

**Stand-Alone
Lumbar Lateral Interbody Fusion (LLIF)
vs.
Supplemental Fixation**

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Disclosures

- Consultant - Zimmer / Biomet, DePuy Synthes Spine, Amendia, Stryker
- Stock - Innovative Surgical Solutions, Safe Wire, Vivex
- Royalties - Biomet

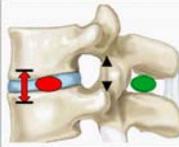
LLIF Approach

- Good indirect decompression
- Good coronal correction
- Solid stabilization construct

A Radiographic Assessment of the Ability of the Extreme Lateral Interbody Fusion Procedure to Indirectly Decompress the Neural Elements

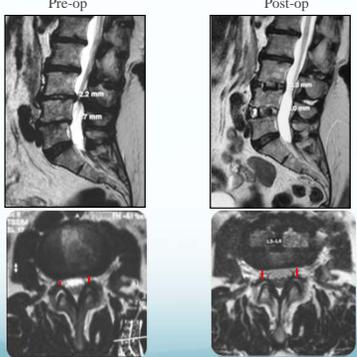
Leonardo Oliveira, BS,* Luis Marchi, MSc,* Ezequiel Costinho, MD,* and Luiz Fimenta, MD, PhD†

- ↑ 41.9% in disc height
- ↑ 13.5% in foraminal height
- ↑ 24.7% in foraminal area
- ↑ 33.1% in central canal diameter
- 2 patients (9.5%) required a second procedure for additional posterior decompression and/or instrumentation.

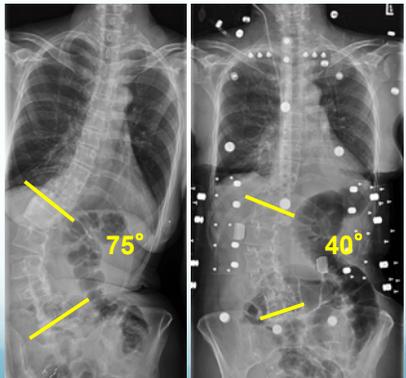


Indirect Decompression

Pre-op Post-op



Coronal Correction



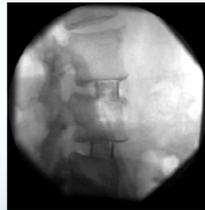
Stability & Fusion Rates

- Strong construct with high rates of fusion (up to 98%)
 - Rodgers et al, SAS journal 2010
 - Anand et al, Neurosurg focus 2010
 - Dakwar et al, Neurosurg focus 2010
 - Zavatsky et al, Ochsner J 2014



Standalone

- Does it provide adequate rigidity for fusion?
- Does it stand the test of time (maintain indirect decompression & deformity correction)?
- Subsidence
- Do certain conditions alter success?
 - osteoporosis
 - spondylolisthesis
 - Scoliosis
 - # of levels
- Can we mitigate complications?
- How much rigidity is necessary to achieve fusion?
- What form of supplemental fixation provides adequate rigidity?
 - Lateral plate
 - Facet screws
 - Spinous process fixation device
 - Unilateral pedicle screws
 - Bilateral pedicle screws



Contents lists available at ScienceDirect
Clinical Neurology and Neurosurgery
Journal homepage: www.elsevier.com/locate/clinneu

Review
Minimally invasive lateral transposas interbody fusion using a stand-alone construct for the treatment of adjacent segment disease of the lumbar spine: Review of the literature and report of three cases

Sheri K. Palejwala, Whitney A. Sheen, Christina M. Walker, Jack H. Dunn, Ali A. Baig

Utilized commonly for adjacent level disease

The Scientific World Journal
Volume 2012, Article ID 454546, 7 pages
doi:10.1500/2012.454546

The Scientific World JOURNAL

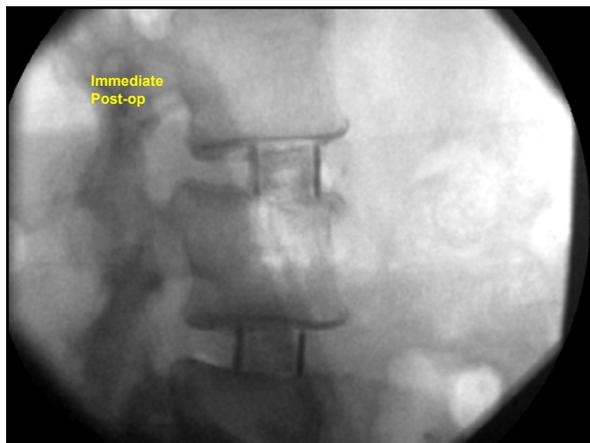
Clinical Study
Stand-Alone Lateral Interbody Fusion for the Treatment of Low-Grade Degenerative Spondylolisthesis

