Journal of Medical Case Reports

CASE REPORT

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Semi-vertebral column resection with preservation of posterior ligament complex for Kümmell's disease: a case report

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Abstract

Background Kümmell's disease is characterized by ischemic osteonecrosis and nonunion after osteoporotic vertebral compression fractures, leading to intractable low back pain, pseudoarthrosis, kyphosis, and neurological dysfunction, which can seriously affect the quality of life and life expectancy of patients. Although many surgical methods have been reported, uniform standard procedures for Kümmell's disease are still lacking.

Case presentation This case described a new procedure for Kümmell's disease. A 67-year-old woman from China underwent semi-vertebral column resection through the posterior of the diseased vertebra, while the posterior ligament complex and the contralateral spinal structure were preserved. Subsequently, intervertebral titanium cage support bone graft fusion combined with posterior pedicle screw internal fixation was conducted, and the patient was followed up with for 22 months. Kyphosis Cobb angle was 20° 2 weeks post-surgery and was maintained at 20° even after 22 months. Titanium cage was in a good position 2 weeks and 22 months after surgery.

Conclusion This new spine surgery could completely decompress the spinal canal and reduce the iatrogenic destruction of spinal stability, which might be helpful for the reconstruction and maintenance of spinal stability.

Keywords Kümmell's disease, Posterior ligamentous complex, Semi-VCR, Decompression, Reconstruction

Introduction

Kümmell's disease, first described by Dr. Hermann Kümmell in 1895 [1], is defined as avascular osteonecrosis following an osteoporotic vertebral compression fracture [2]. It is characterized by progressive back pain, kyphosis, or neurological deficits after months or even years of asymptomatic periods after minor spinal trauma. This illness greatly reduces both the quality of life and life expectancy of patients [3, 4].

In recent years, with the advancement of radiological diagnosis technology, the incidence of Kümmell's disease has found to be increased (between 7% and 37%), especially among the elderly population. An intravertebral cleft (IVC) with or without vertebral collapse, kyphosis, or spinal canal stenosis is a characteristic imaging manifestation of this disease [5]. Because the fracture healing process may fail in conservative treatments, leading to osteonecrosis of the affected vertebrae, this treatment modality is usually not feasible [6]. Alternatively, surgical interventions are recommended.

Various surgical procedures for the management of Kümmell's disease have been reported in literature [3, 7, 8]. However, factors such as advanced age, multiple complications, and severe osteoporosis have limited

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the development of optimal surgical procedures for this disease [8, 9]. An ideal surgical procedure should be minimally invasive and provide optimal outcome with long-term clinical benefits. Hence, we designed a novel surgical procedure that involved posterior semi-vertebral column resection (VCR) while retaining the posterior ligamentous complex, providing a better surgical option for patients with Kümmell's disease.

Case presentation

History and physical examination

A 67-year-old woman from China presenting with persistent back pain and weakness lasting nearly 2 months was admitted to the department of orthopedics at our hospital on 18 March 2019. The patient complained of persistent back pain when walking or changing positions, and the symptoms improved slightly after rest. She had no symptoms such as leg pain or numbness, bowel or bladder dysfunction, fever, poor appetite, night sweats, and weight loss. The patient developed back pain after a minor falling incident a year ago, but recovered quickly after resting. A medical history of about 10 years of hypertension was indicated for this case, but the blood pressure was well controlled by nifedipine sustained-release tablets and aspirin. This case also had a history of smoking for nearly 50 years, consuming 6–7 cigarettes a day. A family history of hereditary diseases was denied by the patient.

The patient's body temperature was normal, the nutritional status was good, and there was no weight loss. No obvious abnormalities in cardiopulmonary and abdominal examinations were observed. Physical exam demonstrated kyphosis in the thoracolumbar segment of the spine in the standing position, with obvious tenderness in this region. Lumbar vertebra activities (forward and backward bending) were limited. Sensory, motor, and reflex examinations of upper and lower extremities were normal. The visual analog scale (VAS) score was 7 points, and the Oswestry Disability Index (ODI) was 62.22% (28/45).

