

The Future of Posterior MIS Solutions

Role of Expandable Technology

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Life moves us

merc

Indications for Surgery

- **Decompression**
 - Spinal cord / nerve roots
- **Realignment**
 - Correct deformity
- **Stabilisation**
 - Prevent / Treat
 - Neurological deficit / deformity / pain
 - (Non fusion technology form of "stabilisation")

All may require fusion

Require Instrumentation

Instrumentation increases fusion

Real Purpose of Surgery

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The Evolution of MIS

1829 Lumbar Laminectomy for Discectomy (Smith)	1969 Chymopapain Chemoneurolysis (Smith)	1999 MIS-Cervical Odontoid Screw Placement (Morgan)
1893 Lumbar Laminectomy for Stenosis (Lane)	1975 Percutaneous Nucleotomy (Hukuda)	2000 Intradiscal Electrostimulation (ICET) (Saul)
1911 Lumbar Fusion (Albee, Hibbs)	1982 Percutaneous Pedicle Screws (Magerl)	2000 MIS-Cervical Laminoforaminotomy (Roh)
1925 Cervical Laminectomy for Discectomy (Elsberg)	1984 Laser Percutaneous Discectomy-LPD (Ascher)	2000 Kyphoplasty (Wong)
1933 Anterior Lumbar Interbody Fusion - ALIF (Burns)	1985 Automated Percutaneous Lumbar Discectomy-aPLD (Maroon, Onik)	2001 Sextant Percutaneous Pedicle Screw System (Foley)
1939 Internal Spine Fixation (Hadra)	1987 Lumbar Arthroscopic Discectomy (Kambin)	2002 MIS-Lumbar Laminectomy for Stenosis (Gulot, Khoo, Pajevic)
1952 Posterior Lumbar Interbody Fusion - PLIF (Cloward)	1987 Vertebroplasty (Gallibert)	2002 MIS-PLIF (Khoo)
1955 ACDF (Robinson)	1991 Laparoscopic Anterior Lumbar Discectomy (Obenchain)	2003 Tubular Discectomy using Microscope-METRX (Foley)
1958 ACDF (Cloward)	1993 Percutaneous Facet Fusion (Wang)	2004 Transaxial Approach (Cragg)
1966 Lumbar Artificial Disc Replacement -ADR (Fernstrom)	1994 MIS-Thoracic Discectomy (Hosozaki)	2004 MIS-Cervical Laminoplasty (Perez-Cruet)
1967 Lumbar Microdiscectomy (Yasargil)	1995 MIS-ALIF (Mathews, Zucherman)	2006 Interspinous Device-XSTOP
1982 Transforaminal Interbody Fusion - TLIF (Harms)	1997 Microendoscopic Discectomy - MED (Foley)	2006 MIS-TLIF (Holly)
1983 Thoracic Discectomy (Benjamin)	1998 Lateral Transpos Approach-OLIF, XLIF (McAfee, Pimenta)	2008 MIS-XLDF (Huetten)
		2008 MIS-Cervical Nucleoplasty (Li)

Why MIS

1. Less blood loss
2. Less infections
3. Less post-op pain
4. Shorter hospital stay
5. Strong patient demand
6. Intense technology development
7. Cost effectiveness?
8. Long-term benefits?

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Spine DEFORMITY

Rates of Infection After Spine Surgery Based on 108,419 Procedures

A Report from the Scoliosis Research Society Morbidity and Mortality Committee

Infection Type	Approach	n	Complication rate (%)
Total infection (P = 0.005)	Open approach	6,241	2.9%
	Minimally invasive	848	1.3%
Superficial infection (P = 1.0)	Open approach	6,241	1.0%
	Minimally invasive	848	0.9%
Deep infection (P < 0.001)	Open approach	6,241	1.9%
	Minimally invasive	848	0.4%

SPINE Volume 36, Number 7, pp 556-563 ©2011, Lippincott Williams & Wilkins

Spine
SURGERY

SPINE Volume 44, Number 9, pp E331-E340
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Comparative Analysis of Two Transforaminal Lumbar Interbody Fusion Techniques

Open TLIF Versus Wiltse MIS TLIF

David H. Ge, BA, Nicholas D. Stekas, BS, Christopher G. Varlotta, BS, Charla R. Fischer, MD, Anthony Petruzzo, DO, Themistocles S. Protopsalis, MD, Peter G. Passias, MD, Thomas J. Enrico, MD, Aaron J. Buckland, MD

Conclusion. In comparing Wiltse MIS TLIF to Open TLIF, the minimally invasive paramedian Wiltse approach demonstrated the lowest EBL, LOS, readmission rates, and complications, but longer fluoroscopy times when compared with the traditional open approach.

Original Article

Minimally Invasive Versus Open Transforaminal Lumbar Interbody Fusion Surgery: An Analysis of Opioids, Nonopioid Analgesics, and Perioperative Characteristics

Global Spine Journal
2019, Vol. 29, 424-432
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DOI: 10.1177/2152450518822390
journals.sagepub.com/home/gsj
SAGE

Conclusion: Patients undergoing MIS TLIF required less inpatient opioids and had a decreased incidence of opioid dependence at 3-month follow-up. Patients with preoperative opioid use undergoing MIS TLIF are less likely to require long-term opioids.

MIS TLIF in Obese Patients

European Spine Journal (2018) 27:1877-1886
https://doi.org/10.1007/s00586-018-5630-0

REVIEW

Is MIS-TLIF superior to open TLIF in obese patients?: A systematic review and meta-analysis

Jun Hao Tan¹ · Gabriel Liu¹ · Ruimin Ng¹ · Nishant Kumar¹ · Hee-Kit Wong¹ · Gabriel Liu¹

Yes!

257SPL
227DDD
Rev lami 9

Clearly better than a HUGE hole
But is it wise to operate on obese patients?...
Op for DDD?...

Indications for Surgery

- What are you trying to achieve?
- MIS is a Tool in Surgical Armamentarium
 - Use when appropriate to achieve your goals
 - Non-maleficence - "first, do no harm" (primum non nocere).
- DO THE APPROPRIATE OPERATION FOR THE PATIENT AND THEIR PATHOLOGY AND YOUR SKILL / ABILITY

The Pathology

- For MIS TLIF / CentraLIF cases
 - L2/3 3/4 4/5 5/1 SPL with stenosis
 - Foraminal stenosis
 - Revision decompressions requiring stabilisation
 - Post discectomy LBP
 - Focal deformity with the above
 - (?) DDD causing LBP
 - Rare – infection / trauma
 - Correction of significant scoliosis / kyphosis – often requires larger surgery / osteotomies

LUMBAR LORDOSIS: A STUDY OF ANGLE VALUES AND OF VERTEBRAL BODIES AND INTERVERTEBRAL DISCS ROLE

LUZ HENRIQUE FONSECA DAMASCENO¹, SILVIO RICARDO GUIMARÃES CATAPÊ², ANTONIO DORIVAL CAMPOS³, HILTON LUIS ARNECADO DINIZ⁴

	Mean Angle (°)	Standard Deviation	Range (°)	% participation in curvature L1S1 (range)
L1-L2	-4.99 *	2.9	4.0 to -12.0	8.16 (-8.57 to 24.00)
L2-L3	-6.89 *	2.73	0.0 to -15.0	11.35 (0.00 to 27.27)
L3-L4	-9.25 *	2.54	-2.0 to -20.0	15.38 (3.03 to 30.95)
L4-L5	-12.29 *	3.39	-2.0 to -26.0	20.43 (3.81 to 42.86)
L5-S1	-15.58 *	5.43	-4.0 a -35.0	26.07 (5.80 a 56.52)

