Int J Clin Exp Med 2015;8(4):5559-5564
www.ijcem.com /ISSN:1940-5901/IJCEM0006347

Original Article

Titanium mesh cage fracture after lumbar reconstruction surgery: a case report and literature review

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Received January 26, 2015; Accepted March 26, 2015; Epub April 15, 2015; Published April 30, 2015

Abstract: Titanium mesh cage (TMC) was introduced recently to provide anterior structural support and interbody fusion without the need to harvest bone from the iliac crest. Because of its good mechanical behavior and satisfactory clinical outcomes, TMC is commonly used for lumbar burst fractures. Here, we present a female patient who underwent a posterior-anterior L4 corpectomy with TMC placement and developed a cage fracture after 42 months. The patient refused the revision surgery and asked for conservative treatment. At the 3-month follow-up, she reported doing well, with no complaints of back pain or leg pain. There were three cases of TMC fracture have been previously reported in the literature. Only one patient performed a revision surgery with an expandable titanium cage, and all this three patients experienced a good outcome during the follow-up period. TMC fracture is a rare complication of spinal surgery. 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.

Keywords: Lumbar spine, titanium mesh cage, fracture, review

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

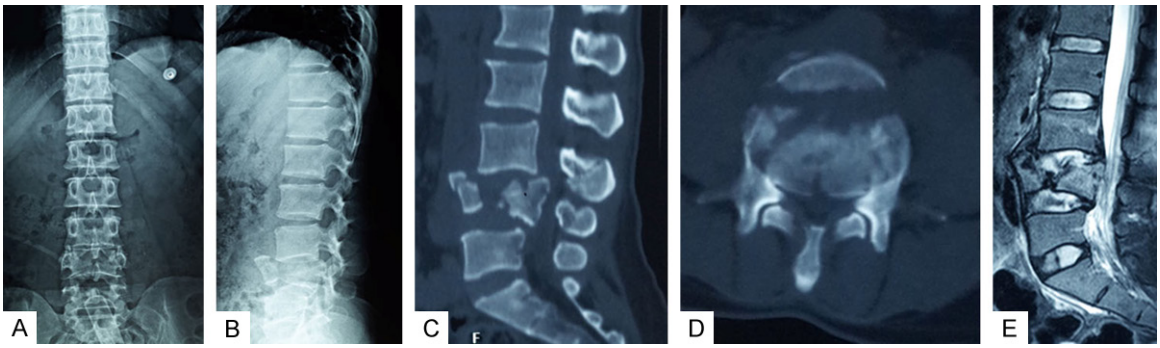

Figure 1. Preoperative X-rays (A, B), mid-sagittal CT images (C), axial CT images (D) and mid-sagittal MRI (E) of the lumbar spine revealed a L4 burst fracture with 60% canal compromise, 50% loss of vertebral body height, a large anteriorly displaced fragment consisting of 50% of the vertebral body depth, and a facet fracture.

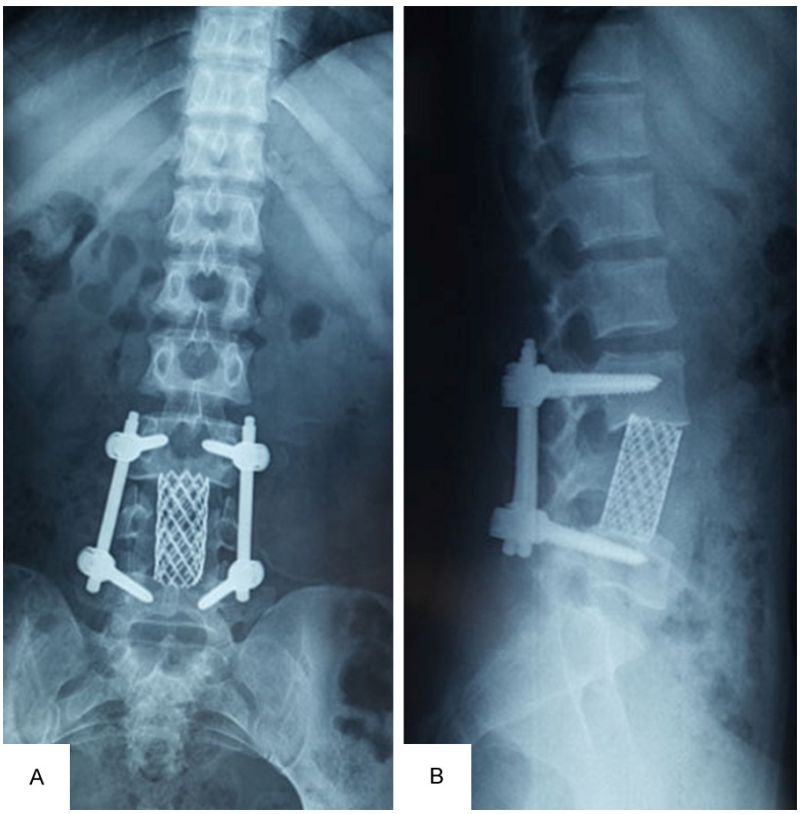

Figure 2. Postoperative X-rays (A, B) demonstrate that the instrumentation was in good position, with some degree of lumbar lordosis.

with high falling injury. 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.

