

CAROLINA NEUROSURGERY & SPINE ASSOCIATES DOM CORIC, M.D.

Castellvi Spine

Single Level: Important or Not Important

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DISCLOSURE



- Spine Wave: Consultant/Stock/Royalties
- Spinal Kinetics: Consultant/Stock
- Medtronic: Consultant
- Globus Medical: Consultant
- DiscGenics: Consultant/Stock
- Premia Spine: Consultant
- United HealthCare: Spine Advisory Board

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INTERBODY FUSION




- **Lumbar Lordosis/Balance**
 - All interbody fusions are biomechanically superior constructs, generally with high arthrodesis rates.
 - ALIF enjoys an advantage over other interbody techniques (LLIF, PLIF, TLIF) in maintaining/restoring sagittal balance.
 - Large spacer (heights 12,14,16) with anterior – posterior height discrepancy allows for greater lordosis (14°, 16°, 18° spacers).

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• ALIF/Sagittal Balance

- ALIF
 - Can powerfully correct sagittal balance at the levels most important for maintaining lumbar lordosis (L4-5, L5-S1: 66% lumbar lordosis).
 - Relatively easily achieves 5-10 degrees of lordosis/level treated.
 - Can be modified with hyperlordotic spacers and posterior facet release/SPO to gain 10-20 degrees of lordosis.
 - Excellent anterior column support without compromising posterior tension band.



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• Lumbar Lordosis/Balance



- Even though the other interbody techniques (LLIF, TLIF/PLIF) do not have an intrinsic ability to easily improve lordosis, they each may be modified to pay greater attention to sagittal balance.
- LLIF: release of ALL with hyperlordotic wedge spacer.
- PLIF/TLIF: Smith-Peterson Osteotomy, (SPO)-type decompression with expandable spacers placed anteriorly in the disc space.

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• LLIF/Sagittal Balance

- LLIF: Standard transpoas approach
- Minimally invasive approach
- Ability to address sagittal balance is limited.
 - Lordosis +2-4° to -2°
 - Difficult to address L5-S1, L4-5 may be limited by lumbar plexus.



Sembrano J, et al. Do lordotic cages provide better segmental lordosis versus non-lordotic cages in LLIF. J Spinal Disord Tech: 5 July, 2014

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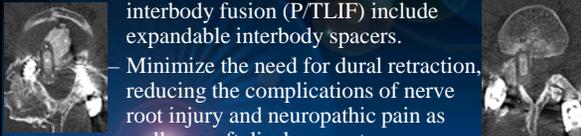
• LLIF/Sagittal Balance

- LLIF: Anterior release
- Able to address lordosis in a powerful fashion to by effecting an anterior column release by resecting ALL followed by placing hyperlordotic wedge spacer.
 - 20-30° lordosis/level (similar to PSO).
- Facilitates anterior psoas sparing approach.
 - Requires an additional incision for posterior release and stabilization.
 - Requires greater lateral exposure with some increased vascular risk to the great vessels.

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P/TLIF/Sagittal Balance

- The most recent quantum improvement in posterior and transforaminal interbody fusion (P/TLIF) include expandable interbody spacers.
- Minimize the need for dural retraction, reducing the complications of nerve root injury and neuropathic pain as well as graft displacement.
- Maximizing disc space height, bone grafting and ability to restore lordosis and minimizing postop malalignment.



PLIF/TLIF

• EXPANDBLE INTERBODY SPACERS

- Over the past decade, expandable interbody spacers were introduced showing a steady evolution with design modifications including the addition of lordotic and hyper-lordotic options as well as graft chamber and titanium plasma sprayed endplates.



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INTERBODY FUSION

- **Expandable cages: Advantages**
 - Biomechanical stability.
 - Load sharing.
 - Graft under compression.
 - Maximize bone grafting.
 - Disc space.
 - Posterolateral.
 - Graft chamber.
 - Post-expansion packing.
 - Minimize neural retraction.
 - *Maximize lumbar lordosis.*



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• TLIF/PLIF

- Bilateral approach allows for maximal disc debulking and local bone harvest as well as interbody bone placement.
- Limited ability to address sagittal balance with traditional PLIF and minimally invasive TLIF techniques.
- Standard PLIF or minimally invasive TLIF procedures result in +2° to -4° of lordosis.



Hsieh P, Koski T, et al: ALIF in comparison to TLIF: implications for the restoration of foraminal height, disc angle, lumbar lordosis and sagittal balance. *JNS-Spine* 7:379-86, 2007
 Kim JK, Moon BG, Kim DR: Postoperative flat back: contribution of posterior accessed lumbar interbody fusion and spinopelvic parameters. *J Korean Neurosurg Soc* 56:315-22, 2014.

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• TLIF/PLIF

- Able to address sagittal balance with bilateral facetectomy/SPO and bilateral expandable spacers (PLIF) or unilateral spacer placed as anteriorly in disc space as possible (TLIF).
- 15-20° lordosis/level.
- “The loss of lumbar lordosis can be considered as the initiating event of sagittal imbalance.”

