



Mechanics Of Spinal Deformity



Prof M J H McCarthy
Consultant Spinal Surgeon



Some Basics First then the Complicated Stuff!



The 7 Ps

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

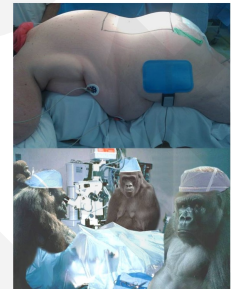


Attention to detail
Never let your guard down



The other 3 Ps

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



Indications for Surgery - DRS

- **D**ecompression
 - Spinal cord / nerve roots
- **R**ealignment
 - Correct deformity
- **S**tabilisation
 - 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



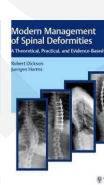


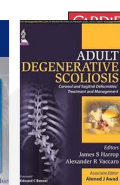
**How deep is the mud?
Depends on who you ask.**



We all go through the same stuff differently.











Assessing and Classifying Spinal Deformity



Causes of Sagittal Malalignment

- Congenital anomaly
- Ankylosing spondylitis
- Iatrogenic:
 - Flatback Syndrome
 - Kyphotic Decompensation Syndrome
 - Adjacent segment pathology
- Post-traumatic
- Infectious
- Neoplastic
- Osteoporotic Compression Fractures
- Degenerative Spinal disorders



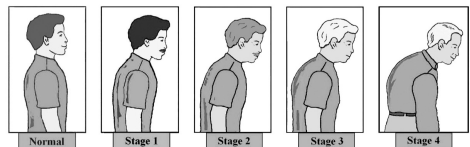






Life is a Kyphosing Event!











Sagittal Balance Parameters

- Pelvic Incidence
- Pelvic Tilt
- Sacral Slope
- Lumbar Lordosis
- Thoracic Kyphosis
- Cervical Lordosis
- Centre of Gravity
- C7 Plumb Line
- Sagittal Vertical Axis
- Chin Brow Vertical Angle
- Kyphosis Tilt Angle
- Sacro Femoral Distance
- T9 Tilt (body centre mass level)
- T1 Spino Pelvic Inclination
- T1 Pelvic Angle
- T1 Sagittal Angle
- Global Tilt
- GAP Score
- Etc etc...



First - Lumbar Lordosis

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

LUIZ HENRIQUE FONSECA DAMASCENO¹, SILVIO RICARDO GUARNIERI CATARINI², ANTONIO DORNAL CAMPOS³, HELTON LUIS APARECIDO DEFRIO⁴

	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 to -35.0	26.07 (5.80 to 56.52)

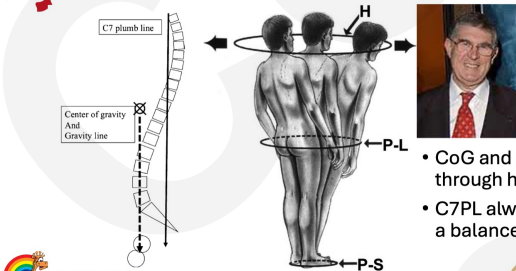
(*Averages different from each other with p<0.001)

Tabela 2 - Intervertebral discs measurements

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



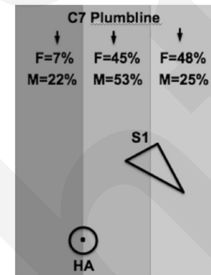
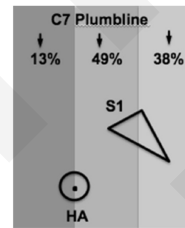
Cone of Economy



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



Normal Distribution



Eur Spine J (1998) 7:99-103
© Springer-Verlag 1998

ORIGINAL ARTICLE

J. Legaye
G. Duval-Beaupère
J. Hecquet
C. Marty

Pelvic incidence: a fundamental pelvic parameter for three-dimensional regulation of spinal sagittal curves

- PI 52 range 34-84 fixed after skeletal maturity
- PT 12 range 5-30
- SS 40 range 20-65
- CL 40 +/- 10
- TK 20-50
- LL 30-80



SS sacral slope
PT pelvis tilt
I incidence

$$PI = PT + SS$$

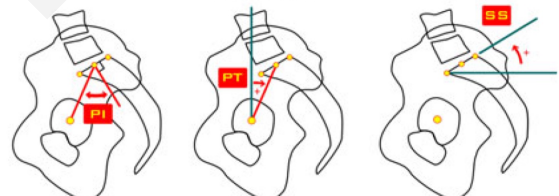
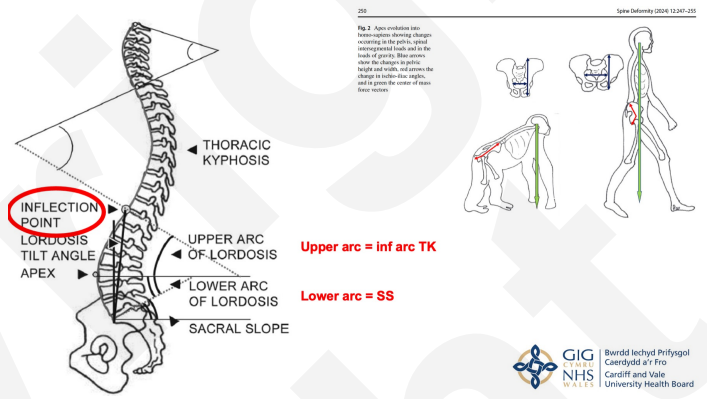
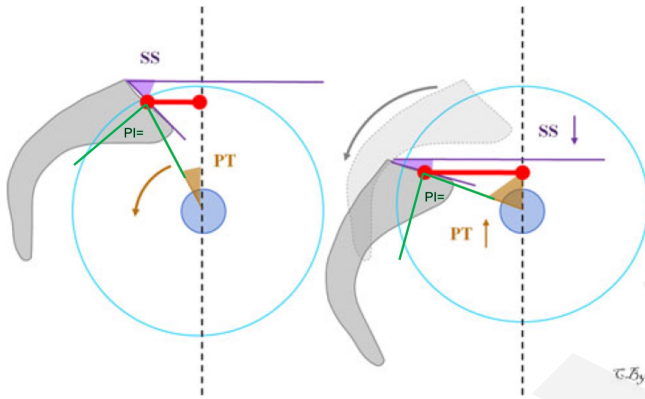


Fig. 10 Pelvic parameters: pelvis tilt, sacral slope, incidence angle. SS sacral slop, PT pelvis tilt and I incidence



Roussouly Classification of Spine Types

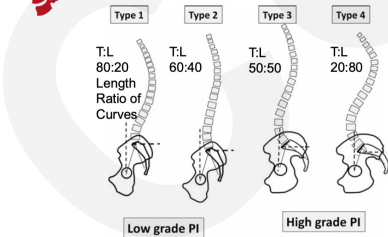


Fig. 4 The shape of lumbar lordosis depends on SS orientation. Type 1 and 2 have SS < 35°; Type 3 has 35° < SS < 45°; Type 4 has SS > 45°. Generally Type 1 and 2 have a low PI and Type 3 and 4 have a high PI

- **Sacrum:**
- **Horizontal = High PI**
- **Vertical = Low PI**
- **PI-LL normally within 10°**

Eur Spine J
DOI 10.1007/s00586-017-5111-x

ORIGINAL ARTICLE

Classification of normal sagittal spine alignment: redefining the Roussouly classification

