



KLINIKUM MAGDEBURG gGmbH

Planung und sagittale Balance für die OP der degenerativen Wirbelsäule

Jörg Franke

Warum

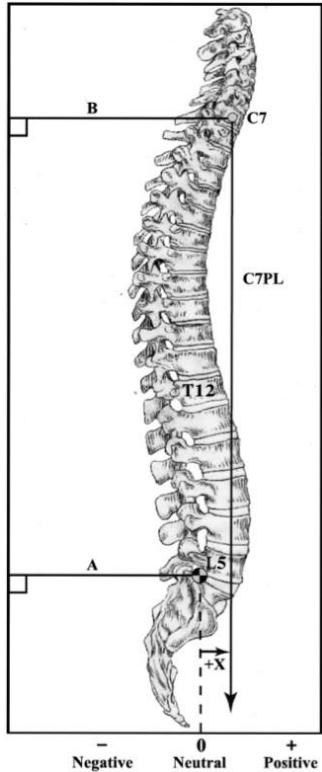
Vorteile bei der Planung

- 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

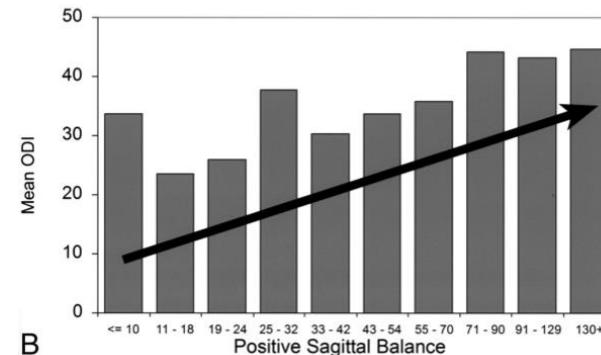
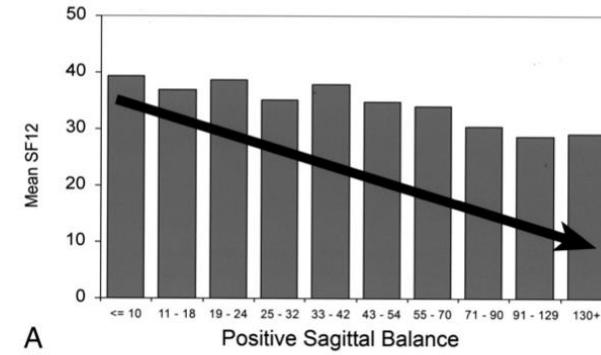
Nachteile bei der Planung

- Zeitraubend
- Fehler aufgrund einer potenziell komplizierten Formel

Degeneration ist kyphogen!!! Und problematisch



Glassman et al Spine 2005;30:2024-29



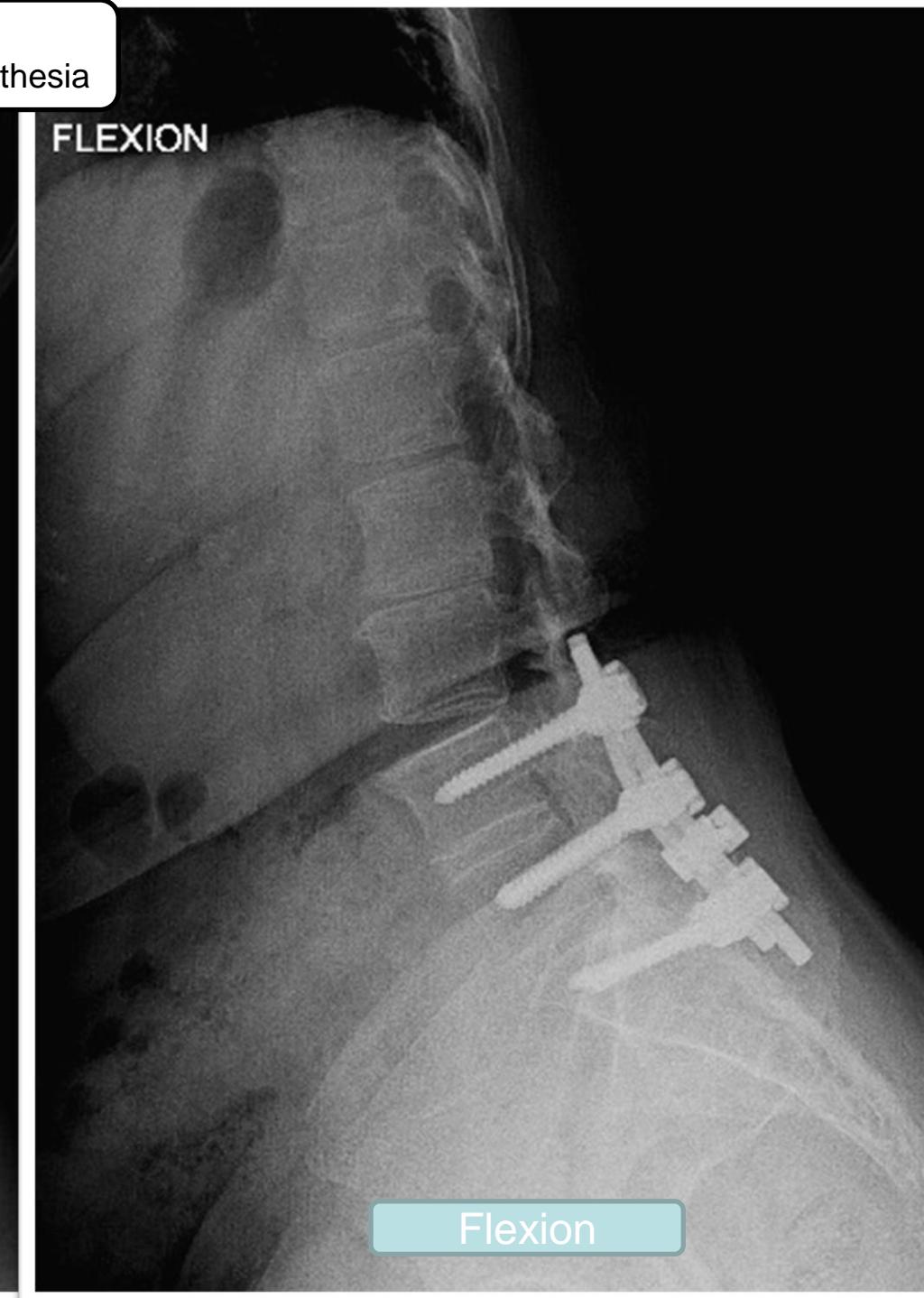
Wert des Röntgen im Stand und der Langaufnahme !!!!



Ohne Rö werden wichtige Dinge übersehen !

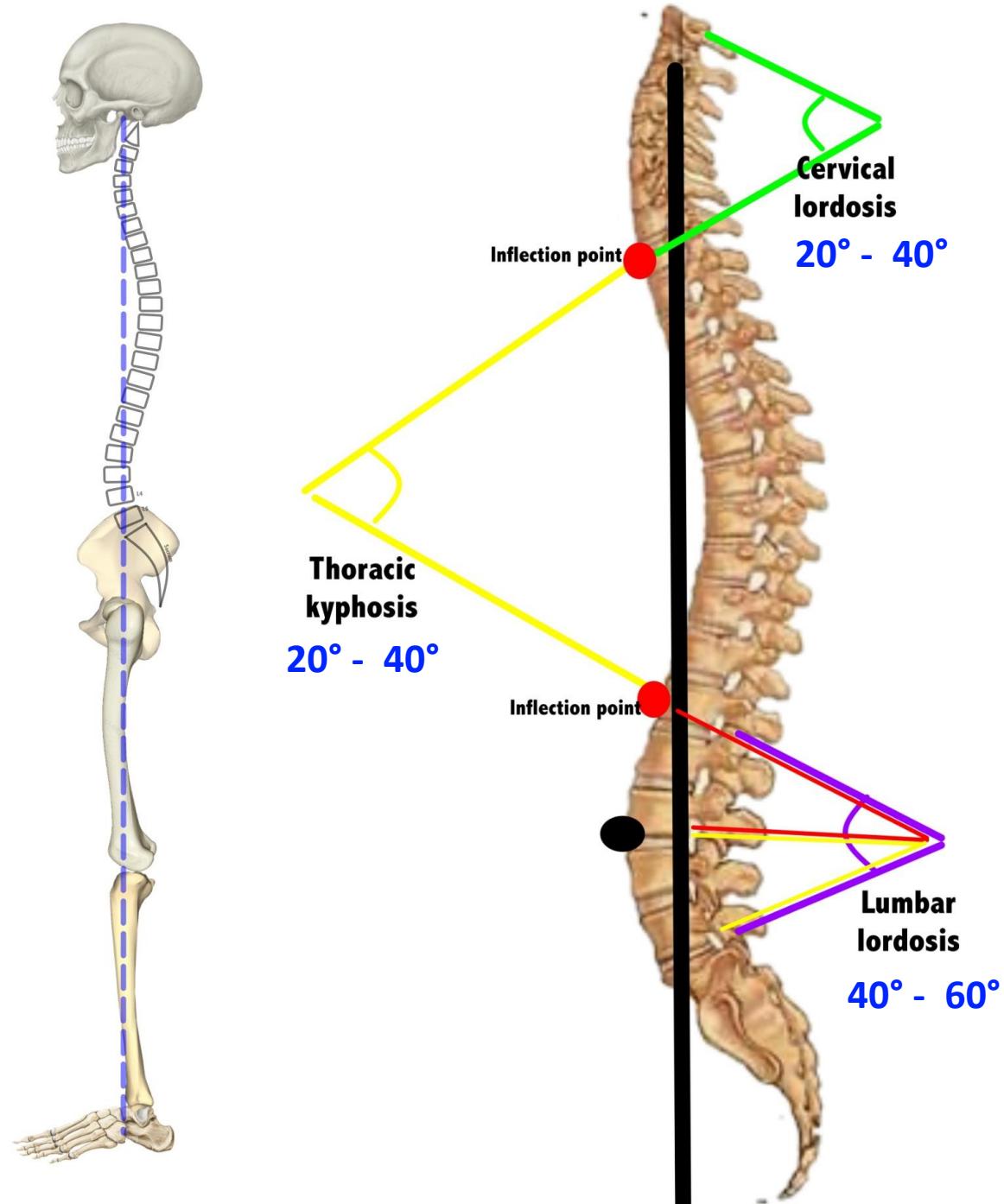
60 yr/F – LBA 4 months, radiating to both lower limb
Operated previously L4 to S1 fusion – **PLF – 2.5 yrs**
ago