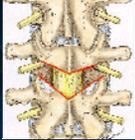


Jagannathan J, Sansur CA, Oslouian RJ, Fu M, Shaffrey CI: Radiographic restoration of lumbar alignment after transforaminal lumbar interbody fusion. *Neurosurg* 64:955-964, 2009
 Le Huec JC, Charosky S, et al: Sagittal imbalance cascade for simple degenerative spine and consequences: algorithm of decision for appropriate treatment. *Eur Spine J* 20:S699-703, 2011

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INTERBODY FUSION

- **PLIF/TLIF**
 - Surgical technique:
 - (A) Positioning: - **extension**
 - (B) Decompression - **SPO, Ponte**
 - (C) Implant - **lordotic, expandable**
 - (D) Instrumentation - **compression**



Coric D, Branch CL: Posterior lumbar interbody fusion in the treatment of symptomatic spinal stenosis. *Neurosurg Focus* 3:1-7, 1997
Soriano-Baron H, Newcomb A, Malhotra D, et al: Biomechanics of nested transforaminal lumbar interbody cages. *Neurosurgery*78:297-304, 2016

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• PLIF/TLIF: Lumbar lordosis

- INTERBODY SPACERS
- PLIF: parallel lordotic, expandable implants facilitate lumbar lordosis.
- TLIF: unilateral implant placed anteriorly in disc space.
- Expandable implant maximizes disc space height, effecting indirect foraminal decompression and further maximizing lordosis with decreased neural retraction.



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• Interbody Fusion

- Preservation/restoration of lumbar lordosis is crucial to the success of any lumbar fusion.
 - *Clinical outcome: pain/disability.*
- Sagittal balance is directly correlated to clinical outcome: avoid sagittal decompensation.
 - *Decreased adjacent level degeneration.*

Glassman SD, Bridwell K, et al: The impact of positive sagittal balance in adult spinal deformity. *Spine* 30:2024-2029, 2005
Kim MK, Lee SH, et al: The impact of sagittal balance on clinical results after posterior lumbar interbody fusion for patients with degenerative spondylolisthesis: a pilot study. *BMC Musculoskelet Disord* 12: 69, 2011

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INTERBODY FUSION

- The consequences of failure to achieve postop alignment objectives include:
 - (A) *Poor clinic outcome: persistent pain and disability.*
 - (B) *Failure of fusion/instrumentation: increased stress at caudal and cephalad aspects of the construct.*
 - (C) *Adjacent level disease: junctional stresses.*
- These negative consequences are applicable for short construct degenerative cases as well as long segment deformity cases.

Lazenec J, Ramare S, Arafati N, et al: Sagittal alignment in lumbosacral fusion: relations between radiological parameters and pain. *Eur Spine J* 9:47-55, 2000

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INTERBODY FUSION

- Not necessarily going to turn a 1- or 2-level fusion into a multi-level deformity procedure in order to address sagittal balance, but compensated patients with pelvic retroversion (*loss of lordosis or high pelvic tilt/low sacral slope*) should undergo open PLIF/TLIF with SPO (as opposed to standard posterolateral fusion, LLIF or minimally invasive TLIF) in order to maximize lordosis.



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INTERBODY FUSION

- Patients with good sagittal balance (lordosis and spinopelvic parameters) are certainly candidates for minimally invasive surgery (TLIF or LLIF).
- In order to correct deformity, ALIF or LLIF with ALL release can be combined with posterior release (SPO or Ponte osteotomy) and stabilization in order to avoid more morbid PSO procedure.

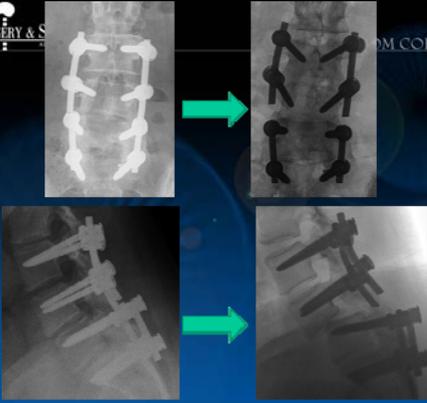
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CASE STUDY

- DH: Pt is 45 yo F who presents with LBP and bilat LE pain 2 yrs s/p L3-S1 fusion.
- Pt initially underwent L5-S1 decompress and pedicle screw fixation with posterolateral fusion.
- Subsequently undergoes exploration and extension of posterolateral fusion L3-S1.
- Pt noted to have instrumentation failure, treated nonsurgically.



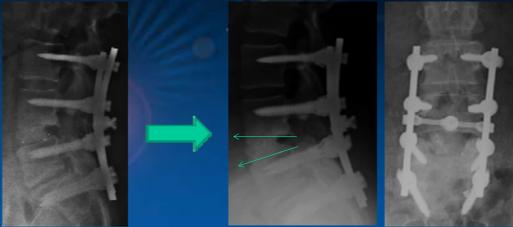
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2012 2013

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- Pt undergoes exploration/revision of fusion, with Smith-Peterson osteotomy at L4-5 with PLIF with expandable, lordotic spacers.





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Conclusion

- The negative consequences of postop malalignment are not limited to long segment deformity cases.
- Malalignment after 'simple' degenerative cases leads to poor clinical outcome with higher risk of instrumentation/fusion failure, adjacent level disease and, ultimately, reoperation.

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Conclusion

Sagittal balance is critical to success of virtually any fusion procedure, large adult deformity or single level degenerative cases.

- It is much easier to maintain sagittal balance than to correct sagittal malalignment.
- Every surgical plan should take into account goals for maintaining or improving sagittal balance/lordosis.

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Conclusion

- Adjacent level disease above and below previous fusion, should be treated with posterior extension of fusion with decompression/SPO at L3-4 and L5-S1 with expandable, lordotic interbody spacers placed anteriorly in the disc space with compression across posterior pedicle screws.



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THANK YOU!