

## Failure of a polyether-ether-ketone expandable interbody cage following transforaminal lumbar interbody fusion

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### Abstract

**Purpose** Expandable cages are a more recent option for maintaining or restoring disc height and segmental lordosis with transforaminal lumbar interbody fusion (TLIF). Complications associated with expandable cages have not yet been widely reported. We report a case of postoperative failure of a polyether-ether-ketone (PEEK) expandable interbody device used during TLIF.

**Methods** A 50-year-old man presented with severe back and right leg pain after undergoing L4–5 and L5–S1 TLIFs with expandable cages and L3–S1 posterior instrumented fusion. Imaging showed retropulsion of a portion of the interbody cage into the spinal canal causing nerve compression. Displacement occurred in a delayed manner. In addition, pseudoarthrosis was present.

**Results** The patient underwent re-exploration with removal of the retropulsed wafer and redo fusion.

**Conclusions** Expandable cages are a recent innovation; as such, efficacy and complication data are limited. As with any new device, there exists potential for mechanical failure, as occurred in the case presented.

**Keywords** TLIF · PEEK · Expandable interbody cage · Retropulsion · Complication

### Introduction

Transforaminal lumbar interbody fusion (TLIF) is now a popular option to achieve circumferential fusion via a single posterior approach. Unlike the traditional posterior lumbar interbody fusion (PLIF), the TLIF is performed unilaterally with access to the disc space through the intervertebral foramen [1]. One of the biggest advantages of the TLIF is the decreased risk of postoperative neurological deficit compared to the PLIF, by requiring less retraction of the nerve root and dural sac [2, 3]. Compared to the combined posterior and anterior approach, the TLIF procedure offers less morbidity, shorter hospital stays, and reduced expense [4, 5]. Typical reported indications for performing TLIF include spondylolisthesis, degenerative disc disease, lumbar stenosis with instability, and recurrent lumbar disc herniation with radiculopathy [6–9].

As with many surgical procedures, complications associated with TLIF can result in significant morbidity. Potential intraoperative and perioperative adverse events include excessive hemorrhage, durotomy, nerve injury, misplaced instrumentation, as well as medical events such as deep venous thrombosis or pneumonia. Long-term complications can involve pseudoarthrosis and instrumentation failure. In particular, posterior displacement of standard interbody cages is one such complication. Expandable interbody cages are a recent innovation and an increasingly popular alternative to standard static cages, with the potential advantages of better disc height restoration and segmental lordosis. However, given its relatively recent introduction, complication data are limited. In this article, we describe the failure of an expandable interbody cage placed during a TLIF that resulted in increased pain and disability.

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## Case report

A 50-year-old man presented with severe back and right lower extremity pain in addition to weakness. Past medical history was notable for multiple lumbar operations performed at an outside institution. His initial procedure involved a right L4-L5 discectomy followed by two reoperations for persistent radicular pain, with one being further complicated by postoperative infection requiring incision and drainage. After these operations, he continued to have back and right hip pain. Subsequent progressive back and proximal lower extremity pain prompted further surgery involving right L4-5 and L5-S1 TLIFs in conjunction with L3-S1 posterior instrumented fusion. For the TLIFs, an expandable polyether-ether-ketone (PEEK) interbody cage (StaXx, Spine Wave, Inc., Shelton, CT) was utilized. Postoperative CT showed a medially placed right S1 screw although the L5-S1 cage appeared adequately placed without evidence of failure (Fig. 2a). Repositioning of the right S1 screw was required 3 months later. All these procedures were performed at another hospital system.

Approximately 1–1/2 years after this multi-level fusion, the patient presented at our institution due to progressive and persistent right lower extremity pain. His pain involved an S1 distribution. He also endorsed numbness in the right lateral foot as well as weakness, specifically with right dorsiflexion. He had no left-sided symptoms. Neurologic examination was significant for 4/5 strength in right ankle dorsiflexion as well as loss of sensation to light touch along the lateral aspect of the right foot. The patient had an absent Achilles reflex. He had a positive straight leg raise on the right.

