Vertebroplasty is a well-known technique used to treat pain associated with vertebral compression fractures. Despite a success rate of up to 90% in different series, the procedure is often associated with major complications such as cord and root compression, epidural and subdural hematomas (SDHs), and pulmonary emboli, as well as other minor complications. In this study, the authors discuss the major complications of transpedicular vertebroplasty and their clinical implications during the postoperative course.

Methods. Vertebroplasty was performed in 12 vertebrae of 7 patients. Five patients had osteoporotic compression fractures, 1 had tumoral compression fractures, and 1 had a traumatic fracture. Two patients had foraminal leakage, 1 had epidural leakage, 1 had subdural cement leakage, 2 had a spinal SDH, and the last had a split fracture after the procedure.

Results. Three patients had paraparesis (2 had SDHs and 1 had epidural cement leakage), 3 had root symptoms, and 1 had lower back pain. Two of the 3 patients with paraparesis recovered after evacuation of the SDH and subdural cement; however, 1 patient with paraparesis did not recover after epidural cement leakage, despite cement evacuation. Two patients with foraminal leakage and 1 with subdural cement leakage had root symptoms and recovered after evacuation and conservative treatment. The patient with the split fracture had no neurological symptoms and recovered with conservative treatment.

Conclusions. Transpedicular vertebroplasty may have major complications, such as a spinal SDH and/or cement leakage into the epidural and subdural spaces, even when performed by experienced spinal surgeons. Early diagnosis with CT and intervention may prevent worsening of these complications. (DOI: 10.3171/2009.4.SPINE08466)

Key Words • complication • spine • epidural cement leakage • subdural cement leakage • subdural hematoma • vertebroplasty

Abbreviations used in this paper: SDH = subdural hematoma; VB = vertebral body.

et al.\textsuperscript{14} to a C-2 hemangioma in 1987,\textsuperscript{2,4,9,11,17,22} the first series was reported in 1997.\textsuperscript{16}

Absolute contraindications of percutaneous vertebroplasty include a lack of a definable level of vertebral collapse, an unstable fracture due to posterior element involvement, bleeding disorders, active local infections (such as osteomyelitis), and/or sepsis.\textsuperscript{7} Relative contraindications include a lack of surgical back-up or patient monitoring facilities, patient inability to lie prone for the expected procedure duration (1–2 hours), and the presence of neurological signs and symptoms caused by VB collapse or tumor extension. Severe vertebral compression may present technical difficulties, but it is not a contraindication to the procedure.\textsuperscript{23,24}
A large-caliber trocar needle is percutaneously inserted into the VB via a transpedicular or an extrapedicular approach under fluoroscopic guidance. Cement or calcium phosphate bone cement is injected slowly into the VB to solidify within the vertebral fracture lines.\textsuperscript{14} The intervention can be performed with the patient in a state of general anesthesia or conscious sedation and local anesthesia.\textsuperscript{17}

Major complications occur in fewer than 1% of patients who undergo vertebroplasty after compression fractures. Adverse reactions to the bone cement, anaphylaxis, hypotension during surgery, pneumothorax, pulmonary embolism, pedicle fracture, spinal cord compression, canal intrusion, epidural hematoma, arterial injury, VB fracture, and death are the primary major complications of transpedicular vertebroplasty.\textsuperscript{6,20,26,28} In the present study, we present 7 cases of major transpedicular vertebroplasty complications from 4 institutions in Turkey. Epidural, foraminal, and/or subdural cement leakage was noted in 5 cases; spinal SDHs were evident in 2 (Table 1).

**Methods**

**Case 1**

Images obtained in a 79-year-old woman without neurological deficits who had fallen down a flight of stairs revealed an L-5 compression fracture (AO classification Type A1.2.) and degenerative lumbar scoliosis. Vertebroplasty was performed, and the patient exhibited neurological deficits after the procedure (bilateral 2/5 dorsiflexion motor force in her feet). Postoperative images revealed cement leakage into the spinal subdural space (Fig. 1). An emergency decompression was performed, and the excessive subdural cement was evacuated via an L-5 laminectomy. The patient’s neurological deficits subsequently normalized (5/5 motor force).