Radiologic assessment

X-ray, computed tomography (CT), and magnetic resonance imaging (MRI) were performed before surgery (Fig. 1). Lateral radiographs showed T12 vertebral wedge deformity with a kyphosis Cobb angle of 28°, and the flexion and extension angles were 33° and 25°, respectively. A T12 vertebra fracture was concluded. CT and MRI showed no intervertebral space destruction or vertebral

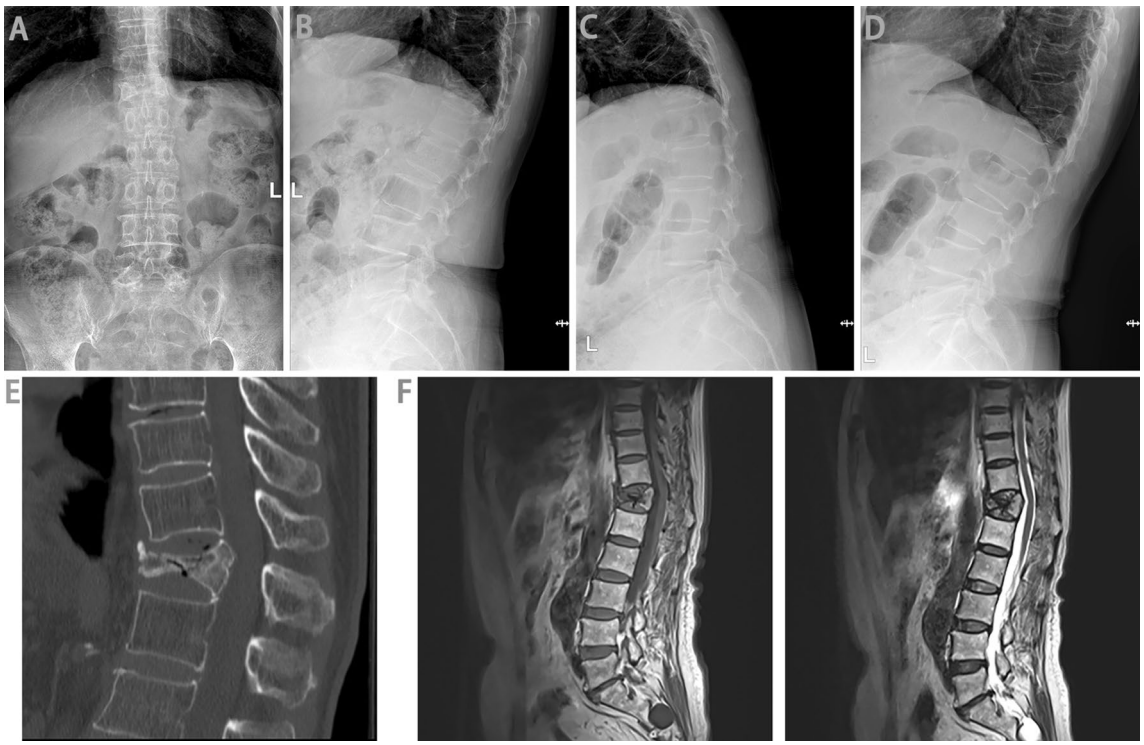

Fig. 1 Radiological findings at diagnosis. **A** Anterior lumbar spine X-ray showed decreased T12 vertebral body height, and **B** lateral lumbar spine X-ray showed wedge shaped T12 vertebral body and a kyphosis Cobb angle of 28°. X-ray results showed that the Cobb angles at (**C**) flexion and (**D**) extension stress position were 33° and 25°, respectively. Computed tomography (**E**) revealed intravertebral vacuum cleft, and magnetic resonance imaging (**F**) indicated that the T12 vertebral fracture was not healed

osteolytic changes, and tuberculosis and tumors were excluded. Combined with the patient's history of traumatic waist pain 1 year ago, the CT revealed intravertebral vacuum cleft (IVC), and the MRI indicated that the T12 vertebral fracture was not healed, so the patient was eventually diagnosed with Kümmell's disease.