The patient's MRI demonstrated a right-sided mass at L5-S1 impinging the traversing nerve root (Fig. 1).

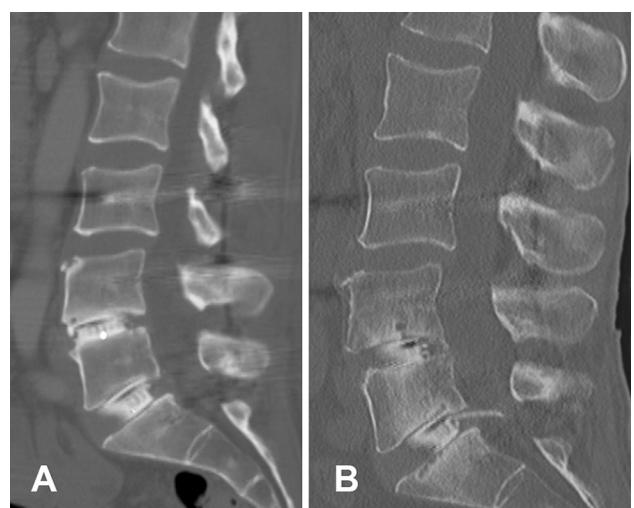


**Fig. 1** Axial T1-weighted MRI showing right-sided mass at L5-S1 impinging the traversing nerve root

Otherwise, no other areas of focal stenosis were appreciated. His most recent CT scan obtained over 1 year after his fusion revealed that one of the wafers used to expand the interbody expandable cage at L5-S1 had migrated posteriorly into the spinal canal (Figs. 2b, 3). Since the previous CT obtained early after his fusion operation did not show a retropulsed wafer, this device malfunction occurred in a delayed manner. The most recent CT also did not show evidence of fusion and it did appear that the left S1 screw had pulled out. Given the evidence of hardware failure and his sensory and motor symptoms in the right lower extremity, he underwent revision surgery with removal of the wafer followed by redo posterior fusion.

Intraoperatively, the right traversing S1 nerve root appeared displaced. Under microscopic visualization, the traversing nerve root was carefully mobilized and the retropulsed wafer from the interbody cage was identified (Fig. 4). There was scar adherent to the wafer. The scar tissue was carefully dissected from the wafer until the wafer could be removed. At this point, the nerve appeared decompressed. The left S1 pedicle screw was loose and was replaced with a larger screw. A redo posterolateral fusion was performed from L3 to S1.

Postoperatively, the patient reported improved radicular pain but reported right-sided perianal numbness and bladder and bowel dysfunction. He also had persistent and severe low back pain that was difficult to manage due to a high tolerance to narcotics. Postoperative MRI was obtained, which did not show any residual stenosis (Fig. 5). The patient was treated symptomatically and had subsequent improvement in his bowel and bladder symptoms, but continued to have severe low back pain and residual



**Fig. 2** **a** Initial postoperative sagittal reformatted CT scan showing adequate placement of cage. **b** Subsequent sagittal reformatted CT scan performed over 1 year after multi-level fusion surgery showing retropulsion of a single wafer



**Fig. 3** Axial CT image showing retropulsion of a wafer



**Fig. 5** Axial postoperative T2-weighted MRI showing adequate decompression



**Fig. 4** Intraoperative picture showing retropulsed PEEK wafer

albeit improved discomfort in his right leg at 9 month follow-up.