Féthi Laouissat^{1,2} · Amer Sebaaly⁴ · Martin Gehrchen³ · Pierre Roussouly²

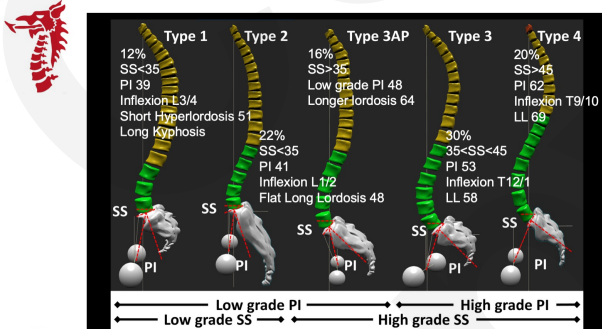
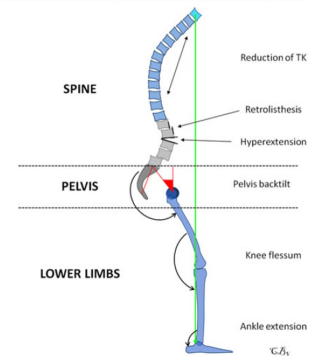
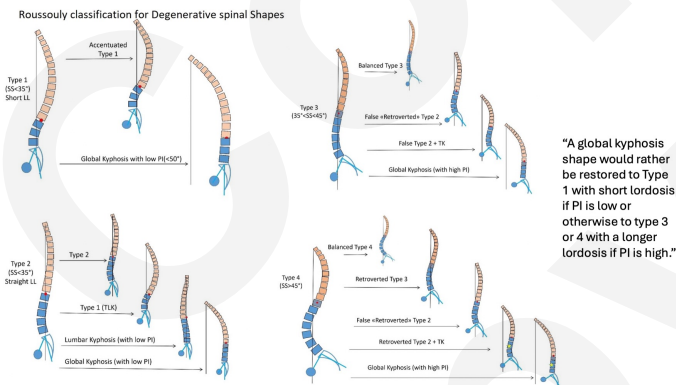


Fig. 5 The shape of lumbar lordosis depends on SS orientation. Type 1 and 2 have SS < 35°; Type 3 has 35° < SS < 45°; Type 4 has SS > 45°. Generally Type 1 and 2 have a low PI and Type 3 and 4 have a high PI

Reduced PI = poor ability to compensate





Importance of Sagittal Balance

Eur Spine J (2015) 24:1251–1258
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ORIGINAL ARTICLE

Pelvic incidence-lumbar lordosis mismatch predisposes to adjacent segment disease after lumbar spinal fusion

Dominique A. Rothenfluh · Daniel A. Mueller · Eslin Rothenfluh · Kan Min

- **PI-LL <10 = 25% revision rate for ASD 4yrs vs**
- **PI-LL >10 = 78%**
- **AdjSegDis group had higher preop PI with non matched LL**

Noak's Ark
Children's Hospital, Cardiff and Vale University Health Board

GIG
Cardiff and Vale University Health Board

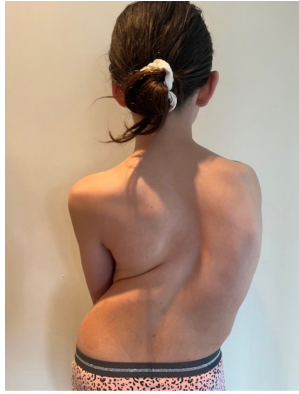
Causes of Coronal Malalignment

- Any cause of (untreated) childhood scoliosis
- Degenerative (de novo) adult scoliosis
- Iatrogenic
- Neuromuscular / Paralytic

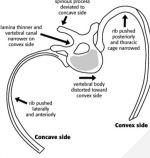
	Idiopathic (residual)	Degenerative (de novo)
Curve pattern	Follows classic curve patterns	Lack classic curve patterns
Vertebral segments	Involves more vertebral segments	Involves fewer vertebral segments
Curve location	Thoracic spine	Lumbar spine
Curve magnitude	Larger curves	Smaller curve magnitude

Scoliosis Classification

- Early onset < 10 years
 - Idiopathic, Congenital, Neuromuscular, Syndromic
- Late onset > 10 years
- Adult onset
- Main Causes:
 - Idiopathic (80-85%), Congenital, Neuromuscular, Syndromic, Degenerative, Trauma, Infection, Tumour



Scoliosis



CURVE TYPE

Type	Proximal Thoracic	Main Thoracic	Thoracolumbar/Lumbar	Description
1	Nonstructural	Structural (major)	Nonstructural	Main Thoracic (MT)
2	Structural	Structural (major)	Nonstructural	Double Thoracic (DT)
3	Nonstructural	Structural (major)	Structural	Double Major (DM)
4	Structural	Structural (major)	Structural	Triple Major (TM*)
5	Nonstructural	Nonstructural	Structural (major)	Thoracolumbar/Lumbar (TL/L)
6	Nonstructural	Structural	Structural (major)	Thoracolumbar/Lumbar (TL/L)

STRUCTURAL CRITERIA (Minor Curves)

Curve	Apex
Proximal Thoracic	T2-T5 Kyphosis > 20°
Main Thoracic	T6-T12 Kyphosis > 20°
Thoracolumbar/Lumbar	L1-L5 Kyphosis > 20°

LOCATION OF APEX (SRS Definition)

Curve	Apex
Proximal Thoracic	T2-T5/T12-D12
Main Thoracic	T12-L1
Thoracolumbar	L1-L2
Thoracolumbar/Lumbar	L1-L2/D12-L4

LUMBAR SPINE MODIFIERS

Lumbar Spine Modifier	CSVL to Lumbar Apex
A	Between Pedicles
B	Touches Pedicles
C	Medial to Pedicles

THORACIC SAGITTAL MODIFIERS

Thoracic Sagittal Profile T5-T12	Apex
Hypert	< 10°
Normal	10°-40°
Hypert	> 40°

Curve Type (1-6) + Lumbar Spine Modifier (A,B,C) + Thoracic Sagittal Modifier (+, N, -) = Classification (e.g., 1B+)

Modified from Lenke LG, Balw S, et al. Adolescent idiopathic scoliosis: A new classification to determine extent of spinal deformity. *Spine* 2001;26(12):1243-1248.



Sagittal classification in adolescent idiopathic scoliosis: original description and therapeutic implications

K. Abelin-Genevois¹, D. Sassi¹, S. Verdun², P. Roussouly¹

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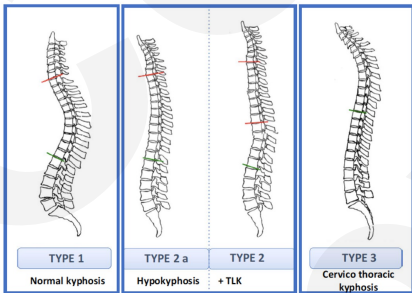
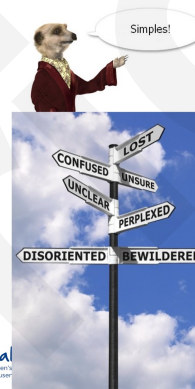
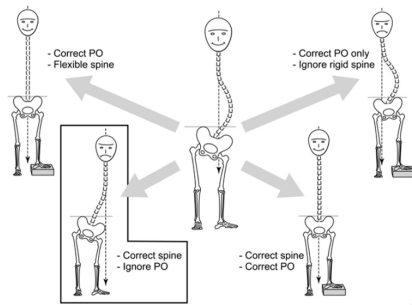