Luis Marchi,^{1,2} Nitamar Abdala,¹ Leonardo Oliveira,¹ Rodrigo Amaral,¹ Etevaldo Coutinho,¹ and Luiz Pimenta^{1,2}

- Prospective nonrandomized observational single-center study.
- Stand-alone LLLF on 52 consecutive patients (67.6 ± 10 y/o; 73.1% female; 27.4 ± 3.4 BMI) with single-level grade I/II single-level degenerative spondylolisthesis without significant spine instability with 2-year follow-up were included.
- Average OR time 73.2 minutes and with less than 50cc blood loss.
- VAS and Oswestry scores showed lasting improvements in clinical outcomes (60% and 54.5% change, resp.).
- The vertebral slippage was reduced in 90.4% of cases from mean values of 15.1% preoperatively to 7.4% at 6-week follow-up (P < 0.001) and was maintained through 24 months (7.1%, P < 0.001).
- Segmental lordosis (P < 0.001) and disc height (P < 0.001) were improved in postop evaluations.

Grade II or III cage subsidence occurred in 9/52 cases (17%)
7/52 cases (13%) spine levels needed revision surgery

At the 24-month evaluation, solid fusion was observed in 86.5% of the levels treated



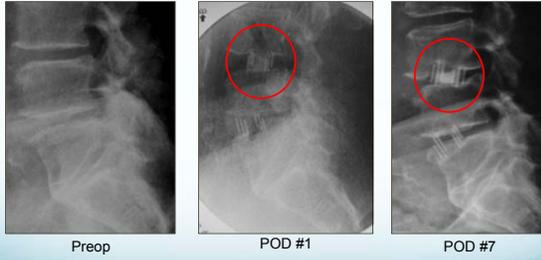




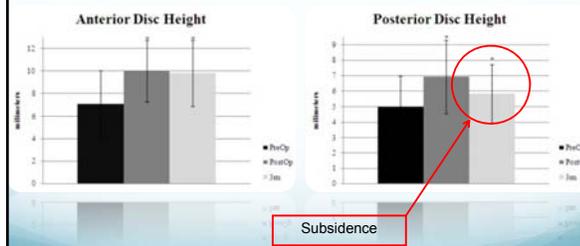




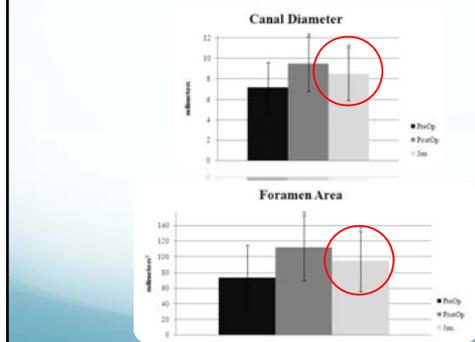
When Does Subsidence Occur?



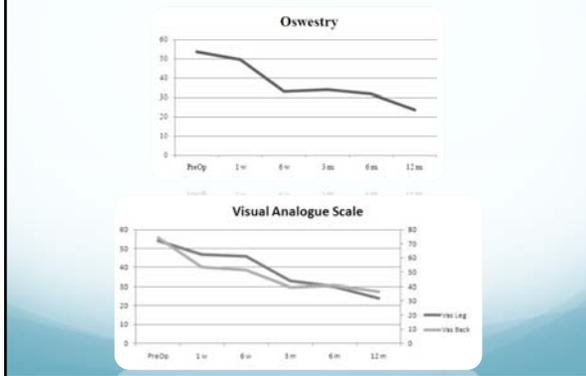
Disc Height



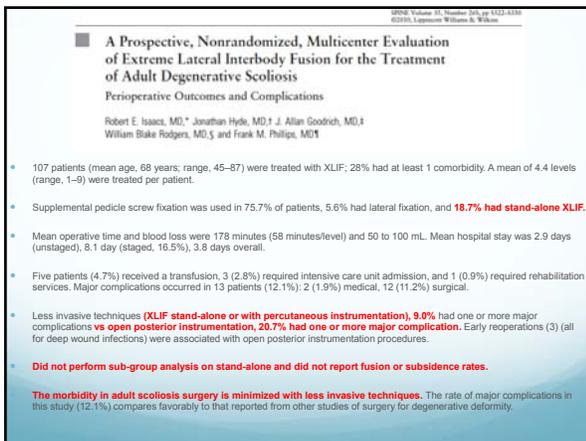
Canal & Foraminal Decompression



But...Clinical Improvements Persist







ScienceDirect
SAS Journal

Two-year clinical and radiographic success of minimally invasive lateral transposas approach for the treatment of degenerative lumbar conditions