**Case 2**

Acute compression fractures of the L-2 and L-4 vertebrae (AO Type A1.1) were detected on images obtained in an 18-year-old man who had no neurological deficits after a motor vehicle collision in which he was the driver. Vertebroplasty was performed at the L-2 and L-4 vertebrae. The patient complained of severe back pain immediately after the procedure and paraparesis developed (2/5 motor force) in his bilateral lower extremities 12 hours later. A spinal SDH extending from T-1 to L-2 was detected on control images (Fig. 2A and B) and evacuated via cross-hemilaminectomy from T-1 to L-2 (skipping 1 segment each time). The patient’s neurological status normalized postoperatively (bilateral 5/5 motor force). Two months after the operation, the patient again experienced back pain, and thoracolumbar MR images revealed multilevel arachnoiditis (Fig. 2C and D). The patient’s symptoms were controlled with steroid and antiinflammatory drug therapy.

**Case 3**

Osteoporotic compression fractures of the L-1 vertebra (AO Type A1.1) were detected on the radiological images of a 75-year-old woman who did not have neurological deficits. Vertebroplasty was performed, and the patient suffered psychosomatic symptoms with paraparesis 12 hours postoperatively. Urinary and fecal incontinence were added to the paraparesis at 24 hours after the procedure. Control MR images revealed a spinal SDH extending from the T-10 to the L-3 vertebra (Fig. 3A and B). The SDH was evacuated via a T-12 laminectomy, and the patient’s neurological status normalized after the second operation. Three months after the operation, the patient reported back pain extending to the bilateral lower extremities. Spinal arachnoiditis was detected on follow-up MR images (Fig. 3C) and controlled with steroid and antiinflammatory drug therapy.

**TABLE 1: Summary of patient data*\textsuperscript{*}\textsuperscript{ }**

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Op Levels</th>
<th>Procedure</th>
<th>Treating Physician</th>
<th>Complication</th>
<th>Level of Complication on Imaging</th>
<th>Early NDs</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>L-5</td>
<td>vertebroplasty</td>
<td>anesthesiologist</td>
<td>subdural CL</td>
<td>L-4 &amp; L-5</td>
<td>bilat L-4 &amp; L-5 root NDs</td>
<td>good</td>
</tr>
<tr>
<td>2</td>
<td>L-2 &amp; L-4</td>
<td>vertebroplasty</td>
<td>neurosurgeon</td>
<td>SDH</td>
<td>T1–L2</td>
<td>paraparesis</td>
<td>good (w/ arachnoiditis)</td>
</tr>
<tr>
<td>3</td>
<td>L-1</td>
<td>vertebroplasty</td>
<td>orthopedic surgeon</td>
<td>SDH</td>
<td>T10–L3</td>
<td>paraparesis</td>
<td>good (w/ arachnoiditis)</td>
</tr>
<tr>
<td>4</td>
<td>L-1 &amp; L-4</td>
<td>vertebroplasty</td>
<td>neurosurgeon</td>
<td>foraminal CL</td>
<td>rt L-4 &amp; L-5 neural foramina</td>
<td>rt L-4 &amp; L-5 root NDs</td>
<td>good</td>
</tr>
<tr>
<td>5</td>
<td>T-7 &amp; T-10</td>
<td>vertebroplasty</td>
<td>neurosurgeon</td>
<td>epidural CL</td>
<td>T4–10</td>
<td>paraparesis</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>L-3, L-4, &amp; L-5</td>
<td>vertebroplasty</td>
<td>orthopedic surgeon</td>
<td>foraminal CL</td>
<td>rt L-3 &amp; L-4 foramina</td>
<td>rt L-3 &amp; L-4 root NDs</td>
<td>good</td>
</tr>
<tr>
<td>7</td>
<td>L-2</td>
<td>kyphoplasty</td>
<td>neurosurgeon</td>
<td>split fracture of corpus</td>
<td>L-2</td>
<td>none</td>
<td>good</td>
</tr>
</tbody>
</table>

* All procedures were done with biplanar fluoroscopic imaging guidance. Abbreviations: CL = cement leakage; ND = neurological deficit.
Major complications of transpedicular vertebroplasty

Case 4

Images obtained in a 72-year-old woman revealed L-1 and L-4 compression fractures (AO Type A1.2; Fig. 4A). Vertebroplasty was performed, and postoperatively the patient had severe pain extending to the right lower extremity. The patient’s neurological examination revealed 3/5 motor force on dorsiflexion of the right foot. Control images demonstrated cement leakage into the right neural foramen between the L-4 and L-5 vertebrae (Fig. 4B and C). The cement was evacuated via a right L-4 hemilaminectomy, and the patient was discharged without any neurological deficits.