Table 1. SRS Adult Deformity Classification

Primary curve types Single Thoracic (ST) Double Thoracic (DT) Double Major (DM) Triple Major (TM) Thoracolumbar (TL) Lumbar (L) Lumbar (L) + Thoracic (T) (LT) Lumbar (L) + Thoracic (T) + Cervical (C) (LTC)	Adult spinal deformity modifiers Regional sagittal modifier (include only if outside normal range as listed) • T11 Proximal thoracic (T12-T13) > 20° • M11 Main thoracic (T12-T13) > 50° • L1 Lumbar (T12-L1) > 20° • L2 Lumbar (T12-L1) > 40° • L3 Lumbar (T12-L1) > 60° • L4 Lumbar (T12-L1) > 80° • L5 Lumbar (T12-L1) > 100° • L6 Lumbar (T12-L1) > 120° • L7 Lumbar (T12-L1) > 140° • L8 Lumbar (T12-L1) > 160° • L9 Lumbar (T12-L1) > 180° • L10 Lumbar (T12-L1) > 200° • L11 Lumbar (T12-L1) > 220° • L12 Lumbar (T12-L1) > 240° • L13 Lumbar (T12-L1) > 260° • L14 Lumbar (T12-L1) > 280° • L15 Lumbar (T12-L1) > 300° • L16 Lumbar (T12-L1) > 320° • L17 Lumbar (T12-L1) > 340° • L18 Lumbar (T12-L1) > 360° • L19 Lumbar (T12-L1) > 380° • L20 Lumbar (T12-L1) > 400° • L21 Lumbar (T12-L1) > 420° • L22 Lumbar (T12-L1) > 440° • L23 Lumbar (T12-L1) > 460° • L24 Lumbar (T12-L1) > 480° • L25 Lumbar (T12-L1) > 500° • L26 Lumbar (T12-L1) > 520° • L27 Lumbar (T12-L1) > 540° • L28 Lumbar (T12-L1) > 560° • L29 Lumbar (T12-L1) > 580° • L30 Lumbar (T12-L1) > 600° • L31 Lumbar (T12-L1) > 620° • L32 Lumbar (T12-L1) > 640° • L33 Lumbar (T12-L1) > 660° • L34 Lumbar (T12-L1) > 680° • L35 Lumbar (T12-L1) > 700° • L36 Lumbar (T12-L1) > 720° • L37 Lumbar (T12-L1) > 740° • L38 Lumbar (T12-L1) > 760° • L39 Lumbar (T12-L1) > 780° • L40 Lumbar (T12-L1) > 800° • L41 Lumbar (T12-L1) > 820° • L42 Lumbar (T12-L1) > 840° • L43 Lumbar (T12-L1) > 860° • L44 Lumbar (T12-L1) > 880° • L45 Lumbar (T12-L1) > 900° • L46 Lumbar (T12-L1) > 920° • L47 Lumbar (T12-L1) > 940° • L48 Lumbar (T12-L1) > 960° • L49 Lumbar (T12-L1) > 980° • L50 Lumbar (T12-L1) > 1000° • L51 Lumbar (T12-L1) > 1020° • L52 Lumbar (T12-L1) > 1040° • L53 Lumbar (T12-L1) > 1060° • L54 Lumbar (T12-L1) > 1080° • L55 Lumbar (T12-L1) > 1100° • L56 Lumbar (T12-L1) > 1120° • L57 Lumbar (T12-L1) > 1140° • L58 Lumbar (T12-L1) > 1160° • L59 Lumbar (T12-L1) > 1180° • L60 Lumbar (T12-L1) > 1200° • L61 Lumbar (T12-L1) > 1220° • L62 Lumbar (T12-L1) > 1240° • L63 Lumbar (T12-L1) > 1260° • L64 Lumbar (T12-L1) > 1280° • L65 Lumbar (T12-L1) > 1300° • L66 Lumbar (T12-L1) > 1320° • L67 Lumbar (T12-L1) > 1340° • L68 Lumbar (T12-L1) > 1360° • L69 Lumbar (T12-L1) > 1380° • L70 Lumbar (T12-L1) > 1400° • L71 Lumbar (T12-L1) > 1420° • L72 Lumbar (T12-L1) > 1440° • L73 Lumbar (T12-L1) > 1460° • L74 Lumbar (T12-L1) > 1480° • L75 Lumbar (T12-L1) > 1500° • L76 Lumbar (T12-L1) > 1520° • L77 Lumbar (T12-L1) > 1540° • L78 Lumbar (T12-L1) > 1560° • L79 Lumbar (T12-L1) > 1580° • L80 Lumbar (T12-L1) > 1600° • L81 Lumbar (T12-L1) > 1620° • L82 Lumbar (T12-L1) > 1640° • L83 Lumbar (T12-L1) > 1660° • L84 Lumbar (T12-L1) > 1680° • L85 Lumbar (T12-L1) > 1700° • L86 Lumbar (T12-L1) > 1720° • L87 Lumbar (T12-L1) > 1740° • L88 Lumbar (T12-L1) > 1760° • L89 Lumbar (T12-L1) > 1780° • L90 Lumbar (T12-L1) > 1800° • L91 Lumbar (T12-L1) > 1820° • L92 Lumbar (T12-L1) > 1840° • L93 Lumbar (T12-L1) > 1860° • L94 Lumbar (T12-L1) > 1880° • L95 Lumbar (T12-L1) > 1900° • L96 Lumbar (T12-L1) > 1920° • L97 Lumbar (T12-L1) > 1940° • L98 Lumbar (T12-L1) > 1960° • L99 Lumbar (T12-L1) > 1980° • L100 Lumbar (T12-L1) > 2000° • L101 Lumbar (T12-L1) > 2020° • L102 Lumbar (T12-L1) > 2040° • L103 Lumbar (T12-L1) > 2060° • L104 Lumbar (T12-L1) > 2080° • L105 Lumbar (T12-L1) > 2100° • L106 Lumbar (T12-L1) > 2120° • L107 Lumbar (T12-L1) > 2140° • L108 Lumbar (T12-L1) > 2160° • L109 Lumbar (T12-L1) > 2180° • L110 Lumbar (T12-L1) > 2200° • L111 Lumbar (T12-L1) > 2220° • L112 Lumbar (T12-L1) > 2240° • L113 Lumbar (T12-L1) > 2260° • L114 Lumbar (T12-L1) > 2280° • L115 Lumbar (T12-L1) > 2300° • L116 Lumbar (T12-L1) > 2320° • L117 Lumbar (T12-L1) > 2340° • L118 Lumbar (T12-L1) > 2360° • L119 Lumbar (T12-L1) > 2380° • L120 Lumbar (T12-L1) > 2400° • L121 Lumbar (T12-L1) > 2420° • L122 Lumbar 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> 3080° • L155 Lumbar (T12-L1) > 3100° • L156 Lumbar (T12-L1) > 3120° • L157 Lumbar (T12-L1) > 3140° • L158 Lumbar (T12-L1) > 3160° • L159 Lumbar (T12-L1) > 3180° • L160 Lumbar (T12-L1) > 3200° • L161 Lumbar (T12-L1) > 3220° • L162 Lumbar (T12-L1) > 3240° • L163 Lumbar (T12-L1) > 3260° • L164 Lumbar (T12-L1) > 3280° • L165 Lumbar (T12-L1) > 3300° • L166 Lumbar (T12-L1) > 3320° • L167 Lumbar (T12-L1) > 3340° • L168 Lumbar (T12-L1) > 3360° • L169 Lumbar (T12-L1) > 3380° • L170 Lumbar (T12-L1) > 3400° • L171 Lumbar (T12-L1) > 3420° • L172 Lumbar (T12-L1) > 3440° • L173 Lumbar (T12-L1) > 3460° • L174 Lumbar (T12-L1) > 3480° • L175 Lumbar (T12-L1) > 3500° • L176 Lumbar (T12-L1) > 3520° • L177 Lumbar (T12-L1) > 3540° • L178 Lumbar (T12-L1) > 3560° • L179 Lumbar (T12-L1) > 3580° • L180 Lumbar (T12-L1) > 3600° • L181 Lumbar (T12-L1) > 3620° • L182 Lumbar (T12-L1) > 3640° • L183 Lumbar (T12-L1) > 3660° • L184 Lumbar (T12-L1) > 3680° • L185 Lumbar (T12-L1) > 3700° • L186 Lumbar (T12-L1) > 3720° • L187 Lumbar (T12-L1) > 3740° • L188 Lumbar (T12-L1) > 