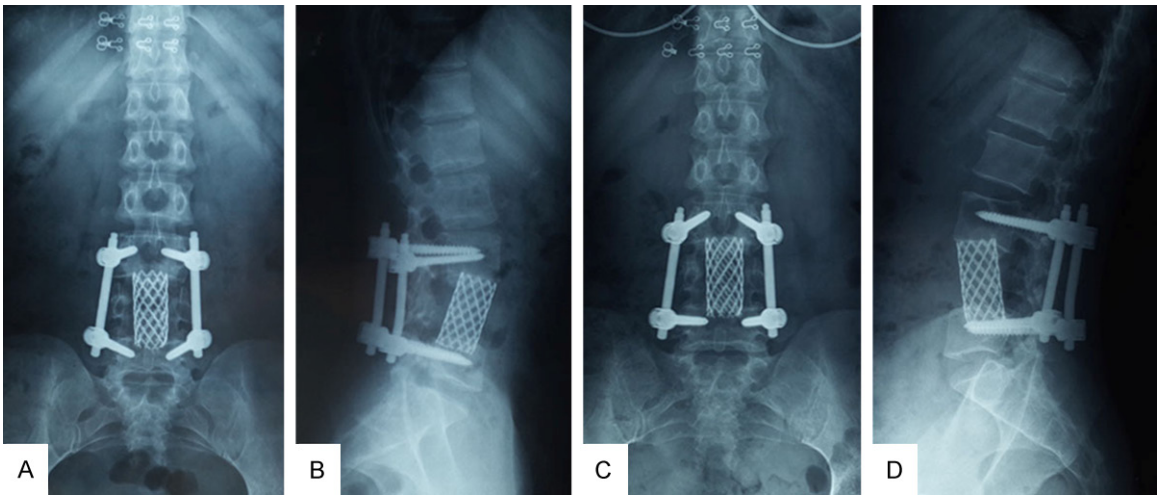

Figure 3. At her first-year (A, B) and second-year (C, D) follow-ups, the X-rays showed little cage subsidence.

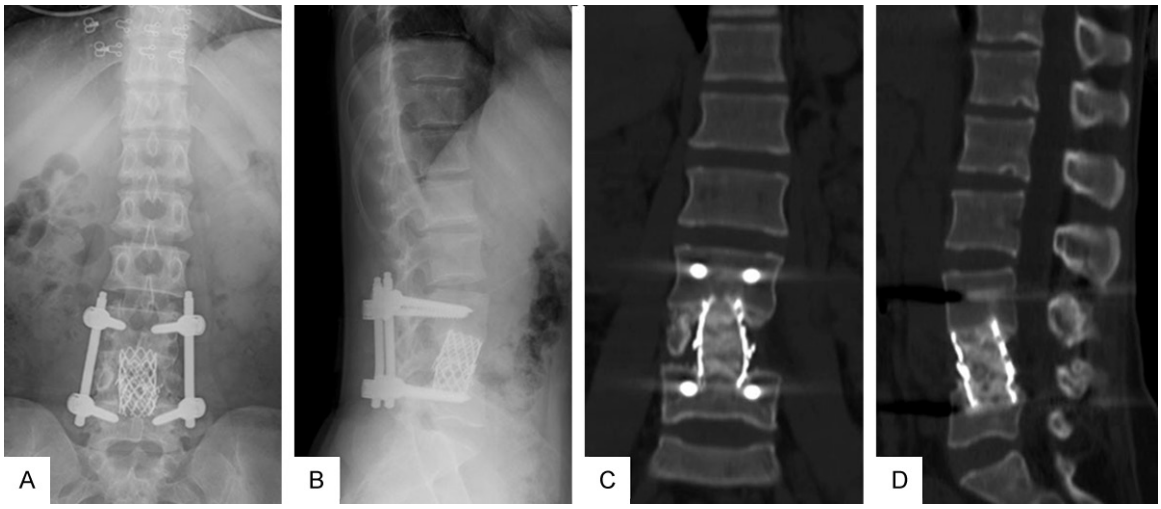

Figure 4. X-rays (A, B), mid-coronary (C) and mid-sagittal CT images (D) demonstrate TMC fracture and collapse.

