Clinical Case Report

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Refracture of osteoporotic vertebral body after treatment by balloon kyphoplasty

Three cases report

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Abstract

Rationale: Balloon kyphoplasty is a widely accepted treatment of osteoporotic vertebral compression fractures (OVCFs) with good results and a low risk for complications. A refracture of previously treated vertebra is a relatively rare condition.

Patient concerns: We reported our 3 cases and reviewed all relevant literatures of 11 cases with refracture of osteoporotic vertebral body after kyphoplasty.

Diagnoses: Follow-up radiographs or magnetic resonance imaging examination confirmed refractures of previously treated vertebrae after kyphoplasty.

Interventions: One patient with 1 refracture of osteoporotic vertebral body after kyphoplasty was treated conservatively, but the other 2 patients were treated surgically because of multiple vertebral fractures or neurological deficits.

Outcomes: The average age of the patients was 76.8 years (range, 63–86 years). All the patients had severe osteoporosis with a mean T-score of −3.46 (range −5.0 to −3.0). The sites of refractures are in the lumbar and thoracolumbar regions. Severe osteoporosis, the presence of intravertebral cleft, and a solid lump injection pattern of polymethylmethacrylate would result in insufficient strengthening effects of cement augmentation and therefore increased the likelihood of refractures of the kyphoplasty vertibrae.

Lessons: Patients with OVCFs and intravertebral cleft who did not obtain complete pain-relief at the treated vertebral level after kyphoplasty should be strictly followed up. Early finding of this condition and rapid intervention might contribute to avoiding the occurrence of the cemented vertebral refracture after kyphoplasty. Conservative treatments such as back brace and antiosteoporotic medications were strongly recommended.

Abbreviations: CT = computed tomography, ECT = emission computed tomography, MRI = magnetic resonance image, OVCF = osteoporotic vertebral compression fracture, PMMA = polymethylmethacrylate, VAS = visual analog scale.

Keywords: cement fragmentation, intervertebral cleft, kyphoplasty, osteoporotic vertebral compression fracture, refracture

1. Introduction

Balloon kyphoplasty has been widely accepted as an effective, minimally invasive treatment of symptomatic osteoporotic vertebral compression fractures (OVCFs) by providing significant pain relief, functional improvement, and vertebral height restoration.[1–4] Despite encouraging clinical outcomes, some related complications have been described, involving bleeding, infection, cement extravation and embolism, and adjacent level fractures following the kyphoplasty procedure.[5,6] Recently, very few articles have focused on the issue of refractures in previously treated vertebrae after cemented vertebral augmentation by kyphoplasty. Several predisposing factors and potential mechanisms of this phenomenon have been sporadically mentioned in previous case reports.[7–9] In the current study, we reported 3 patients who presented with refractures of OVCFs after treatment by kyphoplasty, and institutional review board approval was obtained from the first affiliated hospital of Zhejiang University for data collection. We also reviewed all related published literatures and summarized the clinical and radiological characteristics of these failed cases. The discussion focused on clinical and radiological features, risk factors, and mechanisms.

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2. Case report 1

An 86-year-old man with a T12 OVCF underwent kyphoplasty using polymethylmethacrylate (PMMA) cement via a bipedicular approach at a local hospital. A bone mineral analysis showed severe osteoporosis with a T-score of −4.0. Preoperative radiographs showed a compression fractured T12 vertebra with an intraosseous cleft in the anterior superior portion of vertebral

