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The importance of the anterior longitudinal ligament in lumbar disc arthroplasty: 36-Month follow-up experience in extreme lateral total disc replacement

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Abstract

Background: Current total disc replacement (TDR) for lumbar spine requires an anterior approach for implantation but presents inherent limitations, including risks to the abdominal structures, as well as resection of the anterior longitudinal ligament. By approaching the spine laterally, it is possible to preserve the stabilizing ligaments, which are a natural restraint to excessive rotations and translations, and thereby help to minimize facet stresses. This less invasive approach also offers a biomechanical advantage of placement of the device over the ring apophysis bilaterally; importantly, it also offers a greater opportunity for safer revision surgery, if necessary, by avoiding scarring of the anterior vasculature. We present the clinical and radiologic results of a lateral TDR device from a prospective single-center study.

Methods: A new metal-on-metal TDR device designed for implantation through a true lateral, retroperitoneal, transpsoatic approach (extreme lateral interbody fusion) was implanted in 36 patients with discography-confirmed 1- or 2-level degenerative disc disease. Clinical (pain and function) and radiographic (range of motion) outcome assessments were prospectively collected preoperatively, postoperatively, and serially up to a minimum of 36 months' follow-up.

Results: Between December 2005 and December 2006, 36 surgeries were performed in 16 men and 20 women (mean age, 42.6 years). These included 15 single-level TDR procedures at L3-4 or L4-5, 3 2-level TDR procedures spanning L3-4 and L4-5, and 18 hybrid procedures (anterior lumbar interbody fusion) at L5-S1 and TDR at L4-5 (17) or L3-4 (1). Operative time averaged 130 minutes, with mean blood loss of 60 mL and no intraoperative complications. Postoperative X-rays showed good device placement, with restoration of disc height, foraminal volume, and sagittal balance. All patients were up and walking within 12 hours of surgery, and all but 9 were discharged the next day (7 of those 9 were hybrid TDR–anterior lumbar interbody fusion cases). Postoperatively, 5 of 36 patients (13.8%) had psoas weakness and 3 of 36 (8.3%) had anterior thigh numbness, with both symptoms resolving within 2 weeks. Of the 36 patients, 4 (11%) had postoperative facet joint pain, all in hybrid cases. Visual analog scale pain scores and Oswestry Disability Index scores improved by 74.5% and 69.2%, respectively, from preoperatively to 3-year follow-up. Range of motion at 3 years postoperatively averaged 8.1°. Signals of heterotopic ossification were present in 5 patients (13.9%), and 2 patients (5.5%) were considered to have fusion after 36 months.

Conclusions: The clinical and radiographic results of a laterally placed TDR have shown maintenance of pain relief and functional improvement over a long-term follow-up period. The benefits of the lateral access—minimal morbidity, avoidance of mobilization of the great vessels, preservation of the anterior longitudinal ligament, biomechanically stable orientation, and broader revision options—promote a new option for motion-preservation procedures.

Keywords: Arthroplasty; Total disc replacement; XLIF; Minimally invasive; Lateral approach

Artificial disc replacement surgery has developed as a motion-preservation alternative to fusion procedures for the treatment of pain and instability associated with degenerative disc disease. Currently, all devices have been implanted through an anterior approach, with inherent limitations, including considerable collateral damage to the surrounding tissues and risk of vascular and visceral injuries. Anterior fusion surgeries have shown a complication rate of 38.3%, with complications including sympathetic dysfunction, vas-

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Table 1
A selective (non-comprehensive) list of some of the more relevant inclusion/exclusion criteria for the study

Inclusion criteria
Age 18–60 y
Symptomatic lumbar degenerative disease: magnetic resonance imaging–confirmed disc desiccation, loss of disc height, and bridging osteophytes
Symptomatic level L1-2, L2-3, L3-4, or L4-5
Preoperative Oswestry Disability Index score ≥30 points
Unresponsive to conservative treatment for >6 mo or presence of progressive neurologic symptoms
Willing and able to comply with requirements defined in protocol for duration of study
Signed and dated informed consent form
Exclusion criteria
Prior lumbar fusion surgery at operative level
Prior lumbar laminectomy at operative level
Prior complete lumbar facetectomy at operative level
Prior bilateral retroperitoneal surgery
Radiographic signs of significant instability at operative level (> 3-mm translation, > 11° angulation different from adjacent level)
Bridging osteophytes or absence of motion < 2°
Radiographic confirmation of significant facet joint disease or degeneration
Pars defect, facet abnormality, or other compromise of posterior elements
Spondylolisthesis (greater than grade 1)
Osteopenia, osteoporosis, or osteomalacia to a degree that spinal instrumentation would be contraindicated
Body mass index >40
Active local or systemic infection, including AIDS and hepatitis

