A novel method of anterior lumbosacral cage reconstruction

Technical note

DIMITRIOS Mathios, M.D., PAUL EDWARD KALOOSTIAN, M.D., ALI BYDON, M.D., DANIEL M. SCHUBBA, M.D., JEAN PAUL WOLINSKY, M.D., ZIYA L. GOKASLAN, M.D., AND TIMOTHY F. WITHAM, M.D.

Department of Neurosurgery, The Johns Hopkins Hospital and The Johns Hopkins University School of Medicine, Baltimore, Maryland

Reconstruction of the lumbosacral junction is a considerable challenge for spinal surgeons due to the unique anatomical constraints of this region as well as the vectors of force that are applied focally in this area. The standard cages, both expandable and nonexpandable, often fail to reconstitute the appropriate anatomical alignment of the lumbosacral junction. This inadequate reconstruction may predispose the patient to continued back pain and neurological symptoms as well as possible pseudarthrosis and instrumentation failure. The authors describe their preoperative planning and the technical characteristics of their novel reconstruction technique at the lumbosacral junction using a cage with adjustable caps. Based precisely on preoperative measurements that maintain the appropriate Cobb angle, they performed reconstruction of the lumbosacral junction in a series of 3 patients. All 3 patients had excellent installation of the cages used for reconstruction. Postoperative CT scans were used to radiographically confirm the appropriate reconstruction of the lumbosacral junction. All patients had a significant reduction in pain, had neurological improvement, and experienced no instrumentation failure at the time of latest follow-up. Taking into account the inherent morphology of the lumbosacral junction and carefully planning the technical characteristics of the cage installation preoperatively and intraoperatively, the authors achieved favorable clinical and radiographic outcomes in all 3 cases. Based on this small case series, this technique for reconstruction of the lumbosacral junction appears to be a safe and appropriate method of reconstruction of the anterior spinal column in this technically challenging region of the spine.

KEY WORDS  •  lumbosacral junction  •  Cobb angle  •  spondylectomy  •  cage with adjustable caps  •  anterior spinal column reconstruction  •  oncology  •  fusion

ANTERIOR reconstruction of the lumbosacral junction is necessitated by pathological processes that cause deformity, instability, and/or compromise of the structural integrity of the vertebral bodies and neural elements.14,17 Examples of such processes include degenerative spondylosis, traumatic fractures, osteomyelitis/discitis, osteoporotic fractures, primary neoplastic disease, or more frequently metastatic disease to the spine. In 1996 the Food and Drug Administration (FDA) first approved the use of titanium cages for posterior lumbar interbody fusion.9 Since then, many versions of interbody and cage reconstruction strategies along the anterior and middle columns have been used with varying success.

Anterior reconstruction of the lumbosacral junction poses a considerable challenge for spinal surgeons. This is due to the unique anatomical and biomechanical stresses that occur at this location.

Due to these difficulties, the use of cages that do not fit the contour of the lumbosacral junction tend to be associated with a high rate of pseudarthrosis and failure.2,10 We have experienced technical difficulties with reconstruction of the lumbosacral junction using cages that could not be adjusted based on the inherent morphology of this area of the spine. In some instances this has resulted in construct failure.

We present 2 cases in which preoperative CT and MRI scans were used to uniquely measure appropriate morphological dimensions at the lumbosacral junction. We have also applied this technique to an additional case, which has been previously published.4 Therefore, 2 of our 3 cases are described in more detail in this manuscript. From preoperative imaging data, we were able to obtain an anterior...
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cage configuration that could replace the existing vertebral bodies and disc spaces with the exact and appropriately maintained lordosis. This technique for lumbosacral junction reconstruction utilizes adjustable caps of the Stryker VLIFT cage (Stryker Spine) to modulate the angle of interface with the vertebral endplates. The VLIFT cage can be configured and adjusted preoperatively based on measurements of the Cobb angle that have been calculated from the preoperative imaging studies and can be modified intraoperatively. This technique has been deployed with success at our institution and we have not encountered any occurrences of instrumentation failure in our series. We illustrate the application of this unique construct in our first 3 cases, with the first 2 cases being discussed in more detail.

Methods

Patient Demographics

Three consecutive patients underwent surgery for reconstruction of the anterior lumbosacral junction with the VLIFT cage system. The mean age of the patients was 49.3 years (their individual ages were 45, 58, and 45 years). All 3 patients had neoplastic processes along the region of lumbosacral junction (L3–S1). All patients presented with radicular pain or intractable back pain. The cages were implanted by 2 surgeons.

