



KLINIKUM MAGDEBURG gGmbH

Planung und sagittale Balance für die **OP** der degenerativen Wirbelsäule

Jörg Franke

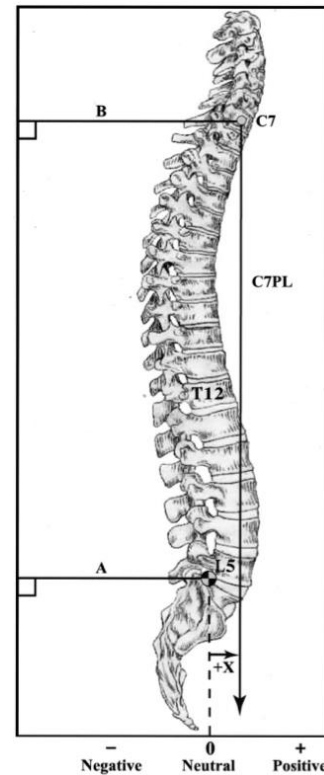
Vorteile bei der Planung

- Sie sind auf den Fall vorbereitet
- Unser Gehirn ist während der Ausführung weniger beschäftigt
-
- Potenzielles Lernwerkzeug
-
- Über KI Wissen von unseren Kollegen erhalten
-
- Mögliche Vorlage

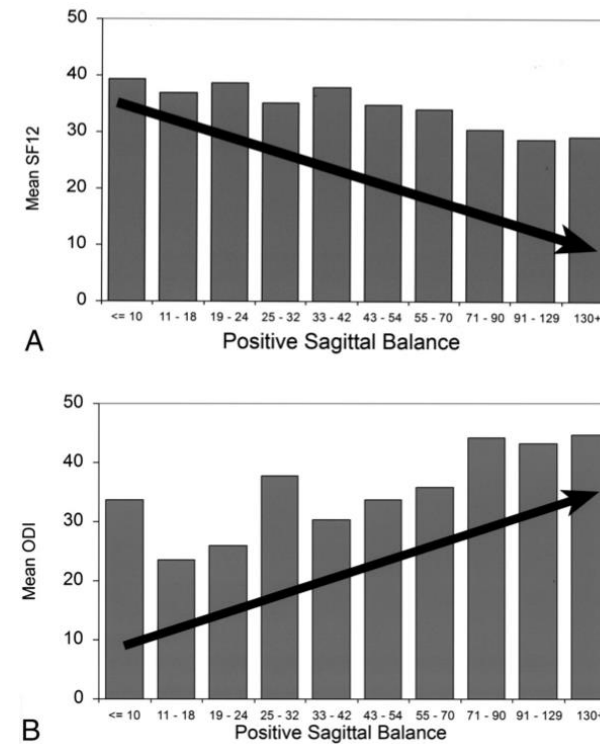
Nachteile bei der Planung

- Zeitraubend
- Fehler aufgrund einer potenziell komplizierten Formel

Degeneration ist kyphogen!!! Und problematisch



Glassman et al Spine 2005;30:2024-29



Wert des Röntgen im Stand und der Langaufnahme !!!!



Ohne Rö werden wichtige Dinge übersehen !

60 yr/F – LBA 4 months, radiating to both lower limb
Operated previously L4 to S1 fusion – **PLF** – 2.5 yrs
ago

Severe claudication
Left EHL grade 4, Left L5 hypoaesthesia

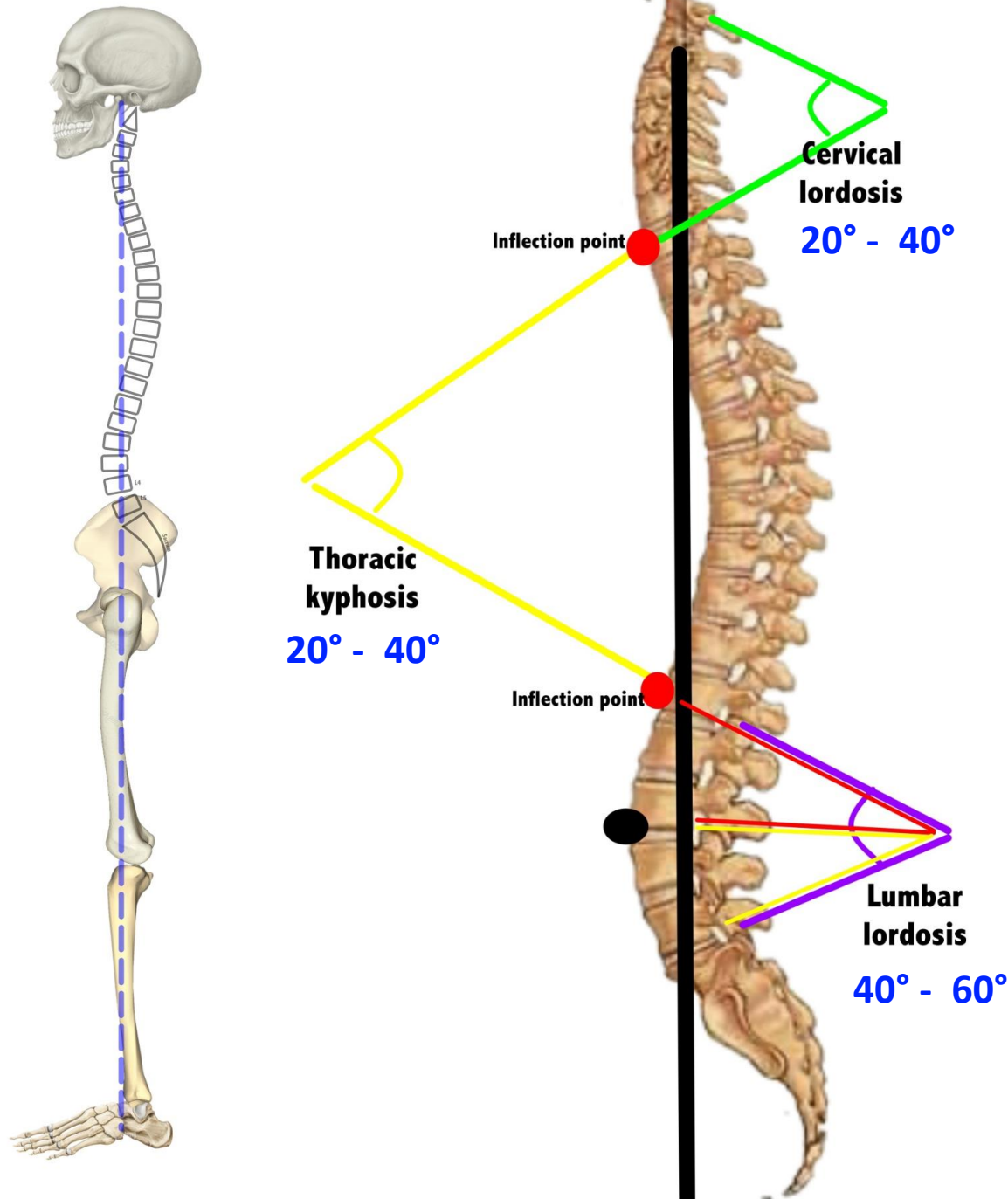


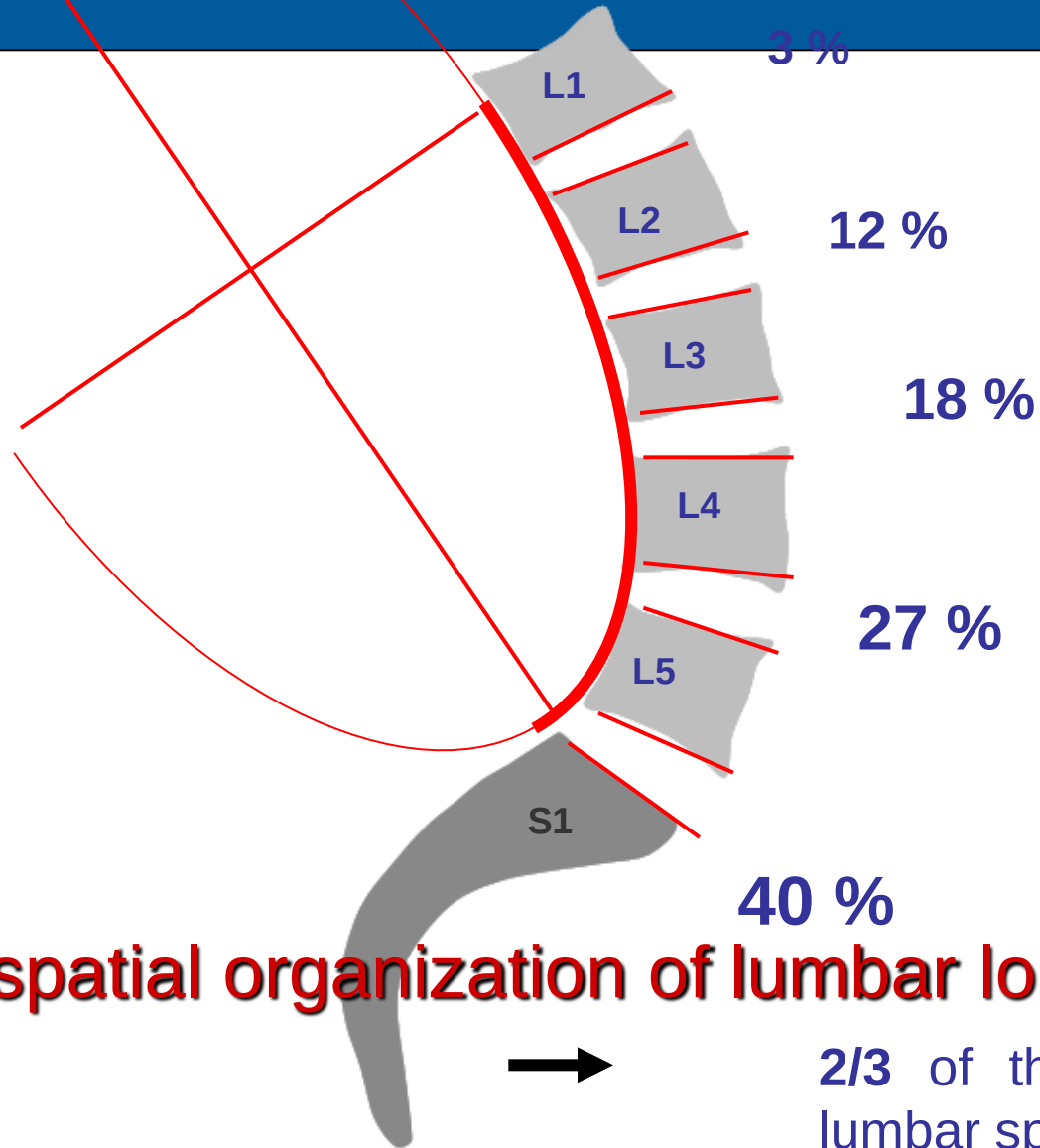
Spinal Alignment

Represents curvatures and angles

Spinal Balance

- Equilibrium between
 - External forces on spine
 - Muscular response of trunk





CLASSICAL ANATOMICAL LANDMARKS

Janik J Orthop res 1998

Typical spatial organization of lumbar lordosis

$\frac{2}{3}$ of the lumbar lordosis located in the lower lumbar spine segment L4-S1

Roussouly curve types 2005

Lower prevalence

Higher prevalence

ST < 35°
Lordotic apex:
center of L5



Type 1

- Hyperlordotic L5-S1; **Sway back**
- Low capacity for pelvic retroversion
- Stress on posterior elements
- Nutcracker type Isthmic spondy
- TL junctional disc degeneration

ST < 35°
Lordotic apex:
base of L4



Type 2

- Hypolordotic; Typical **Flat back**
- High L4-5, 5-S1 DDD
- High intradiscal pressures – Central disc herniations
- Low adaptivity to sports/ weight bearing