Severe claudication
Left EHL grade 4, Left L5 hypoesthesia



Extension

Flexion



Spinal Alignment

Represents curvatures and angles

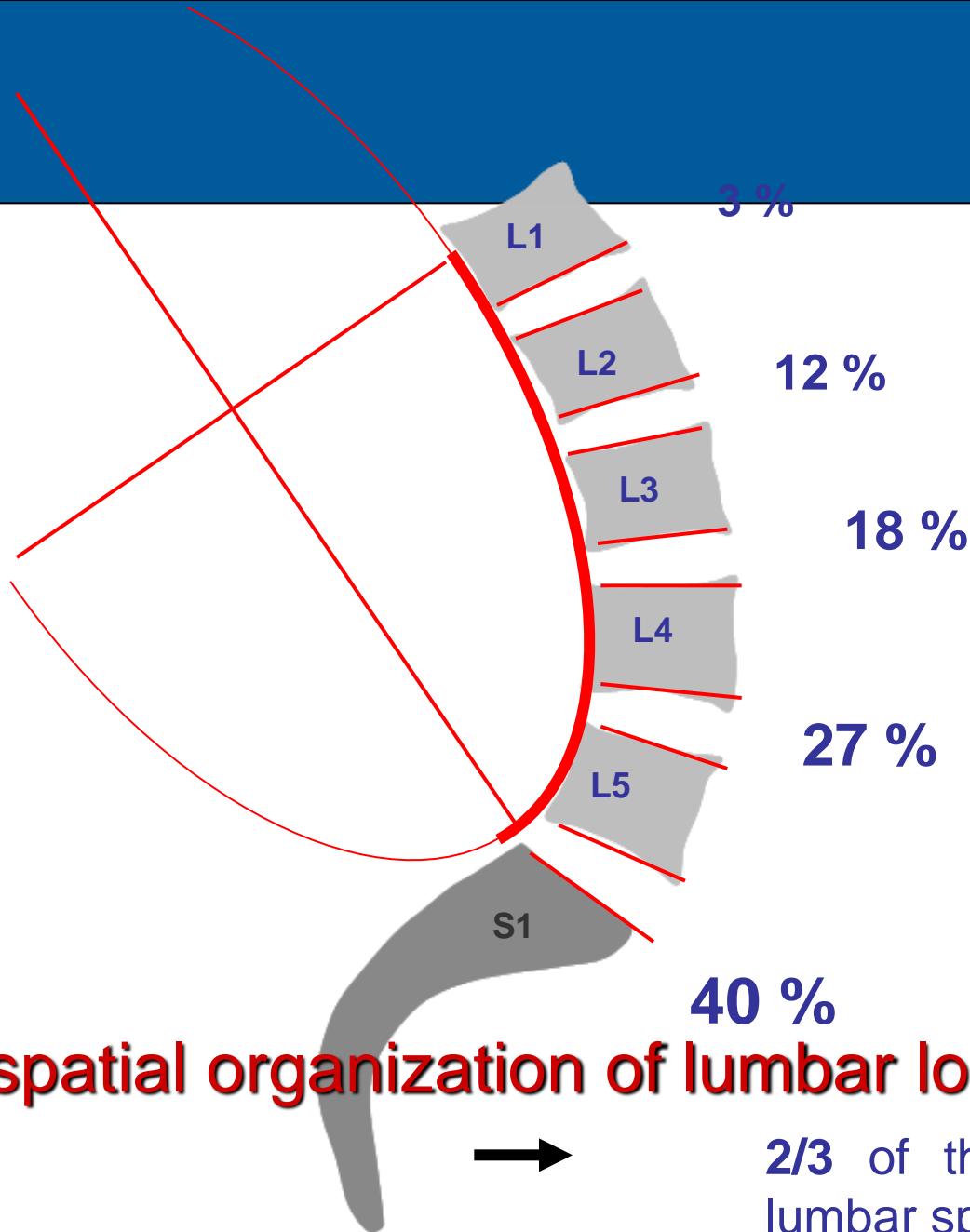
Spinal Balance

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

CLASSICAL ANATOMICAL LANDMARKS

Janik J Orthop res 1998

Typical spatial organization of lumbar lordosis



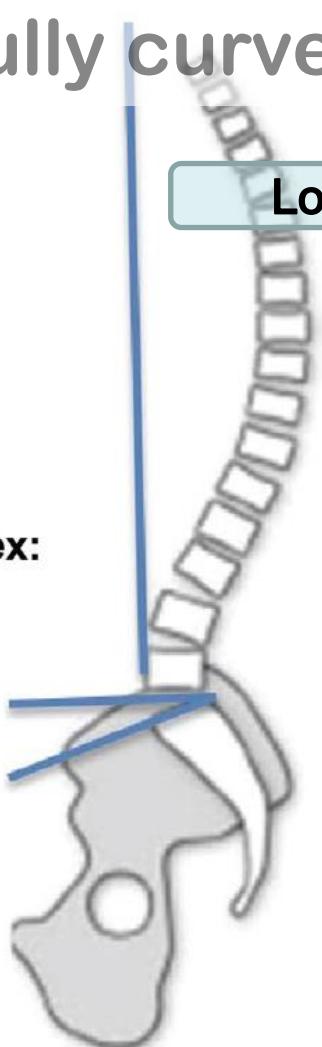
2/3 of the lumbar lordosis located in the lower lumbar spine segment L4-S1

