CASE REPORT

Anterior spinal fixation for recollapse of cemented vertebrae after percutaneous vertebroplasty

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SUMMARY

Although recollapse after percutaneous vertebroplasty (PV) is a serious complication that needs salvage surgery, there is no consensus regarding the best operative treatment for this failure. We present cases of 3 patients, diagnosed as having thoracic osteoporotic vertebral fractures, who had undergone PV at other institutes. Within less than half a year, recollapse occurred at the cemented vertebrae in all 3 patients, and we conducted anterior spinal fixation (ASF) on them. In all cases, ASF relieved the patient's severe low back pain, and there was no recurrence of symptoms during the follow-up period of 6 years, on average. ASF is the optimal salvage procedure, since it allows for the direct decompression of nerve tissue with reconstruction of the collapsed spinal column, and preservation of the ligaments and muscles that stabilise the posterior spine. Surgeons who perform PV need to be able to assess this failure early and to perform spinal fixation.

BACKGROUND

Osteoporotic vertebral fractures (OVFs) are highly prevalent in today's progressively ageing society, and are especially prevalent in elderly women. OVFs cause severe pain and spinal instability, and are devastating to the patient's quality of life.¹ Percutaneous vertebroplasty (PV), first described by Galibert *et al*,² has been widely used to treat OVFs in recent years. PV is a minimally invasive therapeutic procedure in which a bone cement, generally polymethylmethacrylate (PMMA), is injected percutaneously into the vertebral body via the pedicle. This procedure immediately strengthens and stabilises the OVF, and successfully reduces the pain in 80–90% of patients.³

Despite its positive clinical outcome, PV is associated with various complications, including local infection and pyogenic spondylitis, symptomatic cement leakage, pulmonary embolism, cement fragmentation, adjacent vertebral fracture and refracture of cemented vertebrae.^{4–9} In particular, late collapse of the cemented vertebrae is a devastating complication, because it usually requires additional invasive salvage treatment as the result of progressive local kyphotic deformity and spinal cord compression. The incidence of recollapse is 1.54–3.21%,^{10–11} and, due to its rarity, there is no consensus regarding the best treatment for PV failure with this complication.^{12–13} In some cases, repeating the PV effectively relieves the patient's pain.^{14–16} However, most surgeons argue that a failed PV requires salvage by spinal fixation.^{12–13} To date, there are only a few studies on anterior spinal fixation (ASF) as a treatment for failed PV, and its long-term clinical outcomes are lacking.^{12–13–17}

Therefore, we report three cases in which patients were referred to us with recollapse of the cemented vertebral body after PV. These patients underwent revision surgery with ASF at our institute. In all three cases, ASF relieved the patient's severe low back pain, and there was no recurrence of symptoms during the follow-up period (6 years on average). The patients were informed that data from the cases would be submitted for publication, and gave their consent.

CASE PRESENTATION**Case 1**

An 87-year-old woman with a symptomatic T12 osteoporotic compression fracture was treated at another hospital by PV with PMMA and a laminectomy at the same level (figure 1A, B). According to the surgeon, he did not perform spinal fixation after laminectomy because the patient was geriatric. The patient's back pain was relieved immediately after PV, but recurred 2 months later without any traumatic episode. The patient was unable to walk due to intense low back pain, and she was referred to our hospital. Physical examination showed no muscle weakness and intact deep tendon reflexes in both legs. Radiographs showed a local kyphotic deformity (Cobb angle 30°) (figure 1C, D). CT scans revealed air collection around the PMMA and PMMA fragmentation in the vertebra (figure 2A, B). MRI showed compressed spinal cord by the disrupted posterior wall of the T12 vertebra (figure 2C, D).

Figure 1 Case 1: An 87-year-old woman with a postpercutaneous vertebroplasty T12 recollapse. Radiographs showing the cemented vertebra just after the vertebroplasty (A and B) and 4 months later (C and D). Recollapse of the T12 vertebra progressed over time.

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Figure 2 Two months after percutaneous vertebroplasty in case 1. (A and B) CT images showing cement fragmentation in the T12 vertebra. (C) T1-weighted and (D) T2-weighted MRI showing vertebral recollapse.

Case 2

A 74-year-old woman with T11 and T12 osteoporotic compression fractures was treated at another hospital by PV with PMMA at the same levels (figure 3A). Cement leakage into the spinal

Figure 3 Case 2: a 74-year-old woman with postpercutaneous vertebroplasty T11 and T12 recollapse. (A) Radiographic and (B) CT images showing cemented T11 and T12 vertebrae just after vertebroplasty. Cement leakage into the spinal canal was observed at T12 (B: arrowhead). Seven months after vertebroplasty, (C) radiographic and (D) CT images showing progressive recollapse and cement leakage (arrowhead).