Birak M. Orgur, MD^{*,*}, Vijay Agarwal, MD[†], Erin Nui, BS, NP^{*,*}, Luis Pinotta, MD, PhD[†]

- 62 patients were treated with LLIF for degenerative disk disease, spondylolisthesis, scoliosis, and stenosis with a minimum 2-year follow-up between 2003 and December 2006 were included.
 - 26 patients (42%) were single-level; 13 (21%) 2-level; **23 (37%) 3- or more levels.**
- 13 (21%) were stand-alone**
- 45 (73%) included supplemental posterior pedicle fixation; 4 (6%) lateral fixation
 - Fifty-seven (92%) included the use of bone morphogenic protein (BMP), the remainder a mixture of allograft and autograft.
- VAS decreased significantly from pre-op to 2-year follow-up by 37% (p<0.0001).
- ODI decreased significantly by 39% from pre-op to 2-year follow-up (p<0.0001).
- Clinical success by ODI-change definition was achieved in 71% of patients.
- Radiographic success was achieved in 91% of patients
 - 1 patient with pseudarthrosis requiring posterior revision (Did not specify stand-alone, BMP?)**



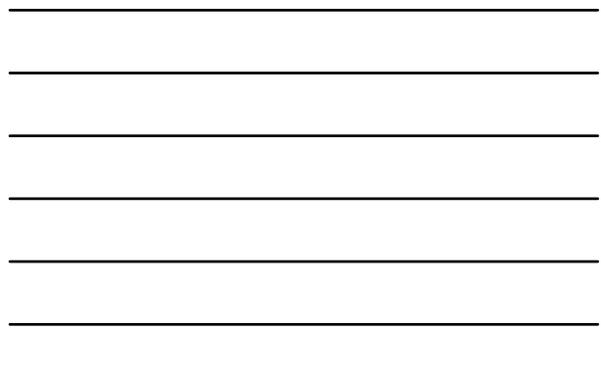
Clinical Orthopaedics and Related Research

SYMPOSIUM: MINIMALLY INVASIVE SPINE SURGERY

Is the Lateral Transposas Approach Feasible for the Treatment of Adult Degenerative Scoliosis?

Carlo Castro MD, Leonardo Oliveira BS, Rodrigo Amaral MD, Luis Marchi MS, Luis Pinotta MD, PhD

- 62 patients were treated surgically for adult degenerative scoliosis between 2004 and 2008.
- 46 (74%) were treated with **stand-alone** lateral lumbar interbody fusion
 - 35 patients** (nine men, 26 women; mean \pm SD age, 68 \pm 10 years) were available for this retrospective review
 - 107 levels were treated (mean, three; range, one to seven)
- Mean VAS back pain scores improved from 85 mm pre-op to 27 mm at latest follow-up (p<0.001)
- VAS leg pain scores improved from 91 mm to 24 mm (p<0.001)
- ODI scores improved from 51 to 29 (p<0.001)
- Coronal Cobb improved from 21° to 12° (p<0.001); Lumbar lordosis improved from 33° to 41° (p<0.001); Sacral slope improved from 28° to 35° (p<0.001)
- Fusion rate was 84% at final evaluation
- High-grade subsidence was seen in 10 patients (29%)**
- 3 patients (9%) needed further surgical intervention**



30th Annual Meeting of the AANS/CNS Section on Disorders of the Spine and Peripheral Nerves

Stand-Alone LLIF vs. Perc Screws

Title: Stand Alone Lateral Interbody Fusion (sALIF) vs Circumferential Minimally Invasive Surgery (cMIS) for Adult Spinal Deformity (ASD)

Authors: Adam S. Karter, David O. Chintrakul, Bryan D. Stolinger, Gregory Munko, Juan S. Urbac, Michael Y. Wang, Praveen V. Mummaneni, Heel Anand, Richard D. Fessler, S. Paul Park, Ka-Keung C. Fu, Virginia Lefkovic, James Tettin, Barbara A. Adams, Vaidhyanathan International Spine Study Group

Field #: 208

View Poster

Introduction: Minimally invasive surgery for ASD is gaining popularity with the promise of reducing surgical complication rates. Lateral lumbar interbody fusion (LLIF) is one such advance, often supplemented by posterior MIS pedicle screws (PP). Controversy exists whether MIS LLIF requires PP to enhance correction, promote stiffness for arthrodesis, and improve outcomes.