3760° • L189 Lumbar (T12-L1) > 3780° • L190 Lumbar (T12-L1) > 3800° • L191 Lumbar (T12-L1) > 3820° • L192 Lumbar (T12-L1) > 3840° • L193 Lumbar (T12-L1) > 3860° • L194 Lumbar (T12-L1) > 3880° • L195 Lumbar (T12-L1) > 3900° • L196 Lumbar (T12-L1) > 3920° • L197 Lumbar (T12-L1) > 3940° • L198 Lumbar (T12-L1) > 3960° • L199 Lumbar (T12-L1) > 3980° • L200 Lumbar (T12-L1) > 4000° • L201 Lumbar (T12-L1) > 4020° • L202 Lumbar (T12-L1) > 4040° • L203 Lumbar (T12-L1) > 4060° • L204 Lumbar (T12-L1) > 4080° • L205 Lumbar (T12-L1) > 4100° • L206 Lumbar (T12-L1) > 4120° • L207 Lumbar (T12-L1) > 4140° • L208 Lumbar (T12-L1) > 4160° • L209 Lumbar (T12-L1) > 4180° • L210 Lumbar (T12-L1) > 4200° • L211 Lumbar (T12-L1) > 4220° • L212 Lumbar (T12-L1) > 4240° • L213 Lumbar (T12-L1) > 4260° • L214 Lumbar (T12-L1) > 4280° • L215 Lumbar (T12-L1) > 4300° • L216 Lumbar (T12-L1) > 4320° • L217 Lumbar (T12-L1) > 4340° • L218 Lumbar (T12-L1) > 4360° • L219 Lumbar (T12-L1) > 4380° • L220 Lumbar (T12-L1) > 4400° • L221 Lumbar (T12-L1) > 4420° • L222 Lumbar (T12-L1) > 4440° • L223 Lumbar (T12-L1) > 4460° • L224 Lumbar (T12-L1) > 4480° • L225 Lumbar (T12-L1) > 4500° • L226 Lumbar (T12-L1) > 4520° • L227 Lumbar (T12-L1) > 4540° • L228 Lumbar (T12-L1) > 4560° • L229 Lumbar (T12-L1) > 4580° • L230 Lumbar (T12-L1) > 4600° • L231 Lumbar (T12-L1) > 4620° • L232 Lumbar (T12-L1) > 4640° • L233 Lumbar (T12-L1) > 4660° • L234 Lumbar (T12-L1) > 4680° • L235 Lumbar (T12-L1) > 4700° • L236 Lumbar (T12-L1) > 4720° • L237 Lumbar (T12-L1) > 4740° • L238 Lumbar (T12-L1) > 4760° • L239 Lumbar (T12-L1) > 4780° • L240 Lumbar (T12-L1) > 4800° • L241 Lumbar (T12-L1) > 4820° • L242 Lumbar (T12-L1) > 4840° • L243 Lumbar (T12-L1) > 4860° • L244 Lumbar (T12-L1) > 4880° • L245 Lumbar (T12-L1) > 4900° • L246 Lumbar (T12-L1) > 4920° • L247 Lumbar (T12-L1) > 4940° • L248 Lumbar (T12-L1) > 4960° • L249 Lumbar (T12-L1) > 4980° • L250 Lumbar (T12-L1) > 5000° • L251 Lumbar (T12-L1) > 5020° • L252 Lumbar (T12-L1) > 5040° • L253 Lumbar (T12-L1) > 5060° • L254 Lumbar (T12-L1) > 5080° • L255 Lumbar (T12-L1) > 5100° • L256 Lumbar (T12-L1) > 5120° • L257 Lumbar (T12-L1) > 5140° • L258 Lumbar (T12-L1) > 5160° • L259 Lumbar (T12-L1) > 5180° • L260 Lumbar (T12-L1) > 5200° • L261 Lumbar (T12-L1) > 5220° • L262 Lumbar (T12-L1) > 5240° • L263 Lumbar (T12-L1) > 5260° • L264 Lumbar (T12-L1) > 5280° • L265 Lumbar (T12-L1) > 5300° • L266 Lumbar (T12-L1) > 5320° • L267 Lumbar (T12-L1) > 5340° • L268 Lumbar (T12-L1) > 5360° • L269 Lumbar (T12-L1) > 5380° • L270 Lumbar (T12-L1) > 5400° • L271 Lumbar (T12-L1) > 5420° • L272 Lumbar (T12-L1) > 5440° • L273 Lumbar (T12-L1) > 5460° • L274 Lumbar (T12-L1) > 5480° • L275 Lumbar (T12-L1) > 5500° • L276 Lumbar (T12-L1) > 5520° • L277 Lumbar (T12-L1) > 5540° • L278 Lumbar (T12-L1) > 5560° • L279 Lumbar (T12-L1) > 5580° • L280 Lumbar (T12-L1) > 5600° • L281 Lumbar (T12-L1) > 5620° • L282 Lumbar (T12-L1) > 5640° • L283 Lumbar (T12-L1) > 5660° • L284 Lumbar (T12-L1) > 5680° • L285 Lumbar (T12-L1) > 5700° • L286 Lumbar (T12-L1) > 5720° • L287 Lumbar (T12-L1) > 5740° • L288 Lumbar (T12-L1) > 5760° • L289 Lumbar (T12-L1) > 5780° • L290 Lumbar (T12-L1) > 5800° • L291 Lumbar (T12-L1) > 5820° • L292 Lumbar (T12-L1) > 5840° • L293 Lumbar (T12-L1) > 5860° • L294 Lumbar (T12-L1) > 5880° • L295 Lumbar (T12-L1) > 5900° • L296 Lumbar (T12-L1) > 5920° • L297 Lumbar (T12-L1) > 5940° • L298 Lumbar (T12-L1) > 5960° • L299 Lumbar (T12-L1) > 5980° • L300 Lumbar (T12-L1) > 6000° • L301 Lumbar (T12-L1) > 6020° • L302 Lumbar (T12-L1) > 6040° • L303 Lumbar (T12-L1) > 6060° • L304 Lumbar (T12-L1) > 6080° • L305 Lumbar (T12-L1) > 6100° • L306 Lumbar (T12-L1) > 6120° • L307 Lumbar (T12-L1) > 6140° • L308 Lumbar (T12-L1) > 6160° • L309 Lumbar (T12-L1) > 6180° • L310 Lumbar (T12-L1) > 6200° • L311 Lumbar (T12-L1) > 6220° • L312 Lumbar (T12-L1) > 6240° • L313 Lumbar (T12-L1) > 6260° • L314 Lumbar (T12-L1) > 6280° • L315 Lumbar (T12-L1) > 6300° • L316 Lumbar (T12-L1) > 6320° • L317 Lumbar (T12-L1) > 6340° • L318 Lumbar (T12-L1) > 6360° • L319 Lumbar (T12-L1) > 6380° • L320 Lumbar (T12-L1) > 6400° • L321 Lumbar (T12-L1) > 6420° • L322 Lumbar (T12-L1) > 6440° • L323 Lumbar (T12-L1) > 6460° • L324 Lumbar (T12-L1) > 6480° • L325 Lumbar (T12-L1) > 6500° • L326 Lumbar (T12-L1) > 6520° • L327 Lumbar (T12-L1) > 6540° • L328 Lumbar (T12-L1) > 6560° • L329 Lumbar (T12-L1) > 6580° • L330 Lumbar (T12-L1) > 6600° • L331 Lumbar (T12-L1) > 6620° • L332 Lumbar (T12-L1) > 6640° • L333 Lumbar (T12-L1) > 6660° • L334 Lumbar (T12-L1) > 6680° • L335 Lumbar (T12-L1) > 6700° • L336 Lumbar (T12-L1) > 6720° • L337 Lumbar (T12-L1) > 6740° • L338 Lumbar (T12-L1) > 6760° • L339 Lumbar (T12-L1) > 6780° • L340 Lumbar (T12-L1) > 6800° • L341 Lumbar (T12-L1) > 6820° • L342 Lumbar (T12-L1) > 6840° • L343 Lumbar (T12-L1) > 6860° • L344 Lumbar (T12-L1) > 6880° • L345 Lumbar (T12-L1) > 6900° • L346 Lumbar (T12-L1) > 6920° • L347 Lumbar (T12-L1) > 6940° • L348 Lumbar (T12-L1) > 6960° • L349 Lumbar (T12-L1) > 6980° • L350 Lumbar (T12-L1) > 7000° • L351 Lumbar (T12-L
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Don't Forget Pelvic Obliquity / LLD