Surgical Technique

After intubation and induction of anesthesia, the patient was positioned supine. One patient underwent single-level corpectomy; the second, 2-level spondylectomy; and the third, 3-level spondylectomy. After direct visualization of the anterior dura was achieved, the anterior spinal column was reconstructed with VLIFT cage (Stryker Spine) implantation (Fig. 1A). The distance between the intact vertebral endplates was measured to choose an appropriate cage length. Based on the preoperative CT scan and intraoperative radiographs, the angle encompassing the interface between the cage caps and the vertebral bodies (Cobb angle) was calculated, and the endplates were adjusted to fit that angle for the VLIFT cage in each instance. The appropriate cage was filled with graft material (Fig. 1A). Next, the cage was placed in the defect and distracted slightly for approximation to the endplates (Fig. 1B and C). An intraoperative radiograph was obtained to confirm the proper positioning of the cage. No evidence of instrumentation failure has been observed in any of the 3 cases as of the most recent follow-up (3 years, 3 months, and 1.5 years).

Illustrative Cases

Case 1

A 58-year-old woman presented with intractable back pain as well as radicular pain involving both legs. An MR image showed an erosive lesion involving the L-4 and L-5 vertebral bodies. A biopsy was performed at an outside institution, resulting in a diagnosis of giant cell tumor. After embolization of the tumor, the patient underwent a posterior L2–pelvis arthrodesis with complete resection of the L-4 and L-5 posterior elements. A second-stage L4–5 spondylectomy for en bloc resection of the tumor was performed via an anterior retroperitoneal approach. Reconstruction of the L3–S1 levels with the Stryker VLIFT cage was achieved using the technique described above. Preoperative imaging (Fig. 2A) was used to calculate the angle necessary for the cage caps to be adjusted to reconstruct the lumbosacral junction area. After radiographic confirmation of the appropriate position of the cage, the device was wired to the posterior construct and was secured from L-3 to S-1 with anterior plating (Figs. 1C and 2B). With 3 years of follow-up, the patient has no evidence of recurrent tumor or construct failure (Fig. 2C).

Case 2

A 45-year-old man presented with progressive mechanical back pain and right L-5 radiculopathy. Imaging demonstrated a destructive lesion involving marked collapse of the L-5 vertebral body with extension into the spinal canal. A biopsy of the lesion demonstrated B-cell lymphoma. Based on the significant loss of anterior col-

![Fig. 1. A: VLIFT cage filled with bone graft before implantation. B and C: Intraoperative photographs obtained after placement of the cage (B) and anterior plating (C).](image-url)
umn support at L-5 and mechanical instability, the decision was made to pursue a 2-staged operation, beginning with anterior corpectomy and reconstruction from L-4 to S-1. Intraoperative imaging (Fig. 3A) was used to calculate the angle necessary for the cage caps to be adjusted for reconstruction. On the basis of these calculations a 30° lordotic end-cap was applied on the bottom of the cage to match the sacral slope; and a 3° lordotic end-cap was applied on the top of the cage to match the L-4 slope. A Stryker VLIFT cage with adjustable caps was used for the reconstruction. The cage was filled with allograft and demineralized bone matrix for the arthrodesis. An intraoperative radiograph as well as a high-resolution CT scan performed the day after surgery (Fig. 3A and B) showed excellent positioning of the cage. A posterior instrumented fusion from L-3 to the pelvis followed. The patient was neurologically stable, with no instrumentation failure (Fig. 3C), but he unfortunately succumbed to his systemic disease 3 months later.

Discussion

Reconstruction of the anterior spinal column is necessary in some cases of mechanical instability and/or deformity at the lumbosacral junction. Several types of anterior reconstruction devices are currently in common use, with varying success rates.12,15,18 Cage reconstruction following corpectomy has been shown to be a very effective way of achieving anterior mechanical stabilization compared with the implementation of other devices currently used.12,15,18,24 Varying success rates have also been reported depending on the spinal segment in which the cages have been applied.1,19 The lumbosacral junction in particular poses a major challenge for spine surgeons. From a biomechanical perspective, it is a junctional point where the lordotic lumbar area and the kyphotic sacral segment of the spine meet. As such, it is the single point in the entire spine that must address considerable load-bearing forces.
and also a variety of directional movements necessary for normal motion. This variety of directional shearing forces applied on the lumbosacral junction leads to increased mechanical instability, recurrent pain, and neurological symptoms, resulting in the need for revision surgery. The technology of the cages that surgeons currently choose from treats the lumbosacral junction like the other parts of the spine and does not account for its unique biomechanical features and greater need for stability and functionality.