Roussouly curve types

2005

Lower 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

Higher prevalence

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

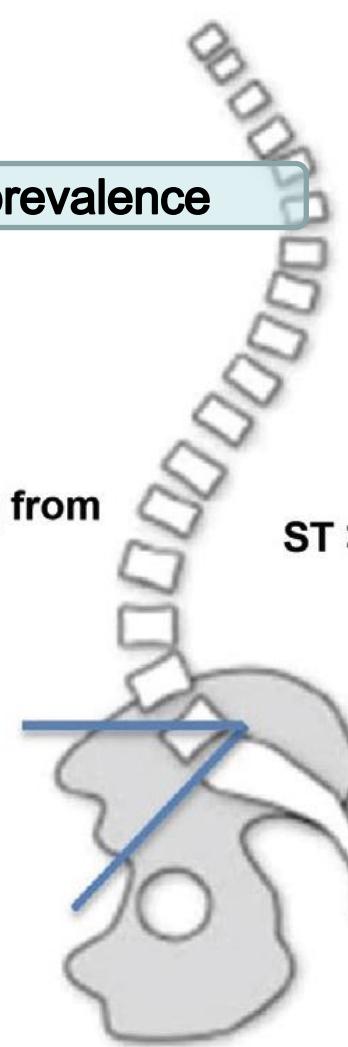
ST ranging from
35° to 45°



Type 3

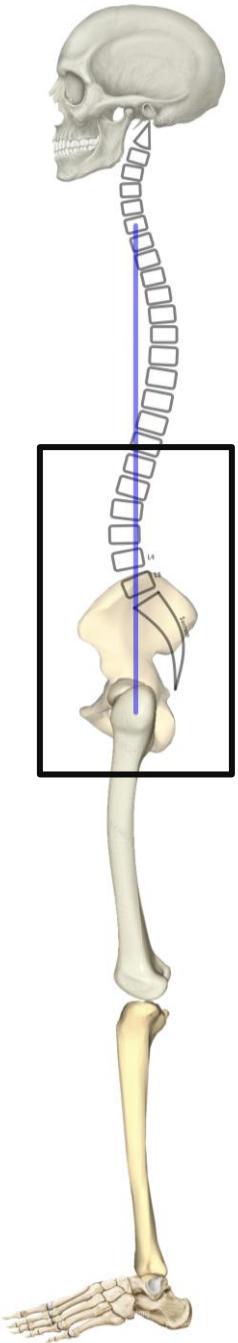
- **Favourable**
- Least chance of DDD

ST > 45°

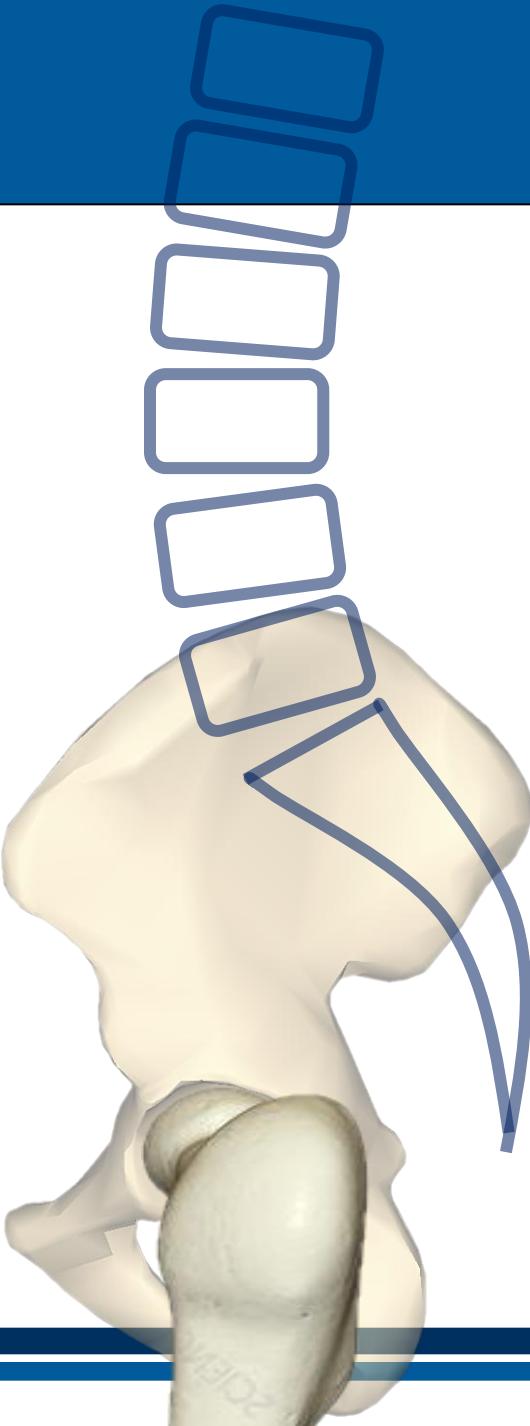
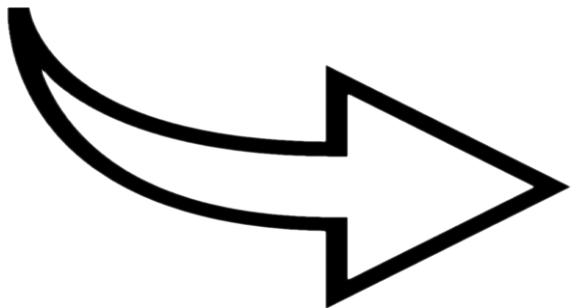


Type 4

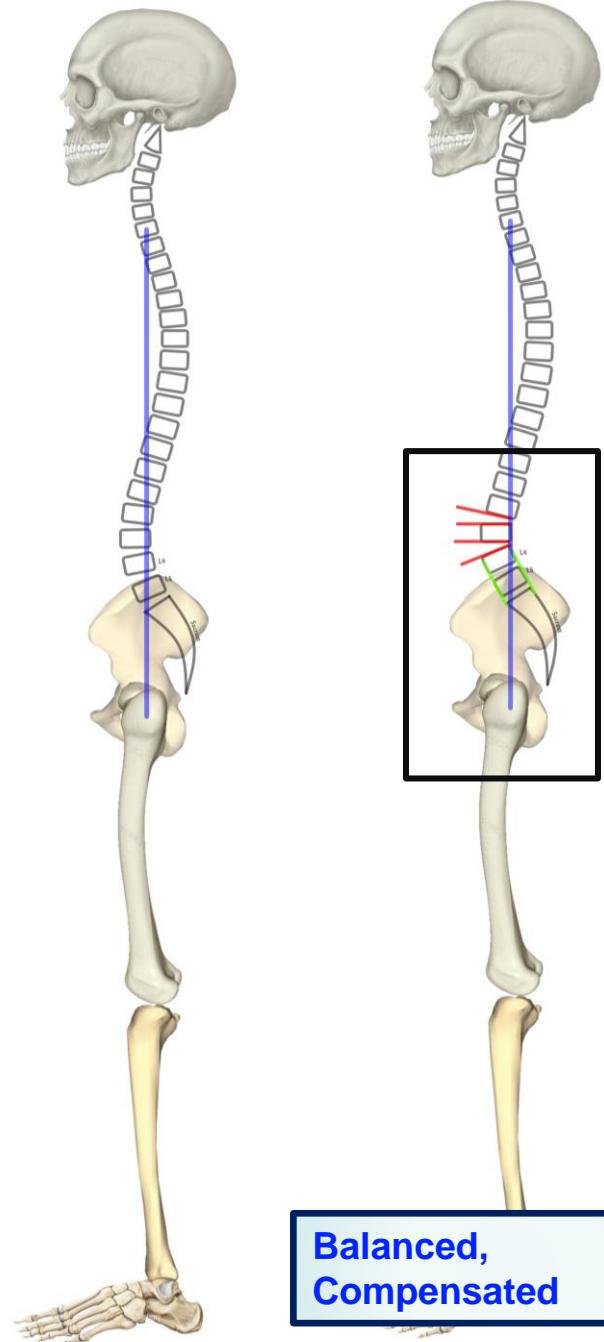
- **Kyphotic-Lordotic posture**
- Higher stress on posterior elements
- Shear type isthmic spondy
- Junctional degeneration