ASD - Have an Algorithm...

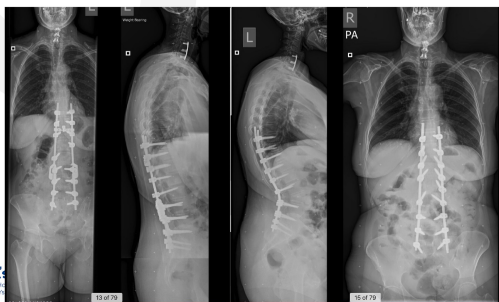
- What does the patient want?
- What is most appropriate for your patient?
- Surgical factors to consider - ABC Approach:
 - **A**ge **A**lignment **A**natomy **A**ccess
 - **B**one Quality / **B**alance
 - **C**ompression – central / lateral / foraminal
 - **D**isc Height / **D**egeneration / **D**eformity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



Deformity – ALL release - ALIF



Deformity – Osteotomy - PSO



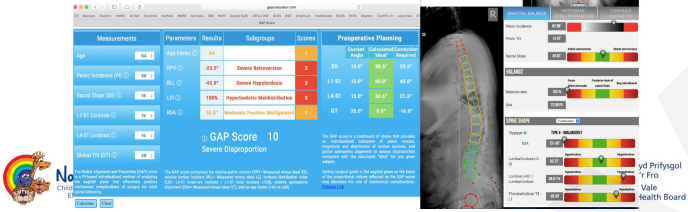
Osteotomy vs ALL Release

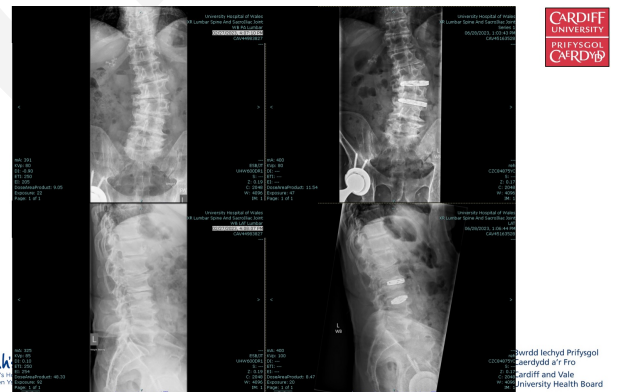
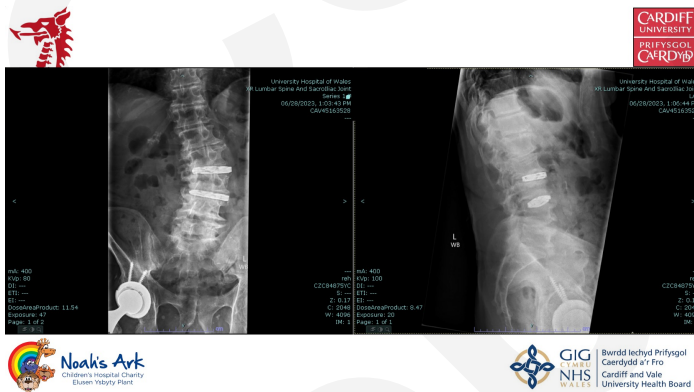
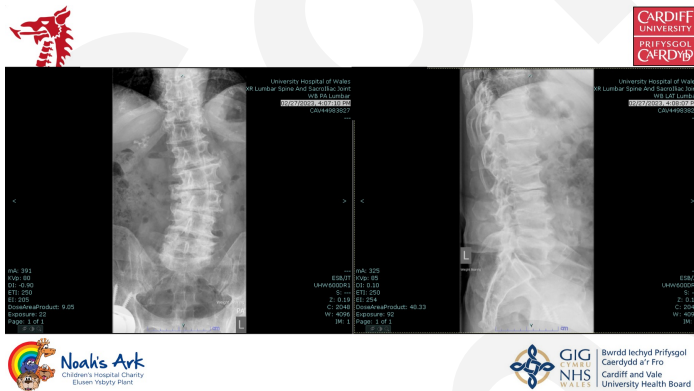
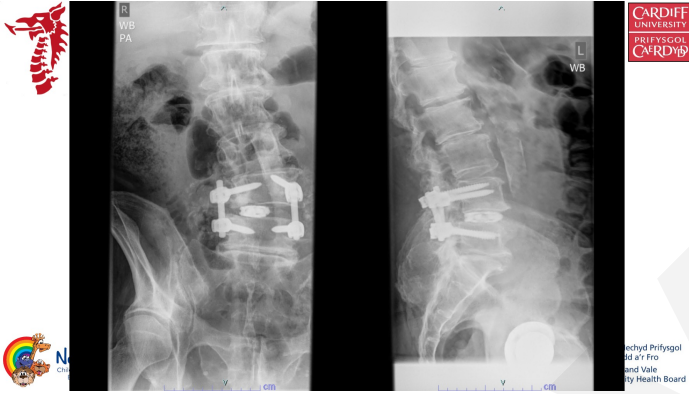
- Osteotomy - PSO
 - Direct canal decompression
 - Direct foraminal decompression (but no height restoration)
 - Shortening procedure
 - "Bone on bone" fusion if performed correctly
 - Correction = per level
 - Typically up to 30 degrees
- ALL release + Cage
 - Indirect canal decompression
 - Indirect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