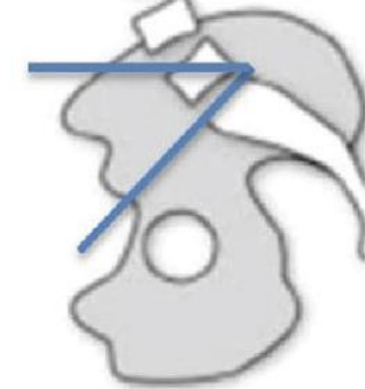
ST ranging from
35° to 45°



Type 3

- **Favourable**
- Least chance of DDD

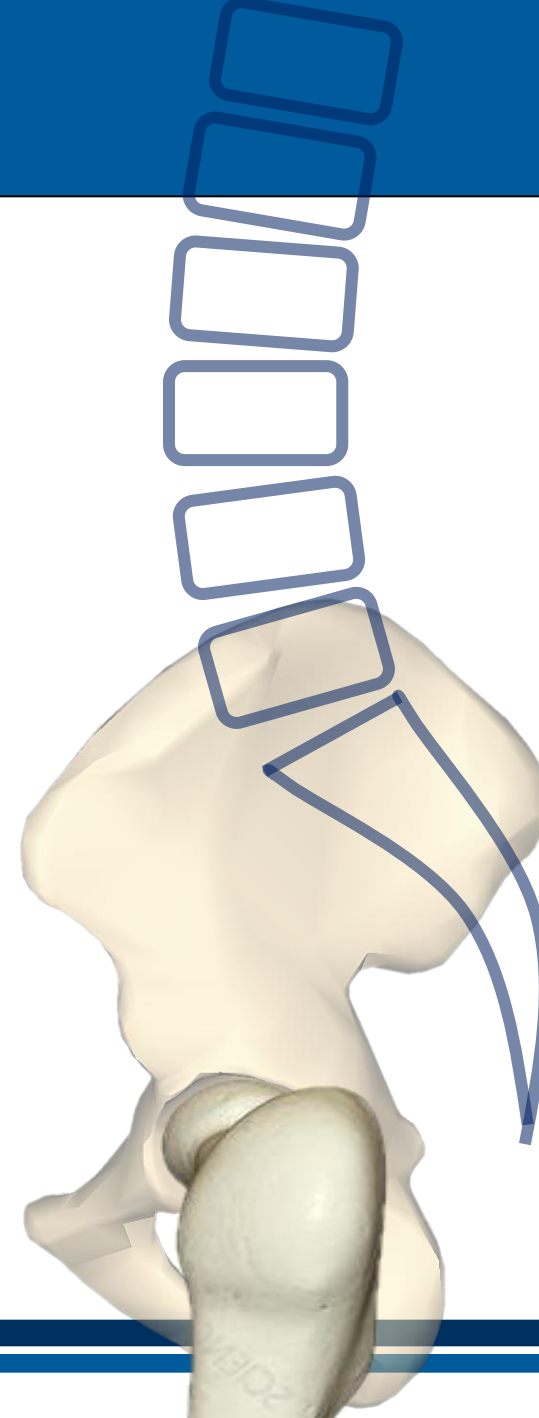
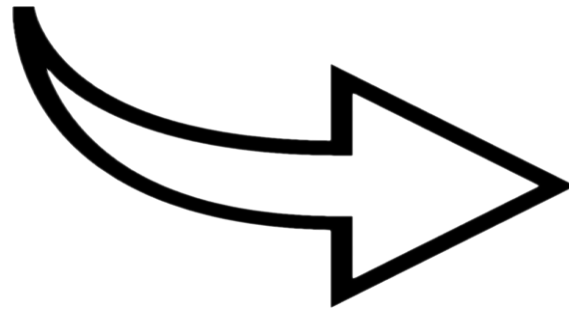
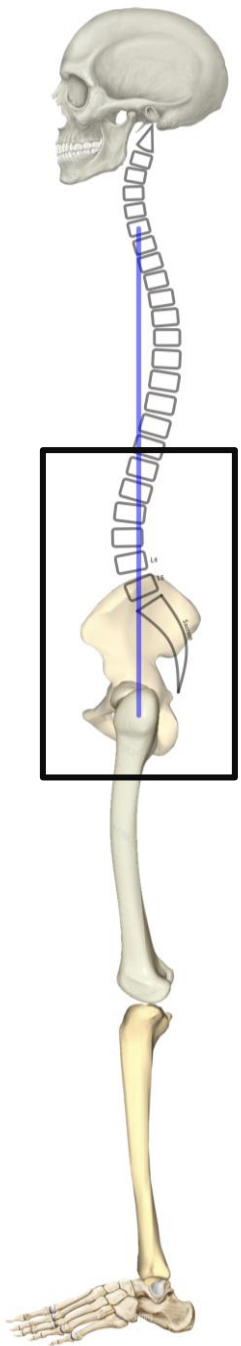
ST > 45°



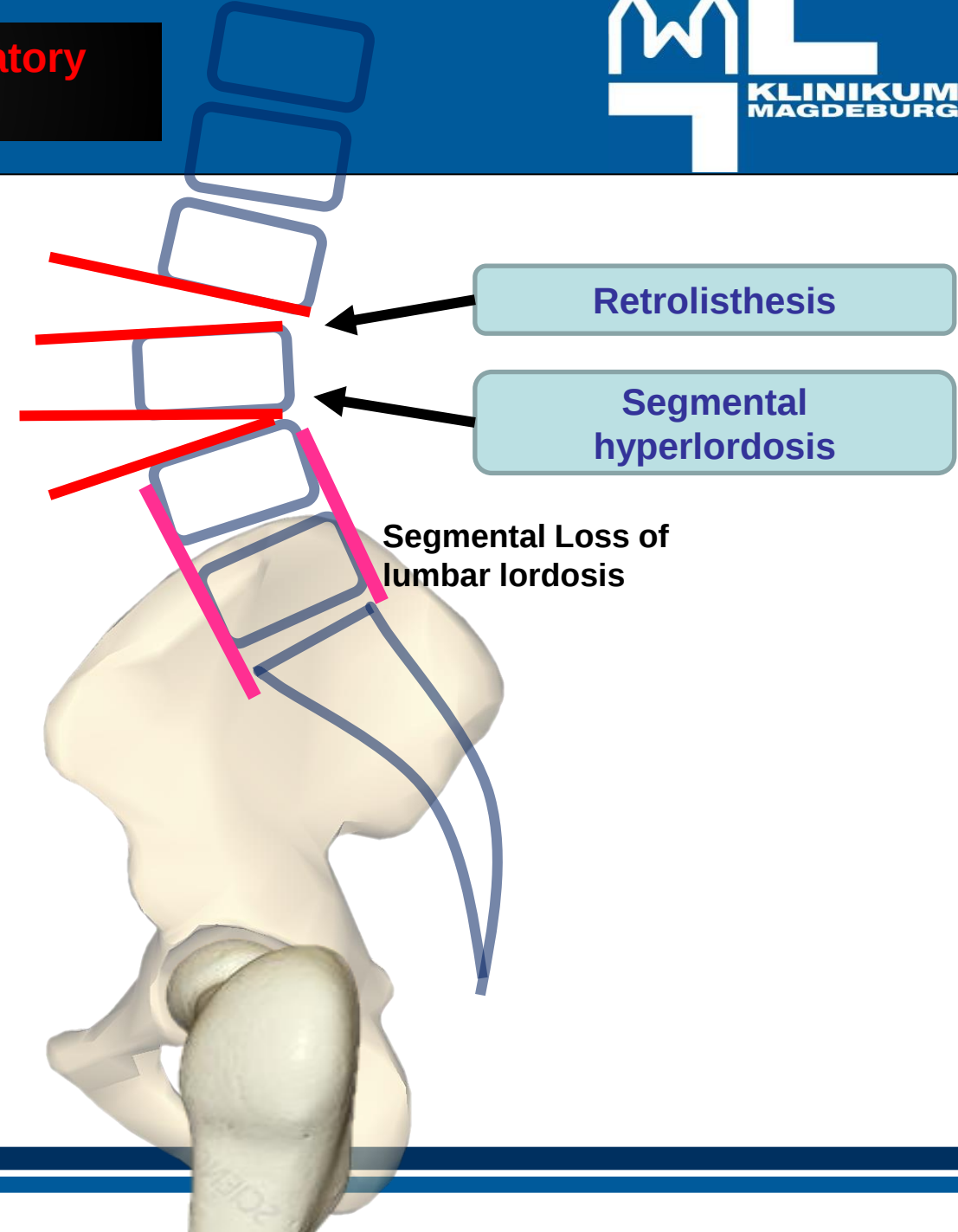
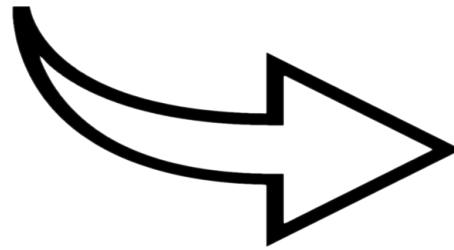
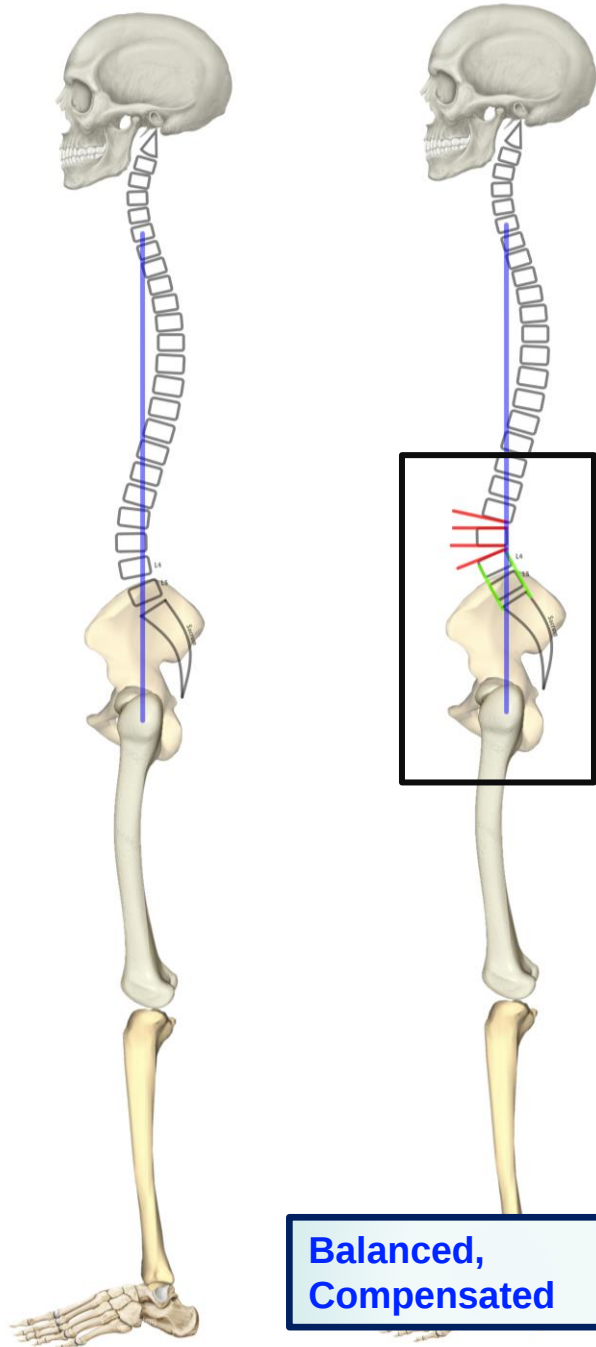
Type 4