(*)Averages different from each other with p<0.001

>50% LL @ L4-S1 (21deg vs 28deg)

Tabela 2 - Intervertebral discs measurements

Lumbar curvature	Damasceno et al. n=350	Jackson and McManus, 1994 ⁽¹²⁾ n=100	Jackson et al., 1998 ⁽¹⁴⁾ n=50	Korovesis et al., 1998 ⁽¹⁵⁾ n=99	Cheng et al., 1998 ⁽¹⁶⁾ n=387	Tüzün et al., 1999 ⁽¹⁸⁾ n=150	Tsuji et al., 2001 ⁽¹⁷⁾ n=489	Guigui et al., 2003 ⁽¹³⁾ n=250
L1S1	-60.9° (-33 to -89)	-60.9° (-31 to -88)	-62.1° (-41 to -86)				-54.2°	-59°
L1L5	-45.1° (-15 to -78)			-45.7°	-41.95°	-45.85°		-43° (-13.6 to -69)

Table 6 - Lumbar lordosis measurement values found in this study and those described in literature by other authors.

Sagittal Balance / Shape of Spine

Type 1 Type 2 Type 3AP Type 3 Type 4

12% SS<35
PI 39
Inflexion L3/4
Short Hyperlordosis 51
Long Kyphosis

16% SS>35
Low grade PI 48
Longer Lordosis 64

22% SS<35
PI 41
Inflexion L1/2
Flat Long Lordosis 48

30% 35<SS<45
PI 53
Inflexion T12/L1
LL 58

20% SS>45
PI 62
Inflexion T9/T10
LL 69

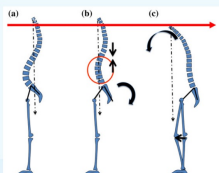
SS PI SS PI SS PI SS PI SS PI

Low grade PI High grade PI
Low grade SS High grade SS

Shape of Spine



- Type 1 – discopathy TL junction, OA facets distal arc, retrolisthesis at junction, nutcracker spondylolysis L5 in hyperlordotic area
- Type 2 – increased risk disc herniation (central) at younger age, multilevel discopathy
- Type 3 – average
- Type 4 – L5 isthmic lysis, later age posterior OA and L4/5 SPL



IDENTIFYING AND UNDERSTANDING THE DEGENERATIVE CASCADE AND SPINE TYPES IS VERY IMPORTANT IN TREATING SPINAL CONDITIONS

THE CASCADE RESULTS IN FLAT BACK

Decompression and Sagittal Imbalance



The Spine Journal 17 (2007) 175–182



Clinical Study

Sagittal imbalance in patients with lumbar spinal stenosis and outcomes after simple decompression surgery

E. Kyung Shin, BS*, Chi Heon Kim, MD, PhD^{a,b,c,d,e}, Chun Kee Chung, MD, PhD^{a,b,c,d,e}, Yunhee Choi, PhD^f, Dahae Yim, MS^f, Whei Jung, BS^f, Sung Bae Park, MD^{a,b,c,d,e}, Jung Hyeon Moon, MD^{a,c}, Won Heo, MD^{a,c}, Sung-Mi Kim, RN^a

"Sagittal imbalance was observed in more than 50% of LSS patients, but this imbalance was correctable via simple decompression in 70% of patients."
83 patients

MIS TLIF and Sagittal Balance 1



Impact of sagittal imbalance correction on clinical outcomes in patients undergoing MIS-TLIF for LSS

Clinical Neurology and Neurosurgery 181 (2019) 119–126

Jun Jia^a, Yiwei Zhao^a, Xinyu Liu^{a,b,c,*}

Conclusions: A significant proportion of LSS patients with preoperative sagittal malalignment had a compensatory mechanism rather than a structural malalignment, while single-segment MIS-TLIF could effectively improve sagittal imbalance at 2-year follow-up. However, we found no correlation between the improvements of sagittal imbalance and 2-year clinical outcomes. Reconstruction of sagittal balance might not be the main goal of single-segment MIS-TLIF for LSS, and did not affect its clinical results at two-year follow-up.

114 LSS cases

MIS TLIF and Sagittal Balance 2



ORIGINAL ARTICLE/ARTIGO ORIGINAL/ARTÍCULO ORIGINAL

IMPACT OF THE MIS-TLIF TECHNIQUE ON THE SPINOPELVIC PARAMETERS OF PATIENTS WITH LUMBAR ARTHRODESIS

IMPACTO DA TÉCNICA MIS-TLIF NOS PARÂMETROS ESPINOPÉLVICOS DE PACIENTES COM ARTRODESE LOMBAR

IMPACTO DE LA TÉCNICA MIS-TLIF SOBRE LOS PARÁMETROS ESPINOPÉLVICOS DE PACIENTES CON ARTRODESIS LUMBAR

Cristiano Magalhães Mendes,^{1,2} Leonardo Fernandes Aguiar,^{1,2} André de Oliveira Araújo,¹ Rodrigo Vieira Cardoso,¹ Germano Senna Oliveira do Valle,² Rodrigo Souza Lima,¹ Mario Leite Bregin,¹ Felipe Miranda Mendonça Fernandes,¹ Joao Halley Guimarães Pinz¹

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<http://dx.doi.org/10.1056/j.bone.2018.05.011>
Cervical spine 2018;18(1):178

ABSTRACT

Objective: To evaluate the influence of the MIS-TLIF technique on the spinopelvic parameters of patients submitted to lumbar arthrodesis up to three levels for the treatment of vertebral degenerative conditions without deformity. **Methods:** Retrospective radiographic evaluation of 52 patients submitted to the surgical treatment of lumbar arthrodesis using the MIS-TLIF technique in up to three levels. The spinopelvic parameters – pelvic incidence (PI), pelvic tilt (PT), lumbar lordosis (LL), segmental lordosis (Lseg), and the difference between lumbar lordosis and pelvic incidence (LL-PI mismatch) were analyzed in orthostatic lateral radiographs in the pre- and postoperative periods, with a minimum follow-up of 1 year. The patients were divided into three groups: PI < 45°, PI between 45° and 55° and PI > 55°. **Results:** Sixty-nine operated levels were evaluated in 15 patients with PI < 45°, 19 with PI between 45° and 55° and 18 with PI > 55°. The mean value of the pelvic incidence was 52.3° (± 11.5), lumbar lordosis 48.1° (pre) 45.6° (post), segmental lordosis 20.2° (pre) 20.6° (post), pelvic tilt 18.5° (pre) 18.2° (post), "mismatch" (P-LL) 7° (pre) 6.6° (post), with no statistical difference among all parameters (p > 0.05). **Conclusions:** The MIS-TLIF technique had no influence on postoperative spinopelvic parameters of patients undergoing lumbar arthrodesis surgery. **Level of evidence:** III. Retrospective comparative study.

