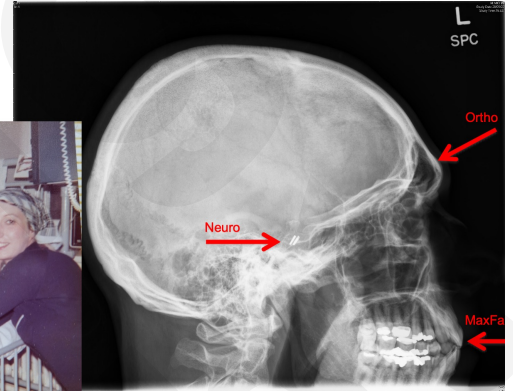




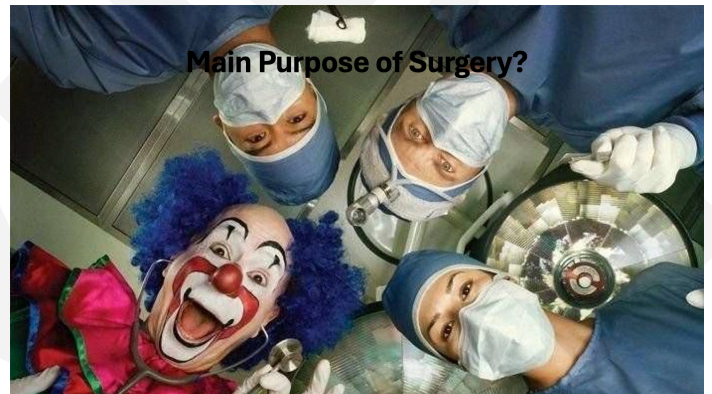
Degenerative Scoliosis: ALIF and XLIF

Professor Michael J H McCarthy
Consultant Spinal Surgeon
University Hospital of Wales



What we will be covering today:

- Adult spinal deformity – surgical planning and interbody fusion techniques
- Pre-operative evaluation
- Surgical planning (radiological parameters, spinopelvic alignment etc)
- Goals of correction
- Decision making in direct/indirect neural decompression
- Selection of interbody fusion technique
- Requirement for osteotomies
- **BUT NOT IN THAT ORDER**



The 7 Ps

- Proper
- Planning and
- Preparation
- Prevents
- P
- Poor
- Performance

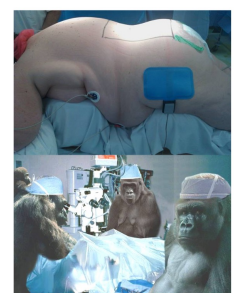


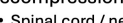
Attention to detail
Never let your guard down



The other 3 Ps

- Personality - Patient
- Personality - Pathology
- Personality - Practitioner



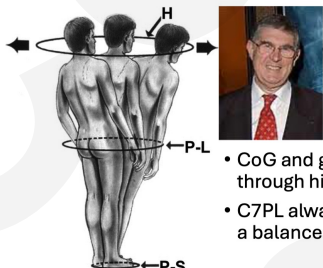
- **Decompression**
 - Spinal cord / nerve roots
 - **Realignment**
 - **Stabilisation**
 - Prevent / Treat
 - Neurological deficit / deformity / pain
 - (Non fusion technology form of "stabilisation")
- 

- All may require fusion
- Require Instrumentation
- Instrumentation increases fusion

Indications for Surgery

- **What are you trying to achieve?**
 - Non-maleficence - "first, do no harm" (primum non nocere).
- **DO THE APPROPRIATE OPERATION FOR THE PATIENT AND THEIR PATHOLOGY AND YOUR SKILL / ABILITY**

Cone of Economy



- CoG and gravity line goes through hips
- C7PL always behind CoG in a balanced spine

SOS

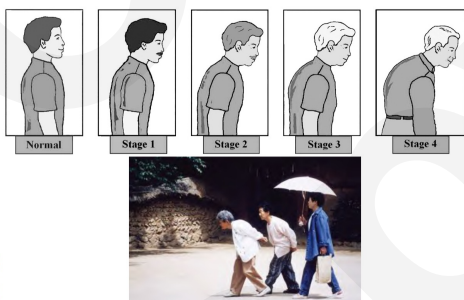
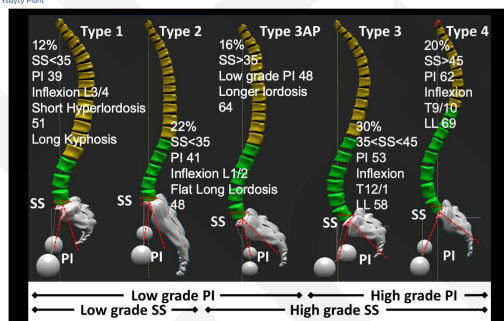
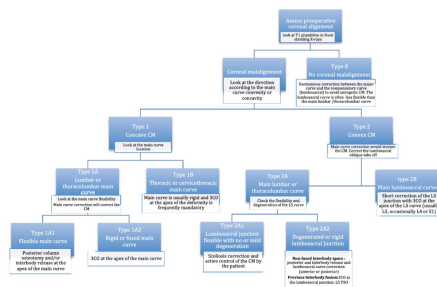
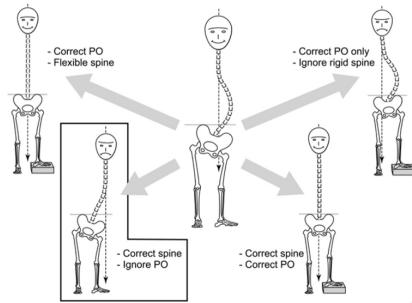