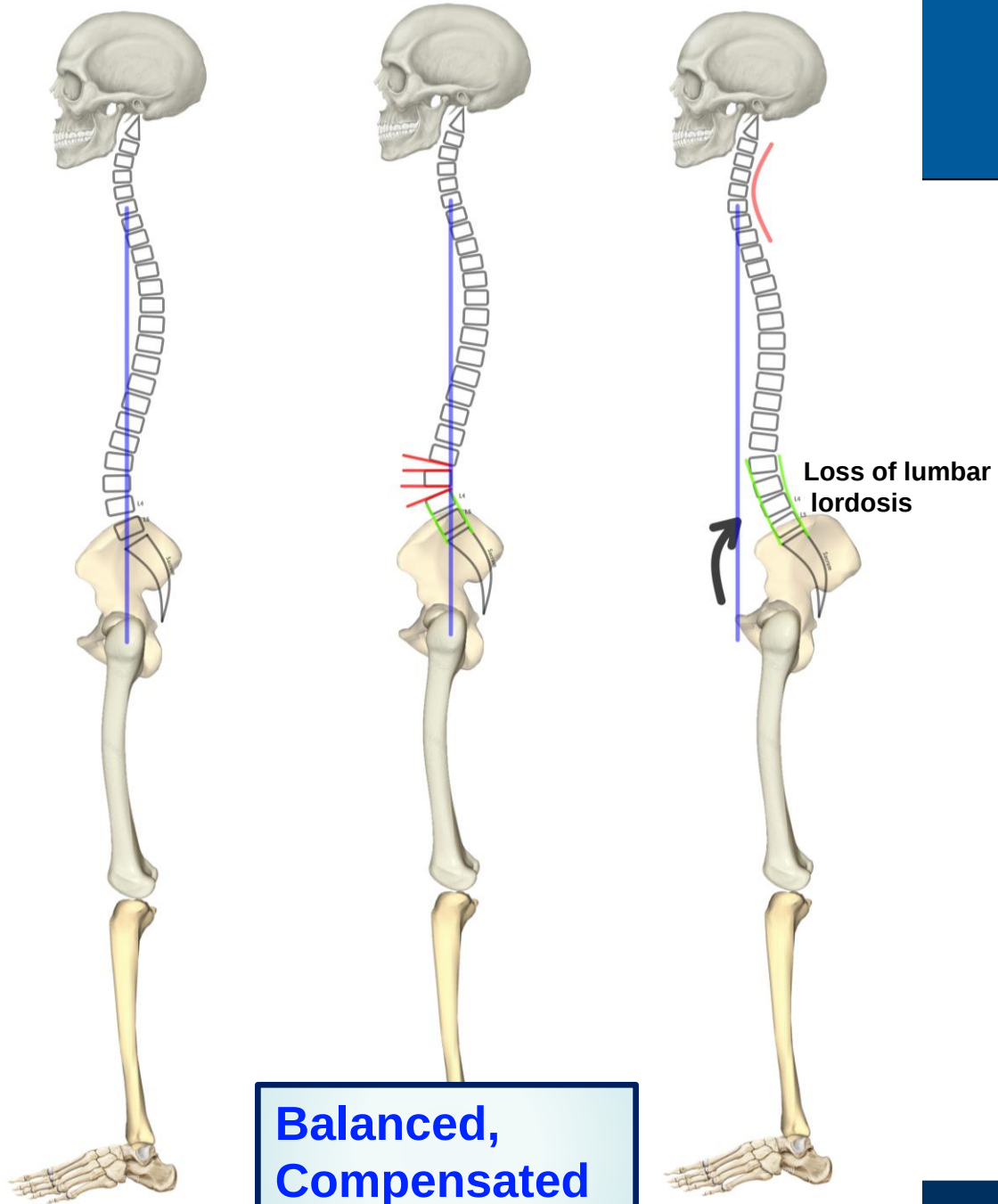
- **Kyphotic-Lordotic posture**
- Higher stress on posterior elements
- Shear type isthmic spondy
- Junctional degeneration