Surgical procedure

On 27 March 2019, under general anesthesia (propofol 250 mg/h, remifentanil 0.4 μg/kg/minute, atracuramide benzene sulfonate 5 mg/h, and sevoflurane 1%), the patient underwent the surgery in a prone position. The procedure included posterior semi-VCR that preserved the posterior ligament complex, intervertebral titanium cage bone graft fusion, and pedicle screw internal fixation. A standard posterior spine incision was made. On the left side of the spine, the paravertebral muscles were stripped from the vertebral lamina to the lateral side of the facet joint. On the right side, the Wiltse approach (~3 cm lateral to the spinous process) was carried out, leaving the right paravertebral muscles and supraspinous and interspinous ligaments *in situ*. Pedicle screws were inserted into the target vertebrae T10, T11, L1 and L2 through the Wiltse approach on the right side and the traditional technique on the left side. Unilateral laminectomy was conducted to decompress and visualize the spinal cord on the left side. The left transverse process of T12 was removed. A careful subperiosteal dissection was carried out on the left side to expose the lateral wall of the T12 vertebral body until the anterolateral aspect was reached. The left pedicle, left articular processes, and the left half of the T12 vertebral body were cut out. The T11/T12 and T12/L1 intervertebral disks were also excised. Spine kyphosis was corrected by a rod bent to the desired contour of the spine, which was connected to pedicle screws on the right side. The titanium mesh filled with autologous bone was placed into the intervertebral space. Another rod with the desired contour was attached on the left side. A drainage tube was placed, and the incision was sutured layer by layer. The surgery time was 150 minutes, and the total blood loss was estimated to be 450 mL.

Postoperative treatment and follow-up

After the operation, the patient was given a prophylactic intravenous injection of cefuroxime sodium 1.5 g (two times per day) for 1 day. Celecoxib was taken orally for 5 days (0.2 g, two times per day) for analgesia, and 0.6 mL of low molecular weight heparin sodium was injected subcutaneously for 2 weeks (once per day) for anticoagulation therapy. On the third day after surgery, the drainage volume was 25 mL, and the drainage tube was removed. The total drainage volume was 410 mL. The patient was allowed to get out of bed with a custom-made plastic orthosis. The plastic orthosis was kept for at least 3 months. On the 14th day after the operation, the surgical sutures were removed, and the patient was discharged. After discharge, the patient continued to take calcitriol (0.25 μg, two times per day) and calcium carbonate (0.6 g, once per day).

Lumbar vertebral X-rays were performed, and the VAS/ODI scores were assessed during the outpatient follow-ups at 3, 6, 12, and 22 months postoperatively.

Results

A total of 1 week after the operation, the patient's low back pain was significantly improved without lower limb pain, numbness, and weakness. The VAS score was 3 at the time of discharge, and X-ray film showed a kyphosis Cobb angle of 20° (Fig. 2). VAS scores at 3, 6, 12, and 22 months of follow-up were 2 points, 1 point, 1 point, and