Decompression Alone for SPL 1



Eur Spine J (2017) 26:414–419
DOI 10.1007/s00586-016-4637-7



ORIGINAL ARTICLE

The outcome of decompression alone for lumbar spinal stenosis with degenerative spondylolisthesis

Sarfraz Ahmad^a · Abdulkader Hamad^a · Amit Bhatia^a · Sarah Turner^a · Birender Balain^a · David Jaffray^a

Rate of post-operative instability and subsequent fusion 10%
83 cases SP osteotomy

Decompression Alone for SPL 2



Eur Spine J (2017) 26:404–413
DOI 10.1007/s00586-016-4663-1



ORIGINAL ARTICLE

The effectiveness of decompression alone compared with additional fusion for lumbar spinal stenosis with degenerative spondylolisthesis: a pragmatic comparative non-inferiority observational study from the Norwegian Registry for Spine Surgery

Ivar M. Austevoll¹ · Rolf Gjestad^{1,2} · Jens Ivar Brox^{3,4} · Tore K. Solberg^{5,7} · Kjersti Storheim⁸ · Frode Rekeland¹ · Erland Hermansen^{1,2,9} · Kari Indrekvam^{1,2} · Christian Hellum^{3,10}

"A considerable number of patients can be treated with decompression alone."

Decompression Alone for SPL 3



NEUROSURGICAL FOCUS

Neurosurg Focus 46 (5):E13, 2019

A comparison of minimally invasive transforaminal lumbar interbody fusion and decompression alone for degenerative lumbar spondylolisthesis

Andrew K. Chan, MD,¹ Erica F. Blisson, MD, MPH,² Mohamad Bydon, MD,³ Steven D. Glassman, MD,⁴ Kevin T. Foley, MD,⁵ Eric A. Potts, MD,⁶ Christopher I. Shaffrey, MD,⁷ Mark E. Shaffrey, MD,⁸ Domagoj Coric, MD,⁹ John J. Knightly, MD,¹⁰ Paul Park, MD,¹¹ Michael Y. Wang, MD,¹² Kai-Ming Fu, MD, PhD,¹³ Jonathan R. Slotkin, MD,¹⁴ Anthony L. Asher, MD,¹⁵ Michael S. Virk, MD, PhD,¹⁶ Panagiotis Kerezoudis, MD, MS,¹⁷ Mohammed Ali Alvi, MBBS,¹⁸ Jian Guan, MD,¹⁹ Regis W. Haid, MD,²⁰ and Praveen V. Mummaneni, MD¹

Reoperation rate 14% vs 1.4%
143 MIS TLIF and 71 MIS decompression

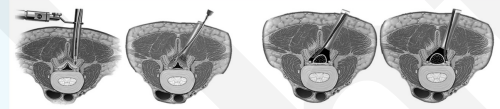
Decompression Alone for SPL 4



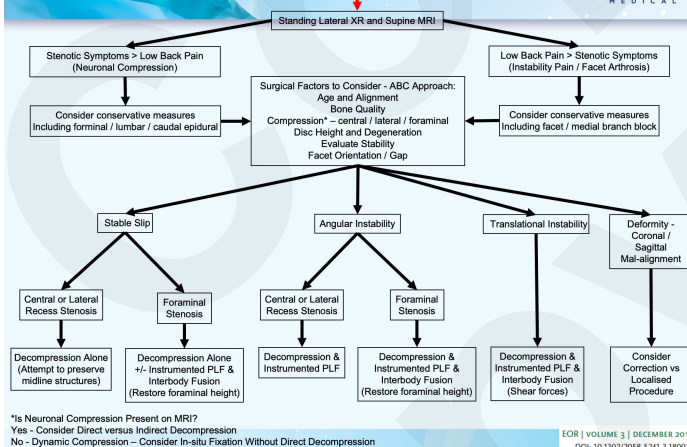
SPINE

Minimally invasive spinal decompression for degenerative lumbar spondylolisthesis and stenosis maintains stability and may avoid the need for fusion