Age-related compensatory mechanisms

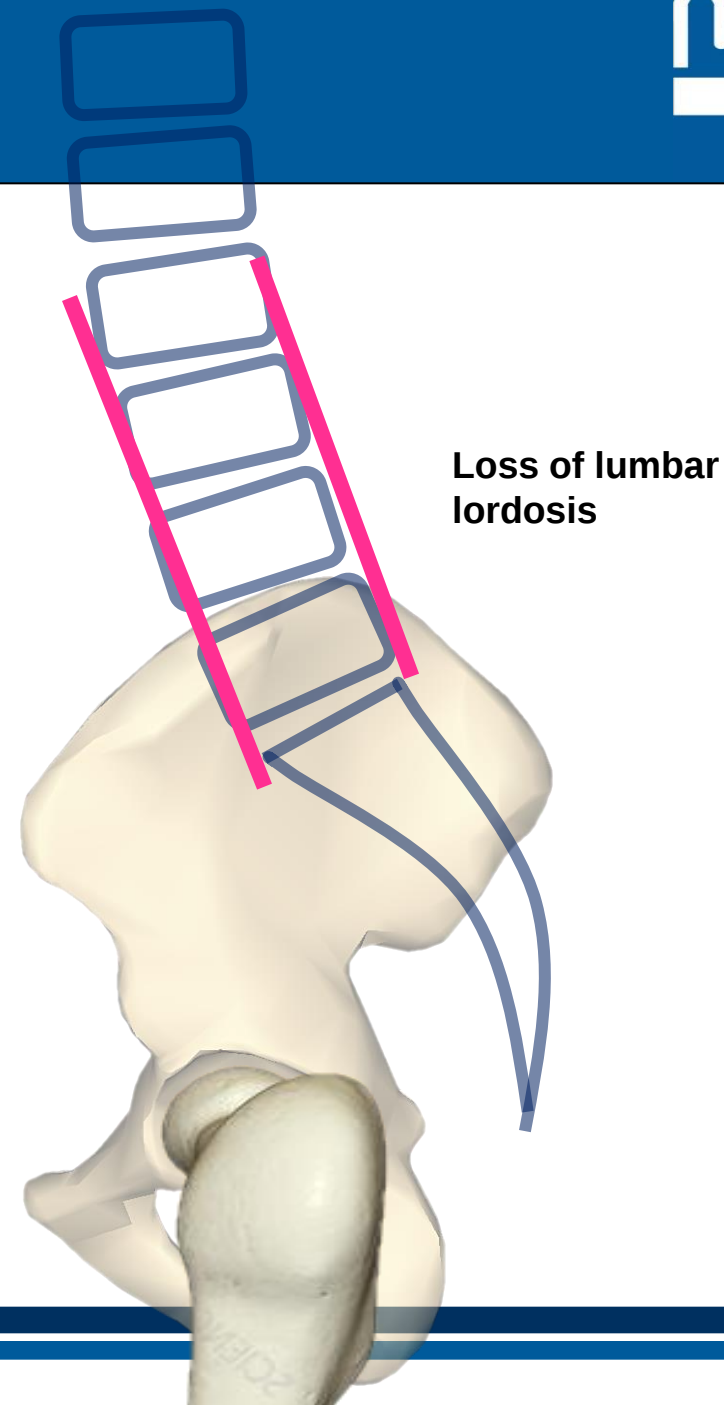


Age-related compensatory mechanisms

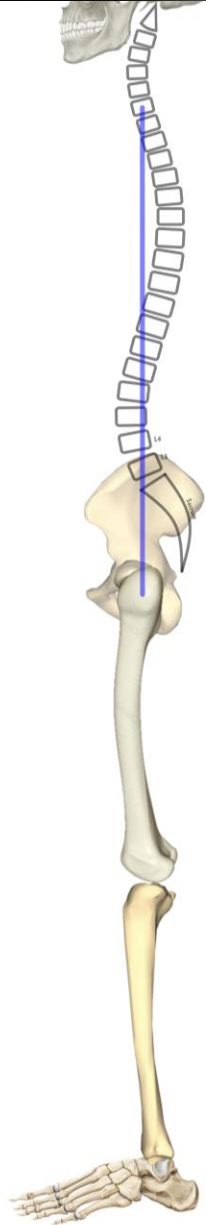




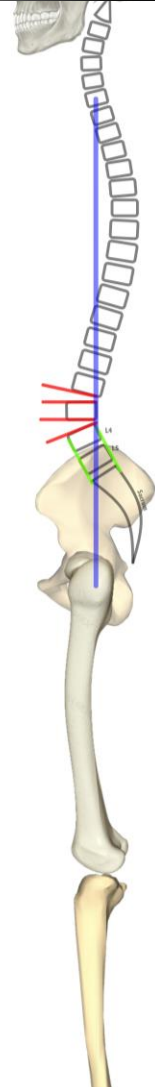
**Balanced,
Compensated**



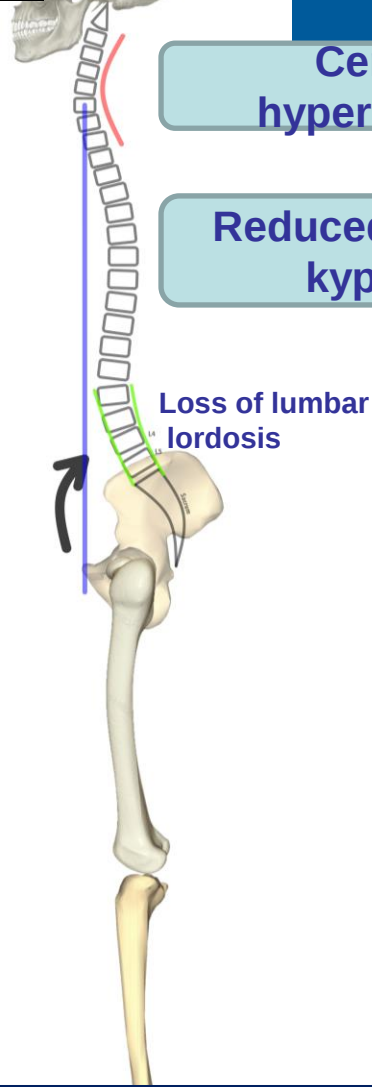
Age-related compensatory mechanisms



Balanced,
Compensated



Un - Balanced,
Compensated

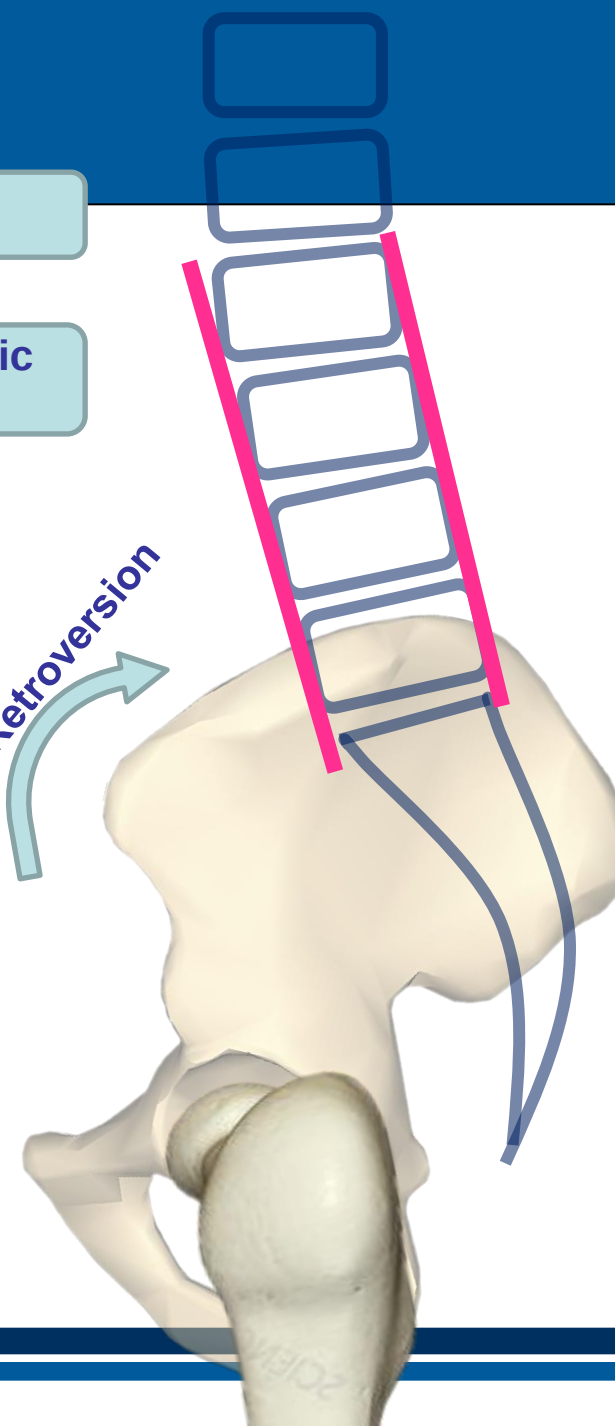


Cervical
hyperlordosis

Reduced Thoracic
kyphosis

Loss of lumbar
lordosis

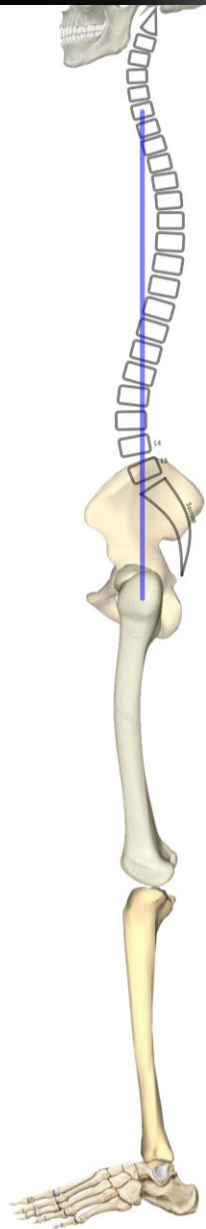
Pelvic Retroversion



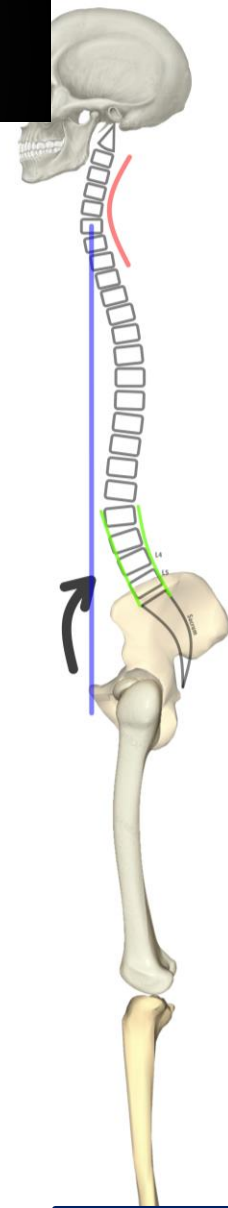
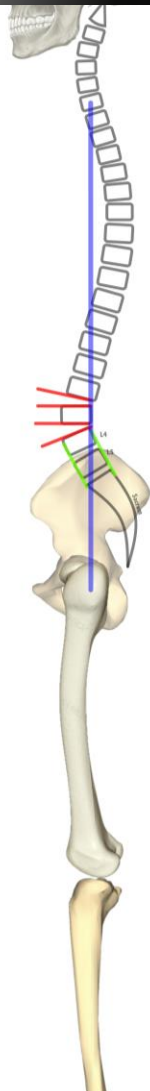
Pelvic retroversion

Hip locks in
extension

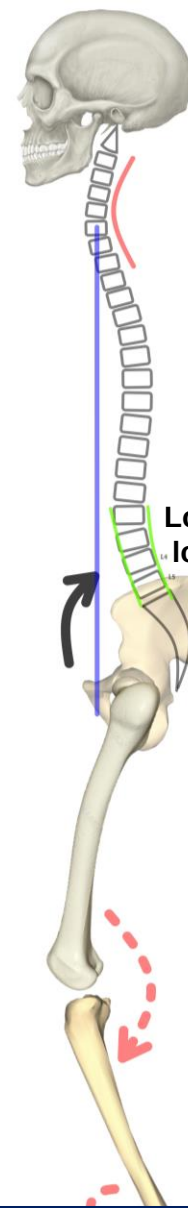
Age-related compensatory mechanisms



Balanced,
Compensated



Un - Balanced,
Compensated



Loss of lumbar
lordosis

Cervical
hyperlordosis

Reduced Thoracic
kyphosis

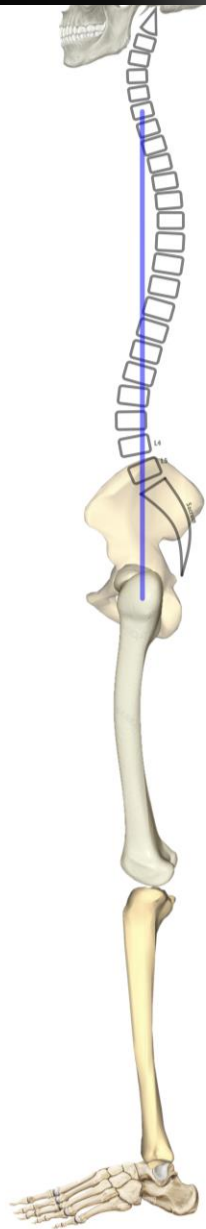
Pelvic retroversion

Hip locks in 'maximum'
extension

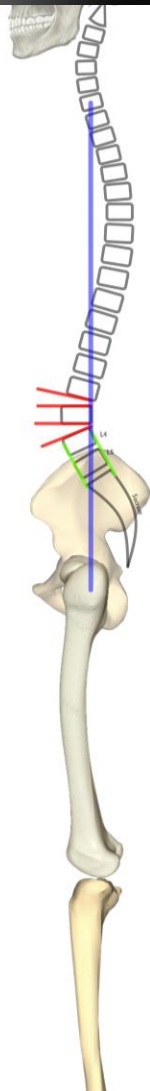
Progressive knee
flexion

Ankle flexion

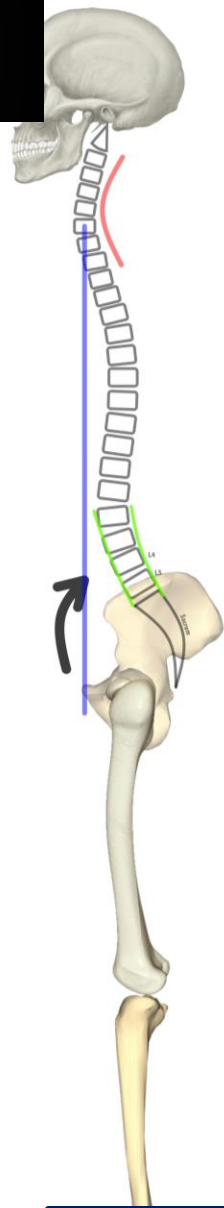
Age-related compensatory mechanisms



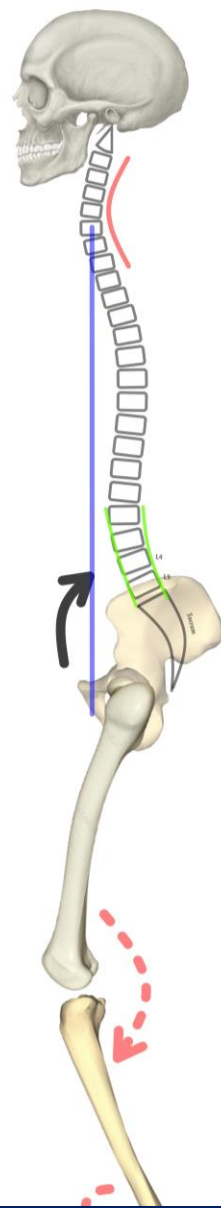
Balanced,
Compensated



Un - Balanced,
Compensated



Un - Balanced,
Compensated



De-



Ankle flexion

Loss of cervical
lordosis

Loss of lumbar
lordosis

Reduced Thoracic
kyphosis

Pelvic retroversion

Hip locks in
'maximum' extension

Progressive knee
flexion

Hyperextension at
O-C1

Not paying attention to it is a mistake !

Eur Spine J (2015) 24:1251–1258

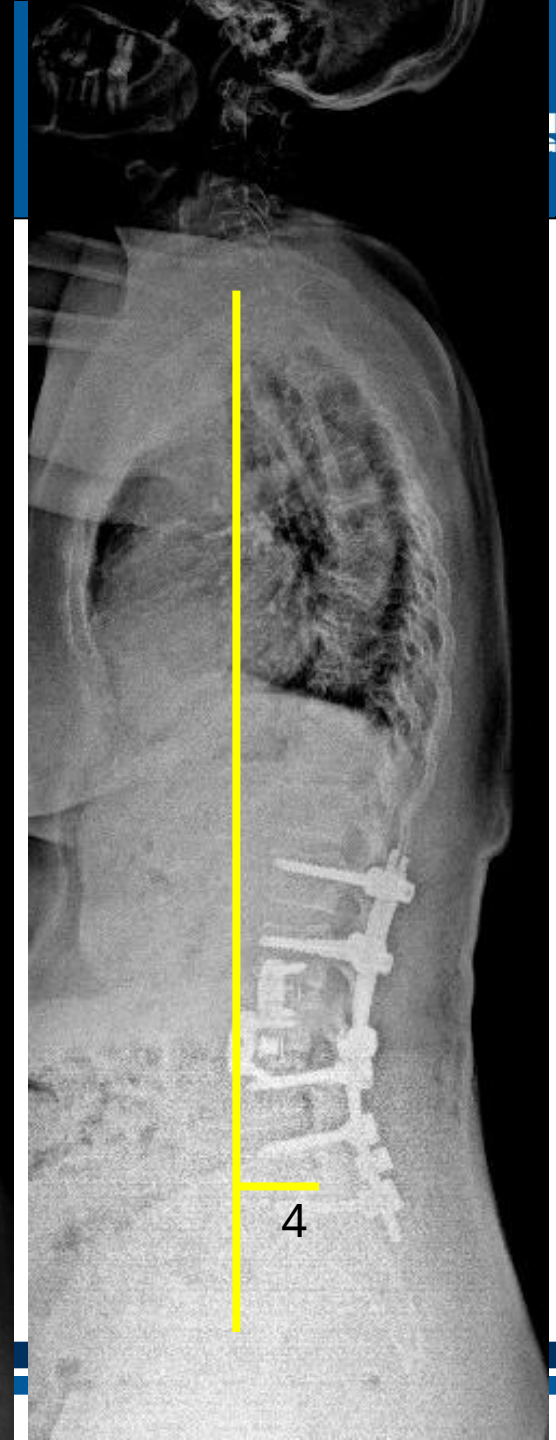
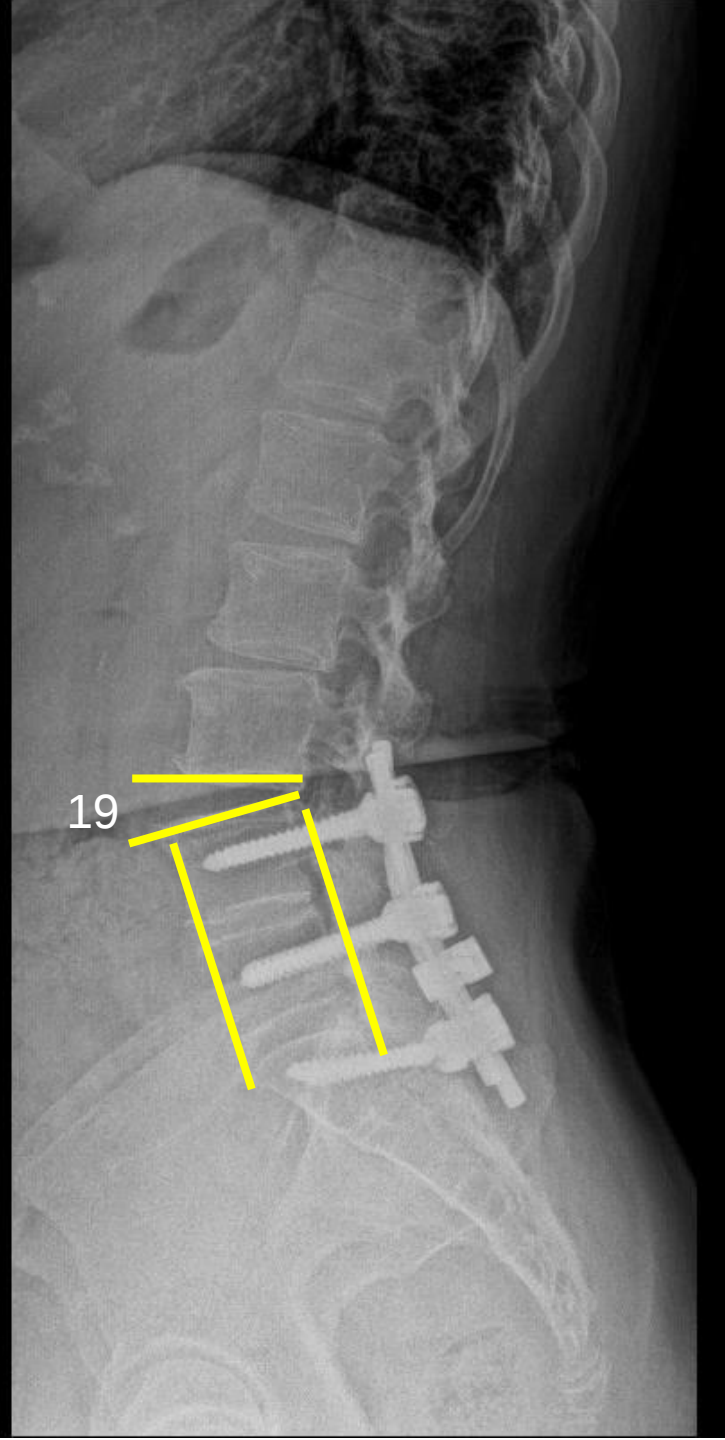
DOI 10.1007/s00586-014-3454-0