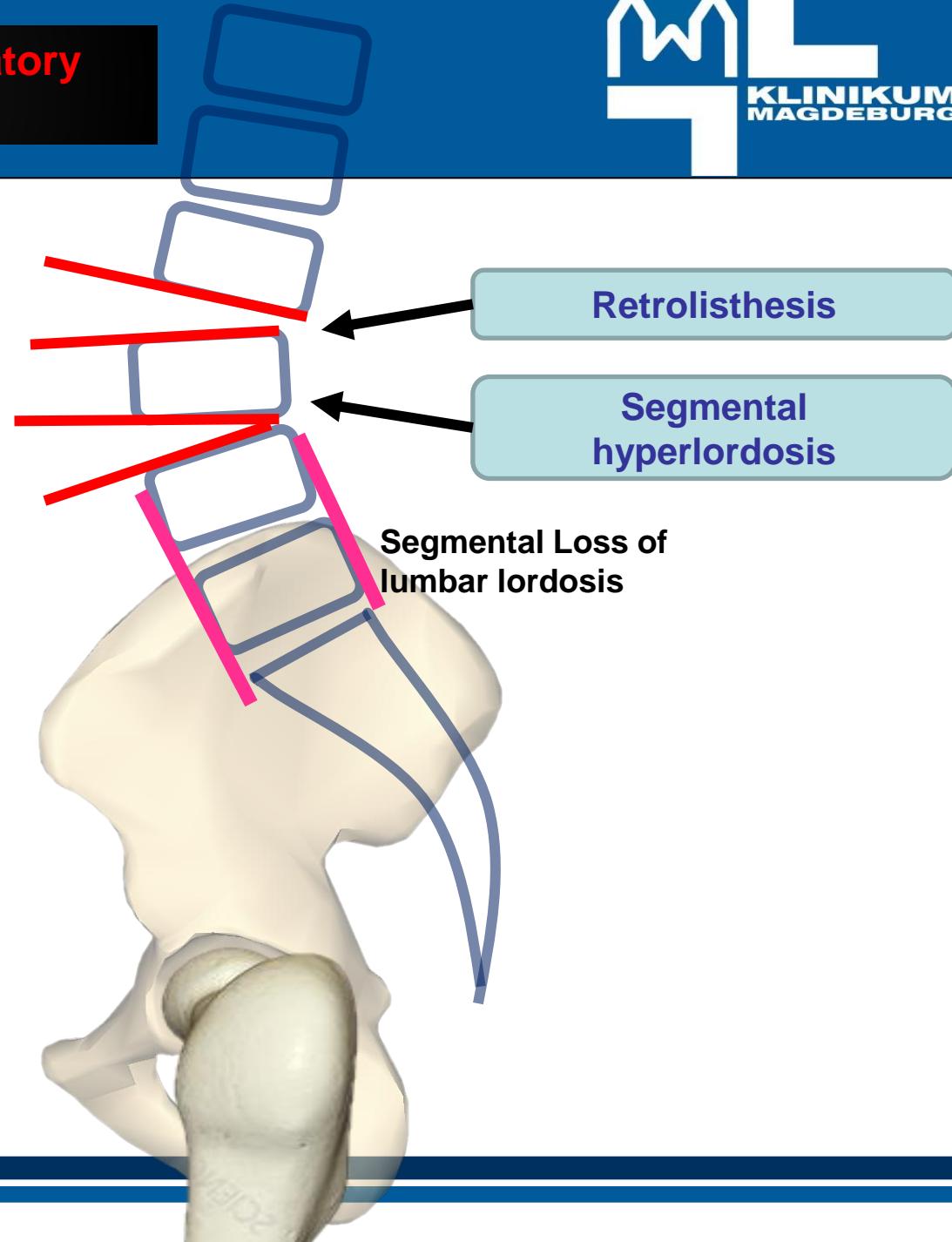
Age-related compensatory mechanisms

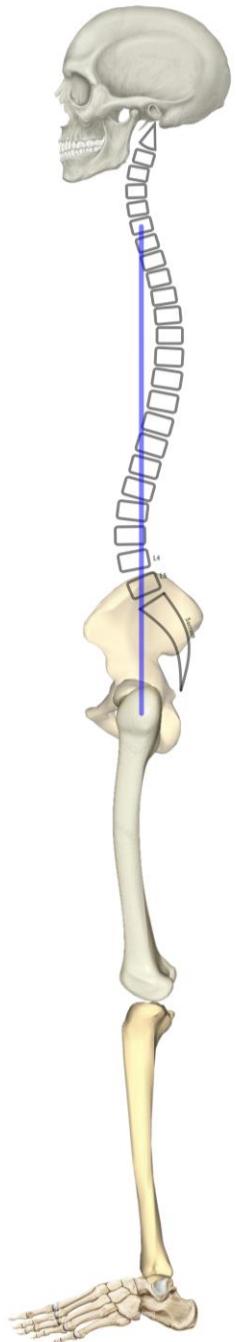


Age-related compensatory mechanisms

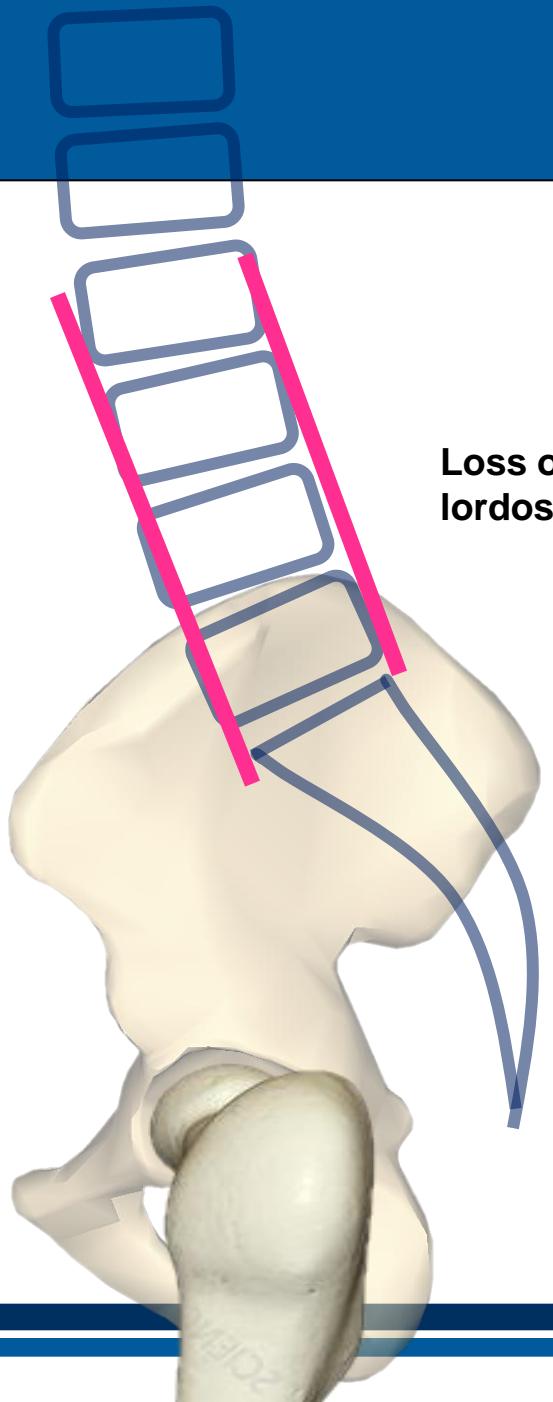
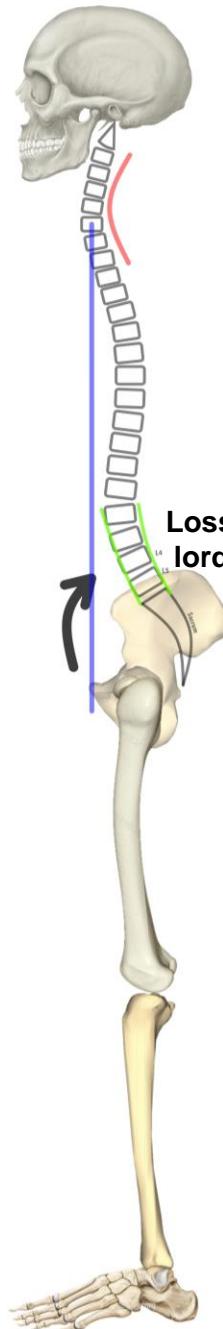
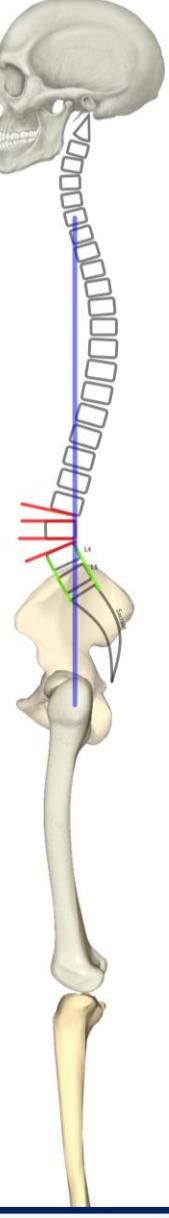