Case 5

Pathological compression fractures of the T-7 and T-10 VBs (AO Type A1.2) were noted on imaging in a 50-year-old man with multiple myeloma. Vertebroplasty was performed at the T-7 and T-10 vertebrae. Postoperatively, the patient had 2/5 motor force in the right lower extremity and 4/5 motor force in the left lower extremity. Twelve hours after the procedure, paraplegia developed. Postoperative images revealed cement leakage into the epidural space extending between the T-4 and T-10 vertebrae (Fig. 5). Multilevel decompressive laminectomy was performed, but the patient’s neurological status did not improve.

Case 6

Images obtained in a 74-year-old woman revealed pathological compression fractures at L-3, L-4, and L-5 (AO Type A1.2). Vertebroplasty was performed on all 3 vertebrae. During the cement injection into the L-3 level, a subligamentous cement leakage was observed, and the injection was stopped. The patient had no neurological deficits immediately after the operation. One day postoperatively, the patient reported mild pain extending to the right leg without any motor deficits. Control images revealed cement leakage into the right neural foramen between the L-3 and L-4 vertebrae (Fig. 6). Steroid treatment was administered and resolved the pain after 6 hours.

Case 7

Images obtained in an 82-year-old woman who had fallen down a flight of stairs revealed acute compression fractures of the L-2 vertebra (AO Type A1.2; Fig. 7A). The patient underwent L-2 vertebral kyphoplasty (Fig.
Fig. 3. Case 3. A and B: Axial (A) and sagittal (B) T2-weighted MR images demonstrating SDH (arrows) at T-12. C: Axial T2-weighted MR image showing arachnoiditis (arrow) at L-2.

Fig. 4. Case 4. A: Preoperative radiograph showing compression fractures of the L-1 and L-4 VBs. B and C: Axial (B) and sagittal (C) CT scans showing epidural leakage of bone cement (arrows) at L-4.
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7B) and was discharged without any neurological deficits. She presented to the emergency department 4 weeks postoperatively with low-back pain. There was no history of trauma or infection after her discharge from the hospital. Imaging studies demonstrated a biconcave fracture that created a split at the L-2 vertebra where the kyphoplasty had been performed (Fig. 7C). She had no deficits on neurological examination. The patient refused open surgery, and conservative treatment was recommended.

Results

The 7 complications we have described in the present study were treated by experienced neurosurgeons, orthopedic surgeons, and anesthesiologists at 4 different institutions. The number of vertebroplasty and kyphoplasty procedures conducted at these 4 institutions totals ~150 patients (100 vertebroplasties and 50 kyphoplasties) per year. Routine biplanar fluoroscopic images were obtained during the vertebroplasty procedures. The complications we have described span a 4-year period, and as such, the rate of major complication is ~1.1% per year.

Three patients had paraparesis (2 had SDH and 1 had epidural cement leakage), 3 had root symptoms, and the last had lower back pain. Two of the 3 patients with paraparesis recovered after evacuation of the SDH and subdural cement; however, 1 patient with paraparesis did not recover after epidural cement leakage despite evacuation of the cement. Two patients with foraminal leakage and 1 with subdural cement leakage had root symptoms and recovered after evacuation and conservative treatment. The...
Discussion

An aging population and changing lifestyles have increased the number of osteoporotic vertebral compression fractures. Vertebroplasty has become a treatment option for malignant vertebral lesions and painful vertebral hemangiomas in addition to the painful osteoporotic vertebral compression fractures for which the procedure was originally invented in the early 1980s.9 Over time, the indications for vertebroplasty have been extended to treat acute traumatic vertebral compression fractures. The spectrum of physicians who perform vertebroplasty has increased, and now includes neurosurgeons, orthopedic surgeons, internists, anesthesiologists, and radiologists. Additionally, within the US in 2002, the number of annual vertebroplasty and kyphoplasty procedures numbered > 65,000 cases.22 There is strong evidence for an improvement in the quality of life after this procedure.2 Although it is a safe procedure, the rate of major complications is ~ 0.5% per operation when the procedure is conducted by experienced spinal surgeons.10,18,27

The major complications of vertebroplasty include epidural hematomas caused by medial pedicle wall breach or by cement via needle malposition, leakage of bone cement into the epidural and neural foraminal areas, pulmonary embolization caused by polymethylmethacrylate, arterial injury, and death.6,10,20,27,28 In this report, we presented a case of subdural leakage of bone cement, 2 cases of SDH, 3 cases of epidural leakage of bone cement, and 1 burst fracture after vertebroplasty. These cases, especially the SDH and subdural leakage of bone cement, represent the rare complications of vertebroplasty. Additionally, 3 cases of subdural cement leakage after vertebroplasty and kyphoplasty have been reported in the literature6,8,30 (Table 2); however, we believe that the reported numbers for subdural cement leakage are far less than the actual complication numbers. Although we did not encounter cement arterial and pulmonary emboli in our patients, they are the most reported major complication in the literature.1,3,5,12,15,19,21 The other reported major complications associated with vertebroplasty and kyphoplasty are death, arterial injury, anaphylaxis, and pedicle fracture6-20 (Table 2); however, we have not encountered any of these complications.

