Postoperative aseptic osteonecrosis in a case of kyphoplasty

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Abstract Aseptic osteonecrosis appears to be an infrequent adverse event after kyphoplasty which has not previously been reported. In the following, we present the case of a 73-year-old female who sustained a compression fracture of the first lumbar vertebra (L1) in a motor vehicle accident. The fracture was treated by kyphoplasty using PMMA cement. Three weeks after hospital discharge the patient was presented with increasing back pain. In imaging, dislocation of the PMMA cement could be shown combined with a total collapse of the L1 vertebra. The resulting significant kyphosis was first reduced by dorsal transpedicular (Th12–L2) internal fixation and stabilized by an anterior cage after total removal of the cement plumb and some remaining bone of the L1 vertebra. Bacterial as well as histological examination of the cement and bone led to the diagnosis of aseptic osteonecrosis. Different underlying events could be discussed. We think it most likely that the osteoporotic bone was unable to interface sufficiently with the PMMA cement and, therefore, disintegrated under loading. Furthermore, the volume of injected cement could have significantly compromised the blood supply within the bone.

Keywords Kyphoplasty · Adverse event · Aseptic osteonecrosis · Lumbar spine

Introduction

Over the last few years, kyphoplasty has become a reliable minimal invasive method in the treatment of osteoporotic vertebra compression fractures in elderly patients. The percutaneous instrumentation as well as the immediate pain relief and stable fixation of the fractured vertebra have placed this procedure above established methods of fracture stabilization such as an internal fixateur. Particularly older patients and those with comorbidities benefit from this method, which, in general, is considered to have a very low risk for complication. In the first step of this procedure, the fractured vertebra is accessed via a transpedicular inserted tube. The vertebra is decompressed using a balloon catheter leaving two cavities of up to 3 cc each which are then filled with polymethylmetacrylat (PMMA), again injected via a transpedicular tube. The risk of cement penetration outside the bone, a known complication of vertebroplasty, is minimized using the balloon inflation technique because the cement can be injected at a considerably lower pressure.

Case report

Here, we present the case of a 73-year-old female patient who sustained a compression fracture of the first lumbar vertebra in a motor vehicle accident. According to the MAGERL classification, the fracture was diagnosed by computer tomography as a compression fracture type A1.2. Fortunately, there was no evidence of neurological deficit due to the fracture. After consideration of the patient's general condition, her complaints as well as the injury itself, kyphoplasty was chosen to stabilize the fracture (Fig. 1a, b). Using percutaneous transpedicular balloon

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Fig. 1 Intraoperative imaging after kyphoplasty in L1, a.p. and lateral view

insertion and inflation, a significant decompression of the L1 vertebra was achieved and fixed by injection of approximately 4.5 cc of PMMA cement on either side. Postoperative X-rays revealed good augmentation of the fracture site without any extravertebral cement (Fig. 2a, b). The patient was recovered from surgery without any complication but was readmitted due to increasing back pain 3 weeks later. X-rays as well as computer tomography and magnetic resonance imaging (MRI) of the lumbar

spine provided evidence of anterior dislocation of the cement plumb. Initially, a local bacterial infection was suspected as the bone structure of L1 has become heterogeneous at that time. Computer tomography guided puncture of the psoas muscle compartment and the area of L1 did not reveal bacterial contamination, furthermore, laboratory parameters gave no evidence for infection at any time. Nevertheless, antibiotic medication was initiated and this indeed reduced pain as reported by the patient.

Fig. 2 X-rays 3 weeks after kyphoplasty lateral view (two images and MRI), showing anterior dislocation of the PMMA cement plumb

Fig. 3 Dorso-ventral spondylodesis by the combination of internal fixateur and an intervertebral cage, a.p. and lateral view

The L1 vertebra collapsed further as observed in follow-up X-ray images so that a total removal of the cement and remainder of the body of L1 was performed 6 weeks later via a left thoracotomy. After removal of the cement, the patient was put in prone position to implant an internal fixateur from Th12 to L2 thus reducing kyphosis at segment L1. The L1 vertebra itself was finally replaced by an expanded cage. A postoperative computer tomography showed the cage in correct position. Unfortunately, the cage broke into the body of L2 after mobilization of the patient and the cage subsequently dislocated. A rethoracotomy was performed to reattain the correct cage position. This time also the osteoporotic bone of Th12 and L2 was resected carefully to place the cage directly between the pins of the internal fixateur (Fig. 3a, b). Now the patient recovered totally and all implants remained in their original position. As all bacterial examinations remained negative this complication after kyphoplasty was considered to be aseptic osteonecrosis in which osteoporosis may also have played a role.