## Discussion

With a TLIF, multiple options exist to obtain interbody fusion including use of iliac crest autograft bone, local autograft bone, allograft bone, as well as biologic agents such as recombinant human bone morphogenetic protein-2 [10–12]. To maintain or reconstitute disc height and segmental lordosis, structural allograft spacers or cages are also utilized. Material used for interbody cages includes titanium, PEEK, and carbon fiber. Titanium cages were the first to be developed and popularized, but do have several

purported disadvantages. Because titanium has a significantly higher Young's modulus (a measure of the stiffness of an isotropic material) than bone, there is increased risk of subsidence. Additionally, titanium cages confer an element of difficulty in postoperative evaluation due to significant imaging artifact on CT or MRI [13]. Synthetic grafts, such as carbon fiber and PEEK, have been developed to attempt to combat the disadvantages of titanium cages. They are constructed to more closely match the Young's modulus of bone, theoretically leading to lower subsidence rates. This advance creates more consistent load sharing between bone and the device, which initially led surgeons to believe that PEEK resulted in higher fusion rates and less osteoporosis over long periods [14]. More recently, however, a retrospective study of 111 TLIF patients showed no statistical difference in the subsidence rate between PEEK and titanium cages [15]. In fact, the study found a failure rate of 10.3 % with PEEK devices compared to 2.9 % when titanium had been implemented.

Although multiple cage designs exist, most interbody cages are designed to be self distracting via a "bullet nose." Even with a self-distracting morphology, one of the biggest challenges in placing a cage via TLIF is the often narrow aperture into the disc space, particularly at L5-S1 where the disc is wedge shaped. More recently, interbody cages have been developed that are expandable rather than static. These new devices allow ease of placement through a narrow posterior disc space aperture and subsequent sagittal expansion to adequately contact the endplates. Further expansion can restore disc height and with lordotic expansion, possibly improve segmental lordosis. The

interbody cage used in the patient presented is one type of expandable cage in which wafers are inserted sequentially into the cage to cause sagittal expansion.

As with any procedure that incorporates an implantable device, there is a risk for migration. While not common, posterior displacement of static interbody cages following TLIF have been reported [16]. However, to our knowledge, there has been only one similar report of failure of an expandable interbody device [17]. In that case, a wafer from the same type of expandable PEEK interbody device that was used in our patient migrated posteriorly, impinging on the thecal sac, causing extreme radicular pain. Upon reoperation, the device was removed and replaced with a static interbody cage. In our case, early postoperative CT scan showed that the interbody cage was intact. Follow-up CT over 1 year later showed posterior retropulsion of one of the wafers used to obtain expansion. The two imaging studies imply a delayed malfunction.

Aoki et al. [16] evaluated 125 patients who underwent TLIF with static cages and reported that risk factors for posterior cage migration included a bullet-shaped cage, higher posterior disc height, scoliosis, and undersized cage. The authors also noted a near statistically significant ( $p = 0.083$ ) increase in posterior cage migration with unilateral pedicle screw fixation compared to bilateral pedicle screw fixation, suggesting that increased motion was a potential risk factor. In a large study of 1,070 patients who underwent PLIF, risk factors for cage migration included multi-level fusion, a wide disc space with instability, a pear-shaped disc, and placement at L5-S1 [18]. The authors suggested that relative increased motion, even with S1 pedicle fixation as well as the shape of the L5-S1 disc space, was a factor that impacted retropulsion. In an in vitro biomechanical evaluation of expandable interbody cages for single level PLIF, it was noted that pedicle screw fixation was required for a statistically significant decrease in range of motion of the segment [19]. In the patient presented in this article, placement at L5-S1 with the continued motion of the segment due to loss of fixation by the S1 pedicle screws and pseudoarthrosis may have contributed to the delayed implant failure. Surgical treatment in this case involved removal of the retropulsed wafer but not removal of the cage, which was a decision based on the extensive surgery required to remove the cage that had partially subsided into the adjacent L5 vertebral body. Instead, a more extensive posterior fusion was performed.

## Conclusions

Compared to static cages, expandable interbody cages offer the potential advantages of ease of insertion as well as controlled expansion to restore disc height and improve

segmental lordosis. However, with any new device there exists the potential for mechanical failure, as occurred in the case presented.

**Conflict of interest** The authors report no conflict of interest associated with this article. Dr. Park receives royalties from Globus and has been a consultant for Globus, Medtronic, and Biomet.

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