Current literature reports a small but significant implant complication rate related to cage placement, involving early or late settling of the cage, with malalignment leading to increased mechanical instability, recurrent pain, and neurological symptoms, resulting in the need for revision surgery. Installation of some distractive cages in the lumbosacral junction region is technically challenging and, in our experience, unfavorable reconstruction outcomes are more common in this area of the spine than in others. We believe that these technical challenges underscore the importance of using cages that address the specific needs of the lumbosacral junction for extra mechanical stability and simulate the normal anatomical alignment of this region. Inadequate cage placement in this region leads to a compromise of the regional anatomy that subsequently leads to unequal distribution of loads on the instrumentation used for reconstruction, which may in turn result in instrumentation failure. Reconstruction efforts after failed instrumentation in this segment of the spine can present a monumental challenge, and revision options are often very limited and undertaken at the expense of patient morbidity.

Our case series reports the clinical outcome in 3 patients who had reconstruction of the anterior spinal column in the lumbosacral junction related to tumor resection. Our first patient had a primary bone lesion, and the operation and the appropriate cage placement played a crucial role in her overall long-term quality of life. In contrast, our second patient, even after a very successful reconstruction, succumbed to his systemic disease. The third patient presented with a chordoma at L3–5, and spondylectomy for en bloc resection across 3 levels with reconstruction of the lumbosacral junction using this technique led to an excellent outcome, with no instrumentation complications as of 1.5 years after the surgery. This case was not discussed at length in this manuscript because it has been previously reported in detail given the extensive nature of the spondylectomy.

There are concerns as to whether the extensive spinal reconstruction described in this manuscript has long-term benefit for patients with late-stage cancer, and this topic has been the subject of discussion in the medical literature. There are studies that report a better quality of life, decreased pain, and overall increased survival in patients who are treated with spinal column reconstruction of this nature. Nonetheless, the decision of whether to offer these patients surgical reconstruction is a difficult one and has been debated. We recommend making this decision based on individual patient factors (age, comorbidities, performance, best estimate of life expectancy, and so forth). Having a candid discussion with the patient and the treating oncologist about the options for treatment and expected outcomes prior to embarking on a major spinal reconstructive procedure is critical. Our second patient did not gain long-term benefit from the procedure because the systemic disease burden led to his untimely death. However, at the time surgery was proposed, the patient was a healthy 45-year-old man with excellent performance status and a good prognosis, given the diagnosis of lymphoma. Although radiation therapy would have been preferred in this case, he had mechanical instability of his lumbosacral junction that would not have been well treated with radiation modalities.

Currently the recommendation for patients with metastatic spine disease in the lumbosacral area is to undergo radiotherapy for palliative purposes. Surgery is indicated in patients with obvious spinal instability and associated mechanical pain or in those with neural compression and significant associated deficit. Radioresistant lesions such as metastatic renal cell carcinoma or metastatic thyroid cancer may also be considered for resection and reconstruction if necessary. In this small case series, 2 of the 3 patients presented with mechanical instability and the third presented with a radioresistant tumor (chordoma).

We have demonstrated in this small case series a novel technique for reconstruction of the lumbosacral junction using preoperative or intraoperative measured Cobb angles to allow for reconstruction of the anterior lumbosacral junction in a more anatomical fashion. An expandable cage with adjustable end-caps can then be used to achieve a normal anatomical alignment in this biomechanically demanding area of the spine. It should be stressed that this type of cage reconstruction should not be used in a stand-alone fashion and should be supplemented with posterior instrumentation. Additional cases and data from longer follow-up are needed to confirm long-term results. Moreover, newer cages have been developed that may allow for reconstruction using the technique that we have described.

Conclusions

Our case series demonstrates the feasibility of utilizing a novel method of anterior reconstruction of the lumbosacral junction, a site that is often difficult to reconstruct surgically. While we do not provide a statistical study demonstrating increased fusion rates compared with the current methods of lumbosacral reconstruction, we show in our case series a possible new alternative strategy that has worked in reconstructing the lumbosacral junction.

Based on our experience in the 2 illustrative cases presented in detail in this paper and our previously reported successful case, this technique is a safe and appropriate method of reconstruction of the anterior spinal column with no radiographic signs of failure for the duration of the follow-up period. These promising results point to the need for a more detailed analysis of the biomechanical characteristics and the clinical applications that this new construct can offer in the reconstruction of the lumbosacral junction.

Disclosure

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Address correspondence to: Timothy F. Witham, M.D., Meyer Building, 7-1095, 600 North Wolfe Street, Baltimore, MD 21287. Email: twitham2@jhmi.edu.