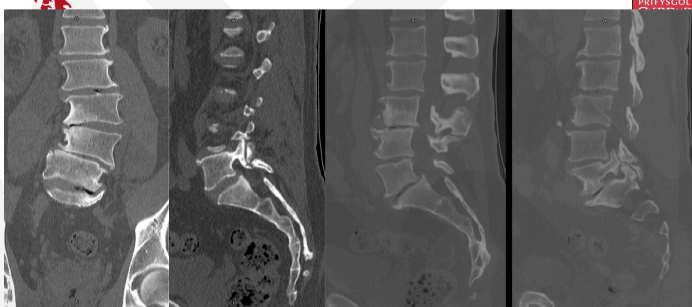
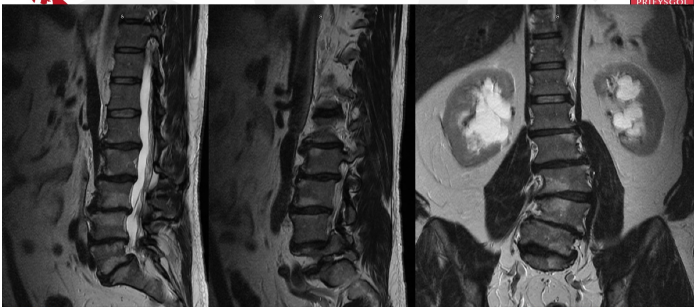
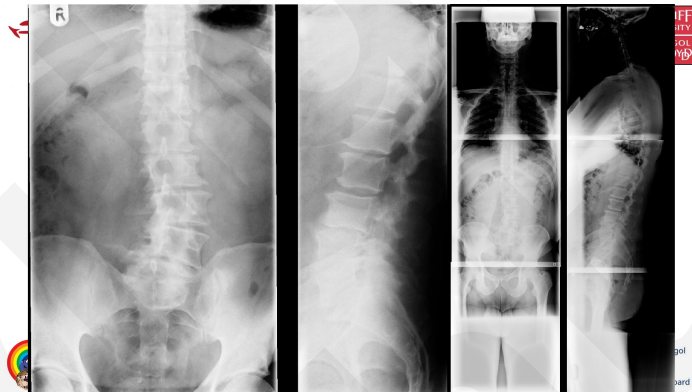


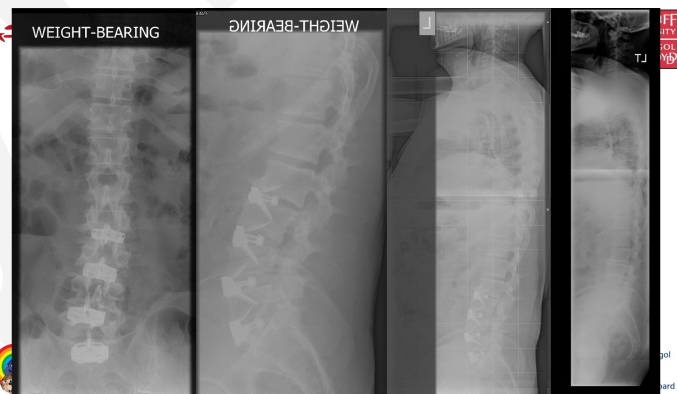
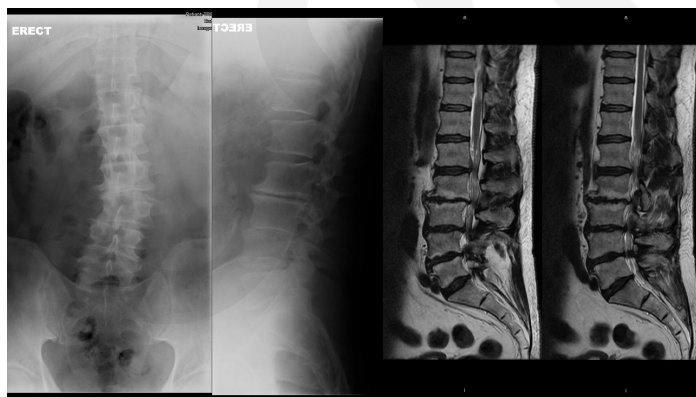
Surgical Planning

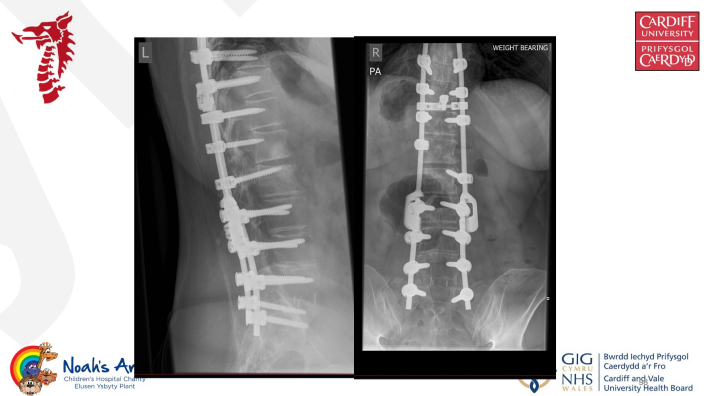
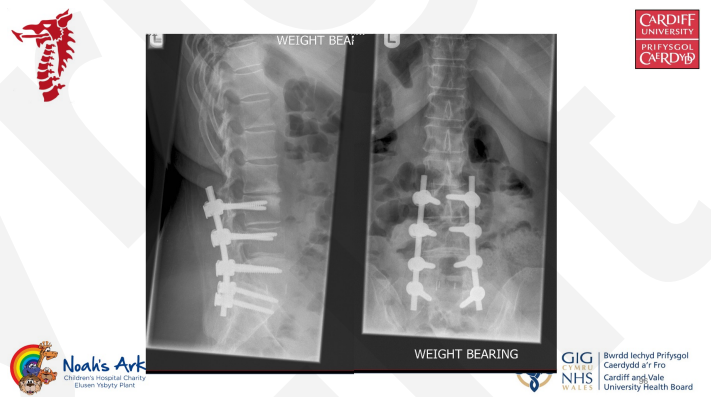
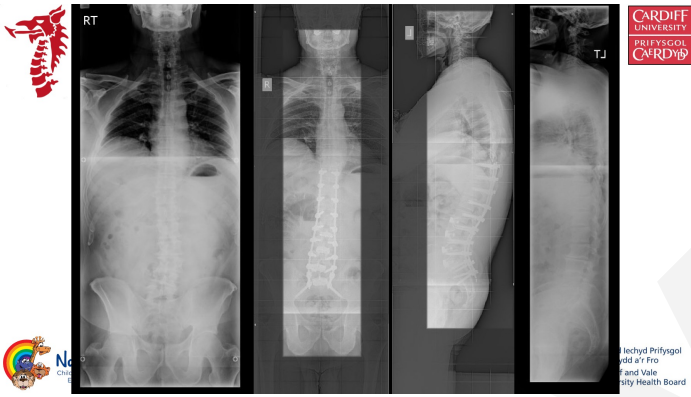
- Depends on understanding all the above!
- There are some tools to help:

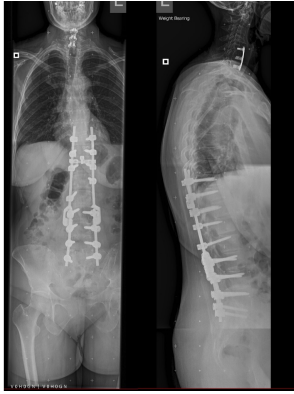










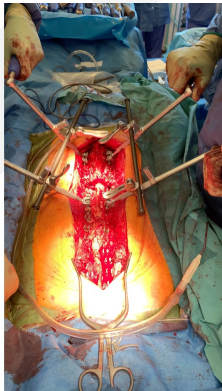
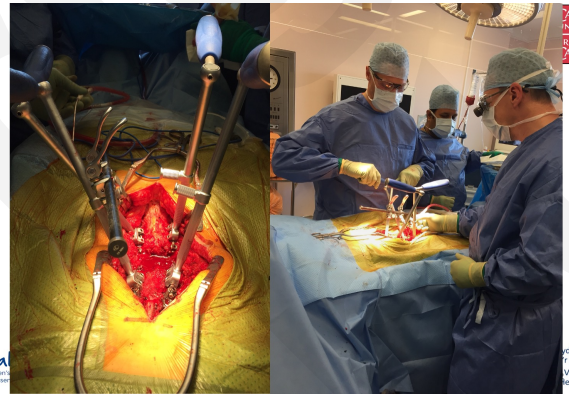
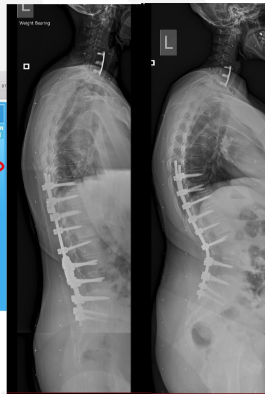


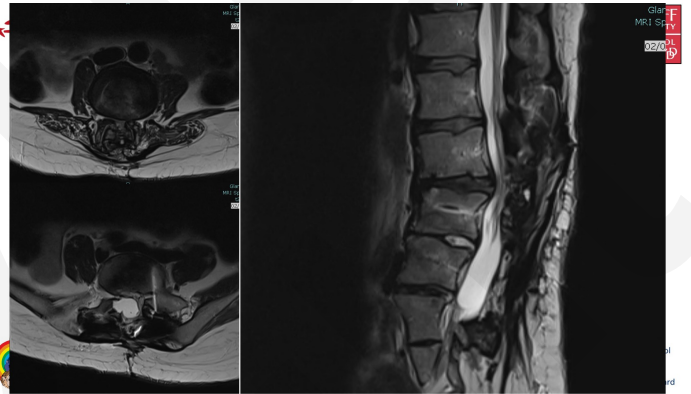
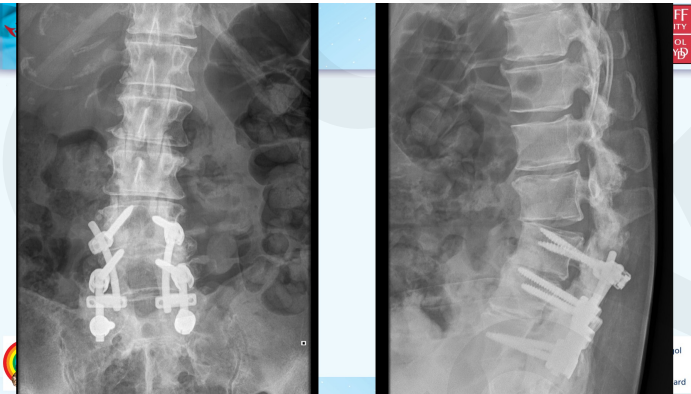
Measurements	Parameters	Results	Subgroups	Scores	Preoperative Planning
Age	Age Factor	64		1	
BPV	BPV	-23.3°	Severe Retroversion	3	
PLL	PLL	-45.8°	Severe Hypolordosis	3	
Secal Slope (SD)	Secal Slope (SD)	-18.2°	Hyperlordotic Malignant	3	
L5/S1 Lordosis	L5/S1 Lordosis	15.5°	Moderate Positive Multilevel	1	
L4/S1 Lordosis	L4/S1 Lordosis	18.8°			
Global T12 (SD)	Global T12 (SD)	19.3°			

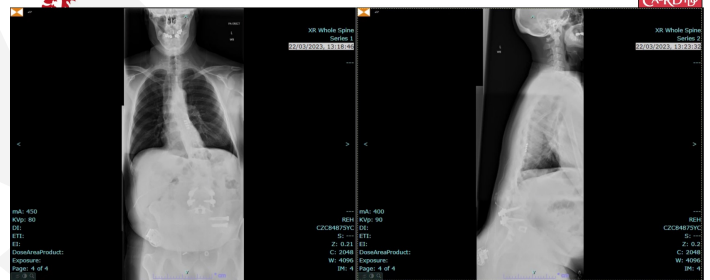
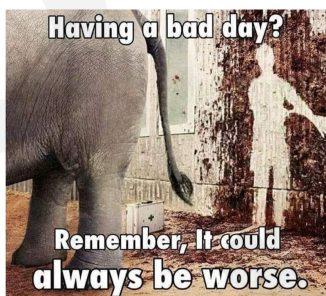
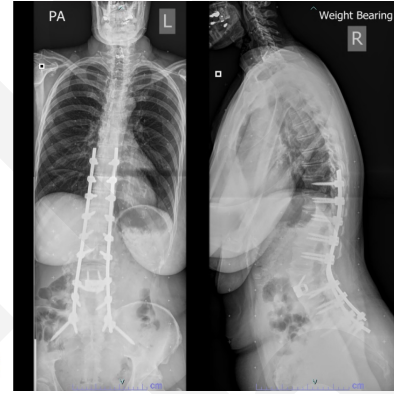
GAP Score 10
Severe Disproportion

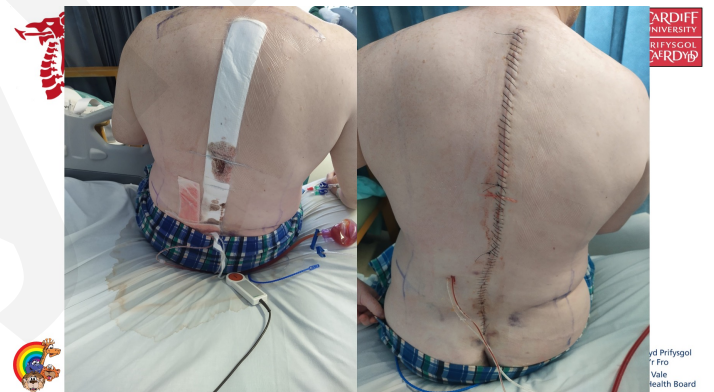
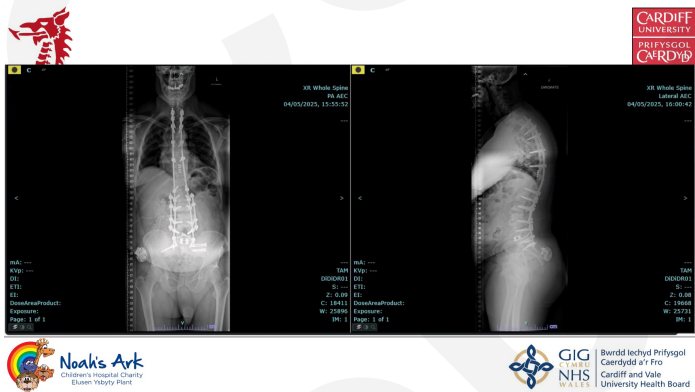
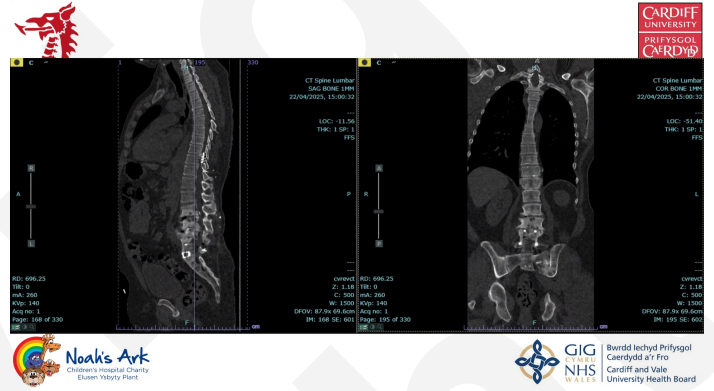
The GAP score is a combination of values that provide an indication of the degree of deformity, with magnitude and distribution of lateral masses, and global sagittal alignment to assess the degree of deformity with the 'lateral mass' for each vertebra.