Figure 4 (A) T1-weighted and (B) T2-weighted MRI in case 2 showing fluid collection around the cement at the T12 vertebra.

canal was already detected by CT scans just after PV (figure 3B). Six months after the PV, her back pain recurred with no traumatic episode. She was referred to our hospital because of intense, progressive back pain; she was unable to lie in a supine position due to the pain. Radiographs showed a local kyphotic deformity (Cobb angle 43°) (figure 3C). CT scans again showed the existing PMMA leakage into the spinal canal (figure 3D). MRI of the T12 vertebra revealed fluid collection around the cement, with low and high intensity in the T1-weighted and T2-weighted images, respectively (figure 4A, B). This pathological condition might reflect osteonecrosis, since MRI fluid sign is correlated with the histopathological evidence of osteonecrosis.¹⁸

Case 3

A 64-year-old woman had neurological deficit in her lower extremities, and her condition was diagnosed at another hospital as L1 osteoporotic burst fracture. She underwent PV using PMMA at that institute; the PV was repeated when the first PV did not resolve her back pain. Her back pain was relieved immediately after the second PV, but recurred 1 month later without any traumatic episode. She was referred to our hospital due to numbness of the lower extremities and intense low back pain that made it difficult to walk. Physical examination showed reduced deep tendon reflex and weakness of the anterior tibial muscles in both legs. Radiographs showed a local kyphotic deformity (Cobb angle 13°) and recollapse of the cemented vertebra (figure 5A, B).

OUTCOME AND FOLLOW-UP

Case 1

The patient underwent ASF with an iliac crest autograft at the T11-L1 levels (figure 6A–D). Intraoperative findings revealed no adhesion of the PMMA to the vertebral bone, and the PMMA

Figure 5 (A and B) Case 3: A 64-year-old woman with postpercutaneous vertebroplasty L1 recollapse seen on radiographs.

Figure 6 Post-anterior spinal fixation (ASF) images for case 1. (A and B) Radiographic and (C and D) CT images showing successful ASF with an iliac crest autograft. (E and F) One year after ASF, radiographic images showing bony fusion.

was easily removed. One year after the ASF, radiographs showed solid bony fusion at the T11-L1 levels and the local kyphotic deformity was improved to 22° (figure 6E, F). The patient could

Figure 7 Post-anterior spinal fixation (ASF) radiographs for case 2. (A and B) Radiographs obtained 7 years after ASF showing bony fusion at the T10-L1 levels.

Figure 8 (A and B) Case 3: after recollapse of cemented vertebra, the patient underwent anterior spinal fixation with iliac crest autografts at T12-L2. (C and D) Radiographs at 10-year follow-up showing solid bony fusion at T12-L2.

walk with a hand crutch, and reported complete relief from low back pain.

Case 2

The patient was treated by removal of the cement and ASF with a fibula autograft at the T10-L1 levels. Radiographs obtained 7 years after the ASF showed solid bony fusion at the T10-L1 levels, and improvement of the local kyphotic deformity to 28° (figure 7A, B). The patient was free of low back pain at the final follow-up.

Case 3

The patient underwent revision surgery with removal of the cement and ASF with an iliac crest autograft at the T12-L2 levels (figure 8A, B). Radiographs obtained 10 years after the ASF showed solid bony fusion at the T12-L2 levels (figure 8C, D). Even though the local kyphotic deformity progressed to 23°, the pain did not recur.

DISCUSSION

PV is a minimally invasive technique that has been used successfully to treat painful OVFs.^{19–21} However, as with the three cases reported here, the cemented vertebrae can recollapse after PV.^{10 12 13 16 22 23} Regarding the risk factors for this complication, Kang *et al*²³ suggested that a higher preoperative local kyphotic angle and a higher sagittal index²⁴ may result in refracture, based on a comparison of patients with or without refracture. Chen *et al*¹⁶ demonstrated that an MRI finding of preoperative osteonecrosis and a relatively large postoperative restoration of anterior vertebral height without a corresponding correction in the kyphotic angle increased the risk of refracture. Therefore, surgeons

should judge the indications for PV carefully. If the patient has a large preoperative local kyphosis and MRIs show necrosis with air or fluid collection in the vertebral body, surgical fixation should be considered as the initial treatment for OVF.

There are a few options for revision strategies for failed PV. If radiographs show poor cement augmentation after PV, repeating the PV may be an option.¹³ He *et al*¹⁵ reported that repeating a PV effectively relieved pain in all of 15 cases in which pain persisted after an initial PV, and concluded that inadequate filling of the unstable vertebral body with cement was responsible for the lack of pain relief after the first PV.