Microendoscopic laminotomy
242 cases
8% reoperation rate

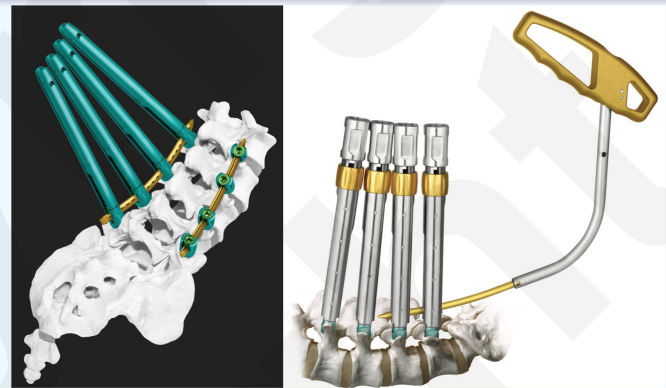


Low Grade Degenerative L4/5 Spondylolisthesis

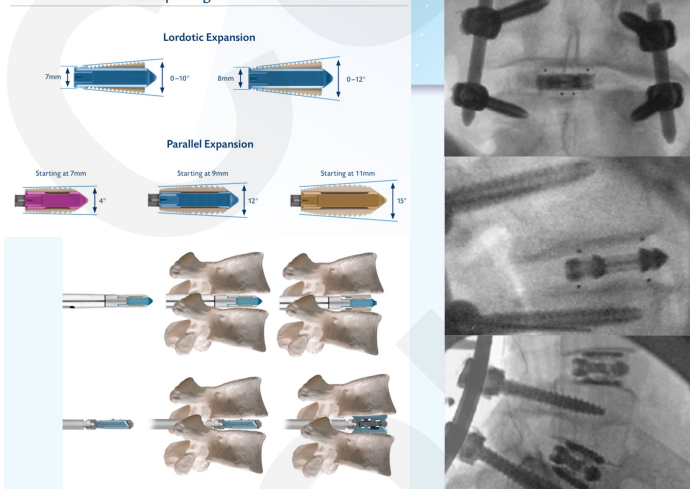


EBOR | VOLUME 3 | DECEMBER 2018
DOI: 10.1302/2058-5241.3.180020

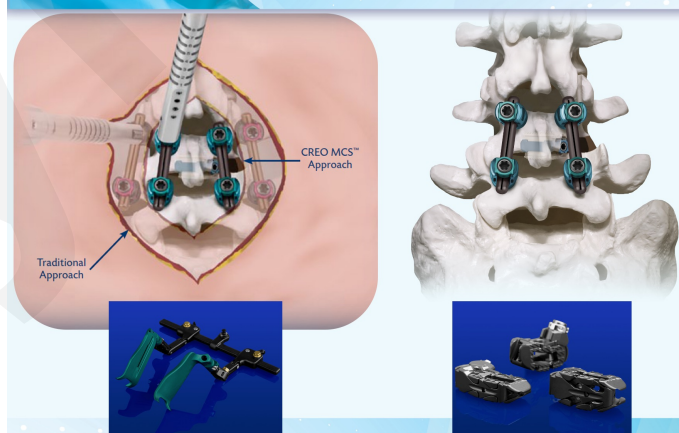
The Implants

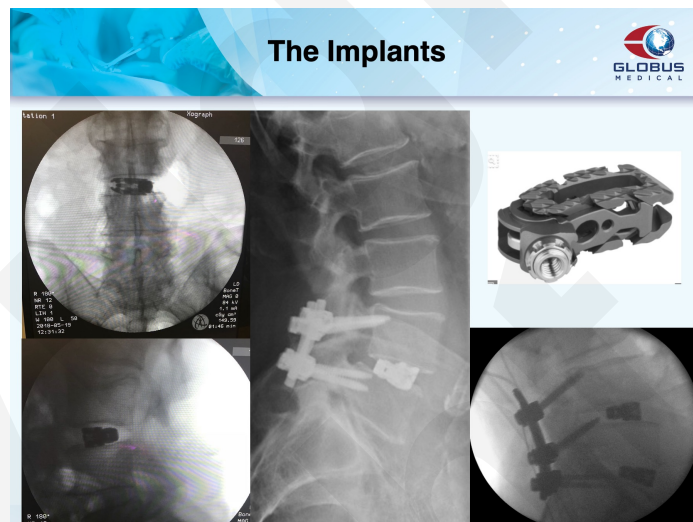
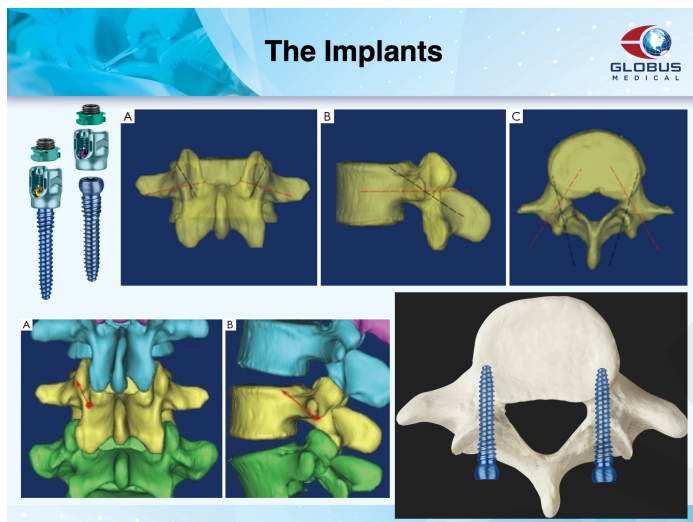


Multiple Sagittal Profiles



The Implants





Fusion

- Fusion – think:
 - α contact surface area ($1/\alpha$ subsidence)
 - $\uparrow$ compression $\downarrow$ tension
 - autograft > allograft > synthetic
 - vascular > avascular
 - structural graft > non structural
 - Biologics...
 - And unfortunately fusion may not be α clinical outcome
- **BUT, Joints are designed to move**
 - Fusion is abnormal
 - Beware – nature against you!

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Fusion

- Is an interbody fusion required?
 - Restore foraminal height (up / down)
 - Improve fusion
 - Revision of failed posterolateral fusion
 - Restore lordosis / correct deformity
 - Biomechanics – shear / large disc height / entire facet removed / long construct involving L5/S1

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Shape of Spine – Restoring Lordosis

- Posterior – **Close at the Back**
 - Osteotomies +/- cages
- Anterior / Lateral – **Open at the Front**
 - Wedged cages (take down the ALL)
- Anterior and Posterior
- Do expandable cages “restore” lordosis...?

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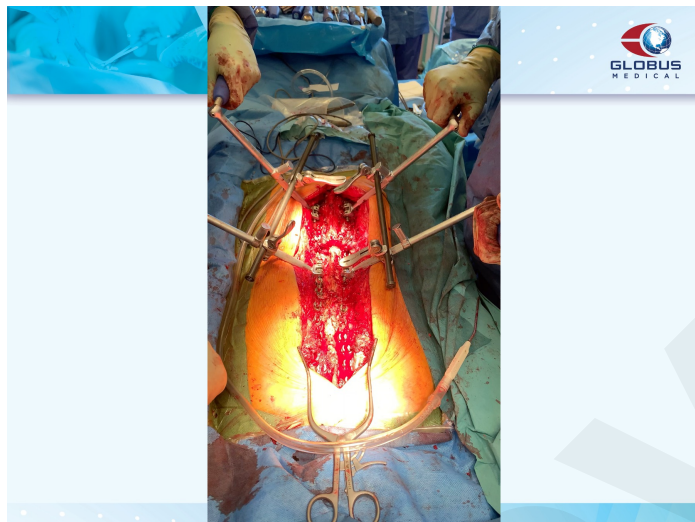
Effect of steerable cage placement during minimally invasive transforaminal lumbar interbody fusion on lumbar lordosis

Timothy E. Lindley^a, Stephanus V. Viljoen^b, Nader S. Dahdaleh^{c,*}

- Bilateral facetectomies
- Cage at front
- Close at back
- Improves lordosis

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Journal of Clinical Neuroscience 21 (2014) 441–444



Static vs Expandable 1

NEUROSURGICAL FOCUS
Neurosurg Focus 43 (2):E10, 2017

Minimally invasive transforaminal lumbar interbody fusion with expandable versus static interbody devices: radiographic assessment of sagittal segmental and pelvic parameters

Conclusions

MIS-TLIF with an expandable interbody device led to a larger and longer-lasting increase in disc height, foraminal height, and index-level segmental lordosis than MIS-TLIF with a static interbody device, especially for patients with a collapsed disc space. MIS-TLIF did not affect radiographic pelvic parameters.

**19 static in 16 pts
29 exp in 28 pts**

Static vs Expandable 2

NEUROSURGICAL FOCUS
Neurosurg Focus 44 (1):E8, 2018

Assessment of radiographic and clinical outcomes of an articulating expandable interbody cage in minimally invasive transforaminal lumbar interbody fusion for spondylolisthesis

49 exp in 44 pts

CONCLUSIONS

The use of this expandable, articulating, lordotic, or hyperlordotic interbody cage for MIS TLIF provides a significant restoration of segmental height and segmental lordosis, with associated improvements in sagittal balance parameters. Patients treated with this technique had acceptable levels of fusion and significant reductions in pain and disability.

Static vs Expandable 3

THE SPINE JOURNAL
The Spine Journal 19 (2019) 951–958

Restoration of lumbar lordosis after minimally invasive transforaminal lumbar interbody fusion: a systematic review

Brandon B. Carlson, MD, MPH^a, Philip Saville, MD^a, James Dowdell, MD^b, Rie Goto, MSLIS^c, Avani Vaishnav, MBBS^a, Catherine Himo Gang, MPH^a, Steven McAnany, MD^a, Todd J. Albert, MD^a, Sheeraz Qureshi, MD, MBA^{a,c}

CONCLUSIONS:

The current literature on MI-TLIF and restoration of LL/SL is limited to 16 published studies, 44% of which are retrospective. The published evidence supporting LL and SL restoration with MI-TLIF is sparse with variable results. This systematic review demonstrates the need for future high-level studies to fully elucidate the capabilities of MI-TLIF procedures for restoring lumbar and segmental lordosis. © 2018 Elsevier Inc. All rights reserved.