Table 1. SRS Adult Delinquency Classification

[illegible]

Don't Forget Pelvic Obliquity / LLD

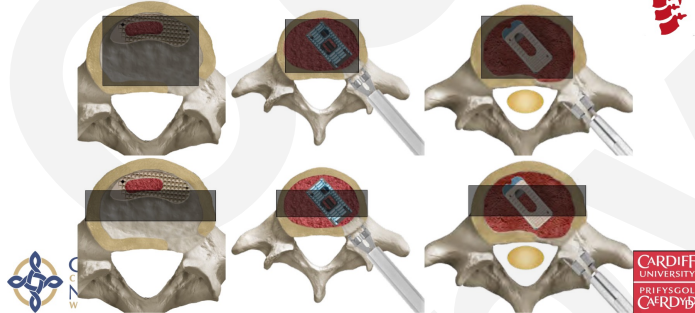


Fusion

- Fusion – think:
 - a contact surface area (1/a subsidence)
 - ↑ compression ↓ tension
 - autograft > allograft > synthetic
 - vascular > avascular
 - structural graft > non structural
 - Biologics
 - And unfortunately fusion may not be a clinical outcome
- **BUT, joints are designed to move**
 - Fusion is abnormal
 - Beware – nature against you!



Fusion Footprints



Interbody 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
- Types:
 - Auto / allograft
 - Threaded / Cylindrical cages
 - Banana cages
 - Oblique cages
 - Articulated cages
 - Expandable cages



Indications TLIF

- All lumbar levels
- 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 ✓



Indications ALIF

- (L2/3) 3/4 4/5 5/1 levels
- 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 ✓



Indications LLIF

- All lumbar levels except L5/1
- Restore foraminal height (up / down) ☒
- Improve fusion ☒
- Revision of failed posterolateral fusion ☒
- Restore lordosis / correct deformity ☒
- Biomechanics – shear / large disc height / entire facet removed ☒



PLIF
Mini Open and MIS
PLIF
Open TLIF
Mini Open TLIF
MIS TLIF
LLIF + Perc Post

Advantages

Bilateral access to canal, restores lordosis
Less painful, low infection, less blood loss, faster recovery
Access, fusion
Less painful, low infection, fusion, less blood loss
Even less pain, low infection, avoids paraspinous muscle damage, less blood loss, faster recovery
Good fusion, less painful, low infection, T5-L5, avoids canal, less visceral vessel injury then ALIF, avoids paraspinous muscle damage, less blood loss, faster recovery
Best fusion, best restoration lordosis, less painful, low infection, avoids canal, avoids paraspinous muscle damage, mostly less blood loss than a TLIF

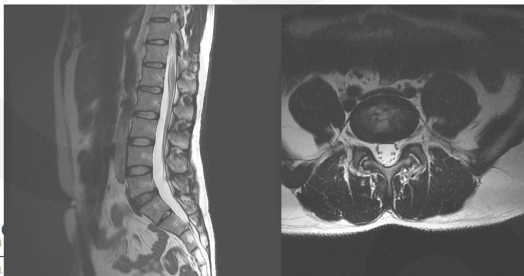
Disadvantages

Painful, infection, neural / dural injury scarring, limited higher up
Fusion?, neural / dural injury scarring, limited higher up
Painful, infection, neural / dural injury scarring, endplate damage / subsidence
Neural / dural injury scarring, disc preparation, endplate damage / subsidence
Fusion?, neural / dural injury scarring, disc preparation, endplate damage / subsidence
L4/5??, L5/S1 – No, endplate damage / subsidence, plexus injury, diaphragm injury, pneumothorax
Access Surgeon, ilio-lumbar vein, visceral vessel injury, ileus, not above L3



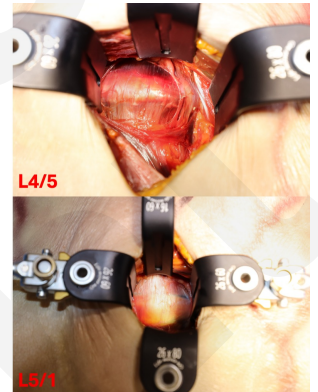
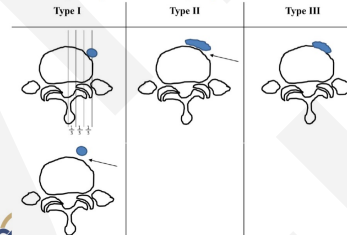
ALIF Limitations

- VESSELS / OBESITY / ELDERLY



Preoperative evaluation of left common iliac vein in oblique lateral interbody fusion at L5–S1

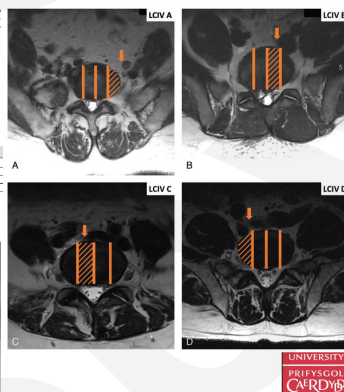
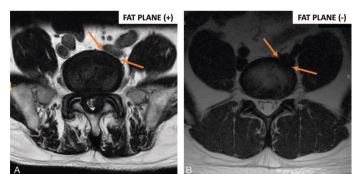
Nam-Su Chung¹ · Chang-Hoon Jeon¹ · Han-Dong Lee¹ · Heon-Ju Kwon¹