Balanced,
Compensated

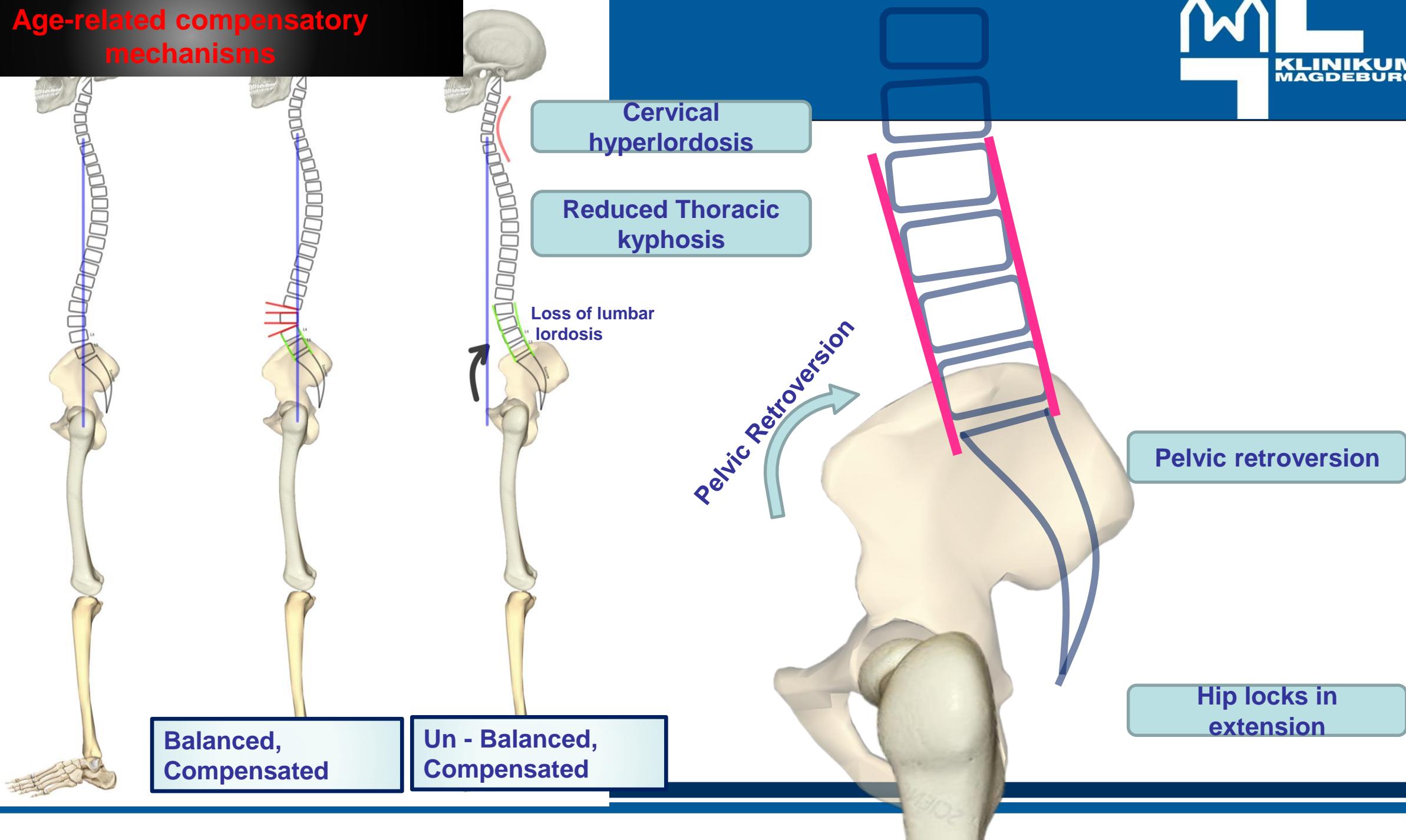




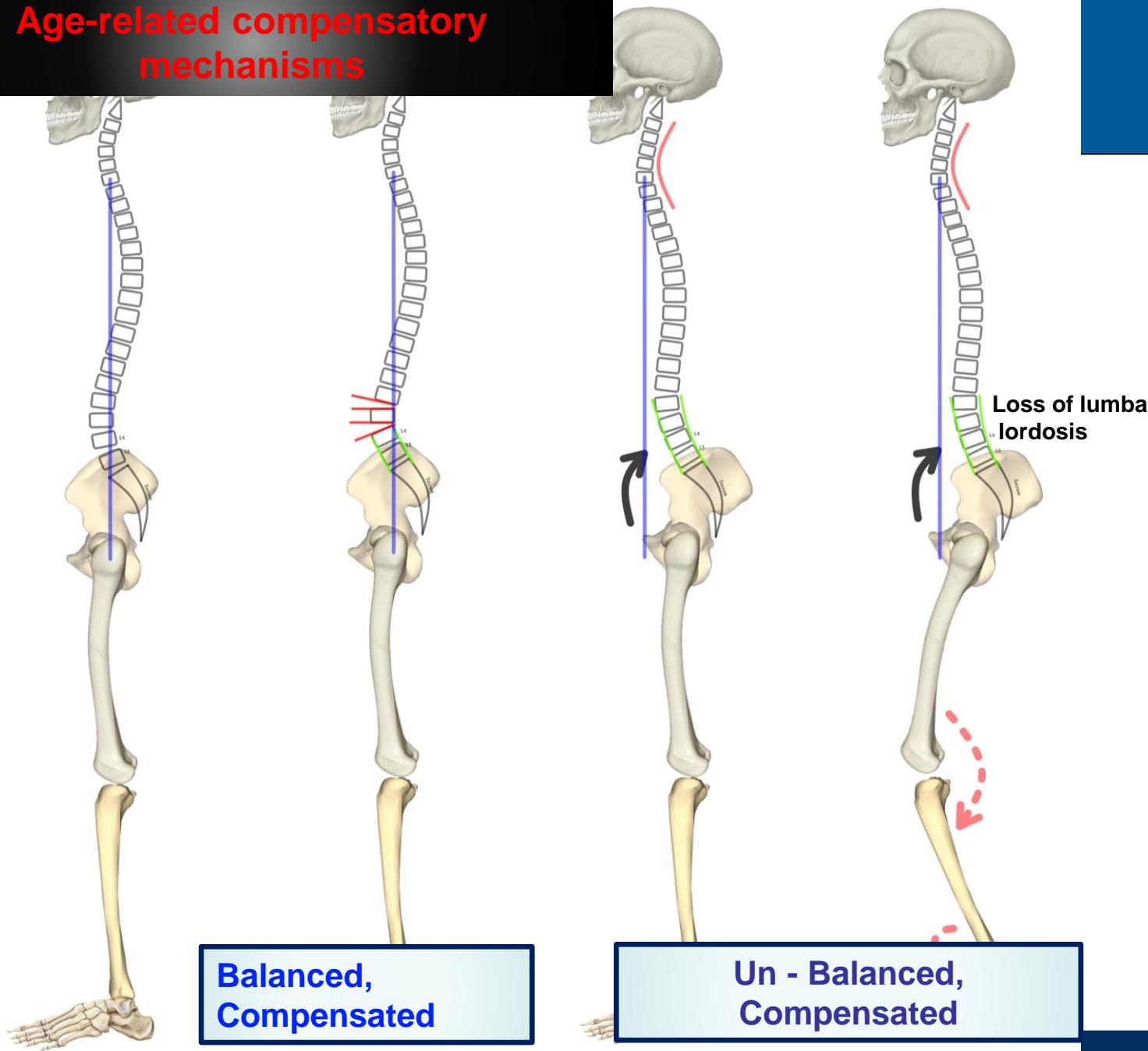
Balanced,
Compensated



Age-related compensatory mechanisms



Age-related compensatory mechanisms



Balanced,
Compensated

Un - Balanced,
Compensated

Cervical
hyperlordosis

Reduced Thoracic
kyphosis

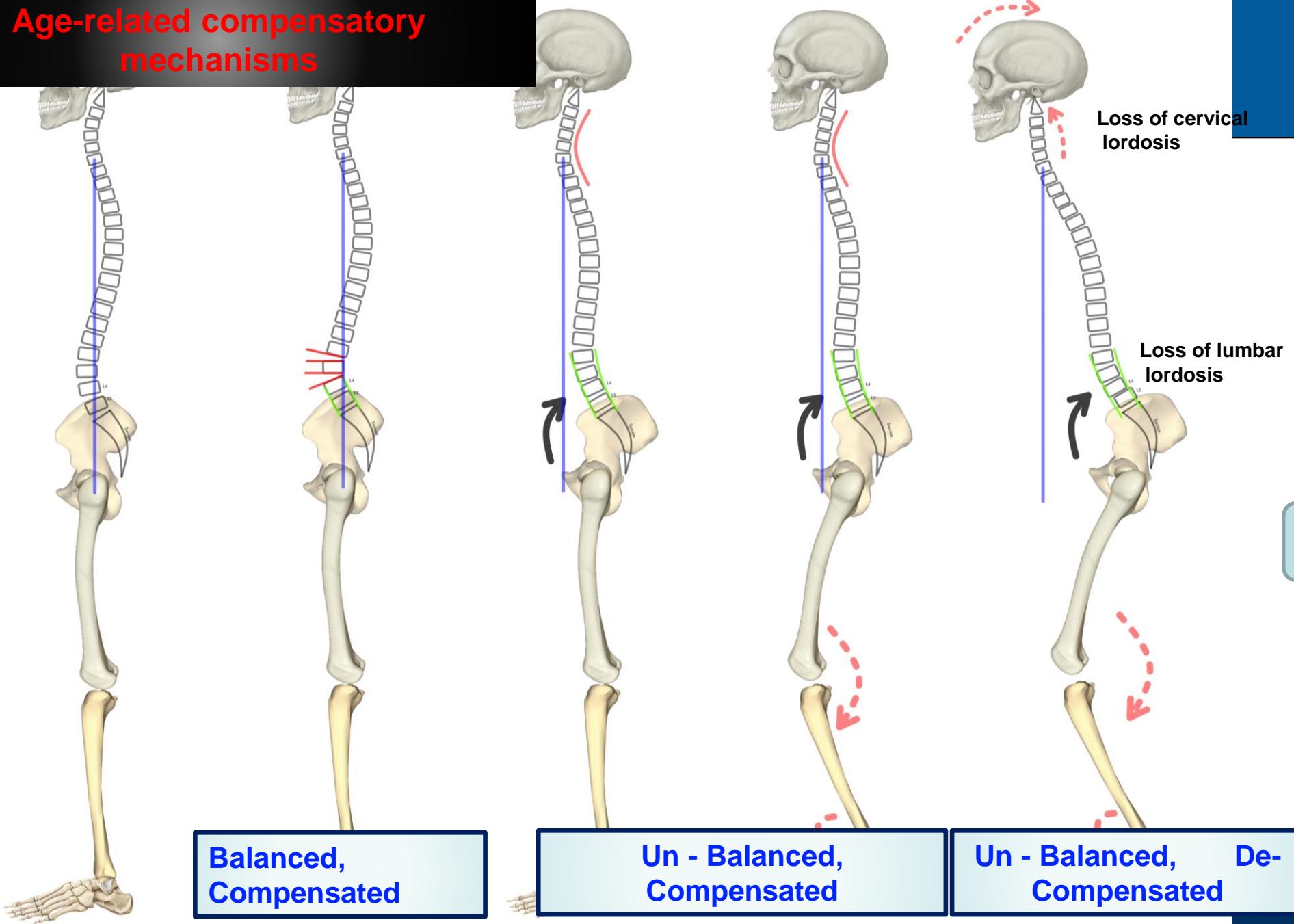
Pelvic retroversion

Hip locks in 'maximum'
extension

Progressive knee
flexion

Ankle flexion

Age-related compensatory mechanisms



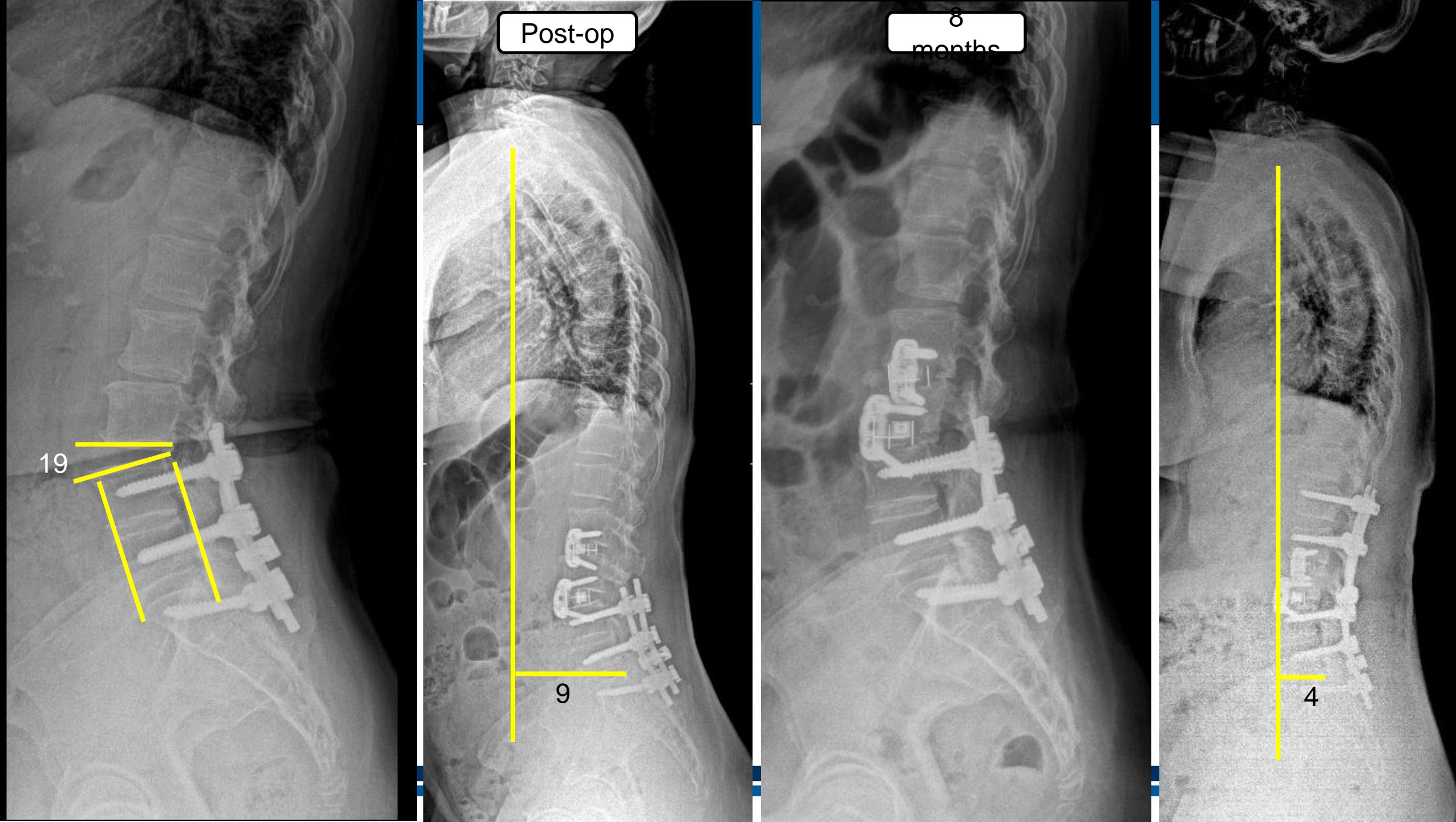
Not paying attention to it is a mistake !