If an initial PV has used a unipedicle approach, it may be possible to repeat the PV from the other side of the pedicle.¹³ If the initial approach was bipedicle, it is still possible to repeat the PV, since a normal-sized pedicle is larger than the diameter of the spinal needle used for PV.¹³ However, this procedure is more difficult than the initial PV, and should only be performed by experienced spine surgeons.

Not all PV failure can be resolved by repeating the PV. In particular, spinal fixation should be decisively selected if severe low back pain worsens and neurological deficits occur due to spinal instability.¹³ Therefore, surgeons who perform PV need to be able to assess PV failure quickly and to perform the specialised techniques involved in spinal fixation.

Fixation to salvage a failed PV can take an anterior, posterior, or combined anterior and posterior approach. Although there is no strong evidence for choosing one surgical approach over another, some studies have shown that combined anterior and posterior surgery was the most reliable method for treating complications related to PV.^{13 17} Chou *et al*¹⁰ performed posterior decompression with instrumentation fixation or posterior decompression alone for patients with progressive kyphosis after PV. In these studies, however, the clinical outcomes after salvage surgery were not reported, and the follow-up period was shorter than in our cases. We believe that ASF is the optimal salvage procedure, since it allows for the direct decompression of nerve tissue, reconstruction of the collapsed spinal column, and preservation of the ligaments and muscles that stabilise the posterior spine.²⁵ Moreover, anterior fixation enables a shorter fusion length than posterior fixation. Loss of correction after ASF is a concern, as shown in our cases. However, ASF provided long-term pain relief for these patients, even with the progression of the kyphotic deformity. In fact, Lakshmanan *et al*²⁶ demonstrated that there was no significant relationship between patients' quality of life and loss of kyphosis correction after spinal fusion for thoracolumbar vertebral fractures. Our present cases indicate that ASF can be an appropriate procedure for salvaging a failed PV, although additional posterior fixation might become necessary because multilevel corpectomies or severe osteoporosis in geriatric patients require posterior reinforcement in some cases.²⁷

In case 1 and 3, we used iliac crest as a bone strut because longitudinal length of the grafted area was <6 cm. If the iliac crest harvested is longer than 6 cm, the crest bone has a curvature structure and is not appropriate as a strut for ASF. In fact, when performing corpectomy with removal of two vertebrae length usually longer than 6 cm is needed. Therefore, we used fibula autograft for case 2 to acquire stabilised fixation with sufficient length of strut.

As with our cases, Miyagi *et al*¹² also used ASF to treat patients with a late collapse of cemented vertebrae, and found that the patients improved after surgery, although the patients were only followed within a year. Our cases demonstrate good surgical outcomes over a longer follow-up period, emphasising the efficacy of ASF after a failed PV.

In case 1, the patient underwent laminectomy in addition to PV. We believe that this procedure is contraindicated for the treatment of OVF. Decompressive laminectomy without fixation for OVF patients further destabilises the spine and increases kyphotic deformity, with subsequent neurological deterioration. In fact, a previous study reported the complete failure of decompressive laminectomy for osteoporotic vertebral collapse.²⁸ Since the posterior column and the associated soft tissues are key to stabilising the spine,²⁵ preserving the posterior complex is an important initial consideration when treating OVFs. If posterior spinal decompression is absolutely necessary, fixation is mandatory to stabilise the spinal column.

Although we only reported OVF cases that were initially treated by PV, balloon kyphoplasty (BKP) is also widely used to manage OVFs. In BKP, inflatable bone tamps are used before injecting the bone cement, with the goal of correcting vertebral deformity and controlling the distribution of the cement.^{29 30} BKP has less risk of cement leakage, a tendency toward longer fracture-free survival and less loss of kyphotic-deformity correction compared with PV.³⁰ Similar to PV, however, BKP carries a risk of recollapse of the cemented vertebra,³¹ which requires a similar salvage technique.

Learning points

- We presented three patients diagnosed with thoracic osteoporotic vertebral fractures who had undergone percutaneous vertebroplasty (PV) at other institutes.
- After recollapse occurred at the cemented vertebrae, we performed anterior spinal fixation (ASF).
- In all cases, ASF relieved the patient's severe low back pain, and there was no recurrence of symptoms during the follow-up period of 6 years, on average.
- ASF is the optimal salvage procedure, since it allows for (1) the direct decompression of nerve tissue, (2) reconstruction of the collapsed spinal column, (3) preservation of the ligaments and muscles that stabilise the posterior spine and (4) shorter fusion length.
- Surgeons who perform PV need to be able to perform spinal fixation as salvage surgery for PV failure.

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