Introduction

Lumbar burst fractures are common spinal injuries that involve severe instability and intracanal bony fragments, which lead to increased risks of neurological complications and kyphosis. For highly unstable lumbar burst fractures, anterior decompression and reconstruction have been developed with a variety of anterior implant systems that have achieved satisfactory results [1-3].

Currently, numerous reports have cited high rates of radiographic and histopathologic fusion and good clinical outcomes in lumbar reconstruction and fusions utilizing titanium mesh cage (TMC) placement and pedicle screw fixation [2, 4, 5]. Good radiographic fusion has been reported to range from 47 to 100% of patients treated with TMC interbody devices [2, 4].

Indeed, TMC-related complications are relatively uncommon, with cage subsidence being the most frequent complication and device fracture being a particularly unusual postoperative complication [6, 7]. To the author’s knowledge, only three cases of TMC fracture have been previously reported in the literature [2, 8, 9].

Here, we present a patient who underwent an anterior L4 corpectomy with TMC placement and posterior transpedicle screw fixation caused by L4 burst fracture and who later developed a fracture of the lumbar TMC. This report details the presentation and management of this rare complication and discusses the biomechanics underlying this rare instrumentation failure.

Case presentation

A 42-year-old female (height, 161 cm tall; weight, 54 kg) was admitted to our hospital...
Titanium mesh cage fracture

Initial imaging revealed a L4 burst fracture with 60% canal compromise, 50% loss of vertebral body height, a large anteriorly displaced fragment consisting of 50% of the vertebral body depth, and a facet fracture (Figure 1). The patient first underwent stabilization from L3 through L5, with pedicle screw instrumentation and a posterior-lateral fusion. Then, she underwent a retroperitoneal approach, L4 corpectomy, decompression of the thecal sac, ventral reconstruction with a TMC (DEPUY SPINE, Inc. Raynham, MA, US), and fusion with local autograft harvested from the corpectomy. The cage was cut to the appropriate size, reinforced with rings at either end, and packed with an autologous bone graft. Postoperative X-rays demonstrated that the instrumentation was in good position, with some degree of lumbar lordosis (Figure 2).

At her first- and second-year follow-ups, the patient’s X-rays demonstrated early fusion with bone bridging from L3 through L5 anterior to the cage. Her sagittal balance remained unchanged from its early postoperative state. The X-rays showed little cage subsidence (Figure 3). The patient did not complain of back or leg pain.

However, the patient experienced acute onset of a crepitating noise in her back 42 months after surgery. Radiographs obtained at that time demonstrated TMC fracture and collapse (Figure 4). Although early evidence of anterior fusion was present, the patient may have had posterior pseudarthrosis, with cage subsidence and the subsequent stress and failure of the anterior instrumentation.

Various options were discussed with the patient. First, the patient was placed on bed rest.
Then, the patient elected to undergo a two-stage revision: a transperitoneal removal of the fractured cage and reconstruction with an expandable titanium cage and autograft fusion, followed by exploration of the posterior instrumentation and arthrodesis. However, the patient refused the operation and asked for conservative treatment. After one week of bed rest, the patient was discharged. At the 3-month follow-up, she reported doing well, with no complaints of back pain or leg pain.

Discussion

The introduction of the titanium mesh cage (TMC) in spinal surgery has led to a variety of applications. Replacement and reinforcement of the anterior column represent the classic use of TMCs in the whole spine in patients with burst fracture, infection, tumor metastases, or tuberculosis [10]. TMCs, with variable diameters and heights, can be filled with autogenous cancellous bone graft and present many advantages when they are used for anterior column support, including immediate anterior stabilization, re-approximation of the intervertebral disc height and obviation of bone graft harvesting from outside the surgical site [11-14]. Additionally, TMCs have been shown to support good sagittal alignment with good evidence of bony fusion [15]. TMCs filled with the autogenous cancellous bone can also shorten the operation time and reduce the risk of complications in the donor site [16].
Multiple studies [17-23] have demonstrated the effectiveness of using TMCs for anterior reconstruction and interbody fusions because of their good mechanical behaviors and satisfactory clinical outcomes [14, 15]. However, stress shielding, postoperative radiographic interference, and a high subsidence rate, pseudarthrosis, and loosening of TMCs are still of great concern, which hinders the likelihood of this cage becoming an ideal reconstructing device [24].