Static vs Expandable 4

Segmental lordosis				Lumbar lordosis			
	Static (n=111)	Expandable (n=60)	p value ^a		Static (n=111)	Expandable (n=60)	p value
Low lordosis	n=27	n=21		Low lordosis	n=27	n=21	
• Preoperative	10.35±3.33	9.39±3.55	.350	• Preoperative	46.86±12.64	49.27±13.27	.442
• Postoperative	13.76±6.16	14.91±6.65	.406	• Postoperative	48.25±11.50	48.20±12.02	.876
• p value ^a	p=.001	p=.001		• p value ^a	p=.773	p=.543	
Moderate lordosis	n=48	n=24		Moderate lordosis	n=48	n=24	
• Preoperative	19.05±2.68	18.59±2.54	.444	• Preoperative	56.69±9.85	56.63±10.02	.783
• Postoperative	17.33±5.40	20.36±5.50	.036	• Postoperative	54.70±10.74	52.33±9.48	.239
• p value ^a	p=.026	p=.247		• p value ^a	p=.037	p=.004	
High lordosis	n=36	n=15		High lordosis	n=36	n=15	
• Preoperative	29.44±3.07	28.62±2.79	.457	• Preoperative	62.11±12.82	59.20±10.25	.450
• Postoperative	25.32±6.98	25.91±5.87	.901	• Postoperative	57.94±13.68	56.86±10.28	.634
• p value ^a	p=.001	p=.078		• p value ^a	p=.003	p=.334	

**Weighted mean SL pre 13 to post 15 degrees
Weighted mean LL pre 40 to post 45 degrees**

**Depends on "Shape of Spine"
"Lordotic Spine You'll Be Fine"**

Static vs Expandable 5

Assessing the Difference in Clinical and Radiologic Outcomes Between Expandable Cage and Nonexpandable Cage Among Patients Undergoing Minimally Invasive Transforaminal Interbody Fusion: A Systematic Review and Meta-Analysis

Mohammed Ali Alvi^{1,2}, Shyam J. Kurian³, Waseem Wahood^{1,2}, Anshit Goyal^{1,2}, Benjamin D. Elder², Mohamad Bydon^{1,2}

- No significant differences fusion rate / radiographic parameters
- Segmental lordosis better in expandable cage group
- But, change in disc height better in static cages
 - Conflicting result!
- Further studies needed including cost analysis

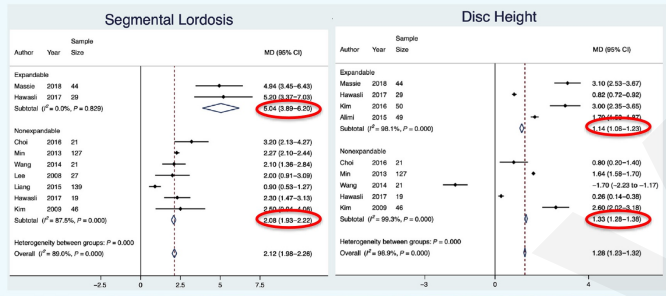
WORLD NEUROSURGERY, <https://doi.org/10.1016/j.wneu.2019.03.284>

Static vs Expandable 6



Assessing the Difference in Clinical and Radiologic Outcomes Between Expandable Cage and Nonexpandable Cage Among Patients Undergoing Minimally Invasive Transforaminal Interbody Fusion: A Systematic Review and Meta-Analysis

Mohammed Ali Alvi^{1,2}, Shyam J. Kurian³, Waseem Wahood^{1,2}, Anshik Goyal^{1,2}, Benjamin D. Elder², Mohamad Bydon^{1,2}



WORLD NEUROSURGERY, <https://doi.org/10.1016/j.wneu.2019.03.284>

Static vs Expandable 7



Original Study

J Spine Surg 2019;5(3):313-319 | <http://dx.doi.org/10.21037/jss.2019.06.07>

Expandable spacers provide better functional outcomes than static spacers in minimally invasive transforaminal lumbar interbody fusion

M. Adam Kremer¹, Jefferson Alferink¹, Stacie Wynasma¹, Torrey Shirk², Charles Ledonio²

- 48 static vs 51 expandable
- XRs only taken after 3 months if clinically indicated...
- Ave 67 vs 43 month FU contact
- 12 static recurrence pain >24/12 - further imaging - 4 had further op
- 3 exp recurrence pain >24/12 - conservative

The Benefits of Expandable Implants



- Why do I use them?:
 - Minimize tissue trauma during insertion
 - Minimize neural retraction
 - Minimize endplate trauma during insertion
 - Minimize implant subsidence (gradual load sharing)
 - Minimize cage back out
 - Maintain lordosis with lordotic implant

The Benefits of Expandable Implants



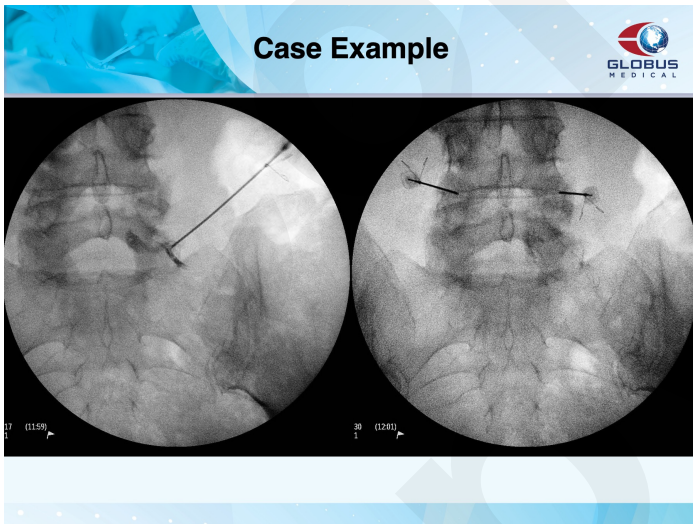
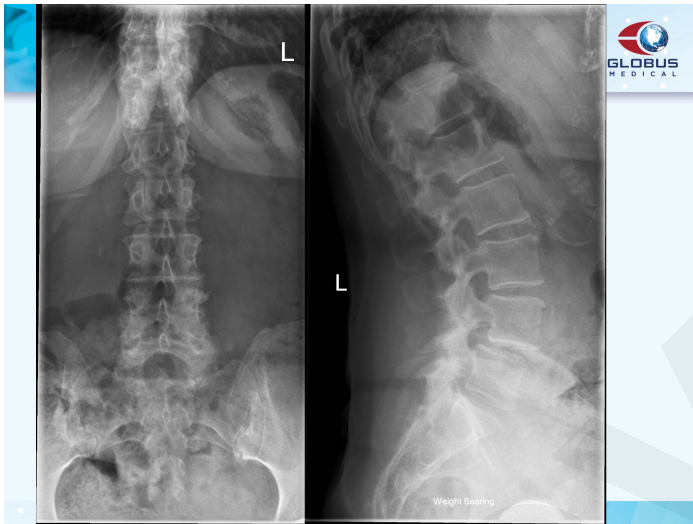
- My personal experience RISE and Caliber:
 - No cage back outs >50 cases
 - No post op subsidence
 - Yes intraop endplate damage and intra op subs
 - Yes cage insertion non parallel to endplates
 - Yes to post op perineural inflammation
 - Stopped using DBM in cage

Cases...