ORIGINAL ARTICLE

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

Dominique A. Rothenfluh • Daniel A. Mueller •

Esin Rothenfluh • Kan Min



62%

of patients remained sagittally malaligned after surgery¹

There is a **10x greater risk** to develop **ADJACENT SEGMENT DISEASE** for degen patients that have not achieved sagittal alignment from their surgery⁴

30% of degen patients have a hidden deformity³

1. Moal B, Schwab F, Ames CP, et al. Radiographic Outcomes of Adult Spinal Deformity Correction: A Critical Analysis of Variability and Failures Across Deformity Patterns. Spine Deform. 2014.
2. Hamilton DK, Buza JA, Passias PG, et al. The Fate of Adult Spinal Deformity (ASD) Patients Incurring Rod Fracture After Thoracolumbar Fusion. World Neurosurgery. 2017.
3. E.Burger, T. Raabe, P. Passias, C.Kleck, T. Protopsaltis. Patient-Specific Rods show a reduction in rod breakage incidence. NASS Abstract. September 2018.
4. Rothenfluh DA, Mueller DA, et al. Pelvic incidence-lumbar lordosis mismatch predisposes to adjacent segment disease after lumbar spinal fusion. Eur Spine J (2015) 24:1251-1258
5. Radius of Curvature in Patient-Specific Short Rod Constructs versus Standard Pre-Bent Rods, Katherine Branche, Rawha Netsanet, Andriy Noshchenko, Evalina Burger, Vikas Patel, David Ou-Yang, Christopher J. Kleck, University of Colorado Anschutz, Medical Campus, Aurora Colorado, USA



Mechanical complications in adult spinal deformity and the effect of restoring the spinal shapes according to the Roussouly classification: a multicentric study

Amer Sebaaly^{1,2,3} · Martin Gehrchen⁴ · Clément Silvestre¹ · Khalil Kharrat^{2,3} · Tanvir Johanning Bari⁴ · Gabi Kreichati^{2,3} · Maroun Rizkallah^{2,3} · Pierre Roussouly¹

Received: 15 August 2019 / Revised: 28 October 2019 / Accepted: 19 November 2019 / Published online: 26 December 2019
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If spine type is not restored in ASD, there is a 3-fold risk of reoperation within the first 2 years postoperatively compared to if restored.



WHAT IS UNiD ?

THE UNiD LAB

THE LAB WORKS COLLABORATIVELY WITH SURGEONS TO:

- PROVIDE A DETAILED ANALYSIS OF THE PATIENT'S SPINOPELVIC PARAMETERS
- SIMULATE SURGICAL STRATEGIES AND TECHNOLOGIES USING PROPRIETARY PREDICTIVE PLANNING MODELS
- COLLECT POST-OPERATIVE OUTCOMES



UNiD LAB™

TEAM OF BIOMEDICAL
ENGINEERS WHO PROVIDE A
SUITE OF SERVICES.

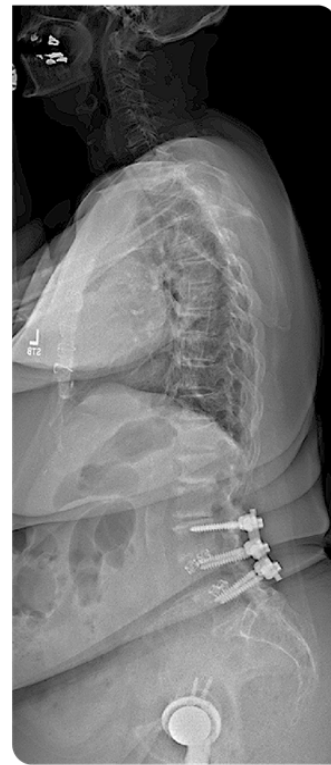
UNID platform can help!!

CALIBRATED SAGITTAL X-RAYS SURGICAL PLAN SIMULATION

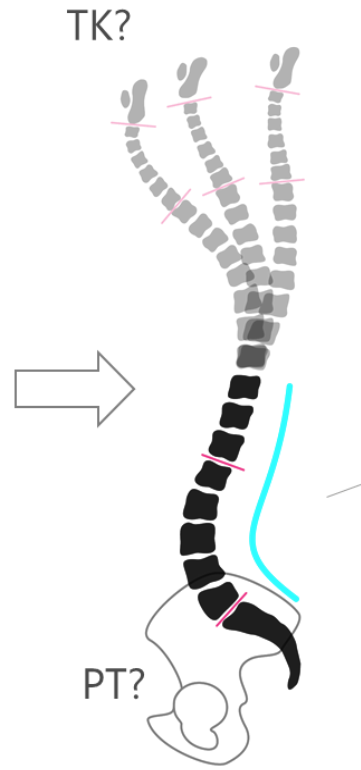
PREDICTIVE MODELING

COMPENSATORY MECHANISMS
MOST LIKELY TO OCCUR

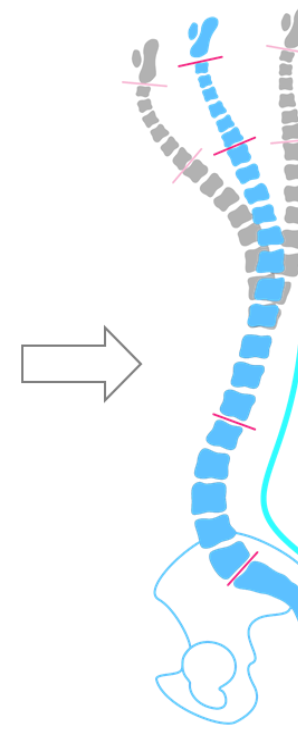
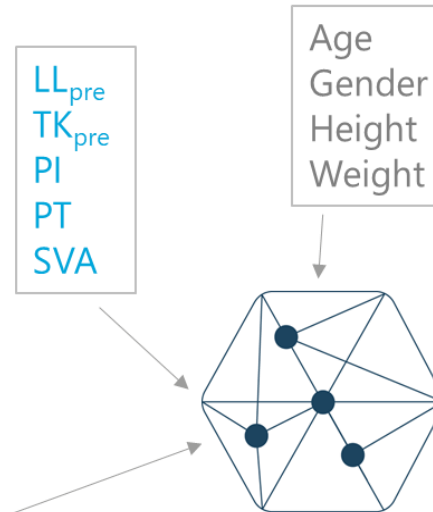
POST-OP DATA



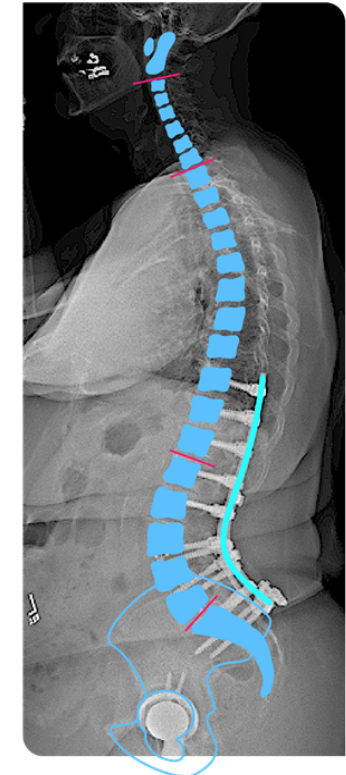
Pre-Op



Planning phase



ASI Planning



Postop

ALLOWS FOR A CYCLE OF IMPROVEMENT TO OPTIMIZE PLANNED PARAMETERS



L1-L2 SPO: 15°

L2-L3 SPO: 15°

PLAN 1		LITERATURE BASED PRE- PLANNING
LL	66	
PI-LL	16	
TK	44	
L1-L4 %	35.5	COMPENSATORY MECHANISMS PREDICTIONS BASED ON A.I.
L4-S1 %	64.5	
PT	35.3	
SVA	48.2	
TPA	32.1	



L4 PSO: 40°

PLAN 2		LITERATURE BASED PRE- PLANNING
LL	76	
PI-LL	6	
TK	47.4	
L1-L4 %	0	COMPENSATORY MECHANISM PREDICTIONS BASED ON A.I.
L4-S1 %	>100	
PT	31.3	
SVA	-11.8	
TPA	22.4	



