Case Study: Fracture Reduction and Stabilization of a L1 Burst Fracture in Active 50-Year-Old Male Using Combined Anterior and Posterior Approach

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Background Context: A trauma patient who suffered an acute burst fracture of the thoracolumbar (TL) spine required acute operative stabilization to avoid a progressive deformity and neurological deterioration. Due to the canal compromise and instability, two types of devices were utilized. The treatment plan dictated a combined anterior and posterior operative procedure to correct the deformity associated with the burst fracture and then stabilization of the fractured vertebra on the anterior aspect of the spinal column. The combined anterior and posterior operations required two instrumentation procedures: Posterior stabilization using the S4® Fracture Reduction Instrumentation System and the expandable Hydrolift VBR to stabilize the anterior column.

Conclusions: The patient had complete neurologic function in his lower extremities following the surgery and went on to achieve a successful fusion with his spine restored to normal anatomic alignment. He also had sustained improvement of the back pain he initially presented with.

Materials and Methods

An expandable cage offers surgeons a vertebral body reconstruction solution and is used in tandem with the S4® Fracture Reduction Instrument (FRI) to correct the fracture or deformity. To successfully treat fractures of the vertebral column, absolute control above and below the fracture site is necessary. The Aesculap Spine S4® FRI instrumentation affords the ability to correct deformity in all planes while utilizing the mechanical advantage engineered into the system for precise realignment and correction of the fracture. For this procedure, the Hydrolift Vertebral Body Replacement (VBR) System uses hydrostatic pressure to expand. A mechanical lock mechanism maintains the distraction of the vertebral body space.

We present a case in which the Aesculap S4® FRI instrumentation was used for reduction of the kyphotic segmental deformity relating to the L1 burst fracture and the Aesculap Hydrolift VBR was employed within the L1 corpectomy defect to provide fixation from T12-L2. No complications resulted from the surgery.

History of present illness

A 50-year-old male presented as a trauma patient to the emergency room for a neurosurgical consultation with intense back pain and radiographic evidence of a spine fracture.

He initially presented to the emergency room six weeks earlier after suffering a generalized seizure for the first time and fell hard to the ground on the beach. At that time, he underwent a CT scan of the head. The scan was normal in appearance and there was no evidence of any intracranial mass lesion. He was not started on anti-seizure medication. His past medical history was notably significant for human immunodeficiency virus. He stated that all of his hematologic indices had been stable on his chronic medication regimen. He was also diagnosed with hypertension.

The patient then experienced a second generalized seizure five days before this visit while he was the restrained passenger in an automobile. He did lose consciousness during this event, but there was no aggressive-type opisthotonus described following this second seizure. However, he now reported a new pattern of significant pain in his upper lumbar region. Upon arrival to the emergency room, he described the pain as intense and fairly constant and aggravated by weight bearing activity. He denied any perception of numbness, tingling, or focal weakness in his legs or any problems with respect to bladder or bowel control. On physical examination, he was afebrile and hemodynamically stable. He was found to be normocephalic and atraumatic. Cervical spine examination did not reveal any focal tenderness. However, thoracolumbar spinal examination noted the presence of focal tenderness to palpation at the thoracolumbar junction in the midline. No other deformity was noted. On neurologic examination, the patient was found to be alert and oriented. Cranial nerve
examination was unremarkable. Motor testing demonstrated 5/5 bilateral upper extremity strength. In the lower extremities, there was 4-4+/5 right hip flexor weakness that might have been due to pain provocation with attempting this muscle group test. Chest and cardiovascular examinations were unremarkable. A CT scan of the TL spine was obtained as well as an MRI of the TL spine to assess the ligamentous structure associated with the fracture to determine the optimal surgical stabilization procedure.

The patient was transferred to the intensive care unit.

He was referred to a neurologist after this second seizure for better elucidation of the etiology of the seizure disorder.

Review of radiographic studies
A CT scan of the TL spine demonstrated evidence of an acute/subacute L1 burst fracture associated with 50% retropulsion into the canal, slightly more pronounced on the right than on the left side. (Fig. 6) There was also a sagittal split component to it and segmental kyphotic deformity associated with this burst fracture, (Fig. 7) but no overt diastasis of the T12-1 or L1-2 facet joints. The MRI of the TL spine identified this as being an unstable fracture pattern.

Diagnosis

1. New onset seizure disorder of unclear etiology
2. History of recent trauma to the TL spine following a mechanical fall relating to his first generalized seizure
3. Development of significant mechanical TL region pain following second generalized seizure five days earlier
4. Radiographic evidence of unstable-appearing L1 burst fracture
5. No overt signs of spinal cord injury

Indication for surgery
The studies clearly demonstrated that the patient had post-traumatic mechanical instability at the level of his fracture, which required operative stabilization because of his intractable pain and the unstable CT/MRI appearance of the fracture. In addition, the patient appeared to have proximal right leg weakness attributable to retropulsed bone fragments and compression on the conus medullaris. He required decompression and stabilization surgery as a result. If he was not to have operative stabilization immediately, he was more likely than not going to develop a progressive deformity at the site of the fracture with progressive pain and potentially further neurologic deterioration of his lower extremities.