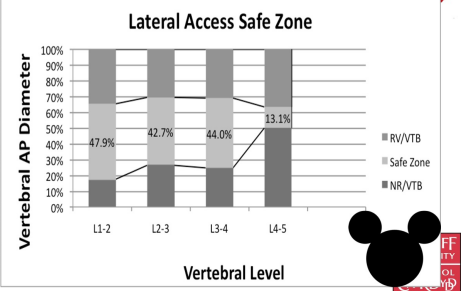
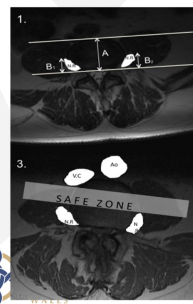
The Feasibility of Anterior Spinal Access

The Vascular Corridor at the L5–S1 Level for Anterior Lumbar Interbody Fusion
Jia-Pu-Peng Ng, MRCs, Matthew Scott-Young, FRACS, +
Daniel Nino-Chen, FRCS, and Jacob Young-Living, FRCS

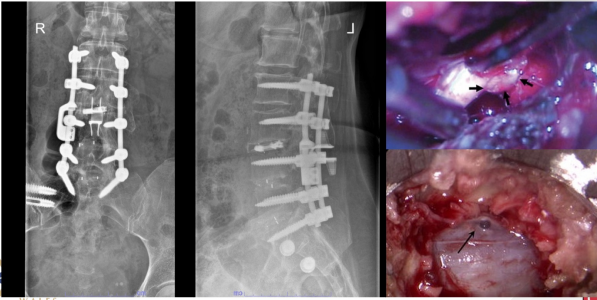
	Easy	Advanced	Difficult
Vascular corridor	Wide	Fails full criteria for easy OR	Narrow
L5/S1 position	A	Difficult	C or D
Safe plane	Yes	No	No
Number (%)	181 (37.30%)	231 (46.70%)	117 (23.80%)



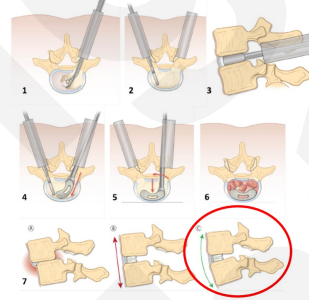
LLIF Limitations



TLIF Limitations



TLIF Lordosis



They can all subside

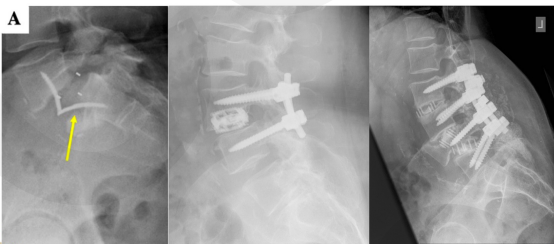


Table 2 Complications of Anterior Spine Exposure

Spine Anatomical Region	Complications
Thoracic	Pulmonary (atelectasis, pneumonia, respiratory insufficiency) Technical (hemothorax, pneumothorax, pleural effusion, infection, wound disruption) Chylothorax Spinal cord ischemia Miscellaneous (cardiopulmonary, stroke, ileus, urinary tract infection, renal failure)
Lumbar	Vascular Arterial injury (thrombosis, hemorrhage) Venous injury (hemorrhage, thrombosis) Neurogenic (retrograde ejaculation, groin nerve injury, warm leg) Wound problems (infection, disruption, hernia, muscle desaturation) Ureteral injury Miscellaneous (cardiopulmonary, stroke, ileus, urinary tract infection, renal failure)

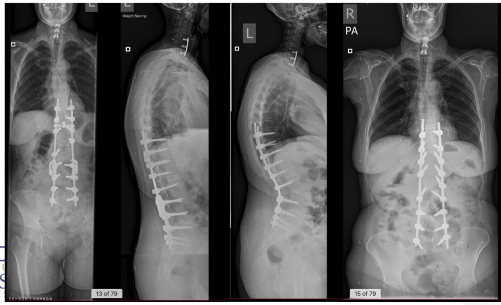
Anatomical!



Deformity – ALL release - ALIF



Deformity – Osteotomy - PSO



Type	Description	Diagram	Reference
1	Resection of posterior elements from mid pars above to pedicle below with realignment of the spine through hinging through a mobile disc		Ponte
2	Resection of posterior elements from mid pars above to pedicle below with realignment of the spine through hinging of the disc posteriorly and opening of the disc anteriorly		Smith-Petersen
3	Posterior-based transpedicular decancellation of the vertebral body with realignment through controlled fracture of the anterior column		Heinig
4	Posterior-based intraosseous wedge resection of the vertebral body with realignment through osteoclasts of the proximal third of the anterior vertebral body		Thomason (PSO)
5	Posterior-based wedge resection with extension of the osteotomy into the supra-adjacent disc and realignment hinging on the anterior column at the intervertebral space		Mod Thomason (Ext PSO)
6	Posterior-based vertebral column resection including one or more vertebra with adjacent discs		Suk (VCR)



Osteotomy vs ALL Release

- Osteotomy - PSO
 - Direct canal decompression
 - Direct foraminal decompression (but no height restoration)
 - Shortening procedure
 - "Bone on bone" fusion if performed correctly
 - Correction = per level
 - Typically up to 30 degrees
- ALL release + Cage
 - Indirect canal decompression
 - Indirect foraminal decompression
 - "Lengthening" procedure
 - Fusion through a cage
 - Requires additional posterior procedure
 - Correction = per level
 - Depends on cage lordosis and facets at back



Adult Spinal Deformity - Algorithm...

