Surgical treatment for delayed pyogenic spondylitis after percutaneous vertebroplasty and kyphoplasty

Report of 4 cases

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Only 6 cases of pyogenic spondylitis following vertebroplasty or kyphoplasty have been reported, and their causes remained unclear. The authors report on 4 cases of delayed pyogenic spondylitis (DPS) following vertebroplasty or kyphoplasty for osteoporotic compression fractures and metastatic disease.

Four patients presented with DPS after vertebroplasty or kyphoplasty and underwent surgical treatment. Clinical history, laboratory examination, and MR imaging confirmed the diagnosis of DPS. Anterior debridement, reconstruction, and posterior instrumented fusion were performed.

The mean interval for the delayed occurrence of pyogenic spondylitis after surgery was 12.3 months. The infections were primarily bacterial in origin, but most patients also suffered diverse medical comorbidities. Despite successful treatment of the infections, comorbidity was and is a factor that compromises good results.

Medical comorbidities associated with compromised immunity may increase susceptibility to DPS after vertebroplasty or kyphoplasty. In cases of incapacitating back pain after a pain-free period following either of these surgeries, evaluation of the erythrocyte sedimentation rate and C-reactive protein level and examination of contrast-enhanced MR imaging studies are essential to rule out delayed vertebral infection. Surgical treatment requires cement removal and anterior reconstruction with or without additional posterior instrumented fusion.

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KEY WORDS • delayed spondylitis • kyphoplasty • vertebroplasty

SINCE its introduction by Galibert et al.,¹² vertebroplasty has been used to successfully treat painful osteoporotic compression fractures and bone-destructive metastatic cancers of the vertebrae.¹³,¹⁴,¹¹ Most studies on vertebroplasty and kyphoplasty have focused mainly on their advantages,¹⁴ but recent reports have demonstrated several related complications. Associated clinical complications of PMMA cement–assisted vertebroplasty and kyphoplasty include spinal cord compression with paraplegia, pulmonary embolism, extravebral cement leakage, rib fracture, new fractures at adjacent vertebrae, and infection.⁹,¹⁰,¹⁶,¹⁷,₂₂,₂₇,₂₉,₃₀,₃₃,₃₆,₃₉,₄₄

To our knowledge, only 6 cases of infectious spondylitis after vertebroplasty, including 1 delayed infection, have been reported.¹⁷,₃₃,₃₇,₃₉,₄₄ The incidence of this complication is likely to increase with the evolving popularity of vertebroplasty and kyphoplasty. Here, we present 4 cases of DPS after vertebroplasty or kyphoplasty and report the treatment outcomes.

Case Reports

Case 1

History and Examination. This 64-year-old woman had a 3-month history of low-back pain. She denied any previous definite injury but had been treated for systemic lupus erythematosus for 13 years. Three years prior to presentation, she was diagnosed with RCC, which had spread through the adrenal glands and metastasized to the urinary bladder; this condition necessitated a right nephrectomy and anticancer chemotherapy in our clinic’s department of urology and oncology.

Magnetic resonance imaging and PET showed benign osteoporotic compression fractures of L-1 and L-3 (Fig. 1a
and b), without additional metastasis. Conservative treat-
mant with nonsteroidal antiinflammatory drugs and a 3-
week course of immobilization did not relieve the low-back
pain. Vertebroplasty was performed for the L-1 and L-3
compression fractures (Fig. 1c), and the patient’s back pain
decreased, enabling her to ambulate. A previously sched-
uled course of chemotherapy was administered without in-
terruption.

Fifteen months after vertebroplasty, the patient experi-
enced a sudden recurrence of back pain. Laboratory work-
up revealed an elevated level of CRP at 9.8 mg/dl (refer-
ence level 0–0.3 mg/dl) and an elevated ESR of 106 mm/
hour (reference level 0–20 mm/hour). Magnetic resonance
imaging demonstrated pyogenic spondylitis of L-3 with ir-
regular paravertebral abscess formation (Fig. 1d).

**Operation.** We performed combined surgery: anterior de-
bbridement, reconstruction with a Medtronic mesh cage, and
posterior instrumented fusion using a Medtronic TSRH Spi-
nal System (Fig. 1e–h). An intraoperative culture was posi-
tive for *Enterococcus faecalis*.

**Postoperative Course.** Intravenous antibiotics were ad-
ministered for 6 weeks after surgery.

Unfortunately the patient’s general condition became ag-
gravated and sepsis developed, resulting in her death 3
months postoperatively.