L3 PSO: 40°

PLAN 3		
LL	76	
PI-LL	6	
TK	47.4	
L1-L4 %	42.5	
L4-S1 %	57.5	
PT	31.3	
SVA	11	
TPA	24.8	

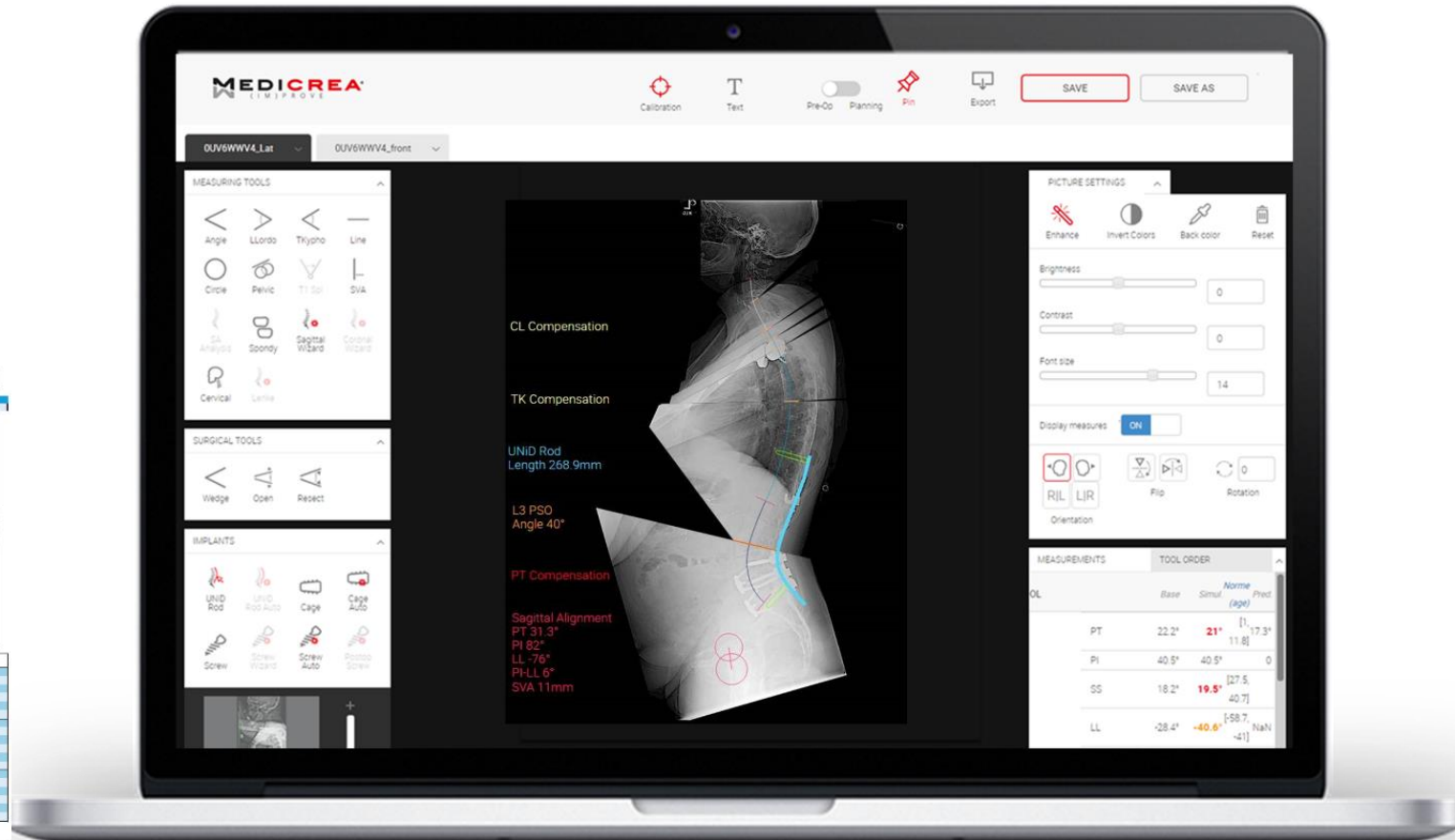
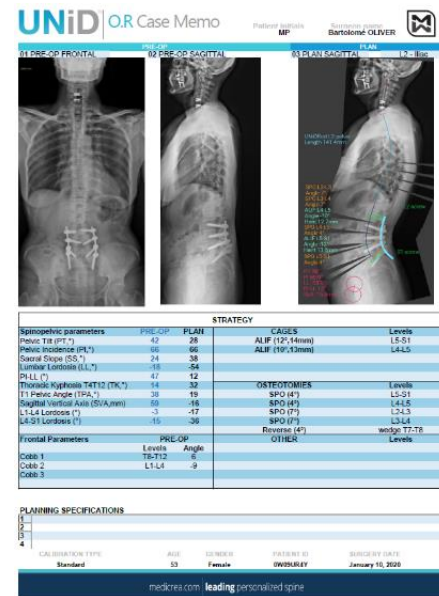
WHAT IS UNiD ?

THE UNID LAB



IMPLANT SIMULATION

- RODS
- SCREWS
- CAGES



UNID BENEFITS

ENSURE EXECUTION OF THE SURGICAL PLAN

- RODS ARE THE MANIFESTATION OF THE PLAN
 - THEY ACT AS INTRA-OPERATIVE TOOL TO CONFIRM THAT THE PLAN HAS BEEN ACHIEVE
- UNID REDUCES BY UP TO **85%** THE RISK OF ROD FRACTURE^{1,2}
- TIME-SAVING IN THE OR
 - NO ROD MANIPULATION, THEY COME PRE-BENT SPECIFICALLY FOR THE PATIENT
- RODS ARE INDUSTRIALLY BENT
 - NO-NOTCH BENDING TECHNOLOGY WHICH IMPROVES THE ROD FATIGUE STRENGTH¹
- RODS MATCH PATIENT SPECIFIC ANATOMY TO REDUCE RISK OF ADJACENT DISEASE

1. Hamilton DK, Buza JA, Passias PG, et al. The Fate of Adult Spinal Deformity (ASD) Patients Incurring Rod Fracture After Thoracolumbar Fusion. World Neurosurgery. 2017.

2. E.Burger, T. Raabe, P. Passias, C.Kleck, T. Protopsaltis. Patient-Specific Rods show a reduction in rod breakage incidence. NASS Abstract. September 2018.

Impact of ML-Unid

	UNID	Moal et al
PI-LL	88%	51%
PT	73%	24%
SVA	82%	54%

>**25%** improvement
in each category
vs historical

58% of those met all three PLANNED vs **33.7 %**
ISSG

24.3% improvement
in each category
vs 2022 series of top US sites

How Good Are Surgeons at Achieving Their Goal Sagittal Alignment Following Adult Deformity Surgery?

Justin S. Smith, MD, PhD¹, Elias Elias, MD, MPH, MSc², Tolga Sursal, MD¹, Breton Line, BSME³, Virginie Lafage, PhD⁴, Renaud Lafage, MS⁵, Eric Klineberg, MD⁶, Han Jo Kim, MD⁵, Peter Passias, MD⁷, Zeina Nasser, MSc, PhD⁸, Jeffrey L. Gum, MD⁹, Khal Kebaish, MD¹⁰, Robert Eastlack, MD¹¹, Alan Daniels, MD¹², Gregory Mundis, MD¹¹, Richard Hostin, MD¹³, Themistocles S. Protopsaltis, MD⁷, Alex Soroceanu, MD¹⁴, D. Kojo Hamilton, MD¹⁵, Michael P. Kelly, MD¹⁶, Stephen J Lewis, MD¹⁷, Munish Gupta, MD¹⁸, Robert Hart, MD¹⁹, Frank J Schwab, MD⁴, Douglas Burton, MD²⁰, Christopher P. Ames, MD²¹, Lawrence G. Lenke, MD²², Christopher I. Shaffrey, MD²³, Shay Bess, MD³, on behalf of International Spine Study Group



UNiD HUB

Harry Kürschner

Birth Year: 1976
Height: 176 cm

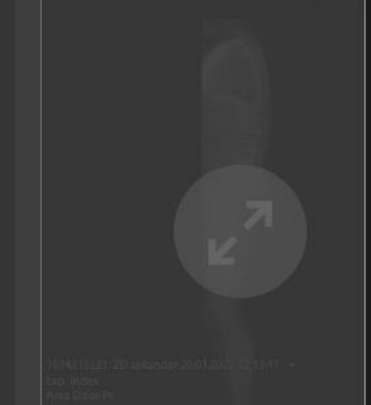
THE UNiD DEVICE HAS BEEN SH
Waiting for UNiD Surgery Confirm

CASE 0Y095RVU

IMAGES

Pre-Op_05/24/2023

Sagittal - X-Ray



Pre-Op



Sagittal Xray



Frontal Xray

Plan



Sagittal



Frontal



Superposition

1674213221. 2D sekundär 20.01.2023 12:13:41

Exp. Index
Area Dose Pr.