- What does the patient want?
- What is most appropriate for your patient?
- Surgical factors to consider - ABC Approach:
 - **A**ge **A**lignment **A**natomy **A**ccess
 - **B**one Quality / **B**alance
 - **C**ompression – central / lateral / foraminal
 - **D**isc Height / **D**egeneration / **D**eformity / **D**ura
 - **E**valuate Stability – supine / erect / dynamic
 - **F**acet Orientation / **G**ap
- How many operations?...



Indirect vs Direct Decompression

- Indirect decompression
 - Minimum risk to the nerves
 - ALIF / LLIF – allow good fusion footprint
 - Harmonious spine / segmental lordosis – hyperlordotic cages
 - LLIF 4.1% failure rate to decompress
- Direct decompression
 - Allows inspection of the nerves
 - TLIF and PSO
 - (Can reduce fusion)

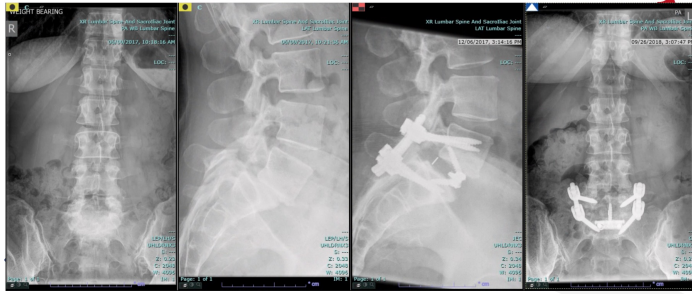


When Indirect Decompression Fails

A Review of 220 Consecutive Direct Lateral Interbody Fusions and Unplanned Secondary Decompression
 Clinton D. Morgan, MD, Corey T. Walker, MD, Jahad Gaddis, MD, Rije E. Othman, MD, PhD, Joshua S. Catapano, MD, Courtney Hengstler, MD, and Juan S. Uribe, MD



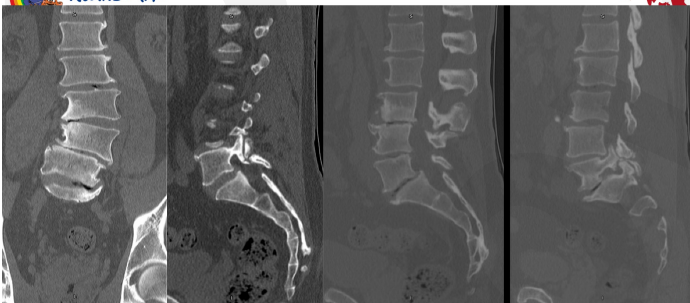
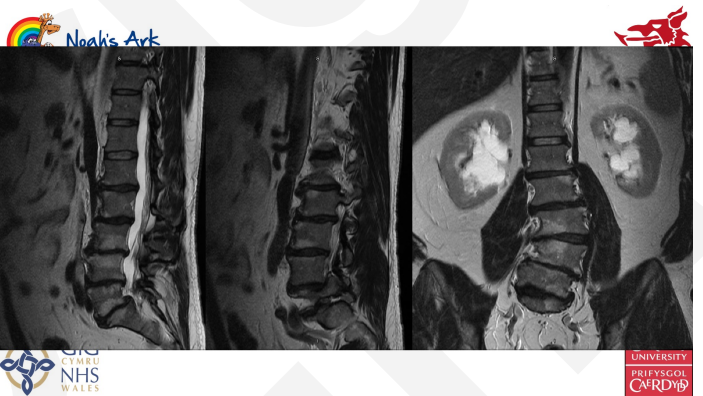
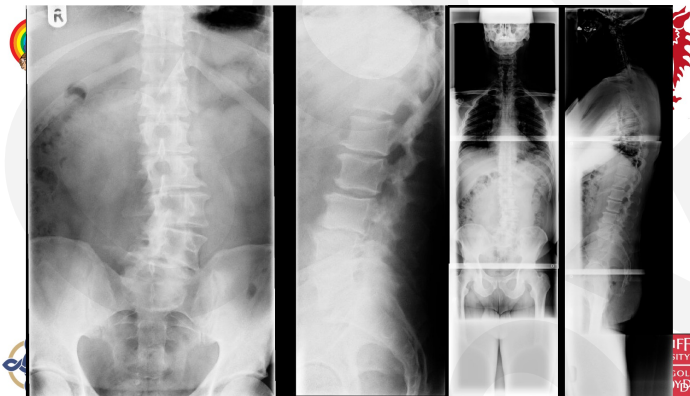
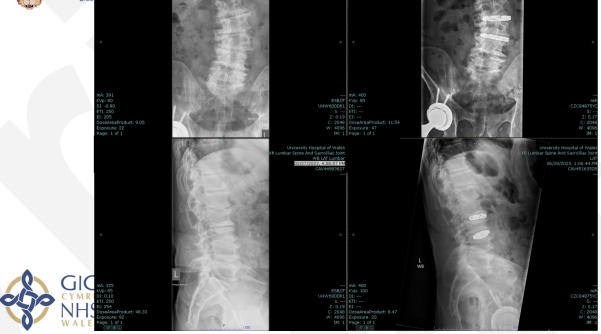
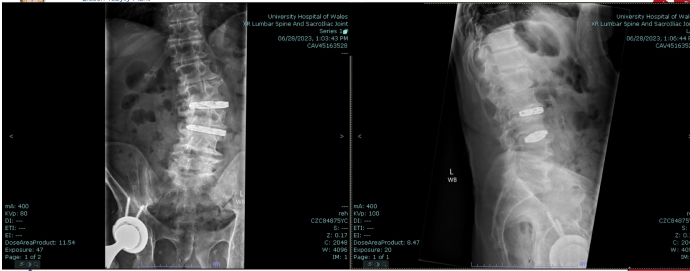
Indirect vs Direct Decompression