**Case 2**

**History and Examination.** This 78-year-old woman was
transferred to our clinic for intractable low-back pain and
radiating pain to both lower extremities. She had under-
gone vertebroplasty at L-2 and L-3 for osteoporotic com-
pression fractures. She had been pain free for 25 months
after her initial surgery when she began to experience a
sudden recurrence of low-back pain. She had also suffered
from poorly controlled DM and hypertension for 13 years.

Plain radiography demonstrated an unstable PMMA
mass surrounded by a radiolucent halo, extending from the
endplates into the disc space and the paravertebral area. A
CT myelogram demonstrated complete obstruction of the
spinal canal and destruction of the L2–3 VBs (Fig. 2a–b).
The MR imaging studies showed heterogeneous enhance-
ment and irregular destruction of the disc, suggesting pyo-
genic spondylitis of L-2 and L-3 (Fig. 2c and d).

**Operation.** We performed combined surgery: anterior
corpectomy, reconstruction with a strut autogenous iliac
bone graft, and posterior instrumented fusion (Fig. 2e). An
intraoperative culture detected *Staphylococcus aureus*.

**Postoperative Course.** Intravenous antibiotics were con-
tinued for 6 weeks postoperatively according to the drug
sensitivity examination. Three years after surgery, the pa-
tient was able to perform normal daily activities with sub-
tle low-back pain but without aggravation of neurological
deficit or deformity.

**Case 3**

**History and Examination.** This 73-year-old woman pre-
sented with intractable back pain and difficulty walking.
She underwent kyphoplasty at our clinic for compression

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**Fig. 1.** Case 1.  
 a and b: Initial plain lateral radiograph and MR image.  
c: Radiograph obtained after vertebroplas-
ty for painful L1–3 compression fractures.  
d: Sagittal MR image showing an ill-defined irregular paravertebral abscess  
of pyogenic spondylitis.  
e: Lateral radiograph obtained after anterior corpectomy and reconstruction with a mesh cage  
and posterior instrumented fusion. Active pus was discharged intraoperatively and the culture was positive for *E. faecalis*.  
The patient developed sepsis and died 3 months after surgery.  
f: Axial CT scan demonstrating PMMA in the VB as well as the leakage of the cement along the segmental vessels.  
g and h: Photographs showing the removed bone cement (f) and the tract of cement leakage (g) along the segmental vessels.
fractures of T-12 and L-1 (Fig. 3a and b). After the initial kyphoplasty, her back pain completely resolved and she was self-ambulatory. However, after a fall 7 months later, she developed new severe back pain.

The patient’s medical records revealed a history of hypertension and major depressive disorder over a 10-year period. Laboratory workup showed that her ESR was within normal limits, but her CRP level had increased to 8.72 mg/dl. In addition, her serum albumin level had decreased to 2.96 mg/dl.

Plain radiography showed a new fracture at an adjacent segment, and the progression of kyphosis with bone resorption was apparent around the injected cement (Fig. 3c arrow). Initially, the patient was treated with bed rest and non-steroidal antiinflammatory drugs for 3 weeks, but her symptoms did not improve. Subsequent MR imaging revealed pyogenic spondylitis of L-1 (Fig. 3d and e). Her condition was misdiagnosed as de novo collapse of the adjacent VB and progression of kyphosis.

At 24 months after surgery, the patient experienced mild low-back pain but was able to perform normal daily activities.
**Operation.** Anterior corpectomy, reconstruction with a mesh cage, and posterior instrumented fusion were performed (Fig. 3f and g). A paravertebral abscess was identified in the surgical field, and an intraoperative culture revealed the presence of *S. haemolyticus*.

**Postoperative Course.** Intravenous antibiotics were continued for 6 weeks according to the drug sensitivity examination. After 2 years, the patient was able to perform normal daily activities, with controlled infection and very mild back pain. Further collapse was not observed, and the patient remained free of neurological deficits.

**Case 4**

**History and Examination.** This 65-year-old woman was transferred to our clinic with low-back pain and severe radiating pain in both extremities accompanied by motor weakness. Two months prior to this visit, she had undergone L-2 kyphoplasty for osteoporotic compression. Initial MR imaging showed a mild decrease in anterior height and a defect in the lower VB, or intravertebral cleft, which was demonstrated as a transverse high signal on T2-weighted imaging (Fig. 4a).

Underlying disease included UTI with *Pseudomonas aeruginosa*, which was sensitive to piperacillin, and the patient’s sputum culture was positive for *Candida albicans*. After kyphoplasty, the patient remained pain free for 6 weeks, at which point she experienced secondary development of back pain.

