td>
<td>10 days</td>
<td>persistent wound drainage &amp; infection</td>
<td>6-mm dural defect</td>
<td>blood</td>
<td>2</td>
<td>yes</td>
<td>successful surgical repair, 4 yrs</td>
</tr>
<tr>
<td>6</td>
<td>57, M</td>
<td>L4–5 &amp; L5–S1 disectomies</td>
<td>1 wk</td>
<td>positional headache</td>
<td>6-mm dural defect</td>
<td>blood</td>
<td>1</td>
<td>yes</td>
<td>successful surgical repair, 4 yrs</td>
</tr>
<tr>
<td>7</td>
<td>49, M</td>
<td>L4–L5 discectomy</td>
<td>2 mos</td>
<td>positional headache</td>
<td>10-mm dural defect</td>
<td>blood</td>
<td>2</td>
<td>yes</td>
<td>successful surgical repair, 6 yrs</td>
</tr>
<tr>
<td>8</td>
<td>43, M</td>
<td>L5–S1 discectomy</td>
<td>1 wk</td>
<td>positional headache</td>
<td>3-mm defect at pseudomeningocele neck</td>
<td>blood</td>
<td>2</td>
<td>yes</td>
<td>successful surgical repair, 1 yr</td>
</tr>
<tr>
<td>9</td>
<td>49, M</td>
<td>L4–5 discectomy</td>
<td>2 wks</td>
<td>palpable pseudomeningocele</td>
<td>2-mm defect at pseudomeningocele neck</td>
<td>blood</td>
<td>1</td>
<td>yes</td>
<td>successful surgical repair, 4 yrs</td>
</tr>
</tbody>
</table>

* Pt = patient; Sx = symptoms.
and fibrin glue and autologous blood were injected. The patient’s symptoms resolved the day after the procedure, and he remained asymptomatic 3 years later.

Case 9

This 49-year-old man who had undergone a left L4–5 discectomy was discovered at his 2-week postoperative clinic appointment to have a bulge underneath the skin at the level of his operation that was suspicious for pseudomeningocele formation. The patient had no significant headache or other symptoms of CSF hypotension. The pseudomeningocele was managed conservatively with tape and a compression brace. Two months later, the bulge persisted and the patient was referred for epidural patching of the dural defect. CT showed a pseudomeningocele emanating from the region of the hemilaminectomy defect. Under CTF guidance, contrast medium was injected into the pseudomeningocele (Fig. 3A). Contrast flowed from the pseudomeningocele into the thecal sac through a 2-mm left dorsal lateral dural defect. The dural defect was approached first via interlaminar (Fig. 3B) and transforaminal injections; however, the contrast and blood patch failed to flow over the dural defect. A transfacet joint approach did succeed in depositing blood over the region of the dural defect (Fig. 3C), and this was followed by injection of blood directly into the pseudomeningocele (Fig. 3D). The patient returned to our clinic 4 days later with a recurrent bulge and shortly thereafter underwent definitive surgical duraplasty.

Discussion

The results of this case series of 9 patients with incidental durotomy incurred during spine surgery show the potential added value of CT myelography in the workup of a postoperative CSF leak and suggest myelographic features that may help predict which cases can be managed with percutaneous CT-guided treatment and which may require repeat surgical intervention.

In this case series, the 4 patients who had dural defects shown at CT myelography to measure less than 5 mm and no associated pseudomeningocele were successfully treated with targeted epidural patching. In all 3 cases of dural defects greater than 5 mm, epidural blood patching failed and surgical duraplasty was required. These results suggest that smaller durotomies are more likely to be effectively closed with percutaneous patching than larger durotomies and that 5 mm could represent a potential cutoff for size of the dural defect, above which CT-guided epidural patching is less likely to be effective.

The cases in our series in which a pseudomeningocele was present both ultimately required definitive surgical management despite the fact that both patients had dural defects that measured less than 5 mm. One possible explanation for this is that the presence of a pseudomeningocele may indicate a higher rate of CSF flow though the defect, making it more difficult for the epidural patch to seal the leak. Alternatively, it is possible that by injecting contrast directly into the pseudomeningocele and thereby evaluating the leak in a retrograde fashion, the size of the dural defect was underestimated.

Previous reports suggest that the presence of a pseudomeningocele does not preclude the possibility of successful percutaneous patching in all cases. In their case series of CT-guided percutaneous epidural fibrin glue patching of postoperative CSF leaks, Patel et al. report successful management of leaks managed with aspiration of several pseudomeningoceles followed by injection of fibrin glue. They did not report the specific imaging features of the durotomies they treated, but they did not routinely use contrast either in the form of CT myelography or injection of contrast medium directly into a pseudomeningocele. Given their success rate of 65%, it is possible that fibrin glue may be superior to autologous blood in this setting. During the period in which most of the procedures in our series were performed, we did not routinely use fibrin glue as a first-line patching agent. It is possible that the use of fibrin glue rather than blood could have influenced the size of dural defects amenable to percutaneous patching and/or improved our success with patching patients with coexistent pseudomeningoceles. One limitation of this investigation is that follow-up imaging was not performed to prove that the CSF leaks had resolved in the cases in which blood patching resulted in symptom resolution. The small CSF leaks that were
CT-guided epidural patching of postoperative CSF leaks

successfully treated by blood patching are either not conspicuous or not well localized on MRI, and CT myelography would have been required to prove that the leaks had resolved. Myelography is not without risk (including the risk of post–dural puncture headache, which may be confused with the presenting clinical symptoms), and it is not our practice to perform follow-up myelography on asymptomatic patients. Furthermore, visualization of a persistent CSF leak in a patient who was no longer symptomatic would not have led to a change in management, as the indication for intervention in the first place was clinical symptomatology. For these reasons, we believe that resolution of clinical symptoms is a more appropriate outcome measure than imaging resolution.

An additional limitation is that the investigation does not directly address the question of whether targeted patching, the technique used in our practice, would be superior to nontargeted patching. However, a previous investigation of patients with spontaneous CSF leaks suggests that percutaneous patching is most effective when the patch is targeted as close as possible to the site of leak.5

Conclusions

Our case series demonstrates that some patients with incidental postoperative durotomies can be treated with CT-guided percutaneous patching and that CT myelography can help define which patients may be more likely to be successfully treated with this technique. Given the risks and potential morbidities of a second operation for primary closure of a postoperative CSF leak, our results suggest that if the dural defect is less than 5 mm and there is no pseudomeningocele, targeted CT-guided percutaneous epidural patching with autologous blood may provide effective treatment. If the dural defect is greater than 5 mm or a pseudomeningocele is present, autologous blood alone is unlikely to be an effective patching agent.

Disclosure

The authors have no personal financial or institutional interest in any of the materials or devices described in this article.

Author contributions to the study and manuscript preparation include the following. Conception and design: all authors. Acquisition of data: all authors. Analysis and interpretation of data: all authors. Drafting the article: Mihlon. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Gray. Study supervision: Gray.
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