cular injury, somatic neural injury, sexual dysfunction, prolonged ileus, wound incompetence, deep vein thrombosis, acute pancreatitis, and bowel injury.[1] Studies of anterior total disc replacement (TDR) surgeries corroborate these approach-related complications.[2] To reduce or even avoid these potential complications, the lateral approach is required for a less invasive device implantation.

The lateral approach has been indicated for anterior fusion of the thoracolumbar spine. Previous studies have reported the safety and effectiveness of the extreme lateral interbody fusion (XLIF) approach, with few approach-related complications and minimal morbidity with rapid recovery.[3–7] The placement of an artificial disc replacement device by the lateral approach allows less invasive access to the degenerated disc, preserving the stabilizing ligaments and providing greater endplate support, with positioning of the device at the vertebral apophyseal ring.[8] We present the clinical and radiographic results of a lateral TDR device (XL-TDR; NuVasive, Inc., San Diego, California) after 36 months from a prospective single-center study.

Methods

A prospective nonrandomized study was conducted to evaluate the clinical and radiographic outcomes of a TDR procedure using a lateral approach. All patients provided informed consent to participate. Inclusion/exclusion criteria (partially listed in Table 1) were similar to those previously cited for other lumbar TDR studies.[2,9–12] Because of the inability to access the L5-S1 disc level by the lateral approach, this level was excluded.

Surgical technique

The approach was the standard XLIF technique for fusion,[3,4,13] with care taken to maintain the anterior longitudinal ligament (ALL) intact. The ALL provides an anterior restraint not only to extension but also to axial rotation. It has been shown that resection of the ALL leads to hypermobility of the segment and potential facet arthrosis at the same level and adjacent levels.[10,14–16]

A discectomy was performed, reaching the contralateral margin and releasing the contralateral annulus. The device must be positioned in proper sagittal and coronal alignment, permitting the placement of the prosthesis on both sides of the ring apophysis. Studies of endplate strength have shown that the apophyseal ring is the strongest area and that the center of the endplate, where most anterior implants are currently placed, is the weakest[17] and is susceptible to subsidence.[18]

For proper insertion, sequential sizing was used, and the lateral TDR device (XL-TDR) was inserted. The device consists of a superior endplate and an inferior endplate with a metal-on-metal (cobalt-chromium-molybdenum alloy) ball-and-socket articulation (Fig. 1). The surfaces of the endplates have spikes to increase primary fixation into the vertebral bone and are also coated with a dual-layer titanium plasma spray and hydroxyapatite plasma spray to facilitate bone on-growth for secondary fixation. The device covers more than 50% of the endplate area and spans the ring apophysis on both sides. The device must be in the midline, providing ideal placement of the prosthesis because of the position of its kinematic center of rotation.

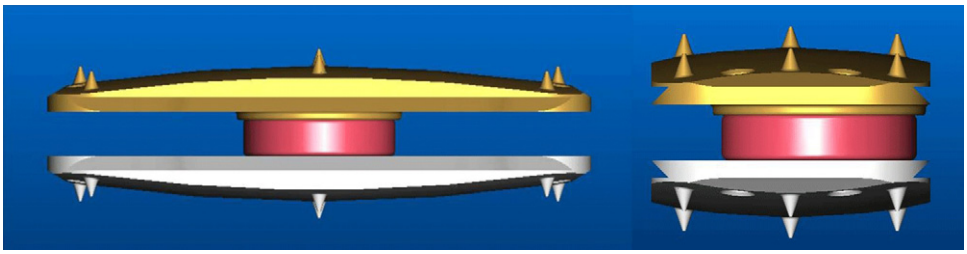

Fig. 1. Anteroposterior and lateral views of prosthesis (XL-TDR).