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



TODAY'S REMAINING surgical BURDENS



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:

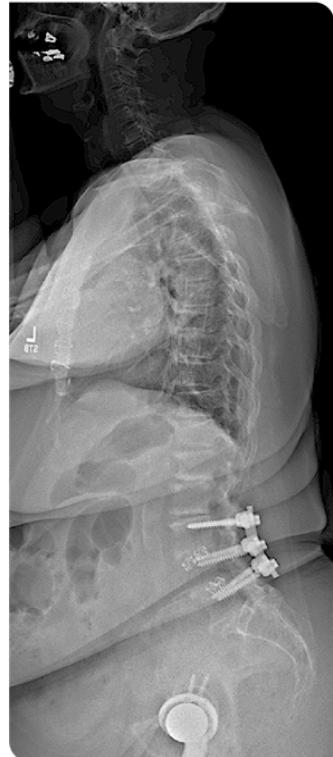
- PROVIDE A DETAILED ANALYSIS OF THE PATIENT'S SPINOPELVIC PARAMETERS
- SIMULATE SURGICAL STRATEGIES AND TECHNOLOGIES USING PROPRIETARY PREDICTIVE PLANNING MODELS
- COLLECT POST-OPERATIVE OUTCOMES



UNID LAB™
TEAM OF BIOMEDICAL
ENGINEERS WHO PROVIDE A
SUITE OF SERVICES.

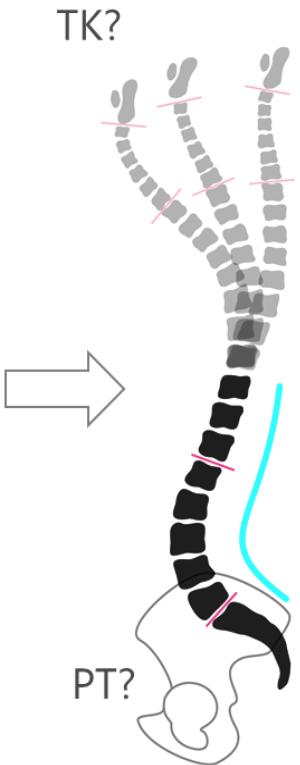
UNID platform can help!!