20.01.2023, 12:12:30

Klinikum Magdeburg

Z: 32767,0, B: 65535,0



P

Shipping

UNiD Surgery
Postponed



Sagittal Xray

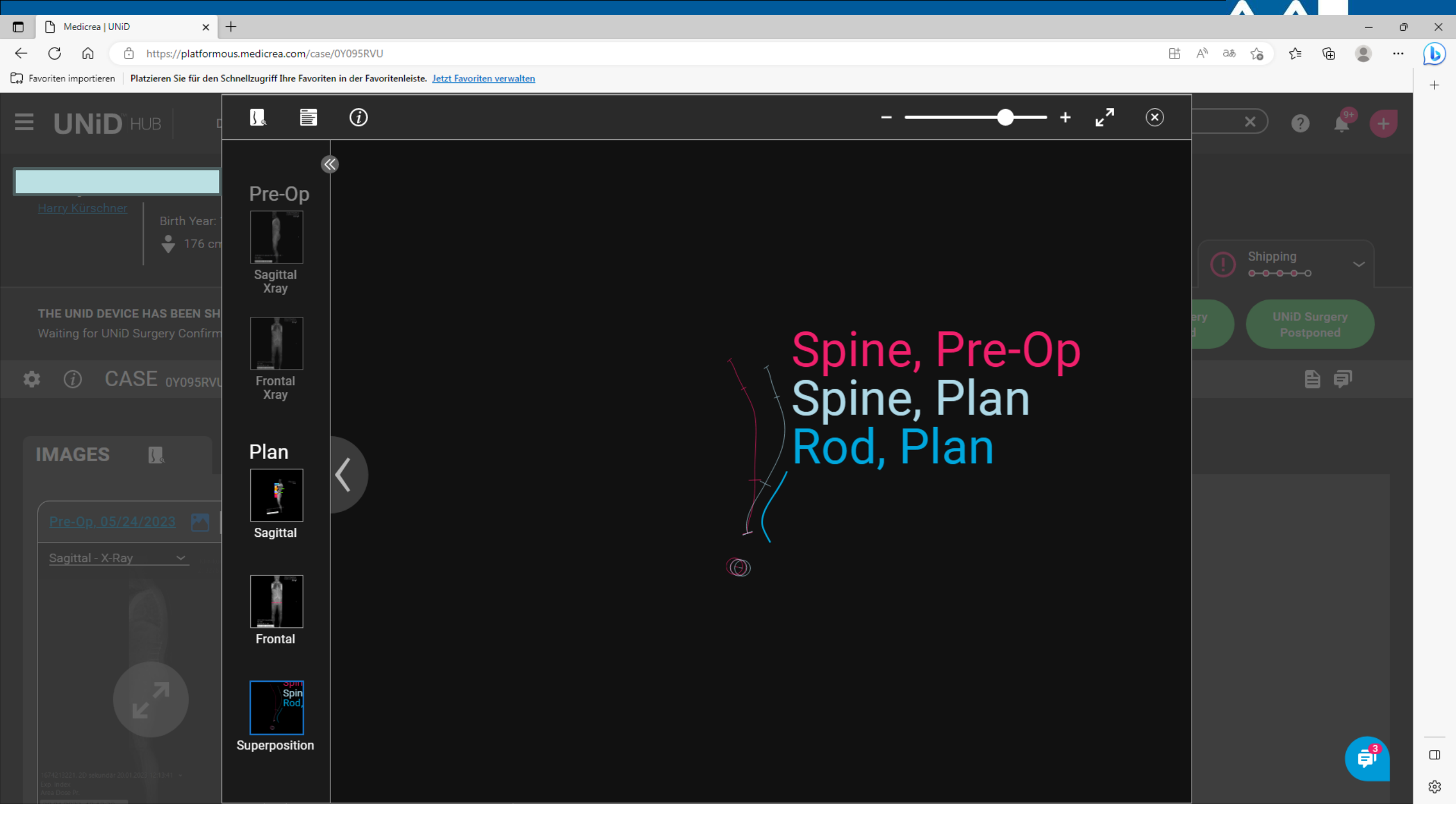
Frontal
Xray

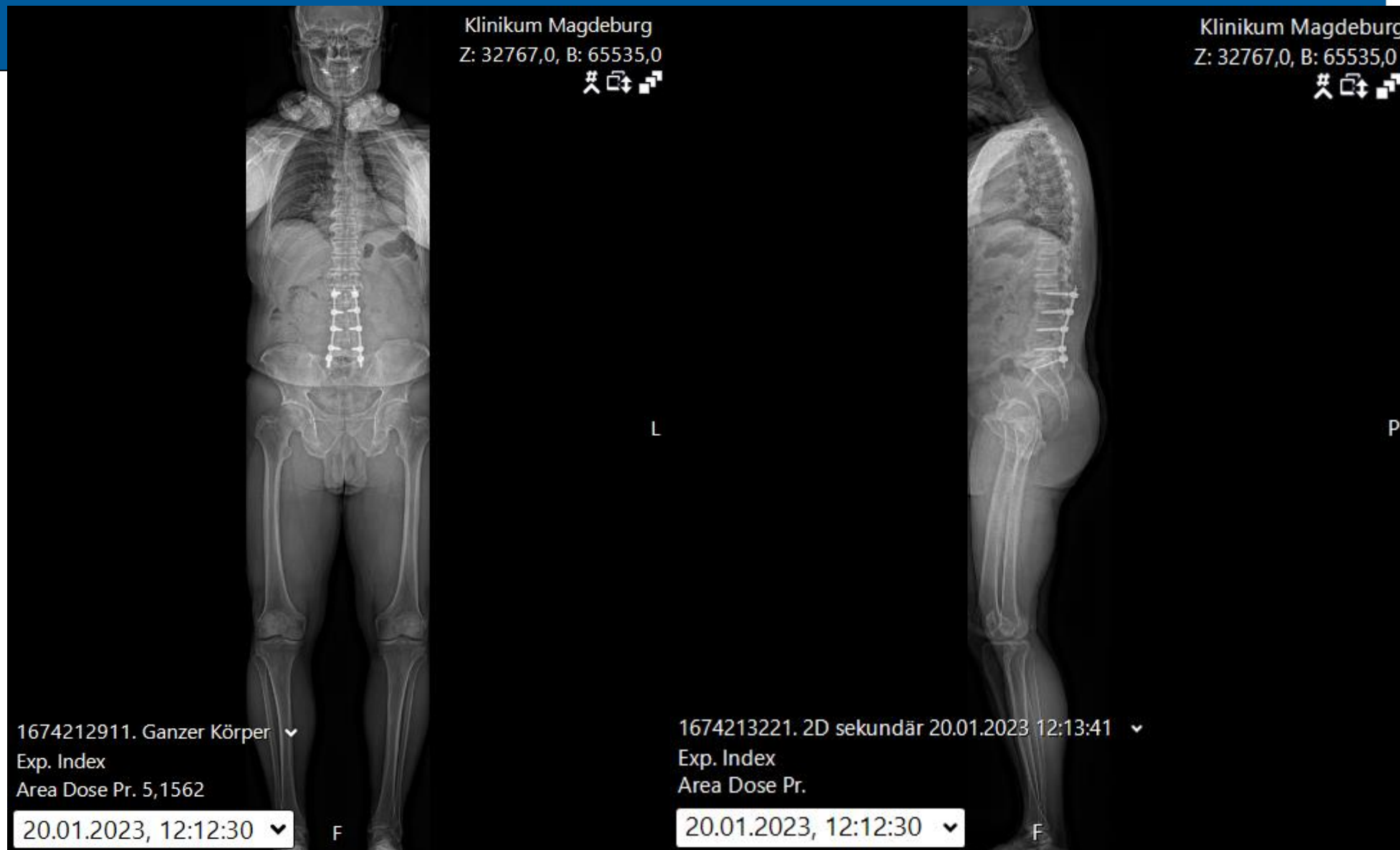
Sagittal

Frontal

Superposition









Klinikum Magdeburg
Z: 30208,0, B: 60416,0
Icon



Klinikum Magdeburg
Z: 32767,0, B: 65535,0
Icon

1685448266. 2D sekundär 30.05.2023 14:04:26 ▾

Exp. Index

Area Dose Pr.

▶ 30.05.2023, 14:03:40 ▾

F

1685448140. Ganzer Körper ▾

Exp. Index

Area Dose Pr. 5,6903

▶ 30.05.2023, 14:03:40 ▾

F

P

Case #4

60 y/o female

Adult idiopathic scoliosis 57 °

Increasing back pain

Pain medication, physical tx, infiltration with no effect

Pain from lower back to buttocks, left leg to great toe



Case #4

Pelvis

Pelvic parameters	Value		Pelvic parameters	Value	
Pelvic incidence (1)	79°		Pelvic obliquity (1)	1 mm	
Sacral slope (1)	37°		Pelvis axial rotation (2)	-1°	
Pelvic tilt (1)	41°				

1) Parameters calculated in the patient frame (based on a vertical plane passing through the center of the acetabula), which corrects the effect of a potential axial rotation of the pelvis during acquisition.
2) A pelvis axial rotation is positive when the pelvis is rotated towards the patient left side.

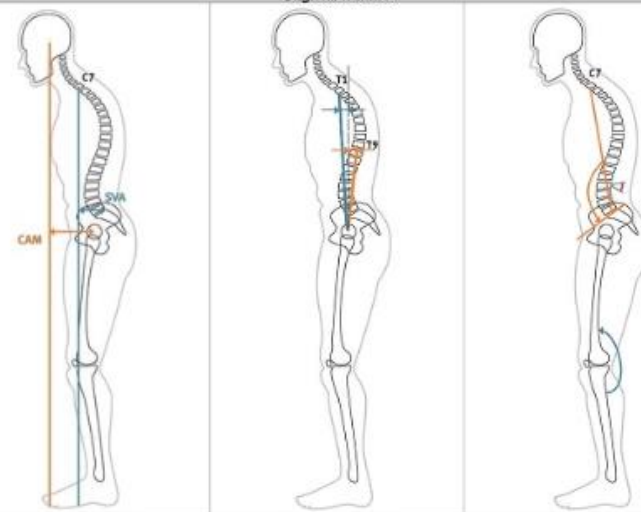
Spine

Coronal balance (1) and Scoliosis (3)

C7-CSL	15 mm		Cobb angle T4/T10	27°
			Cobb angle T10/L4	54°

Postural assessment

Sagittal balance

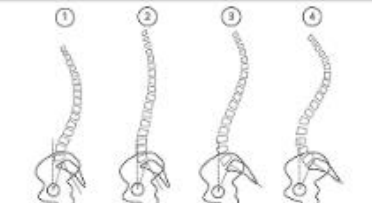


SVA (1)	-3 mm	Spino Sacral Angle (1)	130°
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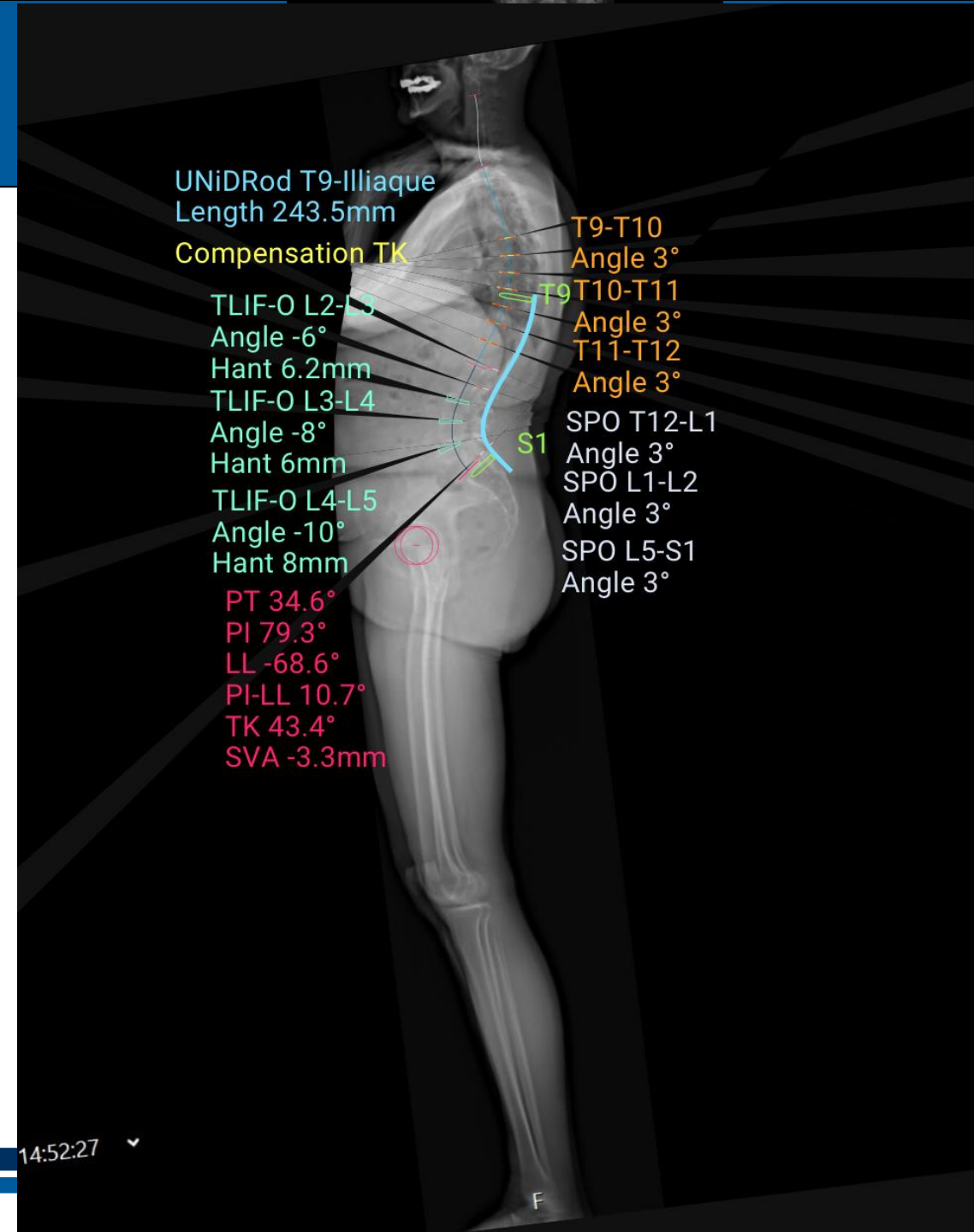
Kyphosis/Lordosis (3)

Kyphosis T4/T12	21°		Lordosis L1/S1	53°
			Lordosis L2/S1	48°

Reference values

Pelvic parameters	Measured	Theoretic (2)	
Pelvic incidence	79°	-	
Sacral slope	37°	-	
Pelvic tilt	41°	-	
Sagittal balance	Measured	Theoretic (2)	
Lordosis L1/S1	53°	58° (3)	
Kyphosis T4/T12	21°	-	
Global alignment	Measured		
SVA	-3 mm	-	
Roussouly's classification (4)	Type 4	-	

Case #4

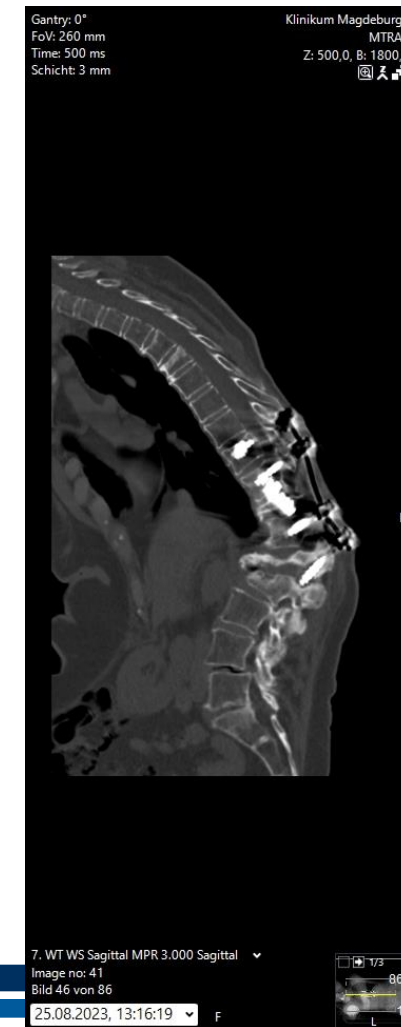
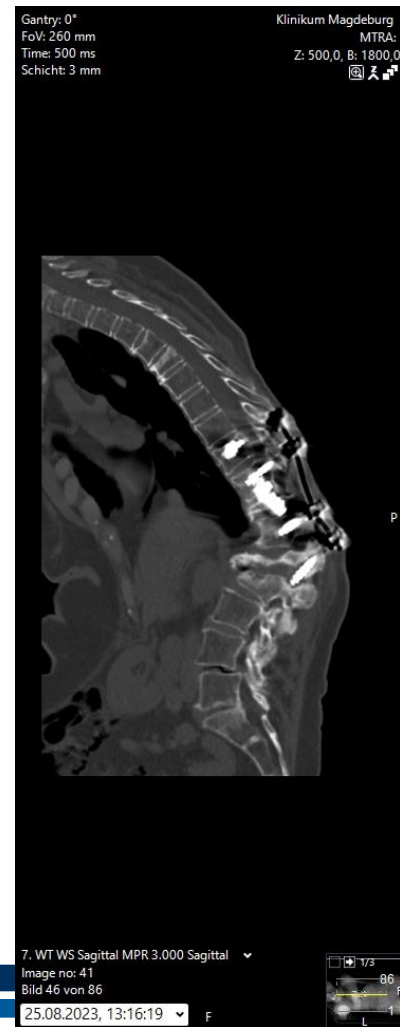