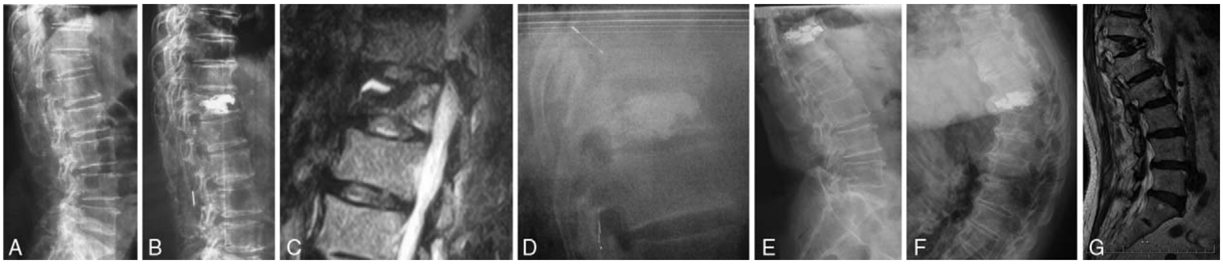

Figure 1. A preoperative lateral radiograph: a compression fractured T12 vertebra with an intraosseous cleft (A). Anterior vertebral body height and kyphotic angle were notably corrected after kyphplasty (B). Two weeks later, an unfilling intraosseous cleft containing fluid with high-signal (C). One month later, the injected PMMA cement was condensed and reduced in size with slight anterior height loss (D). Ten months later, 1 significant compression fracture of T12 vertebral body (E). Sixteen months follow-up radiograph: bony union of T12 vertebral body (F). MRI: no bone marrow edema with high-signal at T2 image (G). MRI = magnetic resonance image, PMMA = polymethylmethacrylate.

body (Fig. 1A). Immediate postoperative radiographs showed that the anterior vertebral body height and kyphotic angle were notably corrected after the kyphoplasty treatment (Fig. 1B). The patient's visual analog scale (VAS) pain score improved from 9 to 3. Two weeks later, the patient continued to have back pain in the same area. Magnetic resonance image (MRI) examination confirmed an unfilling intraosseous cleft containing fluid with a high-signal at T2-weighted image (Fig. 1C). Bed rest was therefore suggested and antiosteoporotic medications, including bisphosphonates, calcitriol, and vitamin D, were used. Slight back pain relief was attained after 1-month conservative treatment, but radiographs showed the injected PMMA cement was condensed and reduced in size with slight anterior height loss of T12 vertebral body (Fig. 1D). The patient did not adhere to further follow-up examination and oral antiosteoporotic medications, until he experienced a sudden, severe onset of unrelenting back pain more severe than any previous episodes 10 month later. The patient's VAS pain score was 9 points. Conventional radiographs of the lumbar spine at our institution demonstrated a significant compression fracture of T12 vertebral body with cement fragmentation (Fig. 1E). The patient refused surgical therapy, elected to previous conservative treatment. He obtained therapeutic benefit of pain relief for consistently adhering to a prescribed regimen. Sixteen-month follow-up radiographs showed new bone formation and bony union of T12 vertebral body without further vertebral height reduction (Fig. 1F). MRI confirmed no bone marrow edema with high signals at T2-weighted image (Fig. 1G). The patient's rehabilitation was satisfactory with an improvement in the VAS pain score from 9 to 1.

3. Case report 2

An 82-year-old man with an acute L3 OVCF was referred to a local hospital (Fig. 2A). A bone mineral analysis showed severe osteoporosis with a T-score of −3.8. And a unilateral transpedicular approach was used to perform an L3 kyphoplasty with PMMA cement (Fig. 2B). After the surgery, the patient's VAS pain score improved from 10 to 3. Two months later, the patient experienced low back pain again, and MRI of the lumbar spine demonstrated further compression at the previously treated L3 level and high signals around the cement at T2-weighted image (Fig. 2C). Conservative treatment including analgesia, antiosteoporotic medicine, and bed rest was administered for 2 weeks, but the patient still had increasingly severe low back pain. Computer tomograph (CT) and MRI of the lumbar spine confirmed a L3 vertebral refracture and 1 new OVCF at L2 level. Moreover, 1 intravertebral cleft was also observed at the anteroinferior portion of the L2 vertebral body (Fig. 2D and E). These radiological findings were further depicted on emission computed tomography image (Fig. 2F). Considering vertebral factors such as severe osteoporosis, cemented vertebrae refracture, and new adjacent vertebral fracture characteristics, a kyphoplasty was chosen to treat L2 OVCF and the pedicle screws reinforced with PMMA cement were inserted percutaneously at the L1 and L4 levels, with the aim of strengthening the stability of

Figure 2. A preoperative lateral radiograph: a compression fractured L3 vertebra with an intraosseous cleft (A). Kyphplasty was used to treat L3 OVCF with PMMA cement (B). Two months later, MRI confirmed that bone marrow edema around the cement with high signal at the previously treated L3 level (C). Two weeks later, repeated CT and MRI examination of the lumbar spine confirmed a L3 vertebral refracture and 1 new OVCF at L2 level with an intravertebral cleft (D, E). ECT image further confirmed a L3 vertebral refracture and 1 new L2 fracture (F). A kyphoplasty was used to treat L2 fracture and the pedicle screws reinforced with PMMA cement were inserted percutaneously at L1 and L4 levels (G). CT = computed tomography, ECT = emission computed tomography, MRI = magnetic resonance image, OVCF = osteoporotic vertebral compression fracture, PMMA = polymethylmethacrylate.