Details of operation
A left TL approach for L1 corpectomy and T12-L2 anterior fusion was performed five days after neurosurgical consultation in ER.

T12-L2 anterior fusion
Fluoroscopy was used throughout the operation for localization. The patient was placed in the prone position on a Jackson table. The L2 level was localized and an incision marked at the posterior midline, overlying the T12-L2 levels. The fracture was approached posteriorly through the mid-line TL incision and dissection was taken down to the lumbodorsal fascia. The fascia was opened in the midline and a subperiosteal dissecting technique was used to expose the dorsal elements of T12-L2. Hemostasis was obtained and
deeper retractors were advanced. Once the dorsal elements were completely denuded of soft tissue, the posterior stabilization was begun. With fluoroscopic guidance, Aesculap S® pedicle screws were inserted into the T12 and L2 pedicles bilaterally. At each pedicle screw entry site, a starter hole was made with the high-speed drill and the 4mm coarse diamond bur. A gear shift was then passed along the appropriate trajectory. Each hole was probed prior to tapping and insertion of appropriate length pedicle screws followed. After insertion of all four screws, additional anterior posterior (AP) fluoroscopic images were obtained to confirm that the trajectories were correct. The neurophysiologic monitoring equipment was then used to stimulate all four screws. The Aesculap S® FRI instrumentation was applied to the pedicle screw heads for reduction of the kyphotic segmental deformity relating to the L1 burst fracture. Using the S® FRI instrumentation, distraction was applied between T12 and L2 and then lordosis facilitated. Correction of the segmental kyphotic deformity was visible on the lateral fluoroscopic imaging. When optimal correction of the kyphosis was achieved, the locking caps were applied over the rods on each side. The locking nuts were provisionally secured and the S® FRI jig removed from the screw heads. Final tightening was performed using a torque wrench. A high-speed cutting bur was used to decorticate the posterolateral surfaces between T12 and L2. Allograft was then applied to these decorticated surfaces. This was interspersed with local autograft bone taken from the T12-L1 and L1-2 facet joints and transverse processes. The wound was then closed in standard fashion over a drain.

**L1 Corpectomy**

The T12-L1 and L1-2 disk spaces were localized and then the left lateral aspect of the spinal column was exposed at that level. The annuli of the T12-L1, L1-2 disc spaces were incised and the material was removed using straight pituitary rongeurs in combination with upgoing curettes. The L1 vertebral body was noticeably disrupted and large pieces of fragmented L1 body were readily removed using the Leksell Rongeur and large pituitary rongeurs. Additional fragments of bone from the L1 body were removed using the large upgoing Epstein Curette. A thin anterior rim of L1 vertebral body was left in place to protect the adjacent vascular structures. The location of the left L1 pedicle was defined and used as a landmark to identify the retropulsed L1 vertebral body fragment. A high-speed drill with the 4mm coarse diamond burr was then used to thin out the retropulsed bone fragments. A downgoing Epstein curette was used to mobilize the retropulsed fragments from the canal, decompressing the thecal sac. Some minor epidural venous bleeding was controlled with irrigation as well as FLOSEAL. After the thecal sac was adequately decompressed from pedicle to pedicle across the length of the L1 vertebral body the T12 and L2 end plates were prepared for fusion. The endplates were decorticated with an Epstein Curette. Sizers from the Aesculap Hydrolift VBR set were inserted. After measurements were taken for an optimal expandable cage dimension, the appropriate Hydrolift expandable VBR was selected. The VBR was placed and positioned appropriately within the L1 corpectomy defect. (Fig. 8) Using hydrostatic force, the Hydrolift VBR was expanded open to allow a fixation from T12-L2. (Fig. 9) AP and lateral fluoroscopy was performed to confirm adequacy of expansion of the VBR. Local corpectomy autograft bone was then packed into the anterior and left lateral spaces surrounding the expandable VBR. The graft material was buffered from the thecal sac by a layer of DuraGen®. The wound was then closed in standard fashion.

![Fig. 8](image_url)
Fracture Reduction and Stabilization of a L1 Burst Fracture in Active 50-Year-Old Male Using Combined Anterior and Posterior Approach, Frank J. Coufal, MD, FACS, LaJolla Neurosurgical Associates

DISCUSSION

This was a challenging case because of the location of the fracture at the TL junction and the kyphotic curvature of the spine. To address the problem of post-traumatic mechanical instability, two types of devices were needed for correction: the Aesculap S4® Fracture Reduction Instrumentation (FRI) and the Hydrolift Vertebral Body Replacement (VBR). The treatment plan dictated a combined anterior and posterior operative procedure to correct the deformity associated with the burst fracture and then stabilization of the fractured vertebra on the anterior aspect of the spinal column.