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-

ferent 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 considered in any patient after spine 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.

Acknowledgements

The study was supported by Program for Young Excellent Talents in Tongji University and Key Discipline Construction Project of Pudong Health Bureau of Shanghai, Tongji University Outstanding Youth Training and Action Plan Foundation (2013KJ075) and Pudong New District Health System Key Discipline Construction Foundation (PWZx2014-02).

Disclosure of conflict of interest

None.

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References

[1] Dai LY, Jiang LS and Jiang SD. Anterior-only stabilization using plating with bone structural autograft versus titanium mesh cages for two- or three-column thoracolumbar burst fractures: a prospective randomized study. Spine (Phila Pa 1976) 2009; 34: 1429-1435.

[2] Dvorak MF, Kwon BK, Fisher CG, Eiserloh HL, 3rd, Boyd M and Wing PC. Effectiveness of titanium mesh cylindrical cages in anterior column reconstruction after thoracic and lumbar vertebral body resection. Spine (Phila Pa 1976) 2003; 28: 902-908.

[3] Sasso RC, Best NM, Reilly TM and McGuire RA Jr. Anterior-only stabilization of three-column thoracolumbar injuries. J Spinal Disord Tech 2005; 18 Suppl: S7-14.

[4] Jacobs WC, Vreeling A and De Kleuver M. Fusion for low-grade adult isthmic spondylolisthesis: a systematic review of the literature. Eur Spine J 2006; 15: 391-402.

[5] Togawa D, Bauer TW, Lieberman IH, Lowery GL and Takikawa S. Histology of tissues within retrieved human titanium mesh cages. Spine (Phila Pa 1976) 2003; 28: 246-253; discussion 254.

[6] Chen L, Yang H and Tang T. Cage migration in spondylolisthesis treated with posterior lumbar interbody fusion using BAK cages. Spine (Phila Pa 1976) 2005; 30: 2171-2175.

[7] Eck KR, Lenke LG, Bridwell KH, Gilula LA, Lashgari CJ and Riew KD. Radiographic assessment of anterior titanium mesh cages. J Spinal Disord 2000; 13: 501-509; discussion 510.

[8] Robertson PA, Rawlinson HJ and Hadlow AT. Radiologic stability of titanium mesh cages for anterior spinal reconstruction following thoracolumbar corpectomy. J Spinal Disord Tech 2004; 17: 44-52.

[9] Klezl Z, Bagley CA, Bookland MJ, Wolinsky JP, Rezek Z and Gokaslan ZL. Harms titanium mesh cage fracture. Eur Spine J 2007; 16 Suppl 3: 306-310.

[10] Wang B, Lv G, Liu W and Cheng I. Anterior radical debridement and reconstruction using titanium mesh cage for the surgical treatment of thoracic and thoracolumbar spinal tuberculosis: minimium five-year follow-up. Turk Neurosurg 2011; 21: 575-581.

[11] Hwang SL, Lee KS, Su YF, Kuo TH, Lieu AS, Lin CL, Howng SL and Hwang YF. Anterior corpectomy with iliac bone fusion or discectomy with interbody titanium cage fusion for multilevel cervical degenerated disc disease. J Spinal Disord Tech 2007; 20: 565-570.