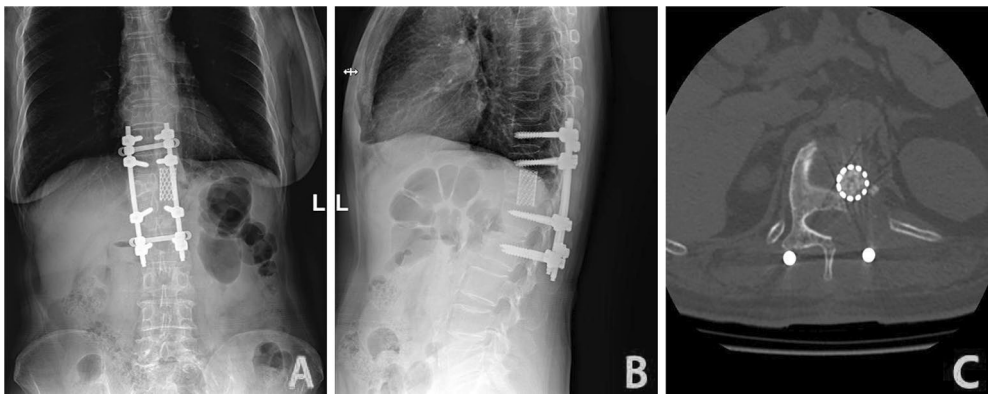

Fig. 2 Radiological findings 2 weeks after surgery. X-ray (**A**, **B**) showed that the kyphosis Cobb angle was 20°. **C** Computed tomography results showed that spinous process and the structure of the vertebral body were preserved, the spinal canal was fully decompressed, and the titanium cage was in good position

1 point, respectively. ODI scores at each time point were 22.22% (10/45), 11.11% (5/45), 11.11% (5/45), and 11.11% (5/45), respectively. X-ray examination showed that the internal fixation position was good 2 weeks and 22 weeks after surgery. There were no loosening, displacement, broken nails, and broken rods. The kyphosis Cobb angle was maintained at 20° 2 weeks after the operation, and there was no obvious change even at the 22-month follow-up visit (Fig. 3).

Discussion

In the current study, we reported a novel surgical method to treat Kümmell's disease, which involved the posterior semi-VCR with the preservation of the posterior ligament complex. We have observed the clinical benefits from this procedure for up to 22 months. Maintaining a 20° kyphosis Cobb angle and keeping the titanium cage in a good position during follow-up were the two major significant advantages of this surgery.

Currently, there is no uniform standard approach to treat Kümmell's disease, and the efficacy of several therapies described to date remain controversial. Conservative treatment modalities of Kümmell's disease include bed rest and analgesic medication, but these methods are not ideal [10]. Elderly patients usually cannot tolerate long-term bed rest, and bed rest may not be able to reverse bone necrosis.

Kümmell's disease often occurs in geriatric patients with osteoporosis, diabetes, and other complications. Therefore, percutaneous kyphoplasty (PKP) or percutaneous vertebroplasty (PVP) [11] as a minimally invasive operation has been commonly used to treat this disease, and has achieved good short-term clinical results [8, 10, 12–14]. However, there is still a lack of reports on the long-term clinical benefits with this surgical approach. Yi *et al.* [15] observed that PKP/PVP had a high incidence of bone cement leakage, so it is not an ideal surgical method. It has also been reported that the correction of kyphosis deformity after PKP cannot be well maintained, and the VAS score gradually increases [9]. In addition, bone cement displacement can lead to surgery failure [16]. Thus, PKP/PVP can only provide temporary benefits in supporting and stabilizing the spine, but cannot provide long-term spine stability similar to bone healing. Even if combined with posterior pedicle screw fixation [17], the stability and timeliness of fixation provided by PKP/PVP for osteoporosis patients are debatable. Nevertheless, PKP/PVP can be an effective procedure for elderly patients with poor general conditions, intolerance of surgery, and short life expectancy. During the limited survival period, the pain of these patients was relieved, and the quality of life was improved.

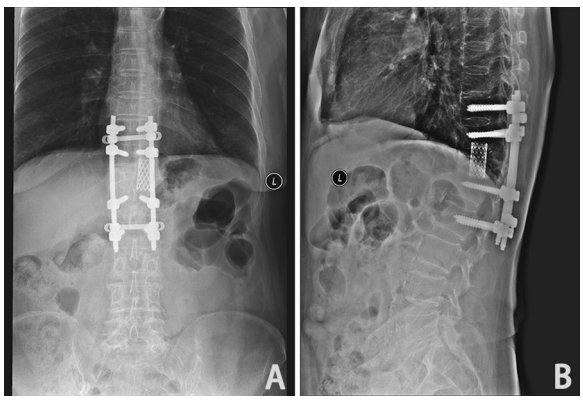

Fig. 3 Postoperative radiological findings. A total of 22 months after operation, anterior (**A**) and lateral (**B**) X-rays showed that there was no loosening of vertebral body fixation, the titanium cage was in good position, and the kyphotic Cobb angle was 20°. No obvious changes were found compared with previous X-rays

Kümmell's disease is characterized by nonunion, osteonecrosis, and formation of pseudarthrosis after an osteoporotic fracture, followed by kyphosis, spinal canal stenosis, and spinal cord compression [6]. Hence, the core components of this disease treatment should focus on: (a) spinal fusion to rebuild the long-term stability of the spine, (b) spinal kyphosis correction, and (c) relieving spinal cord compression. For patients who are healthy, are relatively young, have a long life expectancy, or have spinal canal stenosis and spinal cord compression, open surgery is the appropriate choice.