Laboratory examination revealed an elevated ESR (57 mm/hour) and CRP level (5.33 mg/dl), and serum albumin was low (2.88 mg/dl). Lumbar MR imaging revealed a heterogeneously enhanced VB and the irregular spread of a paravertebral abscess compressing the retrovertebral dura mater, suggestive of infectious spondylitis (Fig. 4b1–3).

**Treatment.** The patient was treated conservatively with intravenous antibiotics, including piperacillin and vancomycin, for 2 weeks. Her status was refractory, and thus combined surgery including posterior instrumented fusion was followed by anterior L-2 corpectomy and anterior reconstruction with AIBG.

**Postoperative Course.** At Week 2, MR imaging demonstrated that the dura was adequately decompressed after debridement of the osseous tissue and paravertebral abscess (Fig. 4c1–3). Recovery from the paraparesis was noted.

Examination of intraoperative cultures demonstrated no microbiological growth, but intraoperative antibiotics, including vancomycin for 2 weeks followed by piperacillin for 4 weeks, were administered. Oral quinolone antibiotics were administered for an additional 2 months, until the patient’s ESR normalized.

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**Fig. 4.** Case 4. a: Initial MR image demonstrating an osteoporotic compression fracture of L-2. b1–3: Two months after surgery, the patient developed severe back pain and paraparesis in both legs. Magnetic resonance imaging confirmed the presence of an abscess compressing the retrovertebral dural sac. The patient’s ESR and CRP level were elevated to 57 mm/hour and 5.33 mg/dl, respectively. c1–4: Under impression of pyogenic spondylitis, we performed anterior debridement, reconstruction using an AIBG, and posterior instrumented augmentation fusion.
Delayed pyogenic spondylitis after vertebroplasty or kyphoplasty

The patient reported an improvement of back pain and was able to perform normal daily activities at the 1-year follow-up.

**Discussion**

Although pyogenic spondylitis is relatively uncommon, the rates of postoperative infection for an instrumented spinal fusion have ranged from 1 to 13%. However, there is a paucity of data regarding the rate of infection after vertebroplasty. Yu et al. have reported 1 infection among 200 vertebroplasty cases, whereas Kallmes et al. reported 1 infection among 63 cases. In our clinical experience, only 2 cases (1.9%) of postoperative pyogenic spondylitis developed after vertebroplasty or kyphoplasty of 145 vertebrae in 104 patients over a 5-year period.

Walker et al. have concluded that all patients who undergo vertebroplasty should be screened for any systemic infection prior to treatment. Yu et al. have also reported that it is essential to exclude the possibility of a spinal infection before the vertebroplasty procedure by performing a detailed evaluation.

The rate of delayed infection after spinal fixation has been reported to range from 0.2 to 4.7%. Bose has summarized 3 possible causes of a delayed infection after the application of instrumentation: intraoperative seeding; metal fretting causing a sterile inflammatory response or festering of low-virulence organisms; and hematogenous seeding. Delayed infections are typically caused by hematogenous spread rather than surgical inoculation.

Many reports on kyphoplasty or vertebroplasty have shown that most patients experience partial or complete pain relief of symptoms within 72 hours and that the relief may endure for years. The new onset of back pain after a certain asymptomatic period following vertebroplasty or kyphoplasty should be considered an ominous indication of pyogenic spondylitis. In our experience, the patients complained of back pain at a mean of 12.3 ± 10.0 months (range 2–25 months) after the initial procedure (Table 1).

Underlying diseases such as metastatic malignant tumors in combination with chemotherapy increase the risk of immune depression and susceptibility to DPS. Other systemic diseases such as poorly controlled DM as well as decreased albumin levels may also contribute to immune depression. Postoperative infection is more frequent among the nutritionally deficient elderly population and may reflect a defective immunoinflammatory adaptation system. Immunodeficiency increases the risk of opportunistic infection. In addition, injection of cement into vertebrae may create tiny spaces or gaps, possibly as a result of a balloon–cement mismatch or as a result of fractures that are not completely packed during the injection procedure. These spaces may permit hematogenous seeding of bacteria followed by successful colonization in immunocompromised patients. The inoculation of bacteria associated with upper-respiratory, urinary tract, or other opportunistic infections could occur during normal activities.

Other patients suffering from metastatic disease complained of severe low-back pain. Before diagnosing aggravated metastatic pain of the spine, one must differentiate pyogenic spondylitis to implement a proper treatment plan. In our experience, the presence of an elevated ESR or CRP level and a careful interpretation of enhanced MR images are helpful in this respect.

The patient in Case 1 was undergoing chemotherapy for metastatic RCC, and vertebral metastatic pain was relieved by kyphoplasty. In retrospect we suspect that a poor general condition resulting from systemic metastasis, immune depression owing to chemotherapy, and advanced age could have all contributed to the development of a delayed infection during postoperative Month 15.