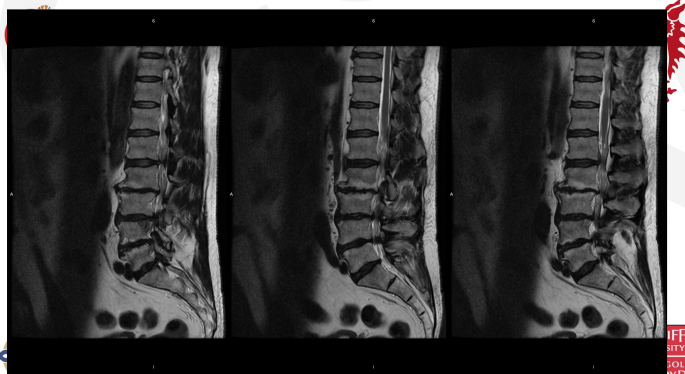
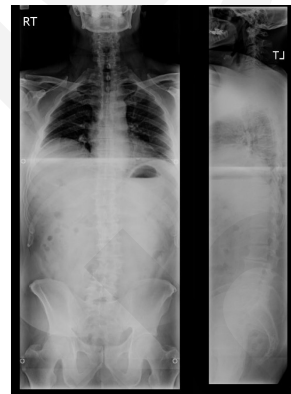
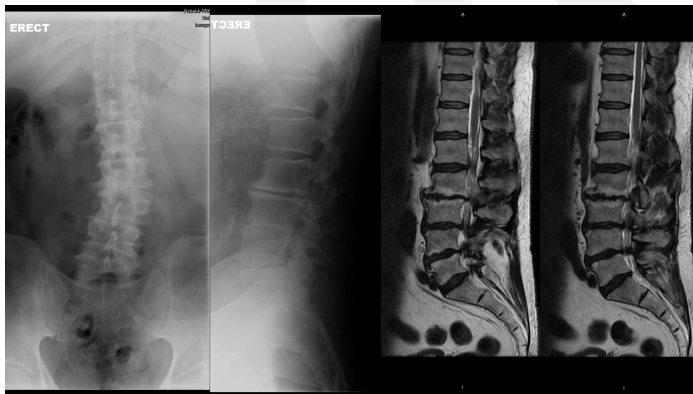


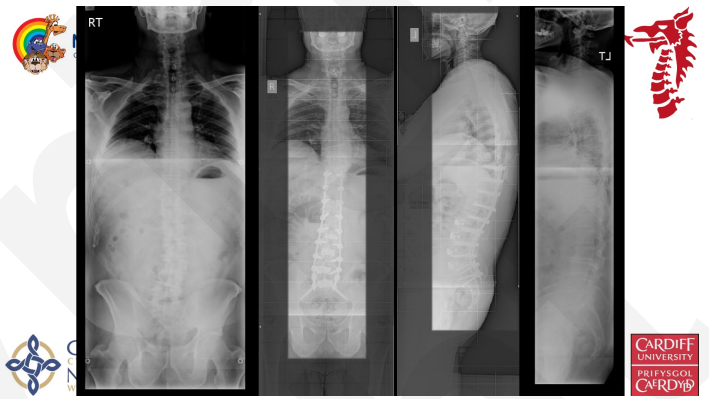
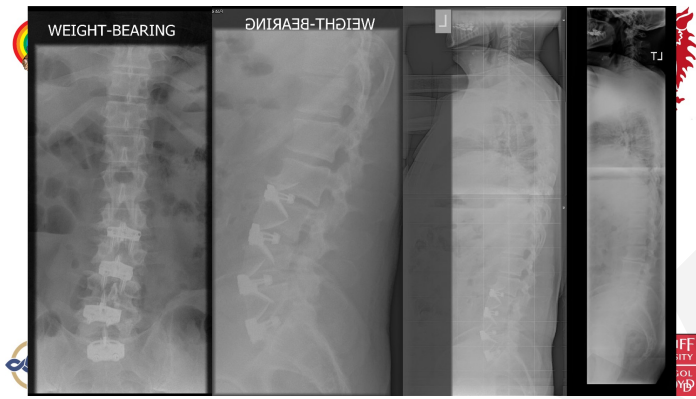
Indirect vs Direct Decompression