Case Example







My Indications MIS TLIF vs CentraLIF	
MIS TLIF	CentraLIF
- SPL Stenosis mainly unilateral - Want to directly decompress foramen / restore height - Want to avoid revision midline - Obese patient - Previous anterior surgery	- SPL stenosis mainly central / bilateral - No need to directly decompress foramen - Obese patient - Previous anterior surgery

Patient Selection



• Pt factors

- Obese vs. Slim
- Paraspinal musculature
- Infection Risk factors
- Skin issues
- Revision/ previous midline scar
- Pseudomeningocele

• Unit factors

- Technology
- Radiology
- Surgeon training



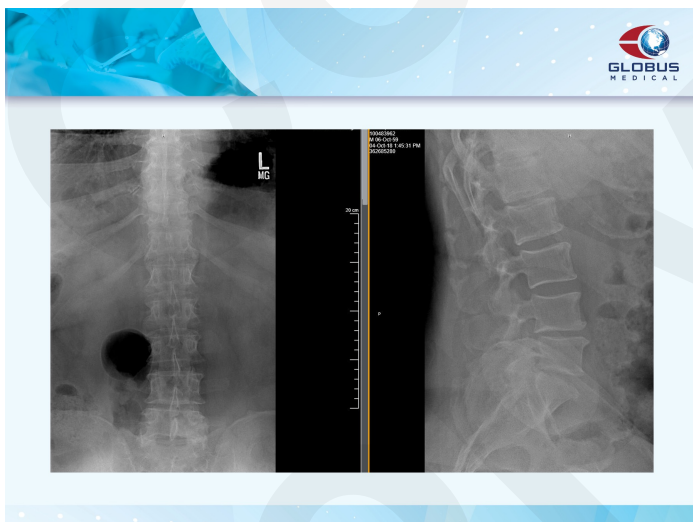
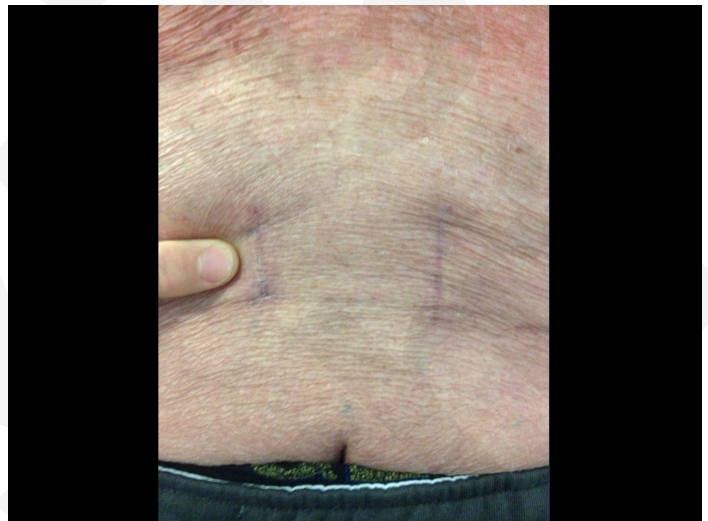
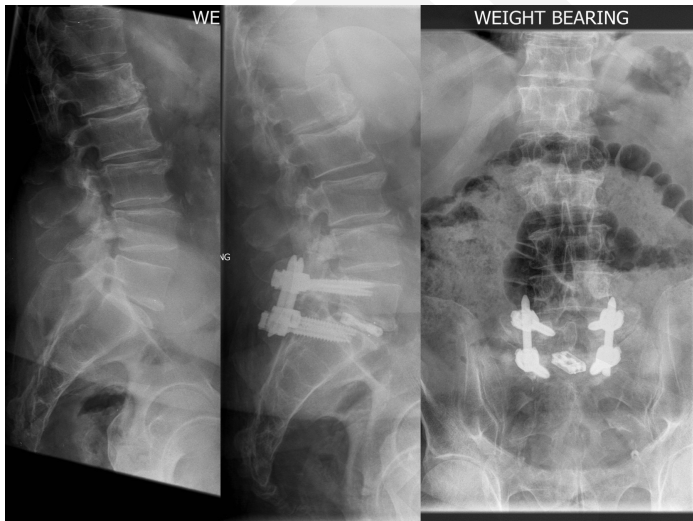
• Symptoms

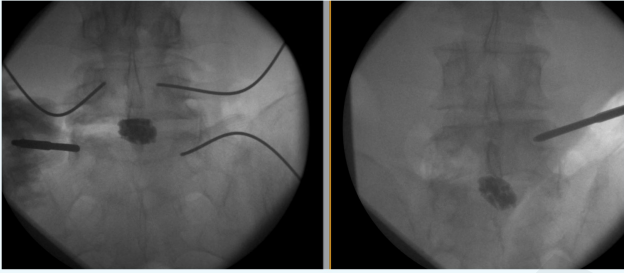
- Unilateral vs. bilateral
- Radicular vs. claudicant

• Morphology

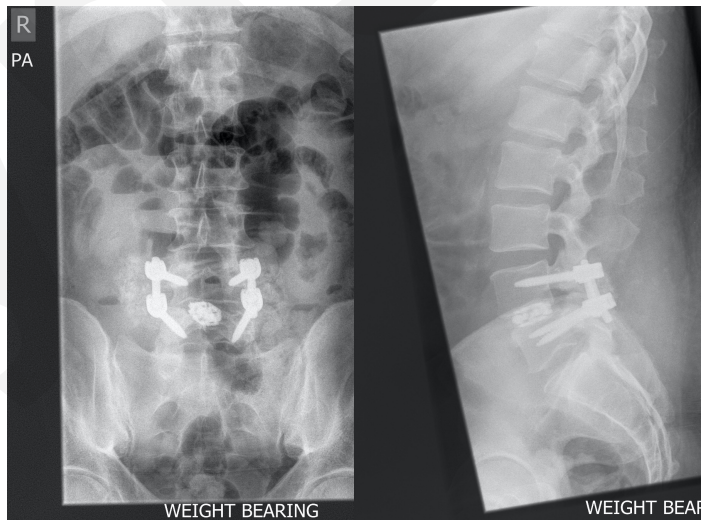
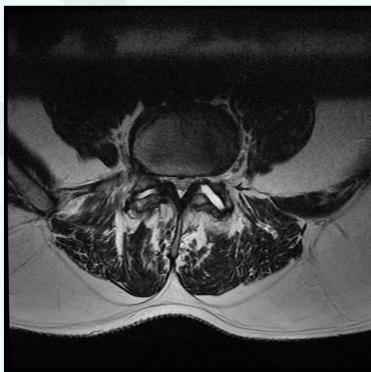
- Central vs. foraminal stenosis
- Facet arthropathy