Open anterior and posterior surgery have been proven to be effective in the treatment of Kümmell's disease. Anterior surgery can directly remove the diseased vertebral body, decompress, and support bone graft. However, anterior surgery often invades the diaphragm, interferes with lung function, and causes significant surgical trauma. Posterior surgery can also remove the anterior vertebral body and intervertebral disc, and achieve 360° decompression of spinal cord and nerves, with less associated trauma. At the same time, long-segment fixation can be adopted. The loss of the kyphosis correction angle is smaller compared with anterior surgery. Hence, depending on the general conditions of patients and related osteoporosis, posterior surgery may be a better choice [8].

Posterior surgery involves extensive removal of the posterior structures of the spine, including lamina, facet joints, spinous processes, the interspinous ligament, and ligamentum flavum. However, these structures constitute a stable structure behind the spine and play an important role in maintaining the balance of the spinal sagittal plane [18, 19]. Destruction of these structures will inevitably result in the instability of the spine. Moreover, if there is associated osteoporosis, the fixation provided by

implants is not strong enough. Removal of the posterior spinal structures often leads to the loss of postoperative kyphosis correction angle [20, 21].

In this case, the posterior approach was used to remove the hemilateral lamina, articular processes, transverse process, pedicle of vertebral arch, semi-vertebral body, and adjacent intervertebral discs of the diseased vertebra. In the meantime, the integrity of the contralateral lamina, articular process joints, and ligamentum flavum, especially the posterior ligament complex composed of the spinous process and interspinous and supraspinous ligaments, was preserved. This procedure minimized surgical trauma, and the spinal canal was fully decompressed. The stability of the spine was retained, especially in the sagittal plane. The combination of pedicle screw fixation and bone grafting support between anterior vertebral bodies brought the following benefits: (a) the stability of the sagittal plane of the spine could be fully reconstructed, (b) reliable support was provided before the spine reached bony fusion, and (c) the loss of sagittal correction angle could be avoided. The patient was followed up with for 22 months. Lumbago was significantly relieved, and kyphosis correction angle was not lost, thus achieving good surgical results.

Conclusion

The posterior semi-VCR that preserved the posterior ligament complex could completely decompress the spinal canal and reduce the iatrogenic destruction of spinal stability. This approach might be helpful for the reconstruction of spinal stability and the maintenance of postoperative stability. Thus, we reported an effective surgical treatment for Kümmell's disease, which might be a new alternative procedure for treating this disease in the future.

Abbreviations

VCR	Vertebral column resection
IVC	Intravertebral cleft
VAS	Visual analog scale
ODI	Oswestry Disability Index
CT	Computed tomography
MRI	Magnetic resonance imaging
PKP	Percutaneous kyphoplasty
PVP	Percutaneous vertebroplasty

Acknowledgements

Not applicable.

Author contributions

TW and ZL designed the operation; YT, ZL, TW, LH, and GY performed the operation; LH analyzed data; YT and TW wrote the manuscript; and ZL made manuscript revisions. All authors reviewed the results and approved the final version of the manuscript.

Funding

None.

Availability of data and materials

Not applicable.

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of the Third Central Hospital of Tianjin. All procedures performed in this study involving human participants followed the relevant guidelines and regulations of the Declaration of Helsinki.

Consent for publication

Written informed consent was obtained from the patient for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Competing interests

The authors declare no competing interests.

Received: 5 June 2024 Accepted: 26 December 2024
Published online: 06 February 2025

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