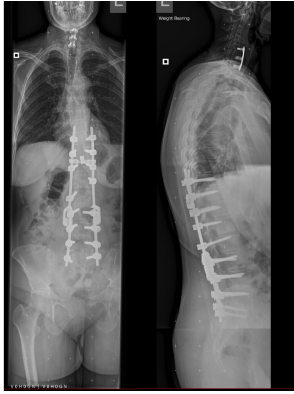








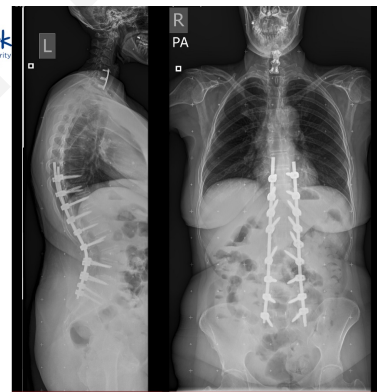
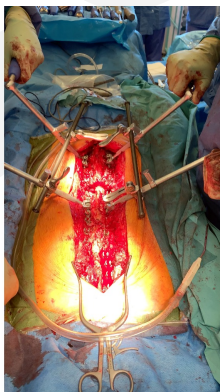
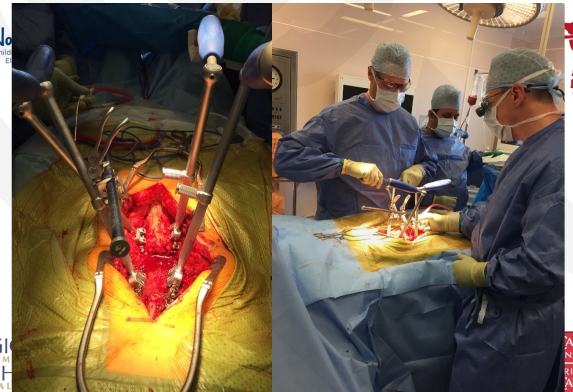
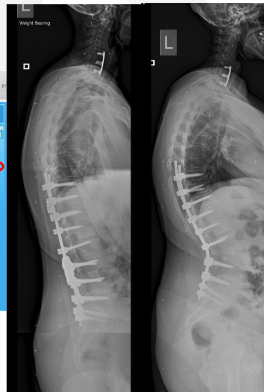




Measurements	Parameters	Results	Subgroups	Scores	Preoperative Planning
Age	Age Factor	64		1	
Platib incidence (°)	BPV	-23.3°	Severe Retroversion	3	Severe
LLT	LLT	-45.8°	Severe Hypolordosis	3	Severe
Severe Slope (°)	L5/S1	100%	Hyperlordotic Malignant	3	Severe
L5/S1 Lordosis (°)	L5/S1	15.5°	Moderate Positive Multigrades	1	Moderate
L4/S1 Lordosis (°)	L4/S1	18.8°			
Global T12 (°)	Global T12	19.3°			

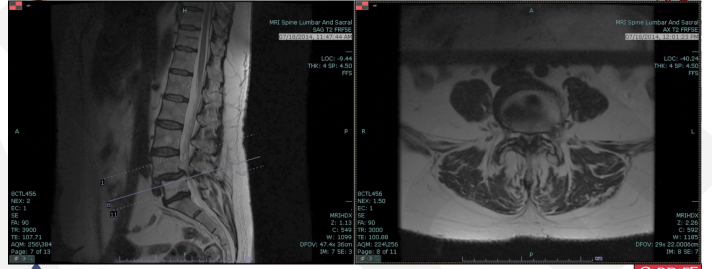
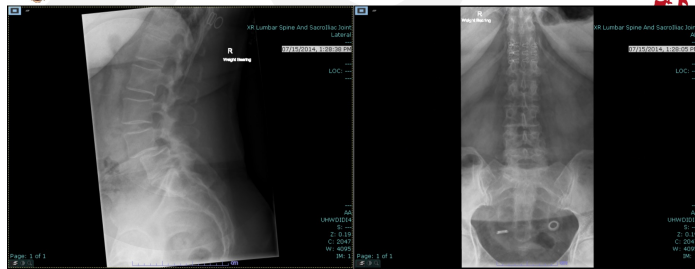
GAP Score 10
Severe Disproportion

The GAP score is a combination of values that provide an indication of the degree of deformity, the magnitude and distribution of lateral masses, and the degree of asymmetry in the spine. The GAP score is a combination of values that provide an indication of the degree of deformity, the magnitude and distribution of lateral masses, and the degree of asymmetry in the spine. The GAP score is a combination of values that provide an indication of the degree of deformity, the magnitude and distribution of lateral masses, and the degree of asymmetry in the spine.