L5/S1 Foraminal Stenosis

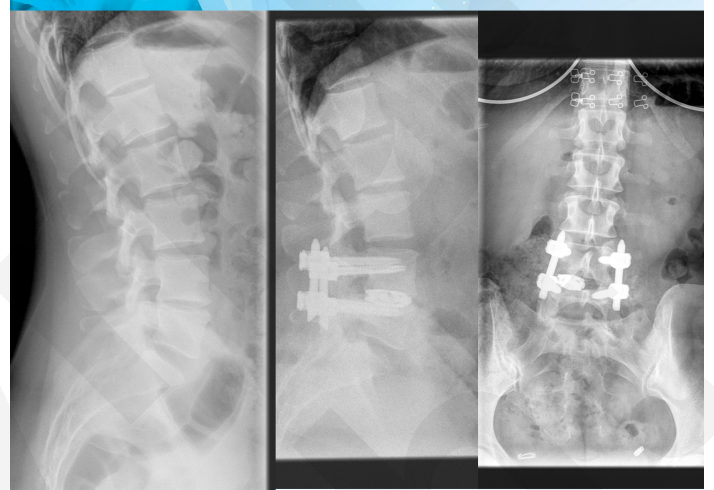




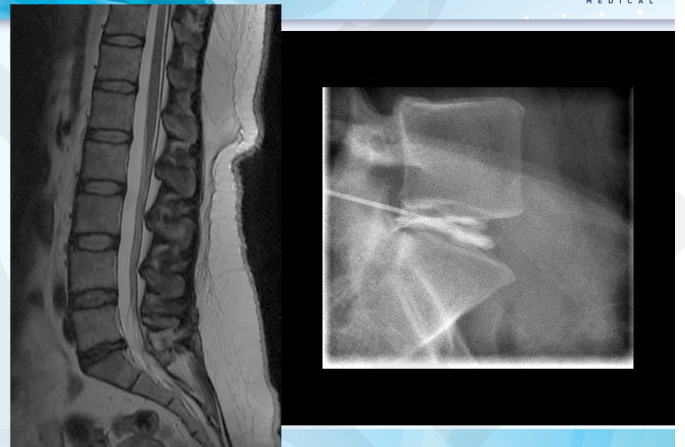
L4/5 SPL



L4/5 Foraminal Disc



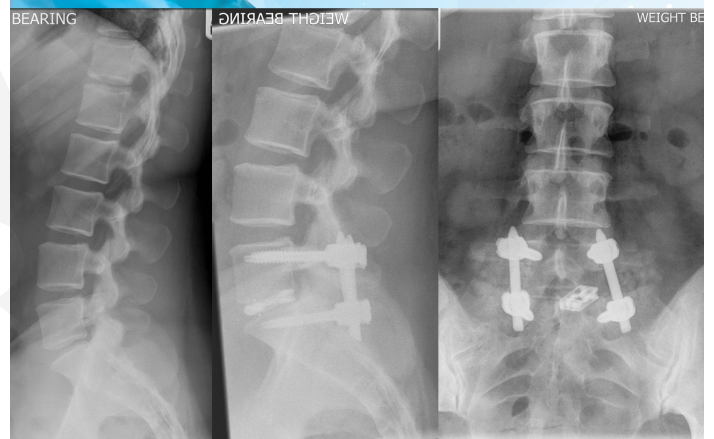
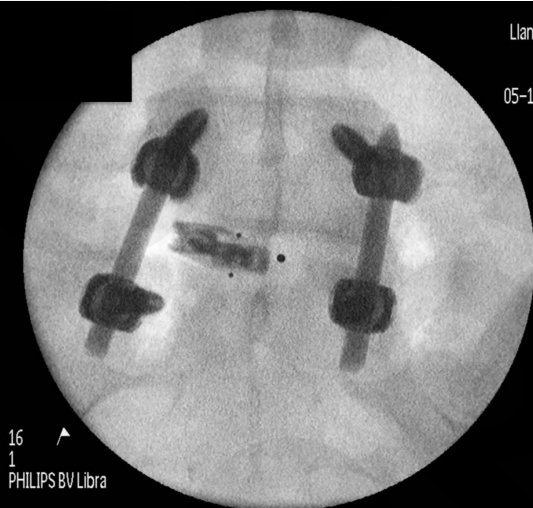
L5/S1 DDD

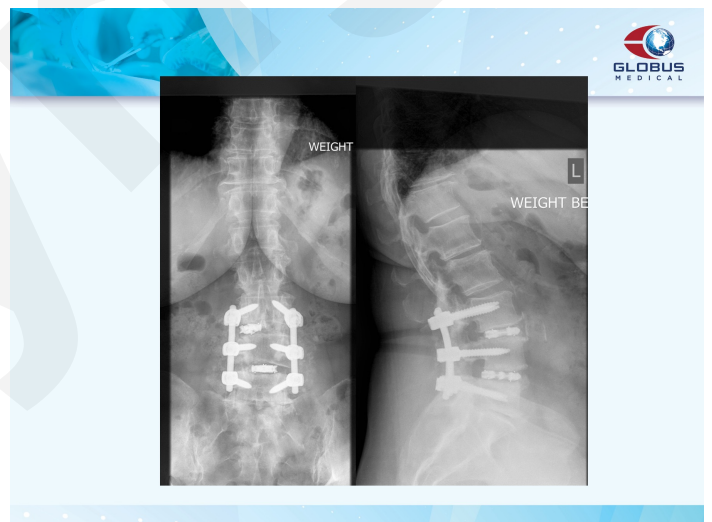
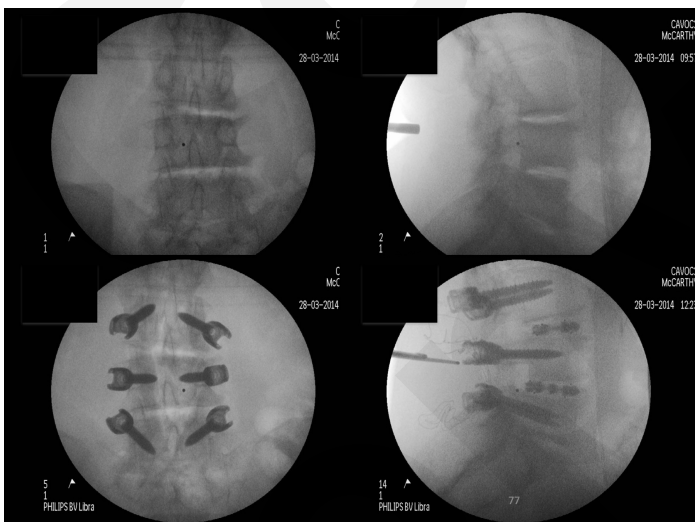
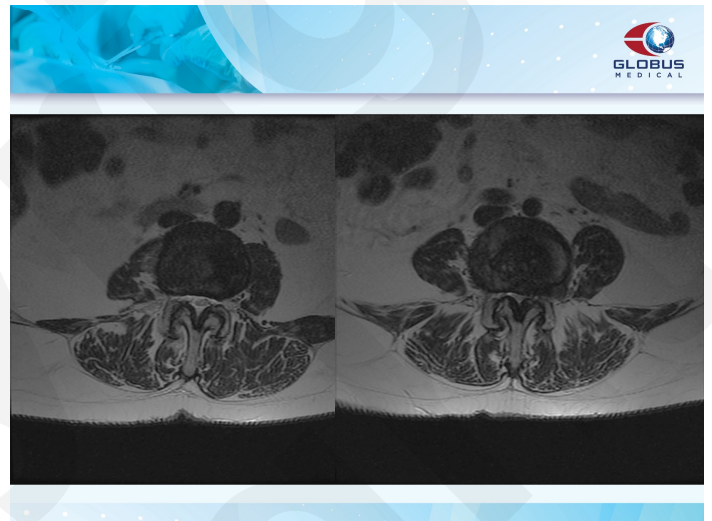
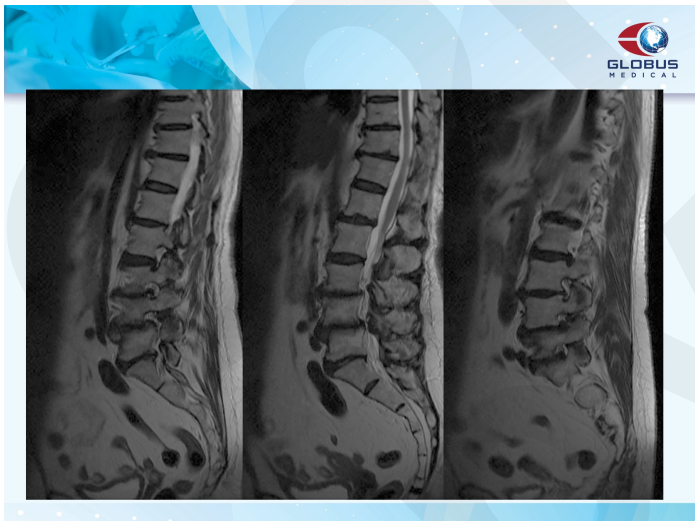
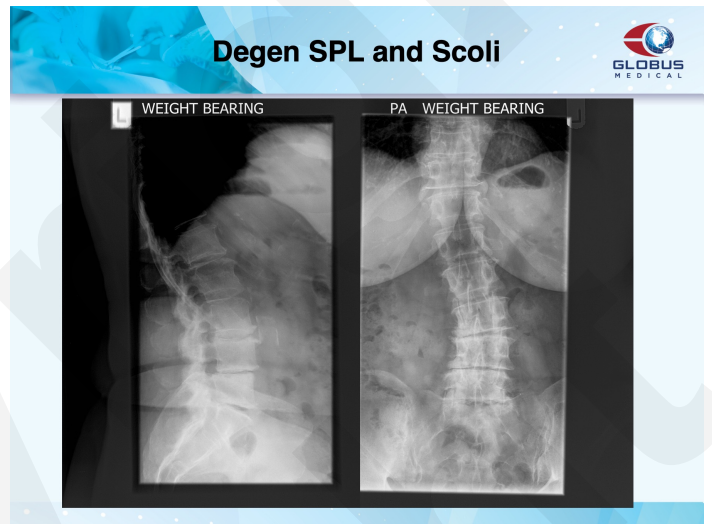