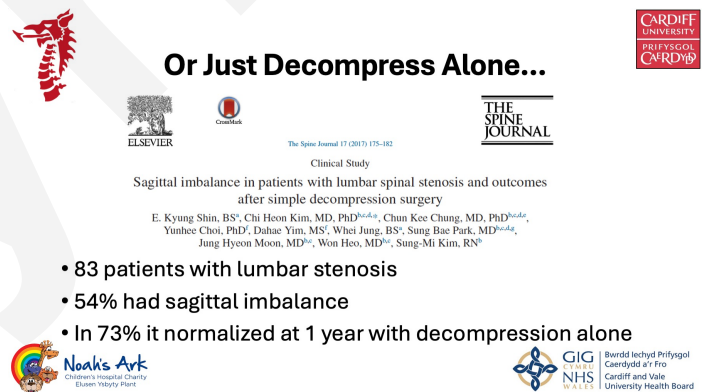
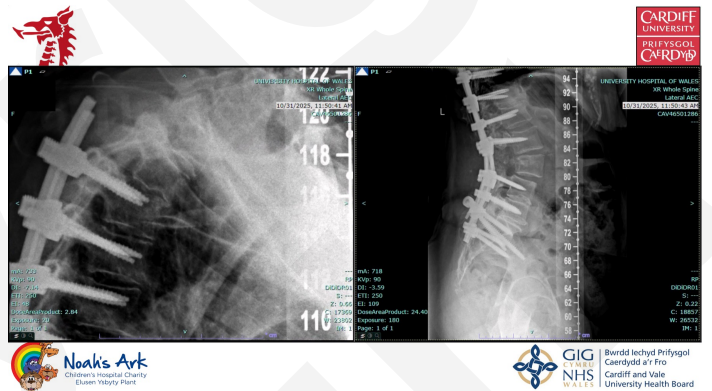
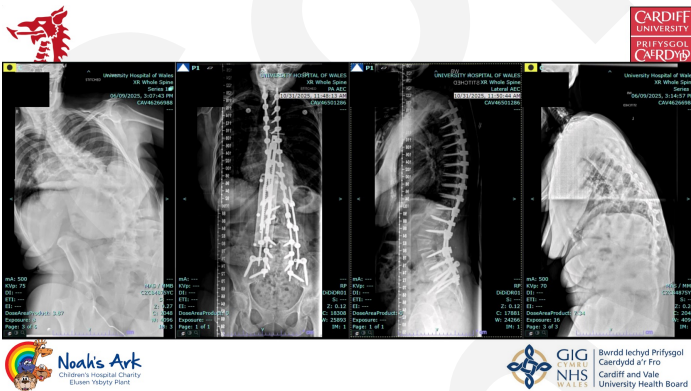
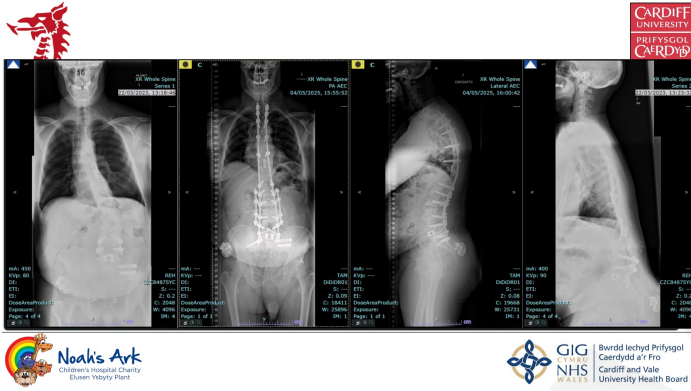
The GAP score contains the relative values of: 1) Measured curve (SD), 2) Measured curve (SD), 3) Measured curve (SD), 4) Measured curve (SD), 5) Measured curve (SD), 6) Measured curve (SD), 7) Measured curve (SD), 8) Measured curve (SD), 9) Measured curve (SD), 10) Measured curve (SD), 11) Measured curve (SD), 12) Measured curve (SD), 13) Measured curve (SD), 14) Measured curve (SD), 15) Measured curve (SD), 16) Measured curve (SD), 17) Measured curve (SD), 18) Measured curve (SD), 19) Measured curve (SD), 20) Measured curve (SD), 21) Measured curve (SD), 22) Measured curve (SD), 23) Measured curve (SD), 24) Measured curve (SD), 25) Measured curve (SD), 26) Measured curve (SD), 27) Measured curve (SD), 28) Measured curve (SD), 29) Measured curve (SD), 30) Measured curve (SD), 31) Measured curve (SD), 32) Measured curve (SD), 33) Measured curve (SD), 34) Measured curve (SD), 35) Measured curve (SD), 36) Measured curve (SD), 37) Measured curve (SD), 38) Measured curve (SD), 39) Measured curve (SD), 40) Measured curve (SD), 41) Measured curve (SD), 42) Measured curve (SD), 43) Measured curve (SD), 44) Measured curve (SD), 45) Measured curve (SD), 46) Measured curve (SD), 47) Measured curve (SD), 48) Measured curve (SD), 49) Measured curve (SD), 50) Measured curve (SD), 51) Measured curve (SD), 52) Measured curve (SD), 53) Measured curve (SD), 54) Measured curve (SD), 55) Measured curve (SD), 56) Measured curve (SD), 57) Measured curve (SD), 58) Measured curve (SD), 59) Measured curve (SD), 60) Measured curve (SD), 61) Measured curve (SD), 62) Measured curve (SD), 63) Measured curve (SD), 64) Measured curve (SD), 65) Measured curve (SD), 66) Measured curve (SD), 67) Measured curve (SD), 68) Measured curve (SD), 69) Measured curve (SD), 70) Measured curve (SD), 71) Measured curve (SD), 72) Measured curve (SD), 73) Measured curve (SD), 74) Measured curve (SD), 75) Measured curve (SD), 76) Measured curve (SD), 77) Measured curve (SD), 78) Measured curve (SD), 79) Measured curve (SD), 80) Measured curve (SD), 81) Measured curve (SD), 82) Measured curve (SD), 83) Measured curve (SD), 84) Measured curve (SD), 85) Measured curve (SD), 86) Measured curve (SD), 87) Measured curve (SD), 88) Measured curve (SD), 89) Measured curve (SD), 90) Measured curve (SD), 91) Measured curve (SD), 92) Measured curve (SD), 93) Measured curve (SD), 94) Measured curve (SD), 95) Measured curve (SD), 96) Measured curve (SD), 97) Measured curve (SD), 98) Measured curve (SD), 99) Measured curve (SD), 100) Measured curve (SD).













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 – Is the sacrum vertical?...
 - Measure the PILL and observe the lordosis L4-S1
 - If in doubt – get whole spine films
 - IS A FUSION REALLY REQUIRED???



If considering fusion think alignment / deformity



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...**