The patient in Case 2 successfully underwent kyphoplasty for an osteoporotic compression fracture but then de-

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**TABLE 1**

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Initial ESR/CRP</th>
<th>Albumin†</th>
<th>Mean Interval to PS Detection (mos)</th>
<th>Causative Organism</th>
<th>Associated Disease</th>
<th>Surgery</th>
<th>FU Period (mos)</th>
<th>Complication</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>64, F</td>
<td>VP: L-1, L-3</td>
<td>106/9.8</td>
<td>1.43</td>
<td><em>E. faecalis</em></td>
<td>RCC, adrenal metastasis, urinary bladder metastasis</td>
<td>ant corpectomy w/ mesh &amp; pst instrumentation</td>
<td>3</td>
<td>sepsis (died)</td>
</tr>
<tr>
<td>2</td>
<td>78, F</td>
<td>VP: L-2, L-3</td>
<td>62/1.92</td>
<td>2.8</td>
<td><em>S. aureus</em></td>
<td>HTN, DM</td>
<td>ant corpectomy w/ AIBG &amp; pst instrumentation</td>
<td>24</td>
<td>none</td>
</tr>
<tr>
<td>3</td>
<td>73, F</td>
<td>KP: L-1, L-2</td>
<td>3/8.72</td>
<td>2.96</td>
<td><em>S. haemolyticus</em></td>
<td>HTN, depression</td>
<td>ant corpectomy w/ mesh &amp; pst instrumentation</td>
<td>12</td>
<td>transient ARF, pulmonary edema, delirium</td>
</tr>
<tr>
<td>4</td>
<td>65, F</td>
<td>KP: L-2</td>
<td>57/5.33</td>
<td>2.8</td>
<td>no growth</td>
<td>UTI (<em>P. aeruginosa</em>) &amp; sputum positive for <em>C. albicans</em></td>
<td>ant corpectomy w/ AIBG &amp; pst instrumentation</td>
<td>13</td>
<td>none</td>
</tr>
</tbody>
</table>

* ant = anterior; ARF = acute renal failure; FU = follow-up; HTN = hypertension; KP = kyphoplasty; PS = pyogenic spondylitis; pst = posterior; VP = vertebroplasty.
† Reference ranges: 0–10 mm/hour (ESR), 0–0.3 mg/dl (CRP), and 3.8–5.3 g/dl (albumin).
have reported a delayed infection 25 months after surgery. Poorly controlled DM was observed in the patient.

Seven months after kyphoplasty, the patient in Case 3 experienced back pain, which was misdiagnosed as a de novo adjacent-segment fracture. Despite an elevated CRP level, the inflammation focus was not initially thought to be infectious spondylitis because of the additional wedging of the adjacent segment. Kyphosis progressed, and the bone around the cement was resorbed, resulting in unexpectedly prolonged back pain. The results of subsequent MR imaging led us to diagnose infectious spondylitis. During surgery, pus was evacuated from the paravertebral area. This case demonstrates the importance of evaluating for DPS when back pain suddenly recurs or persists after vertebroplasty/kyphoplasty, as well as the importance of monitoring ESR and CRP levels postoperatively.

In the patient in Case 4, MR imaging revealed an intravertebral cleft prior to kyphoplasty. Vats and McKiernan have suggested that such a cleft may lead to incomplete PMMA filling, creating a space that is inaccessible to antibiotics due to decreased vascularity and thus facilitating colonization by infectious organisms. When DPS was diagnosed 2 months later, tests also showed a positive result for a UTI with Pseudomonas aeruginosa, and her sputum culture was positive for Candida albicans. An opportunistic fungal infection and a decreased serum albumin level (2.88 g/dl) may have reflected immune depression in this patient. Although an infection after a period of 6–8 weeks suggests the possibility of surgical inoculation during the initial procedure, the patient’s pain relapse and sudden increase in CRP level suggest that her immune-compromised state may have aggravated the opportunistic infection. The bacterial source was not clearly determined, most likely as a result of preoperative antibiotic administration for 2 weeks.

A delayed infection is more likely to be related to medical comorbidities and general condition than to an early infection. Vats and McKiernan have reported a case of conservatively treated DPS that occurred 6–7 months after a second vertebroplasty. The patient had uncontrolled DM, a decubitus ulcer, and poor general condition before the onset of the delayed infection.

Of the 6 infected cases reported in the literature, three patients underwent combined anteroposterior surgery and a fourth exhibited a satisfactory result after receiving conservative antibiotic therapy with restricted movement. Treatment modalities were not reported for the remaining 2 patients. All patients suffered sustained medical comorbidities such as alcoholic liver cirrhosis, UTI, history of steroid therapy, and discitis (Table 2).