[12] Ikenaga M, Shikata J and Tanaka C. Long-term results over 10 years of anterior corpectomy and fusion for multilevel cervical myelopathy. Spine (Phila Pa 1976) 2006; 31: 1568-1574.
[13] Kanayama M, Hashimoto T, Shigenobu K, Oha F, Ishida T and Yamane S. Pitfalls of anterior cervical fusion using titanium mesh and local autograft. J Spinal Disord Tech 2003; 16: 513-518.
[14] Majd ME, Vadhva M and Holt RT. Anterior cervical reconstruction using titanium cages with anterior plating. Spine (Phila Pa 1976) 1999; 24: 1604-1610.
[15] Eck KR, Bridwell KH, Ungacta FF, Lapp MA, Lenke LG and Riew KD. Analysis of titanium mesh cages in adults with minimum two-year follow-up. Spine (Phila Pa 1976) 2000; 25: 2407-2415.
[16] Kang CN, Cho JL, Suh SP, Choi YH, Kang JS and Kim YS. Anterior operation for unstable thoracolumbar and lumbar burst fractures: tricortical autogenous iliac bone versus titanium mesh cage. J Spinal Disord Tech 2013; 26: E265-271.
[17] Brodke DS, Klimo P Jr, Bachus KN, Braun JT and Dailey AT. Anterior cervical fixation: analysis of load-sharing and stability with use of static and dynamic plates. J Bone Joint Surg Am 2006; 88: 1566-1573.
[18] Das K, Couldwell WT, Sava G and Taddonio RF. Use of cylindrical titanium mesh and locking plates in anterior cervical fusion. Technical note. J Neurosurg 2001; 94: 174-178.
[19] Fayazi AH, Ludwig SC, Dabbah M, Bryan Butler R and Gelb DE. Preliminary results of staged anterior debridement and reconstruction using titanium mesh cages in the treatment of thoracolumbar vertebral osteomyelitis. Spine J 2004; 4: 388-395.
[20] Dorai Z, Morgan H and Coimbra C. Titanium cage reconstruction after cervical corpectomy. J Neurosurg 2003; 99: 3-7.
[21] Nakase H, Park YS, Kimura H, Sakaki T and Morimoto T. Complications and long-term follow-up results in titanium mesh cage reconstruction after cervical corpectomy. J Spinal Disord Tech 2006; 19: 353-357.
[22] Castellvi AE, Castellvi A and Clabeaux DH. Corpectomy with titanium cage reconstruction in the cervical spine. J Clin Neurosci 2012; 19: 517-521.
[23] Yang X, Chen Q, Liu L, Song Y, Kong Q, Zeng J, Xue Y and Ren C. Comparison of anterior cervical fusion by titanium mesh cage versus nano-hydroxyapatite/polyamide cage following single-level corpectomy. Int Orthop 2013; 37: 2421-2427.
[24] Chen Y, Chen D, Guo Y, Wang X, Lu X, He Z and Yuan W. Subsidence of titanium mesh cage: a study based on 300 cases. J Spinal Disord Tech 2008; 21: 489-492.
[25] Gercek E, Arlet V, Delisle J and Marchesi D. Subsidence of stand-alone cervical cages in anterior interbody fusion: warning. Eur Spine J 2003; 12: 513-516.
[26] Lim TH, Kwon H, Jeon CH, Kim JG, Sokolowski M, Natarajan R, An HS and Andersson GB. Effect of endplate conditions and bone mineral density on the compressive strength of the graft-endplate interface in anterior cervical spine fusion. Spine (Phila Pa 1976) 2001; 26: 951-956.
[27] Lau D, Song Y, Guan Z, La Marca F and Park P. Radiological outcomes of static vs expandable titanium cages after corpectomy: a retrospective cohort analysis of subsidence. Neurosurgery 2013; 72: 529-539.
[28] Barsa P and Suchomel P. Factors affecting sagittal malalignment due to cage subsidence in standalone cage assisted anterior cervical fusion. Eur Spine J 2007; 16: 1395-1400.
[29] Niu CC, Liao JC, Chen WJ and Chen LH. Outcomes of interbody fusion cages used in 1 and 2-levels anterior cervical discectomy and fusion: titanium cages versus polyetheretherketone (PEEK) cages. J Spinal Disord Tech 2010; 23: 310-316.
[30] Ordway NR, Rim BC, Tan R, Hickman R and Fayyazi AH. Anterior cervical interbody constructs: effect of a repetitive compressive force on the endplate. J Orthop Res 2012; 30: 587-592.
[31] Lee SW, Lim TH, You JW and An HS. Biomechanical effect of anterior grafting devices on the rotational stability of spinal constructs. J Spinal Disord 2000; 13: 150-155.
[32] Yang JJ, Yu CH, Chang BS, Yeom JS, Lee JH and Lee CK. Subsidence and nonunion after anterior cervical interbody fusion using a stand-alone polyetheretherketone (PEEK) cage. Clin Orthop Surg 2011; 3: 16-23.
[33] Truumees E, Demetropoulos CK, Yang KH and Herkowitz HN. Effects of disc height and distractive forces on graft compression in an anterior cervical corpectomy model. Spine (Phila Pa 1976) 2008; 33: 1438-1441.
[34] Hee HT, Majd ME, Holt RT, Whitecloud TS 3rd and Pienkowski D. Complications of multilevel cervical corpectomies and reconstruction with titanium cages and anterior plating. J Spinal Disord Tech 2003; 16: 1-8.
[35] Togawa D, Bauer TW, Brantigan JW and Lowery GL. Bone graft incorporation in radiographically successful human intervertebral body fusion cages. Spine (Phila Pa 1976) 2001; 26: 2744-2750.
[36] Epari DR, Kandziora F and Duda GN. Stress shielding in box and cylinder cervical interbody fusion cage designs. Spine (Phila Pa 1976) 2005; 30: 908-914.