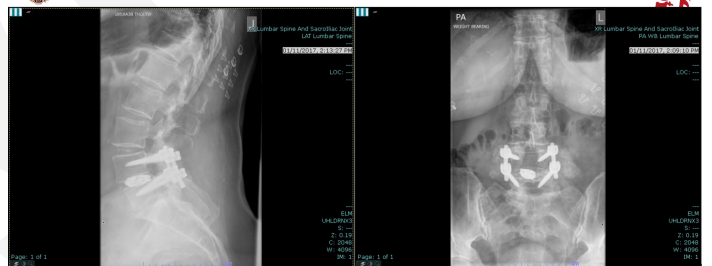


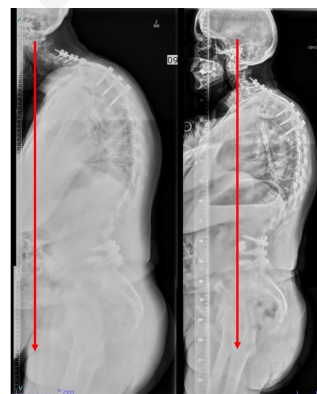
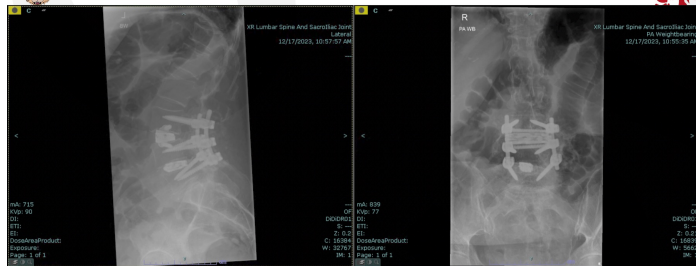
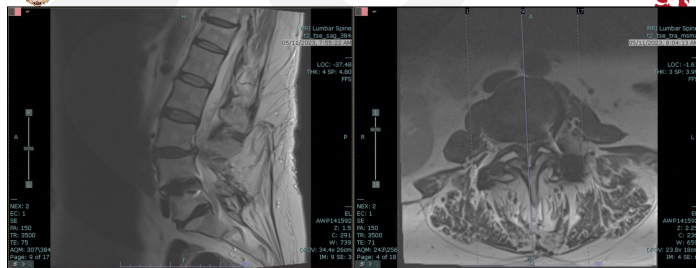
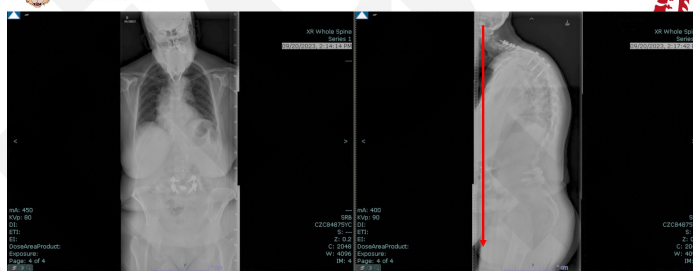
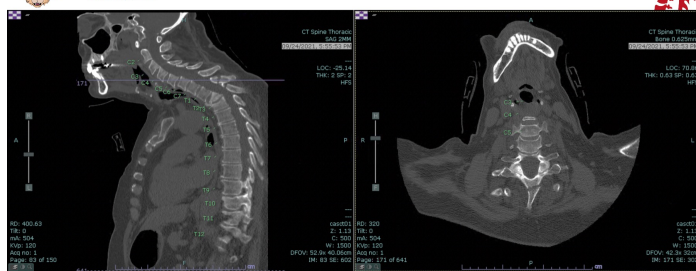