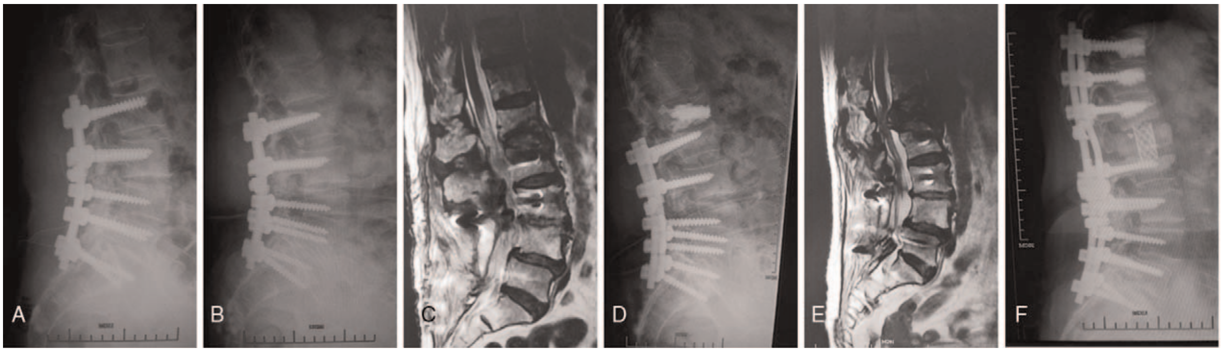

Figure 3. A postoperative lateral radiograph showed decompression and instrumented fusion for lumbar degenerative scoliosis (A). Four months after the primary operation, radiograph and MRI confirmed a L1 OVCF (B, C). L1 kyphoplasty with PMMA cement was performed (D). Three months later, repeated MRI demonstrated refracture of the L1 vertebral body with cement fragmentation, and resultant neural canal encroachment (E). One cage with autograft was inserted, and 6 pedicle screws combined with PMMA cement reinforcement were performed (F). MRI = magnetic resonance image, OVCF = osteoporotic vertebral compression fracture, PMMA = polymethylmethacrylate.

the affected segments (Fig. 2G). The operation was successful and the VAS pain score improved from 10 to 4. Unfortunately, the patient died of pulmonary infection 3 month later.

4. Case report 3

A 75-year-old female patient received surgical decompression and instrumented fusion due to chronic low back pain and neurological claudication caused by degenerative scoliosis (Fig. 3A). A bone mineral analysis showed osteoporosis with a T-score of −3.0. Four months after the primary operation, the patient had the sudden onset of a severe back pain, and radiographs and MRI of the lumbar spine at a local hospital confirmed a L1 OVCF (Fig. 3B and C). A bilateral transpedicular approach was chosen to perform an L1 kyphoplasty with PMMA cement (Fig. 3D). The patient's VAS pain score improved from 10 to 2. However, 3 months after the kyphoplasty procedure, the patient had recurrent severe back pain in the same area and weakness in both the legs. MRI demonstrated refracture of the L1 vertebral body with cement fragmentation, and resultant neural canal encroachment (Fig. 3E). A L1 corpectomy involving the PMMA cement resection was performed for surgical decompression. One cage with autograft was inserted for anterior column reconstruction, and 6 pedicle screws combined with PMMA cement reinforcement were used to fix from T12 to T10 level (Fig. 3F). The patient's postprocedure course was satisfactory, with an improvement in back pain and neurological deficit. At 3 months follow-up, the patient's VAS score was 2 points and he was able to perform some daily activities.

5. Discussion

The phenomenon of refracture of the cemented vertebrae after kypholasty has been sporadically reported in recent literatures.[7–9] As we know, only 14 cases have been reported, including the present 3 cases. The average age of the patients is 76.8 years (range, 63–86 years). These cases include 11 women and 3 men. All the patients had severe osteoporosis with a mean T-score of −3.46 (range −5.0 to −3.0). The refractured sites of the present series are in the lumbar and thoracolumbar regions (Table 1).