Discussion

In the elderly patient, a trauma related spine fracture as well as a collapsing vertebra due to osteoporosis may result in persistent back pain and other related complaints. Vertebral fracture and osteoporosis frequently have a significant impact on the patient's physical activity and may

reduce quality of life. Fractures of the spinal column in the elderly may result in a higher mortality rate [2, 3, 10, 13]. Kyphoplasty in these patients may reduce pain significantly and, thus, increase their physical capability and quality of life [9, 11, 16]. For augmentation of the fractured vertebra, PMMA cement is used in most cases because of long term good experience with this material in arthroplasty where PMMA has proven its ease of handling and high primary mechanical stability. Despite some well-known disadvantages of PMMA cement such as cytotoxicity [5] there have been only a few reported complications after kyphoplasty using PMMA cement. In a study of 2,194 cases the mean complication rate per fracture was 0.2% [8]. Others have reported an incidence of 2.5% of symptomatic complications such as a missed entry point leading to cement dislocation and consequent neurological compromise [7, 16].

In the case reported here, the L1 compression fracture presented a good indication for kyphoplasty which was performed correctly. The following is a brief discussion of the possible causes of the above adverse event with secondary dislocation of the plumb.

One reason may be the amount of injected cement. According to Liebschner [12], 3.5 cc are equal to 15% of the vertebra total volume and should restore the primary mechanical stability of the vertebral body. Cadaver studies have attempted to define the amount of cement needed to stabilize a thoracic or lumbar vertebra, which was stated to be 4 cc and up to 6 cc, respectively [1, 4]. In all cases, the amount directly correlated with the mechanical stability achieved. Although the injected amount of cement has not yet been reported to have any negative effect one could speculate that the amount used here was insufficient to establish a stable interface between cement and the compressed cancellous bone. Considering the total volume of 9.0 cc used here, which certainly is more than enough with respect to previous reports, one could assume that the body of L1 was not just decompressed but possibly even distracted, which could result in an insufficient bone cement contact interface. The optimal time of cement insertion with regard to the polymerisation seems to be important as well as the cement viscosity which will affect the distribution and integration of cement within the cancellous bone structure. In each scenario, a micro-instability within the fracture site would be left which may have caused a secondary dislocation and vertebra collapse. Wilke et al. [15] have recently investigated losses of height after cyclic loading in a model of vertebro/kyphoplasty as well as in non-augmented cases and found height-loss in all cases.

Another reason for the observed complication in this case may well be due to an exothermic reaction during the time of cement polymerisation. Similar types of reactions to thermal influence have been reported in adverse events

involving neurological deficiencies [6]. Togawa et al. [14] reported that only very few foci of osseous necrosis could be found in vertebral bodies after vertebro/kyphoplasty. A change of the cancellous bone structure due to an increasing temperature during kyphoplasty has not yet been reported. Nevertheless, it is not unlikely that cement polymerisation has a negative impact on bone vitality especially in osteoporotic bone thus leading possibly to local aseptic osteonecrosis in a worst case scenario.

Any type of allergic reaction towards the cement used was ruled out by specific tests after surgery. Additionally, no evidence of bacterial or other infect related loosening of the cement could be found.

Conclusion

In elderly patients suffering from osteoporotic or trauma related vertebral compression fractures, kyphoplasty has become one of the first choices for fracture stabilization. The minimally invasive surgical technique as well as the immediate pain relief achieved by fracture stabilization has been highly appreciated by many of the patients treated so far. The most common adverse event is cement dislocation which can be avoided by stepwise instead of bolus cement insertion. According to the case reported here, it seems that besides the method of cement insertion also its viscosity at the time of insertion and the amount of cement are important to establish a stable cement to bone interface. The phrase “more is better than less” does not seem to be true for kyphoplasty. Once kyphoplasty fails, any salvage procedure should include a dorsoventral fixation which totally bridges the injured segment of the spine.

Conflict of interest statement None of the authors has any potential conflict of interest.

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