- 60-year-old female
- severe LBP and stenotic leg symptoms



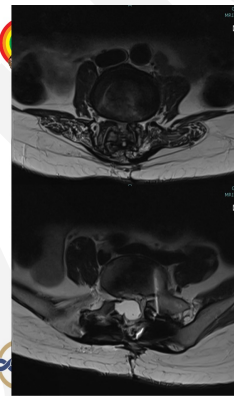
DDD, spondylolisthesis and stenosis

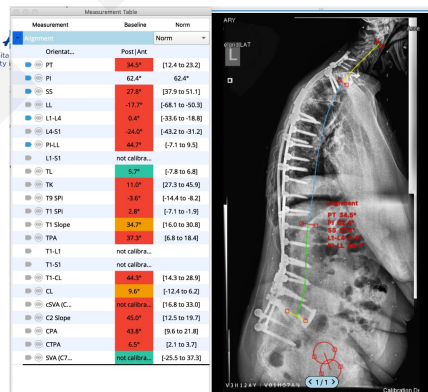


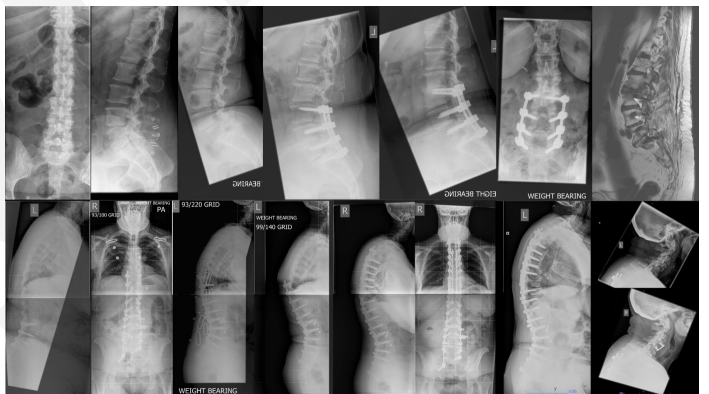
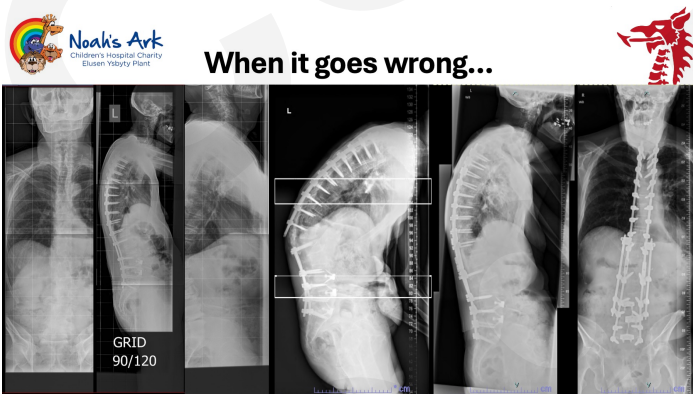
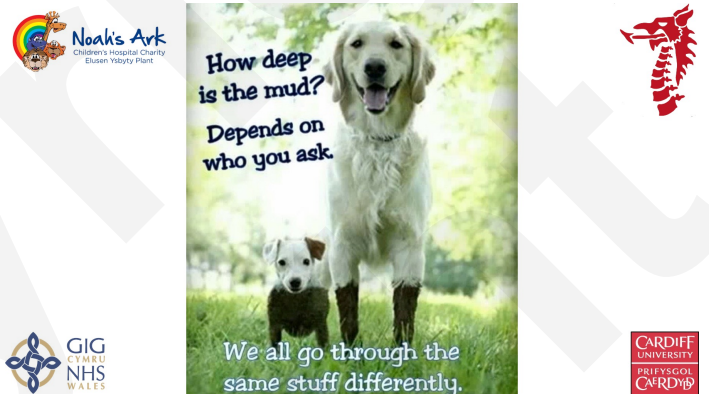
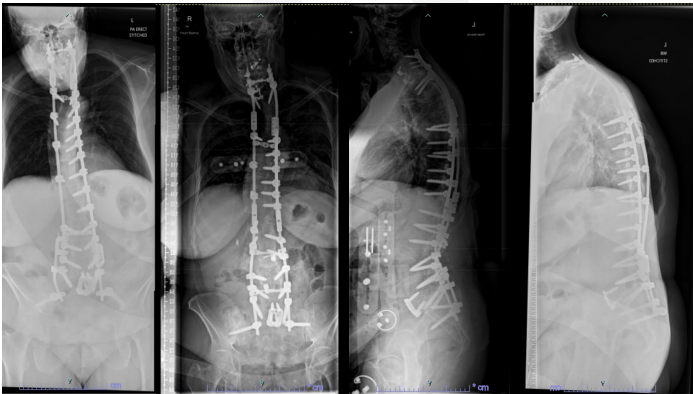
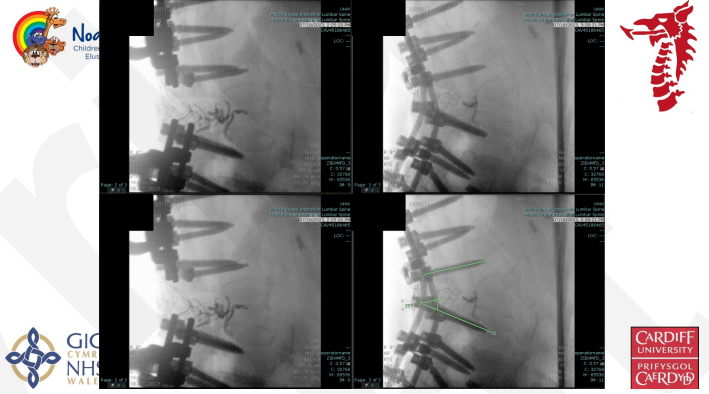




- 50 year old female
- Lots and lots of previous surgery with dural tears
- Presents with acute CES at 11pm









Or Just Decompress Alone...



The Spine Journal 17 (2017) 179–182



Clinical Study

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

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

- 83 patients with lumbar stenosis
- 54% had sagittal imbalance
- In 73% it normalized at 1 year with decomp alone



Day to Day Lumbar Degen Patients

- Keep it simple
 - Patient factors
 - Age / Fitness / Morbidities
 - Examination
 - Stand upright - legs straight
 - Walking
 - Erect Lumbar XRs
 - Compare to lying MRI (Slips / Scoliosis)
 - Look at L4 / look at Sacrum / look at Hips
 - Measure the PILL and observe the lordosis L4-S1
 - If in doubt – get whole spine films
- IS A FUSION REALLY REQUIRED???



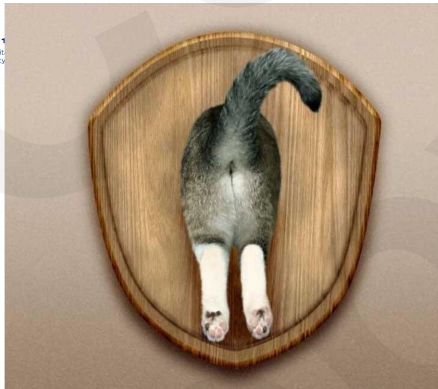
Know When To Quit

A man's got to know his limitations



Adult Spinal Deformity:

Pay attention to the detail
Never let your guard down
Otherwise it'll be a...



Thank you

