A New Paradigm in Cage Design to Promote Lateral Bridging Bone Formation during Trans-Psoas Intervertebral Fusion*

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Introduction

Since the advent of the Bagby and Kuslich (BAK) cage1, there have been many new technologies and biologics developed to improve our ability to fuse the intervertebral space2-6. However, there is little attention to achieving fusion along the periphery of the vertebral bodies. When we look at naturally occurring fusions we see conditions where the body tries to bridge near or along the lateral margins such as anklyosing spondylitis (marginal bridging) or DISH (nonmarginal bridging) respectively. In the natural process of aging, the intervertebral disc degrades leading to anterior and lateral “bridging” osteophyte formation1-4. The adaptive nature of bone formation under mechanical loading is well described in animal models6-21; and, it is presumed that vertebral osteophyte formation is stimulated by the same mechanisms as in these models because they grow out of compressed bone in the intervertebral disc spaces.

In this report we describe a novel intervertebral cage design for lateral access fusion (sagittal lumbar interbody fusion technology (S-LIFT), SpineFrontier Inc. Beverly, MA) that was developed to promote intervertebral bone formation as well as to replicate the natural tendency of lateral bridging bone22. We aim to illustrate how S-LIFT technology uses the rich blood supply of the psoas muscle to promote lateral fusion in two patients.

Case Report 1

A 71 year old male patient with a smoking history was referred with intractable back pain, neurogenic claudication, sciatica, and difficulty walking. He had a history of L4-5 unilateral pedicle screw attempted fusion for grade 2 degenerative spondylolisthesis with hemilaminectomies. Our patient reported continuous 8/10 pain scored using a visual analogue scale (VAS). Significant examination findings included painful and decreased range of motion in all planes; 5-5 strength in all groups except left hip flexion, quadriceps, hamstrings, hallucis longus, and bilateral anterior tibialis (4+/5). X-ray and computed tomography (CT) myelogram of the lumbar spine illustrated stenosis at L3-5, pseudoarthrosis (L4-5), a loose pedicle screw (L4-5), degenerative spondylolisthesis, facet disease (L3-4 and L4-5), L4-5 facet impingement by instrumentation and a vacuum disc at L4-5 (Figure 1A-B and Figure 2A-B).

The patient consented to revision L3-5 decompression and instrumented fusion. A lateral-retroperitoneal trans-psoas approach22 to fuse the discs at L3-4 and L4-5 was deemed best to use the virgin, more vascular psoas muscle overlaying the disc spaces laterally and to avoid the devascularized scar posteriorly where he had prior instrumentation and decompression.

The patient underwent discectomy and cage placement at the L3-4 and L4-5 disc spaces and two 10mm x 53mm S-LIFT PEEK cages placed (Figure 3). Each cage was packed with INFUSE® (Medtronic, Memphis TN) and cancellous allograft. The cage design has an open back design that allows packing of the graft after cage placement to avoid graft spillage during impaction and to constantly expose the graft to the rich psoas blood supply (Figure 4A-B).

At five visits throughout the year postoperatively the patient reported lessened back pain (graded between 0 and 6/10 on VAS), which was described as being intermittent in nature. At a 13 month follow-up visit, x-rays and CT confirmed L3-4 and L4-5 interbody fusion with nonmarginal bridging bone formation confirming lateral fusion (Figures 5A-D).

Case Report 2

A 74 year old female presented with prior L4-5 lumbar fusion, chronic lower back pain, difficulty walking, neurogenic claudication, and sciatica. X-ray and magnetic resonance imaging (MRI) showed L4-5 pedicle screws with no interbody,

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*Figure 1A* and *Figure 1B* show cases with lateral view before and after S-LIFT cage placement.

*Figure 2A* and *Figure 2B* show computed tomography (CT) myelography showing lateral view of L3-4 and L4-5, respectively.

*Figure 3A* and *Figure 3B* show photo and illustration of S-LIFT cage.

*Figure 4A* and *Figure 4B* show illustration of S-LIFT open back design in-situ before and after packing with bone graft.

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1-4. We aim to illustrate how S-LIFT technology uses the rich blood supply of the psoas muscle to promote lateral fusion in two patients.

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*Figure 5A* and *Figure 5B* show lateral view before and after S-LIFT cage placement.

*Figure 6A* and *Figure 6B* show posterior view before and after S-LIFT cage placement.

*Figure 7A* and *Figure 7B* show lateral view before and after S-LIFT cage placement.
grade 1 L3-4, L4-5 degenerative spondylolisthesis, severe L3-4 spinal stenosis, L3-4 bilateral foraminal stenosis; right L5-S1 foraminal stenosis; L5-S1 degenerative disc disease and L3-S1 degenerative facet disease (Figure 6). The patient underwent a revision L3-S1 decompression and instrumented fusion. A lateral–retropereitoneal trans-psoas approach was used for interbody fusion at L3-4 and L4-5 using S-LIFT PEEK cages. At her 10 month follow-up our patient reported lessened pain and there was radiographic confirmation of L3-4, L4-5 interbody fusion with nonmarginal bridging bone formation confirming lateral fusion (Figure 7A-B and Figure 8A-B).

Discussion

Both of the surgeries highlighted here involved minimal intraoperative blood loss (less than 150mL) and the lengths of surgery were short (average length of surgery was 190 minutes for the S-LIFT cages). The S-LIFT cage is novel in lateral lumbar fusion, as it is designed to provide an even larger area for bone graft packing than current cages. The large central cavity and open back design allowed for generous bone graft packing after the cage was placed. In fact, the S-LIFT cage will allow between 2.098 and 7.495cm³ and 2.294 and 8.219 cm³ of bone graft in the 19 and 22mm sized cages respectively. Since the time of surgery for these two described procedures a new S-LIFT cage has been designed to provide an even larger area for bone graft packing into a large central cavity; this new implant will allow between 2.276 and 8.903 cm³ of bone graft into the cavity of the newer cages. The cage is placed after removing the disc from the intervertebral space to create a cavity into which the S-LIFT cage is inserted extending completely across the endplate to prevent subsidence.

In these two patients the bone formation was localized to the margins of the disc space (Figures 5B-D, 7A, 7B, 8A-B). We hope this report will spur further interest in this approach to cage design as trans-psoas intervertebral fusions including this system are very important surgical strategies for primary and revision lumbar spine surgeries.

References