Methods: A multicenter retrospective analysis of prospectively collected data of 45 patients, from 7 sites. Inclusion criteria: age \geq 40 years with minimum of 20° Cobb angle and 1 year follow-up. In cMIS, patients underwent LLIF followed by PP; in sALIF, patients underwent transposas LLIF without PP.

Results: Mean follow-up was 29 mos for cMIS (n=39) and sALIF (n=6). Preoperatively, there were no differences between cMIS and sALIF in age (53.6 vs 53.9 yrs), gender, or radiographic parameters (Lumbar Cobb 32° vs 34.3°, SVA+2 30m vs 3.1cm, P-LL+21°, respectively for cMIS and sALIF). sALIF patients had a longer ASA grade (2.8 vs 3.4, p=0.015), more subsidence (3.7 vs 1.4, p=0.001), more sALIF subjects were operated (68.7% vs 15.4%, p=0.016). The cMIS group exhibited significant Cobb angle correction (31° to 19°, p<0.001) and increase in lumbar lordosis (34° vs 40°, p=0.001). sALIF did not. Both groups had significant improvements in ODI (41 pre-op to 23 post-op for cMIS, and 43 to 29 for sALIF), with no difference between groups.

Conclusions: Patients treated with sALIF had greater medical problems and history of previous spine surgery. In this study, addition of PP to MIS LLIF results in better correction compared to sALIF procedures alone. Despite greater disability and previous surgery rates, the sALIF group demonstrated equivalent results in clinical outcomes, but limited deformity correction. Long-term follow-up is essential to evaluate patients that did not meet the intended radiographic goals as long-term success has been associated with global sagittal and coronal balance.

- Stand-alone**
 - More revision cases had stand-alone performed**
 - Insignificant Cobb and lordosis correction**
 - Significant improvement in ODI (43 \rightarrow 29)**



Spine
 CLINICAL CASE SERIES
 SPINE, Volume 39, Number 5, pp E324-E331
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Rate of Revision Surgery After Stand-alone Lateral Lumbar Interbody Fusion for Lumbar Spinal Stenosis

Venu M. Neman, MD, PhD,* Alexander Aichmair, MD,* Fadi Taher, MD,† Darren R. Lehl, MD,* Alexander P. Hughes, MD,* Andrew A. Sama, MD,* Frank P. Cammisia, MD,* and Federico P. Girardi, MD*

- 117 patients stand-alone LLIF for symptomatic spinal stenosis with an indication for fusion were included in the analysis.
- **10.3% of patients ultimately required revision surgery**
 - Persistent radiculopathy
 - Symptomatic implant subsidence
- Average time to revision was 10.8 months.
- No difference in radiographic correction between patients who did and did not require revision surgery.
- Authors concluded that LLIF provides a minimally invasive means to treat lumbar spinal stenosis with an acceptable revision rate for foraminal posterior decompression at early follow-up.

Assuming Subsidence is a Problem... ... Can it be Prevented?