We found all patients obtained pain relieve immediately after kyphoplasty, but developed refractures of the previously operated vertebrae at the meantime of 3 months (range, 1–4 months) postoperatively. That indicated the mechanical strength

Table 1

Patient characteristics.

No.	Sex	Age (y)	Vertebra	T-score	Presence of IVC	Time of refracture (mo)	Cement filling pattern	VAS Preop.	VAS Postop.	VAS Last	Treatment
1	M	63	L4	−5.0	Unknown	2	Solid pattern	10	2	5	Conservation
2	F	73	T12	−3.1	Yes	4	Solid pattern	9	2	3	Conservation
3	F	77	L2	−4.9	Yes	4	Interdigitated pattern	8	3	3	Conservation
4	F	82	T11	−4.2	Yes	3	Solid pattern	8	2	6	Conservation
5	F	72	L1	−3.8	Yes	3	Solid pattern	9	3	4	Conservation
6	F	81	T12	−4.0	Yes	3	Solid pattern	9	2	2	Conservation
7	F	70	T12	−4.0	Yes	3	Interdigitated pattern	9	2	4	Conservation
8	F	80	T12	−3.3	Yes	3	Solid pattern	8	1	2	Conservation
9	F	66	L1	−3.0	Yes	3	Solid pattern	9	1	3	Conservation
10	F	84	L1	−3.1	Yes	4	Solid pattern	9	3	4	Conservation
11	F	84	T12	−3.2	Yes	4	Interdigitated pattern	8	3	4	Conservation
12	M	86	T12	−4.0	Yes	1	Solid pattern	9	3	1	Conservation
13	M	82	L3	−3.8	Yes	2	Solid pattern	10	3	4	Surgery
14	F	75	LI	−3.0	No	3	Interdigitated pattern	9	2	2	Surgery

IVC = intravertebral cleft, MOS = months, VAS = visual analog scale, YR = year.

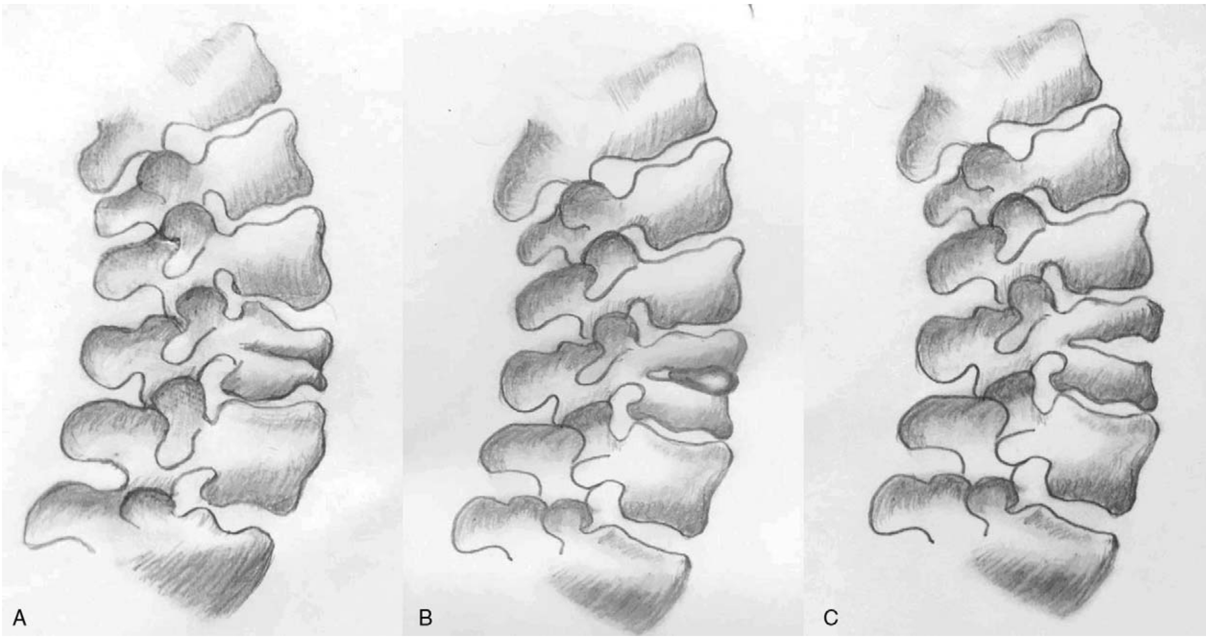

Figure 4. An illustration of the kyphoplasty process in the treatment of 1 OVCF with an intravertebral cleft. One OVCF with an intravertebral cleft (A). The expansion of the balloon tamp within the cleft mainly pushed the fractured segments up and down (B). After that, the vacuum was produced at the site of a previous intravertebral cleft. OVCF = osteoporotic vertebral compression fracture.