Immune depression is characterized by decreased serum albumin levels. The elevation of preoperative nutrition markers is strongly associated with postoperative complications. Nakamura et al. have reported a negative correlation between the level of various nutritional markers such as transferrin, albumin, and total protein and the postoperative CRP level. They also concluded that a patient’s preoperative nutritional state affects the postoperative nutritional state, immunity, and inflammatory response. In our experience, patients who developed pyogenic spondylitis also exhibited a tendency for decreased serum albumin levels (2.5 ± 0.7 g/dl) (Table 1).

Surgery is not always the initial treatment of choice, especially in patients with serious medical comorbidities. In pyogenic spondylitis, conservative treatment with antibiotic agents and motion restriction can be used to allow recovery from the infection and improvement in a patient’s general condition. However, in cases in which the infection is unresponsive to antibiotic therapy or in which the patient exhibits neurological impairment, intractable pain, or the possibility of sepsis, decisive surgery is indicated.

Surgical intervention usually requires an extensive anterior approach, anterior corpectomy, cement removal, debridement, decompression, and interbody reconstruction, which may be accompanied by profuse bleeding. The gold standard for anterior reconstruction of pyogenic spondylitis is the use of an autogenous strut iliac bone graft. Recently, allografts and titanium metal cages, which are bacteriostatic in nature, have been successfully used. Although it is controversial, we have found that, after sufficient debridement, anterior reconstruction involving the placement of a titanium cage packed with autogenous bone is clinically successful in terms of infection control.

Although the cement can be easily removed, dangerous complications may arise if the cement were to leak through the segmental vessels and into major vessels. Intravenous leakage has been reported to be relatively safe, causing no significant clinical deterioration; in some cases, pulmonary emboli caused by cement leakage remained asymptomatic. However, life-threatening complications have also been reported; these include lethal pulmonary embolism, penetration of the right ventricle, renal artery embolism, acute respiratory distress syndrome, and late-onset right atrial thrombus leading to pulmonary thromboembolism, which then required open heart surgery.

Surgeons should be aware that extensive leakage reaching the IVC could significantly compromise ipsilateral debridement and increase the risk of IVC rupture. Therefore, preoperative CT scans should be carefully examined to confirm the extent of cement leakage (Fig. 1f–h). Meticulous ligation of the segmental vessels at the tip of the ce-
ment leakage should be emphasized for leakage limited to segmental veins. If the leaked cement has reached the IVC, complete ipsilateral debridement would probably tear this structure; thus, incomplete removal, which leaves the ves-
sel tips packed with cement, would be warranted. Other-
wise, a contralateral approach that leaves the intravascular
cement in place may be necessary.

The limitations of the present study include the small
number of patients, the inhomogeneity of the initial patient
groups (the vertebroplasty and kyphoplasty groups), the
diversity of immunocompromising comorbidities, and the
lack of accurate prevalence evaluation. A larger cohort is
required to draw firm conclusions regarding the relation-
ship between the category of comorbidity versus increased
risk and the severity of comorbidity versus increased risk.

Nevertheless, our retrospective observations on delayed
pyogenic infection following vertebroplasty or kyphoplas-
ty underscore the possibility of devastating, although rare,
complications. The infections observed in our cases were
typically bacterial in origin, caused by various gram-posi-
tive and -negative organisms. It is critical that physicians
be aware of this complication and work to prevent its oc-
currence after vertebroplasty or kyphoplasty. Scrupulous ase-
tptic procedure and the encouragement of sufficient nutrition
in patients will help to control chronic diseases and main-
tain good postoperative patient condition, particularly in
elderly and comorbidity-compromised patients. Although
pyogenic spondylitis has a low natural prevalence rate, the
risk appears to be increased in patients who are immuno-
compromised, in poor general condition, or suffering from
DM or coexistent comorbidities.

We conclude that in cases of recurrent back pain after
successful pain control following vertebroplasty or kyphop-
asty, an analysis of the ESR, CRP level, and enhanced MR images should be performed to screen for pyogenic spondylitis. Upon diagnosis, antibiotics should be adminis-
tered promptly. In cases of persistent back pain, progressive
neurological deficit, or antibiotic resistance, surgical treat-
ment is indicated. We recommend interior decompressive
surgery with debridement, removal of the cement, and re-
construction using AIBG, allograft, or titanium cages, with
or without posterior fixation. It also appears that malnour-
ishment and decreased immunity in elderly patients are
predisposing risk factors for DPS.

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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