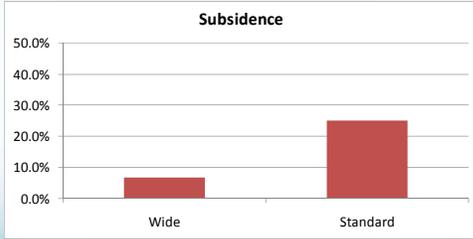


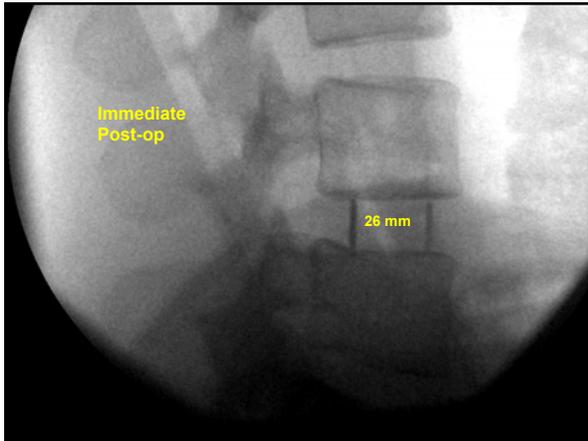
Subsidence

↑Area = ↓Pressure



Subsidence Wide vs. Standard





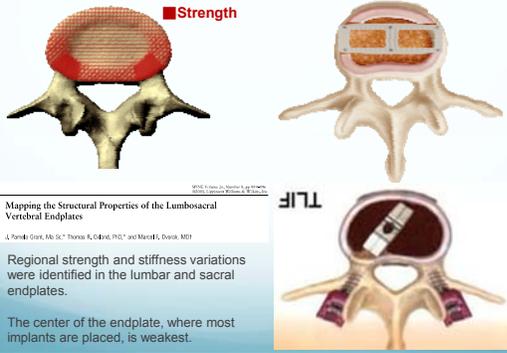


Wider Cages (22, 26, 30 mm)



Greater surface area coverage of apophyseal ring = subsidence prevention and improved fusion

Spanning the Apophyseal Ring & Endplate Preservation

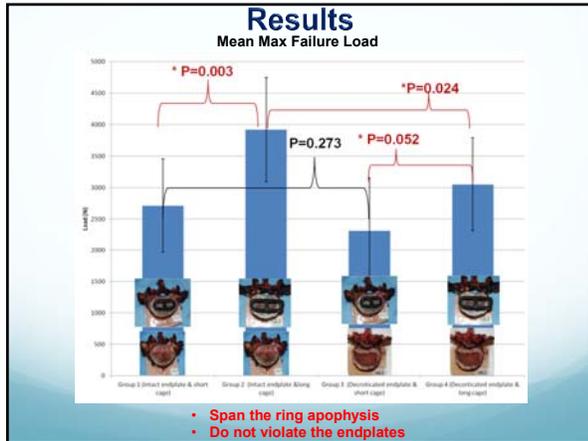


- Mapping the Structural Properties of the Lumbosacral Vertebral Endplates
- Regional strength and stiffness variations were identified in the lumbar and sacral endplates.
- The center of the endplate, where most implants are placed, is weakest.

Bone Quality & Endplate Preparation

- Subsidence can occur even with pedicle screw supplementation.
- Osteoporosis
- Respect the endplates





Cage Migration

- Cage migration
 - Cage size?
- Contralateral annulus release?
- Inadequate discectomy?
- Supplemental augmentation?

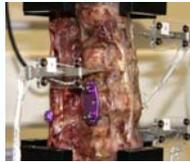
Open Access Case Report DOI: 10.7759/curius.347

Stand-alone LLIF Lateral Cage Migration: A Case Report

Wendy S. Towers¹, Khalid H. Kurtom¹

How Much Rigidity is Required?

- Standard cage alone
- Cage + lateral plate
- Cage + spinous process fixation
- Plate + spinous process fixation
- Cage + Ipsilateral pedicle screws
- Cage + Bilateral pedicle screws



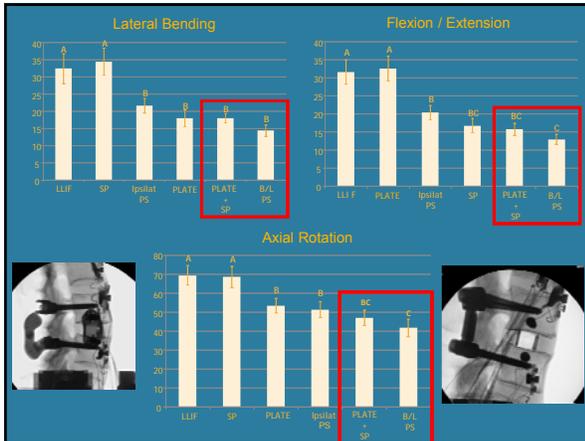
J Neurosurg Spine 20:791-797, 2014
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Biomechanics of lateral lumbar interbody fusion constructs with lateral and posterior plate fixation

Laboratory investigation

GUY R. FOGEL, M.D.,¹ RACHIT D. PARIKH, M.S.,² STEPHEN L. RYU, M.D.,^{3,4} AND ALEXANDER W. L. TURNER, Ph.D.²

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Thank you