CALIBRATED SAGITTAL X-RAYS



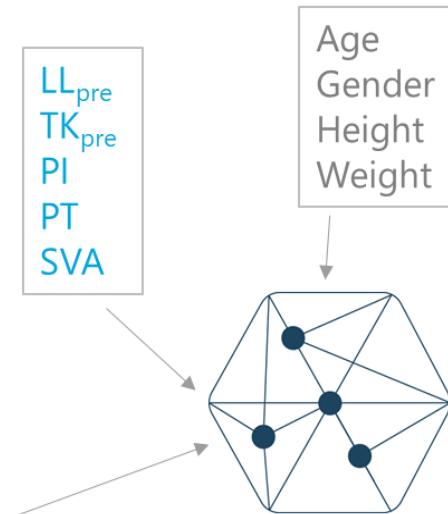
Pre-Op

SURGICAL PLAN SIMULATION

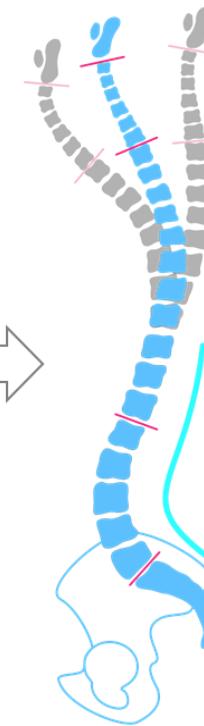


Planning phase

PREDICTIVE MODELING

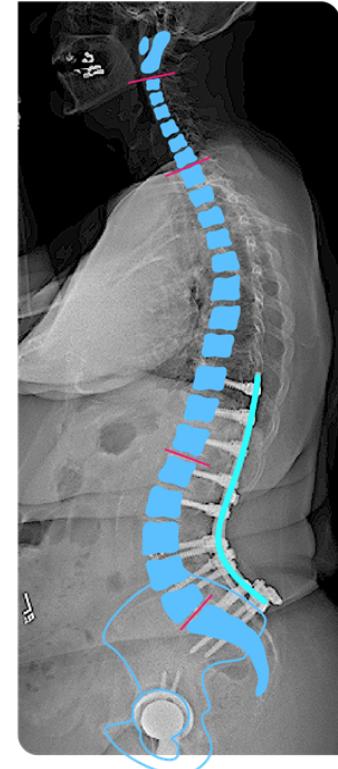


COMPENSATORY MECHANISMS
MOST LIKELY TO OCCUR



ASI Planning

POST-OP DATA

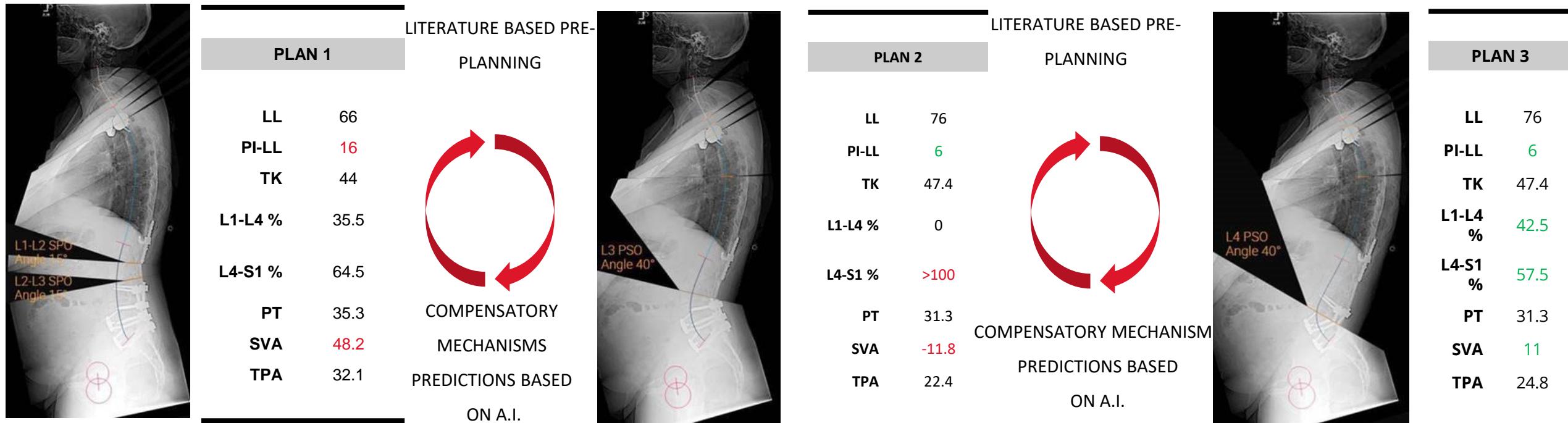


Postop

WHAT IS UNiD ?

THE UNiD LAB

ALLOWS FOR A CYCLE OF IMPROVEMENT TO OPTIMIZE PLANNED PARAMETERS



L1-L2 SPO: 15°

L2-L3 SPO: 15°

L4 PSO: 40°

L3 PSO: 40°

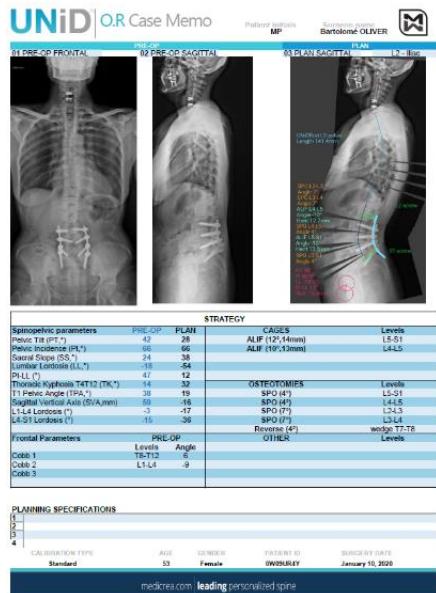
WHAT IS UNiD ?

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 ACHIEVED



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, Buzza JA, Passias PG, et al. The Fate of Adult Spinal Deformity (ASD) Patients Incuring 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

Medicrea | UNiD

https://platformous.medicrea.com/case/0Y095RVU

Favoriten importieren | Platzieren Sie für den Schnellzugriff Ihre Favoriten in der Favoritenleiste. [Jetzt Favoriten verwalten](#)

UNiD HUB

Harry Kirschner

Birth Year: 1960 | 176 cm

THE UNiD DEVICE HAS BEEN SHIPPED
Waiting for UNiD Surgery Confirmation

CASE 0Y095RVU

IMAGES

Pre-Op

- Sagittal Xray
- Frontal Xray

Plan

- Sagittal
- Frontal
- Spin Red
- Superposition

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

Shipping

UNiD Surgery Postponed

1674213221. 2D sekundär 20.01.2023 12:13:41

Exp. Index

Area Dose Pr.

20.01.2023, 12:12:30

F

16:21 26.06.2023

Medicrea | UNiD

https://platformous.medicrea.com/case/0Y095RVU

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UNiD HUB

Harry Kurschner
Birth Year: 1960
176 cm

THE UNiD DEVICE HAS BEEN SHIPPED
Waiting for UNiD Surgery Confirmation

CASE 0Y095RVU

IMAGES

Pre-Op, 05/24/2023

Sagittal - X-Ray

Sagittal X-ray

Frontal X-ray

Plan

Sagittal

Frontal

Superposition

Sagittal X-ray

Frontal X-ray

Superposition

Pre-Op

Klinikum Magdeburg
Z: 32767,0, B: 65°, 0

UNiDRod T11-S2AI
Length 266.2mm

TK compensation
T11-T12
Angle 4°
SPO T12-L1
Angle 10°
SPO L1-L2
Angle 8°
PSO L4
Angle 25°
ALIF L5-S1
Angle -12°
Hart 15.6mm
SPO LS-S1
Angle 3°
PT 11.6°
PL 31.2°
LL -46.8°
PLL 10.1°
TK 40.1°
SVA -77.0mm

1674213221.2D sekundär 20.01.2023 12:13:41

Exp. Index

Area Dose Pr.

20.01.2023, 12:12:30

Shipping

UNiD Surgery Postponed

3

Medicrea | UNiD

https://platformous.medicrea.com/case/0Y095RVU

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UNiD HUB

Harry Kürschner Birth Year: 1960 176 cm

THE UNiD DEVICE HAS BEEN SHIPPED Waiting for UNiD Surgery Confirmation

CASE 0Y095RVU

IMAGES

Pre-Op, 05/24/2023

Sagittal - X-Ray

Sagittal Xray

Frontal Xray

Plan

Sagittal

Frontal

Superposition

Spine Rod

Spine, Pre-Op
Spine, Plan
Rod, Plan

Shipping

UNiD Surgery Postponed

3

1674213221, 2D sekundär 20.01.2023 12:13:41
Expo. Index Area Dose Pr.

- + ⌂ ×

?

9+

+



Klinikum Magdeburg
Z: 32767,0, B: 65535,0
L R A P

1674212911. Ganzer Körper ▾
Exp. Index
Area Dose Pr. 5,1562

20.01.2023, 12:12:30 ▾

F



Klinikum Magdeburg
Z: 32767,0, B: 65535,0
L R A P

P

1674213221. 2D sekundär 20.01.2023 12:13:41 ▾
Exp. Index
Area Dose Pr.