Subsidence may result in instrumentation failure, secondary kyphosis, instability, pseudarthrosis, and the recurrence of pain and/or neurological symptoms that potentially require reoperation [24-27]. The extent of subsidence following cage placement remains unclear, and the subsidence rates reported in recent studies have varied considerably, ranging from 10% to 80% [27]. The risk factors related to the development of subsidence of the cages vary, including not only intraoperative end-plate preparation and osteoporosis but also the cage material and cage shape [23, 28-30]. However, some studies have shown that the inevitable subsidence of the sharp edges of the cage into the adjacent endplates acts against dislocation. Such added support may actually help reduce instrumentation failure after anterior corpectomies [18, 31].

Roberston et al [8] reported a patient treated with single-level thoracolumbar corpectomy with TMC reconstruction and anterior plate. There was evidence of cage fracture in one case when a 4-year follow-up radiograph was taken by chance. There was no evidence of subsidence, kyphosis, or recurrence of pseudarthrosis in this case. The single case of cage fracture raises concerns that this problem, although not clinically symptomatic and not visualized in the other longer-follow-up patients in this series, may still be troublesome. This issue occurred with the thinner mesh of the Harms cage and was an incomplete failure, without evidence of structural instability. This case may have parallels with other instances of implant failure associated with progress to fusion. Dvorak et al [2] reported a 28-year-old male patient with L1 burst fracture who was treated by anterior L1 vertebrectomy with T12-L2 TMCs reconstruction and anterior Z-plate stabilization. Then, the patient experienced cage fracture and lost alignment though there was a significant amount of anterior bone graft, but this patient ultimately had a good clinical outcome with no treatment. Klezl et al [9] reported a 20-year-old male patient who underwent an anterior L4 corpectomy with Harms cage placement and posterior L3 through L5 with pedicle screw instrumentation. This patient later developed a fracture of the TMC at the 13-month follow-up. The patient underwent revision surgery: a transperitoneal removal of the fractured cage and reconstruction with an expandable titanium cage and autograft fusion, followed by posterior instrumentation and arthrodesis. During the anterior approach, the authors noted that the cage had fractured, and two loose pieces of the cage were easily extracted. The remainder of the cage had incorporated into the endplates above and below. At the 6-month follow-up, he recovered from this operation uneventfully, with no evidence of pseudarthrosis or instrumentation failure.

Interestingly, two previous cases of cage fracture in the lumbar spine also showed good radiological fusion around the cages, despite obvious instrumentation failure, which indicates that such fractures may not be related to instability in the overall fusion but to part of the fusion process itself. In both cases, the patients were asymptomatic [2, 8], and no treatments were needed. However, Klezl et al [9] performed a revision surgery with an expandable titanium cage, and the patient experienced a good outcome. Although expandable cages offer several advantages over static cages, there is clinical concern [32] and biomechanical evidence [33] that expandable cages are associated with a greater risk of subsidence; in our study, expandable cages were demonstrated to be independently associated with higher rates and odds for subsidence.

One theory suggests that this failure is caused by the small footprint and surface area of contact of the TMCs, which increase the resistance to the initial anterior dislodgement as well as the initial stability but may also increase the incidence of subsidence and failure by cutting through the endplate [34]. Although end-caps for mesh cages increase the surface area of contact between the cage and the vertebral body endplate, they decrease the contact surface area with the bone graft, which might affect the fusion rate [34]. Histological reviews of bone from within the Harms cages in two dif-
Different series found necrotic bone that was identified within the cages alongside viable tissue, indicating that fusion was still incomplete after 2 postoperative years [5, 35, 36]. Such histological evidence may explain TMC fracture. The insertion technique may also be questioned. Gentle tapping on the cage could have inflicted minor damage to the cage structure, although in this case, the cage placement was performed by impacting it on the sides with the reinforcing rings [9]. The size of the patient, as well as his high level of activity, should also be considered because it undoubtedly contributed to the fracture of the Harms TMC [9].

Conclusion

This case demonstrates the anterior fusion in this case was not able to heal quickly enough to relieve the significant stress on the cage, and it finally failed. TMC fracture is a rare complication of spinal surgery. The real incidence of this event is unknown because TMC imaging is usually performed in symptomatic patients, and asymptomatic TMC fracture may occur more often than expected. Although these patients generally showed favorable outcomes, TMC fracture is a potentially threatening complication that must be considered in patients after surgery. In these situations, X-Ray or CT should be performed, and if a diagnosis is confirmed, close observation or surgical treatment should be considered to improve patient outcomes. Although cage placement, instability, subsidence, and both stress shielding and necrotic bone in the cage appear to play key roles in the pathogenesis of this rare complication, the exact mechanism of this condition remains undetermined.

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Disclosure of conflict of interest

None.

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