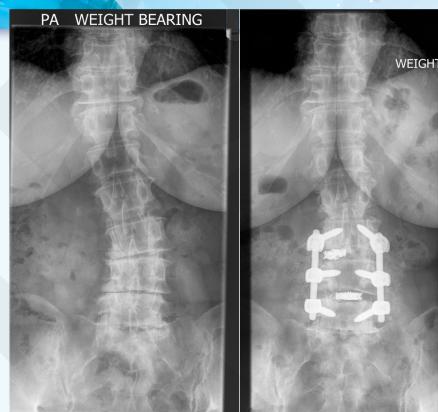
Pack Graft in Gutters



Llandough Hospital
MCCARTHY
05-12-2014 13:51







The Operations

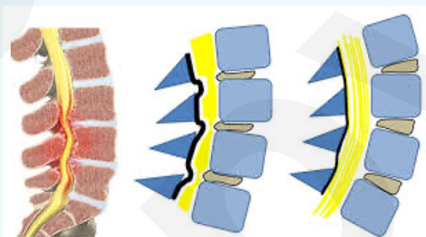
	Advantages	Disadvantages
PLIF	Bilateral access to canal, restores lordosis	Painful, infection, neural / dural injury scarring, limited higher up
Mini Open and MIS PLIF	Less painful, low infection, less blood loss, faster recovery	Fusion?, neural / dural injury scarring, limited higher up
Open TLIF	Access, fusion	Painful, infection, neural / dural injury scarring, endplate damage / subsidence
Mini Open TLIF	Less painful, low infection, fusion, less blood loss	Neural / dural injury scarring, disc preparation, endplate damage / subsidence
MIS TLIF	Even less pain, low infection, avoids paraspinal muscle damage, less blood loss, faster recovery	Fusion?, neural / dural injury scarring, disc preparation, endplate damage / subsidence
LLIF + Perc Post	Good fusion, less painful, low infection, T5-L5, avoids canal, less visceral vessel injury then ALIF, avoids paraspinal muscle damage, less blood loss, faster recovery	L4/S1? L5/S1 – No, endplate damage / subsidence, plexus injury, diaphragm injury, pneumothorax
ALIF + Perc Post	Best fusion, best restoration lordosis, less painful, low infection, avoids canal, avoids paraspinal muscle damage, mostly less blood loss than a TLIF	Access Surgeon, ilio-lumbar vein, visceral vessel injury, ileus, not above L3

Interbody Options

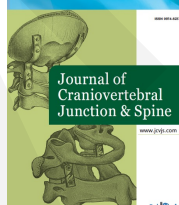
- Restore foraminal height (up / down)
- Improve fusion
- Revision of failed posterolateral fusion
- Restore lordosis / correct deformity
- Biomechanics – shear / large disc height / entire facet removed / long construct involving L5/S1
- Auto / allograft
- Threaded / Cylindrical cages
- Banana cages
- Oblique cages
- Articulated cages
- Expandable cages

APPS

- Anatomy
- Pathology
- Planning
- Surgery



Static vs Expandable 3



Original Article

January-March 2018 / Volume 9 / Issue 1

The expandable transforaminal lumbar interbody fusion – Two years follow-up

Study Name & Date	Type of cage	No of patients	Follow up	Fusion Rate	Maintained disc heights neuroforaminal height	Complication
Cloward et al. 1940	Tricortical graft	40 years experience	N/A	92%	N/A	N/A
Brantigan 1993	Carbon fibre synthetic cage	26	2 years	100%	N/A	N/A
McAfee et al 2005	Static TLIF	120	2 years	N/A	Disco height maintained in 88%	Dural tear (5.8%) Deep infection (1.6%) Cage migration (0.8%) Adjacent segment disease (1.7%) Pseudoarthrosis (0.6%)
Rouben et al 2011	MIS Static TLIF	169	49 months	96%	N/A	Nil
Kim et al 2016	MIS expandable TLIF	50	2 years	97%	Improved & Maintained	Nil
Current study	Expandable TLIF (open & MIS)	54	2 years	100%	Improved & Maintained	Dural tear (1.9%)

Static vs Expandable 8



Original Study

J Spine Surg 2019;5(3):311-319 | <http://dx.doi.org/10.21037/jss.2019.06.07>

Expandable spacers provide better functional outcomes than static spacers in minimally invasive transforaminal lumbar interbody fusion

M. Adam Kremer¹, Jefferson Alferink¹, Stacie Wynasma¹, Torrey Shirk², Charles Ledonio²

Table 3 Patient reported outcomes

Data category	Preop	1 m	3 m	Final ¹	Preop to final P value
Static					
ODI (%)	57.0±17.4	33.3±16.7	29.1±21.0	22.6±16.6	<0.001*
VAS back	6.0±3.2	2.8±2.0	2.9±2.4	2.2±2.0	<0.001*
VAS leg	7.2±2.6	2.9±2.6	2.3±2.5	1.9±1.8	<0.001*
Expandable					
ODI (%)	44.4±11.9	32.6±16.8	13.0±11.7	14.4±13.7	<0.001*
VAS back	6.2±2.5	3.0±2.3	2.7±2.1	2.3±1.9	<0.001*
VAS leg	6.2±3.0	2.3±2.4	1.6±1.8	2.2±2.4	<0.001*

¹, final follow-up for static group: 67.1±16.3 expandable group: 43.0±4.2; *, indicates significance. ODI, Oswestry Disability Index; VAS, visual analog scale.