The number of major complications after percutaneous kyphoplasty procedures is less than those subsequent to vertebroplasty in the literature. We believe that this is because more vertebroplasties are performed. The authors of some studies comparing vertebroplasty and kyphoplasty complications revealed that there is no significant difference between kyphoplasty and vertebroplasty on postinterventional CT studies;25 however, several other studies have reported significant differences between vertebroplasty and kyphoplasty complications.25

The spectrum of neurological findings after these complications was different in our series than in others. In patients with SDH, the neurological examinations were normal immediately after vertebroplasty; however, paraparesis developed within 12–24 hours. We believe that a spinal SDH developed after puncture of the spinal dura mater and that venous blood began to enter the subdural space slowly after this trauma. In patients with cement leakage into the subdural and epidural spaces, the neurological findings became evident earlier than in patients with SDH.

We believe that performing vertebroplasty or kyphoplasty for the right indications may be even more important in terms of complication avoidance than the experience level of the surgeon or the use of image guidance with biplanar fluoroscopy or CT. The first patient we examined in the present study had scoliotic vertebrae, and CT guidance would have potentially reduced the possibility of complications. Additionally, the indications for vertebroplasty in the second case in our series may vary in different disciplines and clinics. Inexperienced surgeons performing vertebroplasties will also increase the potential for complication. This intervention must be performed by experienced surgeons to avoid major complications.10,27

The indications for vertebroplasty and/or kyphoplasty must not be expanded, especially not to include urgent cases of young patients without any neurological deficits. Additionally, careful and slow biplanar fluoroscopic guidance during vertebroplasty procedures may prevent and/or decrease the associated major complications. Performing control CT scans of the fractured level and serial neurological examinations may aid in the detection of major complications, especially in patients with severe back pain during or after the procedure.

If neurological deficits are detected during examination, a control CT scan must be obtained even if the patient has psychosomatic symptoms. Computed tomography–guided vertebroplasty may be performed in patients with

<table>
<thead>
<tr>
<th>Authors &amp; Year</th>
<th>Complication</th>
<th>No. of Cases</th>
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<tbody>
<tr>
<td>Chen et al., 2006</td>
<td>intradural-epidural CL</td>
<td>1</td>
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<tr>
<td>Zheng, 2006</td>
<td>intradural-epidural CL</td>
<td>1</td>
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<td>Weber et al., 2006</td>
<td>intradural-epidural CL</td>
<td>1</td>
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<tr>
<td>Jang et al., 2002</td>
<td>PE</td>
<td>3</td>
</tr>
<tr>
<td>Muller et al., 2006</td>
<td>PE</td>
<td>1</td>
</tr>
<tr>
<td>Baumann et al., 2006</td>
<td>PE</td>
<td>1</td>
</tr>
<tr>
<td>Abdul-Jalil et al., 2007</td>
<td>PE</td>
<td>2</td>
</tr>
<tr>
<td>Lim et al., 2007</td>
<td>PE</td>
<td>1</td>
</tr>
<tr>
<td>Freitag et al., 2006</td>
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<td>1</td>
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<tr>
<td>Amoretti et al., 2007</td>
<td>PE</td>
<td>1</td>
</tr>
<tr>
<td>Biafora et al., 2006</td>
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<td>1</td>
</tr>
<tr>
<td>Cosar et al., 2006</td>
<td>SDH</td>
<td>2</td>
</tr>
<tr>
<td>Francois et al., 2003</td>
<td>arterial emboli</td>
<td>1</td>
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</tbody>
</table>

* PE = pulmonary embolism.
compression fractures in a degenerative scoliotic spine. Because surgical orientation is extremely important, spinal anatomy alterations may change the spinal orientation and thus exacerbate the associated complications. We believe that using the park bench position for our first scoliotic case was the cause of the subdural cement leakage.

Conclusions

Major complications can still be seen after vertebroplasty and/or kyphoplasty. Early postoperative CT scanning can help to detect inappropriate cement leakage, and may lead to proper handling of the problem before clinical worsening. Management of these complications may vary from medical treatment to complex surgical procedures.

Disclaimer

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

References


Address correspondence to: Murat Cosar, M.D., PK: 89 17000 Canakkale, Turkey. email: drcosar@hotmail.com.

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