of the augmented vertebrae could not be restored sufficiently by kyphoplasty in the short term. We also found the vast majority of OVCFs (12/14) had the presence of intravertebral clefts in preoperative images. The pathophysiology of the intravertebral cleft was not completely understood yet and a variety of theories had been proposed to explain this phenomenon. However, dynamic fracture mobility related to intravertebral cleft had been confirmed in radiographs.[10,11] Mckiernan et al[10] reported the previously unrecognized occurrence of dynamic fracture mobility in many OVCFs could be identified in supine cross-table lateral radiographs. They found intravertebral clefts existed in every mobile OVCF but were absent from every fixed OVCF, which indicated intravertebral clefts resulted in dynamic fracture mobility of OVCFs. Therefore, in the treatment of OVCFs with intravertebral clefts by kyphoplasty, the expansion of the balloon tamp did not have the dramatic effect on creating a cavity within the fractured vertebral body but instead it mainly pushed the bony segments up and down, leaving the vacuum at the site of a previous intravertebral cleft (Fig. 4). The injected PMMA cement therefore initially filled the limited cavity created by the ballooned tamp, and the more viscous partially cured cement still followed the pathway of least resistance through the intravertebral cleft. As a result, high pressure could cause the PMMA cement in that state to leak into the intravertebral cleft, which might easily form a solid lumped PMMA mass without interspersion throughout the trabeculae.

Eventually, 10 of 12 OVCFs with intravertebral cleft were filled with PMMA in a solid lump pattern. The solid lump injection pattern of PMMA might result in insufficient filling and a residue PMMA-unaugmented area, in the presence of intravertebral cleft. Therefore, the strengthening effects of augmentation would not be accomplished successfully after kyphoplasty. Additionally, PMMA cement formed as a solid lump rather than as a contiguous bone interdigitation, would alter normal load transfer pattern of the cemented vertebrae so that a stress-shielding effect could occur in the PMMA-unaugmented bony architecture.[12] The stress-shielding effect combined with the patient fracture risk profiles such as severe osteoporosis would further accelerate bone mass loss and diminish the PMMA filling with trabeculae in an interdigitation manner. That might result in microfracture and progressive vertebral body height loss, and bone–cement interface failure, even as cement crack. Recently, several potential risk factors associated with refracture of the cemented vertebrae after vertebroplasty have been also reported, including severe osteoporosis, vertebral body fracture with osteonecrosis or pseudoarthrosis, larger height restoration, and solid lump filling cement.[13–17] These findings were consistent with that in the current study. We believed these technical or vertebral factors might contribute to occurrence of cemented vertebrae refractures after vertebroplasty in a similar biomechanical manner. These mechanisms signified the importance of early diagnosis and active treatment.

In the current series, all the patients experienced recurrent back pain at the same vertebral level after kyphoplasty in a short term. This featured clinical manifestation provided important clues for early diagnosis of the cemented vertebrae refractures. Further examination involving X-ray and MRI should be performed to confirm this rare complication. The conservative methods, such as back brace and antiosteoporosis medicine, were effective for the treatment of 12 patients in this study. However, 1 patient had neurological deficit caused by a cemented vertebrae refracture requiring surgical decompression. Another patient had 1 adjacent OVCF with an intravertebral cleft besides a cemented vertebral fracture after kyphoplasty. High risk of refracture makes us choose the surgical operation, involving a kyphoplasty procedure and percutaneous pedicle screws fixation. We thought this method could restore the stability of lumbar spine sufficiently. No matter which treatment you choose, good compliance with antiosteoporotic medication remained an important treatment procedure for these patients.

We therefore suggested that patients with OVCFs and intravertebral clefts who did not obtain complete pain-relief at the treated vertebral level after kyphoplasty should be strictly followed up, especially when a solid lump injection pattern of PMMA was observed in postoperative radiographs. Early findings of this condition and rapid intervention might contribute to avoiding the occurrence of the cemented vertebral refracture after kyphoplasty. Additionally, we should attach importance to patient adherence to antiosteoporotic medication treatment.

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