Devices

1. Aesculap S4 Spinal System and Aesculap Fracture Reduction Instrumentation

In this case, the Aesculap S4 Spinal System was necessary for a pure posterior approach with monoaxial screw that allows the FRI structure to be built off of above and below the vertebral fracture site. T12 and L2 were anchored and corrected L1.

The challenge with this case was that the burst fracture was at the TL junction and associated with a kyphotic curvature of the spine so the Aesculap S4® Fracture Reduction Instrumentation was very helpful in making the proper adjustment to bring the curvature of the spine back to normal sagittal alignment.

“The Aesculap S4® Fracture Reduction Instrumentation (FRI) is very powerful instrumentation that allowed us to really manipulate the spine. It optimized correction of the deformity particularly in the trauma setting. It’s noteworthy for being not just powerful but easy to assemble so there is not a lot of ‘fiddle factor’ that can otherwise delay a long case. Trays for the FRI are set up great. It is just like following the numbers; laid out per assembly in all four quadrants.” said surgeon, Frank J. Coufal, MD.

To successfully treat fractures of the vertebral column, absolute control above and below the site is necessary. The Aesculap FRI System, a complement to the S4® Spinal System, is intended to correct deformities of the spine caused by severe trauma. Because of its precision and control, the S4® FRI provides the potential to limit neurological injury, restore sagittal balance, minimize loss of function and facilitate a more rapid rehabilitation for patients. The S4® FRI has the ability to correct deformity in all planes while utilizing the mechanical advantage engineered into the system for precise realignment and correction of the fracture. The S4® FRI system can be used in an open, mini open and percutaneous approach in conjunction with the S4® Spinal System.
2. **Aesculap Hydrolift Vertebral Body Replacement System**

In this surgery, the Hydrolift Vertebral Body Replacement (VBR) System was expanded open to allow a fixation from T12-L2. The hydrostatic force allowed for optimized tactile feedback and digitally monitored pressure control that minimized any chance of vertebral body endplate damage.

After the surgery, Frank J. Coufal, MD, said: “The Hydrolift had a continuous expansion that was well controlled using the hydrostatic pressure. It did not limit us to incremental expansion of the expandable VBR as had been our experience with earlier expandable VBR devices. This device allowed us to achieve a tension to our distraction that was more physiologically appropriate.”

The Hydrolift VBR is indicated for use in the thoracolumbar spine (T1 to L5) for partial or total replacement of a collapsed, damaged, or unstable vertebral body due to tumor or trauma (i.e. fracture). The Aesculap Hydrolift VBR is specifically designed with a small cross sectional area to allow for minimal bone resection of the vertebral body; optimizing conditions for a positive bone modeling response in and around the device. The Hydrolift uses hydrostatic force to attain the desired distraction height; final position is maintained through a mechanical lock mechanism providing safety and security. It has an expansion range of 21 mm to 94 mm, addressing the needs of one and two vertebral bodies of the thoracolumbar region.

To perform the partial corpectomy, the edges of the implant bed are marked (Fig. 1) with a chisel (Fig. 2).

A trial VBR endplate size guide is used to determine the appropriate size of the implant endplate (Fig. 3). The base body trial spacers are used to determine the appropriate expansion range (Fig. 4). The trial vertical dimension represents the minimum or collapsed height of each VBR.

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**Outcome**

Post surgery, the patient had complete neurologic function in his lower extremities and he went on to achieve a successful fusion with his spine restored to normal anatomic alignment as well as sustained improvement of the initial back pain and preoperative proximal right leg weakness.
Physician Disclosure

Frank J. Coufal, MD, FACS is the founder of LaJolla Neurosurgical Associates, AMC. He also serves as Medical Director of Neurotrauma and Neurosurgical Emergency Services at Scripps Memorial Campus. Dr. Coufal is a paid consultant for Aesculap Implant Systems, LLC.

About Aesculap Implant Systems, LLC

Aesculap, Inc., a B.Braun company, founded in 1867 in Tuttingen, Germany, is the world’s largest and one of the most respected manufacturers of surgical instruments and sterilization container systems. Aesculap is a leading privately-owned manufacturing company, passionately committed to providing high-quality, innovative products and services to all surgical disciplines, with particular focus in the fields of General, Neuro, Spine and Orthopaedics.

Aesculap Implant Systems, LLC, established by Aesculap, Inc. in 2005, focuses on delivering innovative solutions to the spine and orthopaedic markets. Aesculap Implant Systems maintains a surgeon/patient focus with the goal of improved operative procedures and patient outcomes leading to an improved quality of life. For more information about Aesculap Implant Systems or its medical products, call 800-234-9179, e-mail us at info@aesculap.com or visit www.AesculapImplantSystems.com.

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