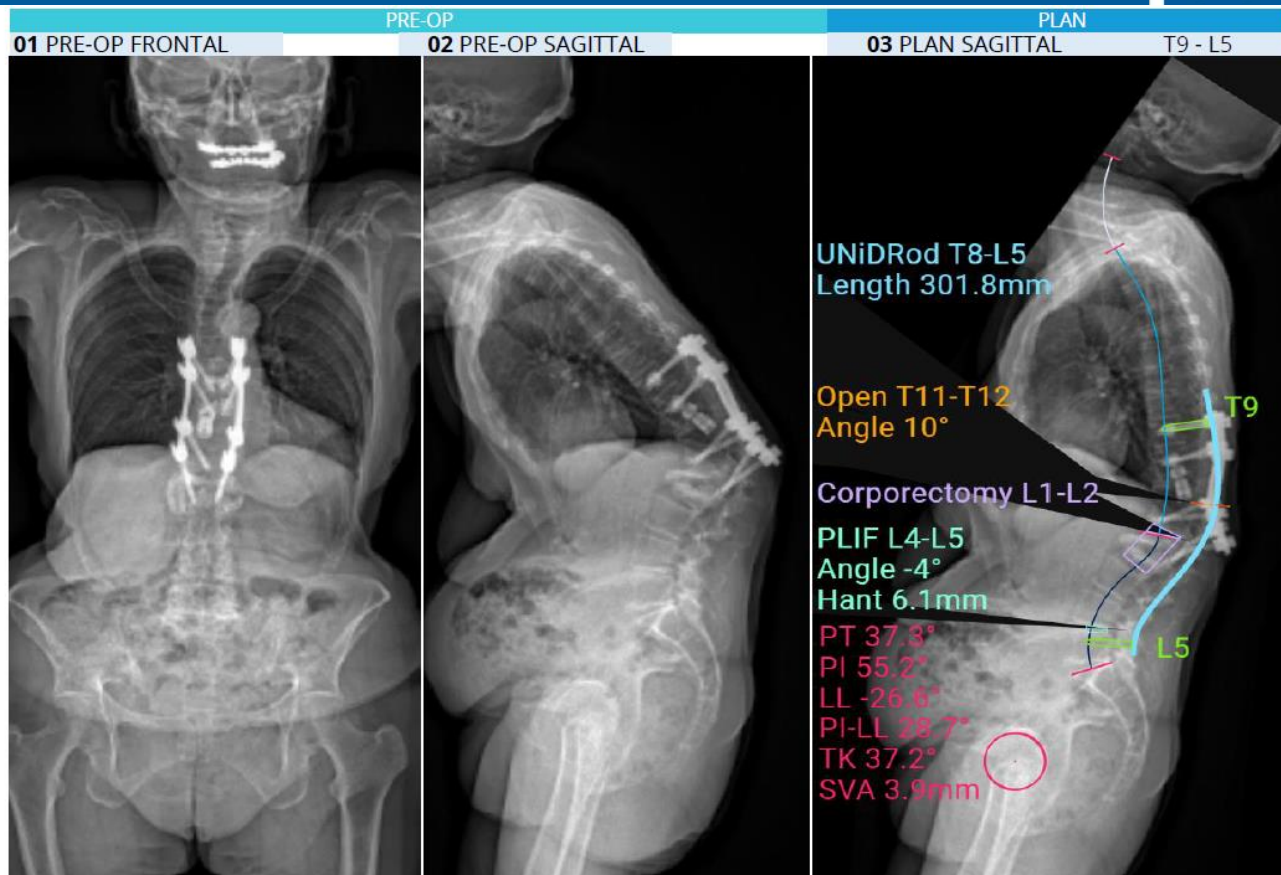
Case #4











STRATEGY				
Spinopelvic parameters	PRE-OP	PLAN	CAGES	Levels
Pelvic Tilt (PT,°)	32	37	Corporectomy (13°,44mm)	L1-L2
Pelvic Incidence (PI,°)	55	55	PLIF (4°,6mm)	L4-L5
Sacral Slope (SS,°)	23	18		
Lumbar Lordosis (LL,°)	-23	-27		
PI-LL (°)	32	29		
Thoracic Kyphosis T4T12 (TK,°)	47	37		
T1 Pelvic Angle (TPA,°)	43	27		
Sagittal Vertical Axis (SVA,mm)	182	4		
L1-L4 Lordosis (°)	14	14		
L4-S1 Lordosis (°)	-36	-40		
			OSTEOTOMIES	Levels
			Open (10°)	T11-T12

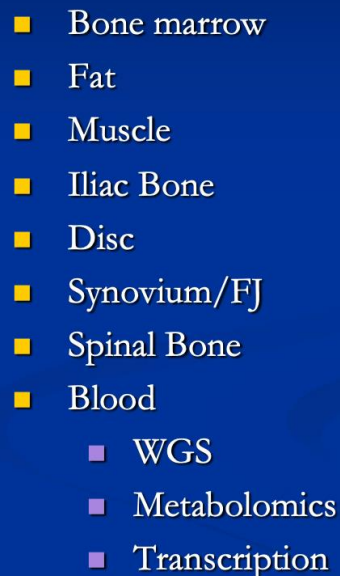


Es wird bis zu einem gewissen Grad von allen gemacht

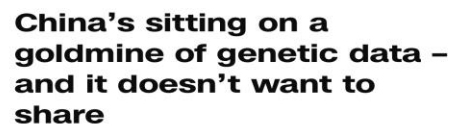
Mit mehr Planung und Nutzung von Big Data und KI haben wir gute Chancen, die Ergebnisse zu verbessern

Das macht Sinn!!!

Variable	<i>n</i> (%) or Mean $\pm$ SD
Number of incoming texts	4 (0–13)
Total incoming text length (characters)	188 (0–689)
Texting in degree	2 (0–4)
Text reciprocity	4 (0–15)
Text responsiveness	0.04 (0–0.28)
No. of outgoing calls	1 (0–4)
Total outgoing call lengths (seconds)	72 (0–561)
Call out degree	1 (0–3)
No. of incoming calls	1 (0–3)
Total incoming call lengths (seconds)	75 (0–619)
Call in degree	1 (0–2)
Call reciprocity	0 (0–2)
Call responsiveness	0 (0–0.44)



Data Summary/Feature	Collection Type	Unit
Pain	Active (survey)	0–10 (low to high)
Time spent at home	Passive	Minutes ($\log_{10}$ scale)
Distance travelled	Passive	Meters ($\log_{10}$ scale)
Radius of gyration	Passive	Meters ($\log_{10}$ scale)
Maximum diameter	Passive	Meters ($\log_{10}$ scale)
Maximum distance from home	Passive	Meters ($\log_{10}$ scale)
No. of significant locations visited	Passive	None
Average flight length	Passive	Meters ($\log_{10}$ scale)
Standard deviation of flight length	Passive	Meters ($\log_{10}$ scale)
Average flight duration	Passive	Seconds ($\log_{10}$ scale)
Standard deviation of flight duration	Passive	Seconds ($\log_{10}$ scale)
Fraction of time not moving	Passive	None
Significant location entropy	Passive	None
Circadian routine	Passive	None
Circadian routine (weekend/day stratified)	Passive	None
No. of outgoing texts	Passive	None
Cumulative length of outgoing texts	Passive	Characters ($\log_{10}$ scale)
No. of people texts were sent to	Passive	None
No. of incoming texts	Passive	None
Cumulative length of incoming texts	Passive	Characters ($\log_{10}$ scale)
No. of people texts were received from	Passive	None
Text reciprocity	Passive	None
Text responsiveness	Passive	None
No. of outgoing telephone calls	Passive	None
Cumulative length of outgoing telephone calls	Passive	Seconds ($\log_{10}$ scale)
No. of people telephone calls were made to	Passive	None
No. of incoming calls	Passive	None
Cumulative length of incoming telephone calls	Passive	Seconds



By **Jessie Yeung**, CNN
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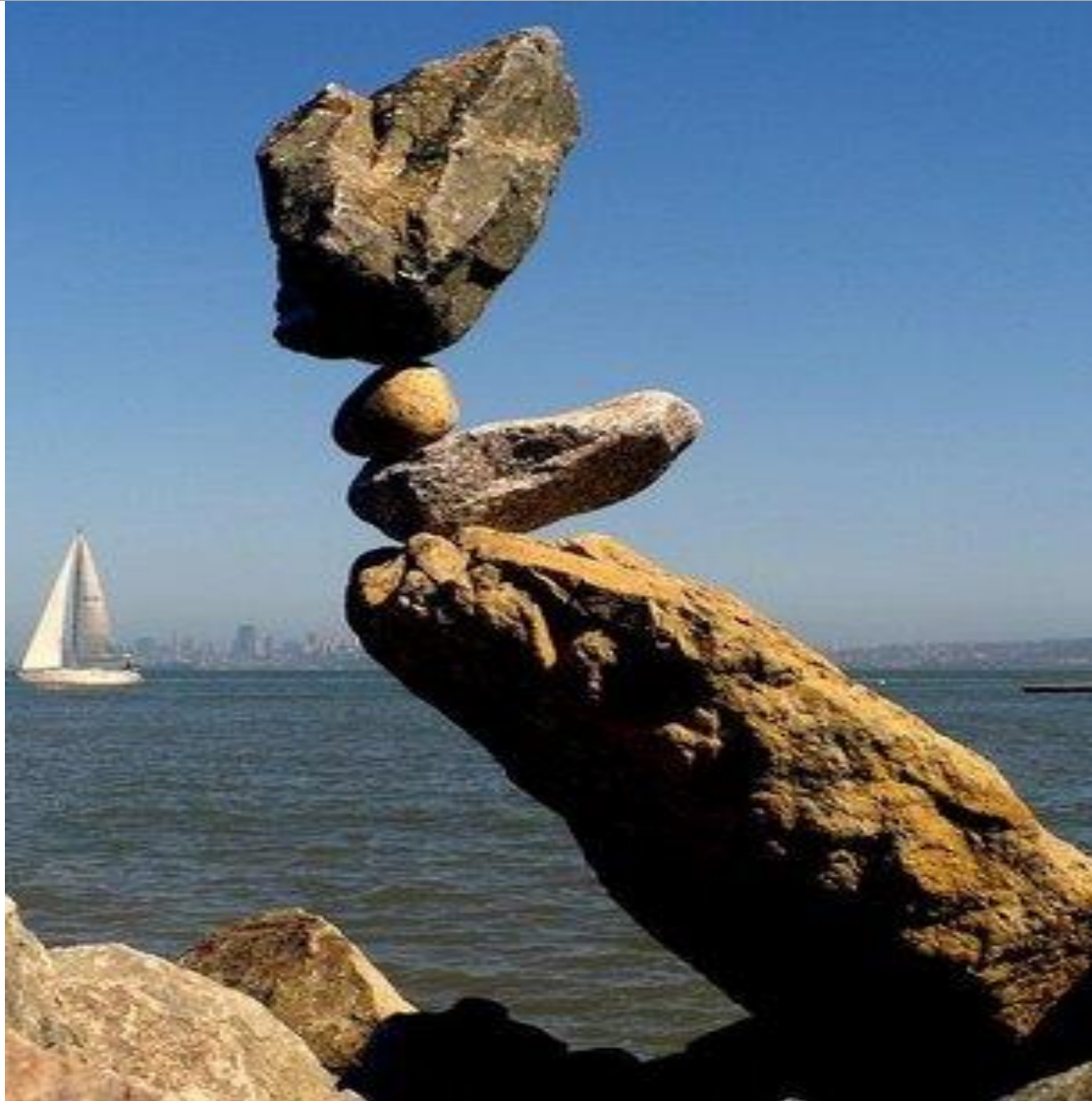


Wei Liang/ICHPL Imaginechina/AP

A Chinese medical worker performs genetic testing on embryos at the Shanxi Province Reproductive Science Institute in Taiyuan, China, in November 2018.

Hong Kong (CNN) — Better cancer treatments, advances in longevity,

Es ist alles eine Frage des Gleichgewichts





Immer eine Frage der BALANCE