20.01.2023, 12:12:30 ▾

F



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



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



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

Case #4

60 y/o female

Adult idiopathic scoliosis 57 °

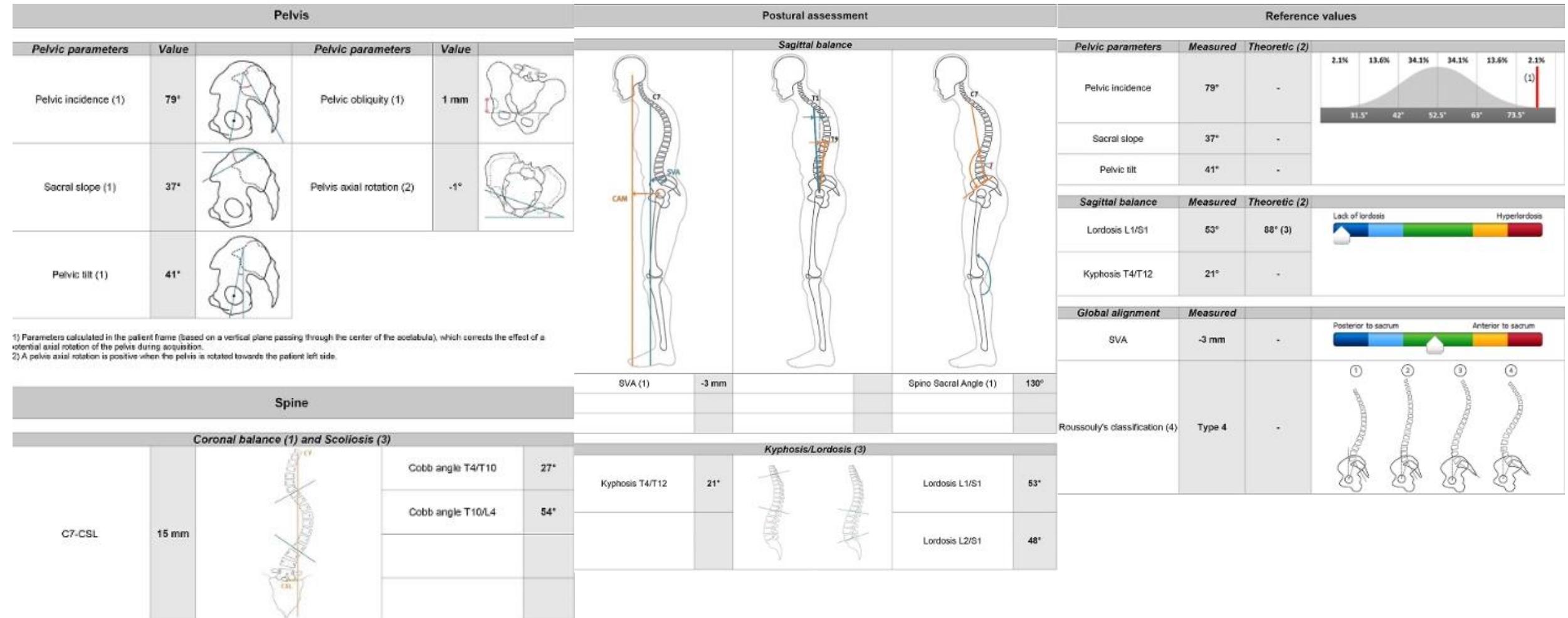
Increasing back pain

Pain medication, physical tx, infiltration with no effect

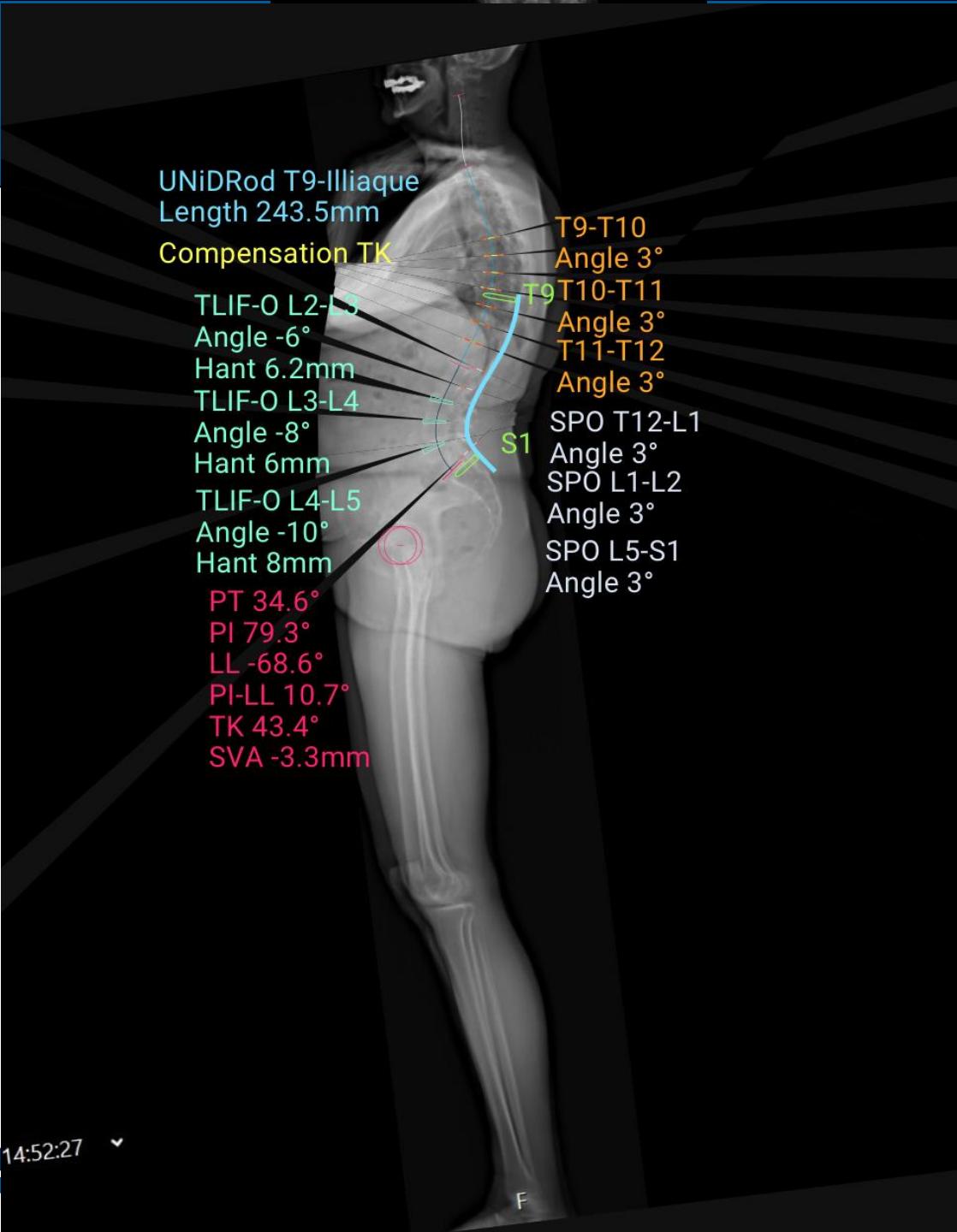
Pain from lower back to buttocks, left leg to great toe



Case #4

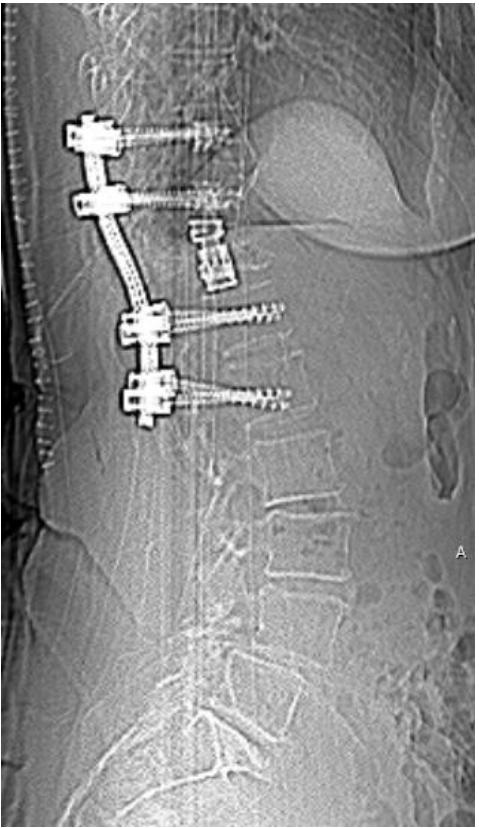


Case #4



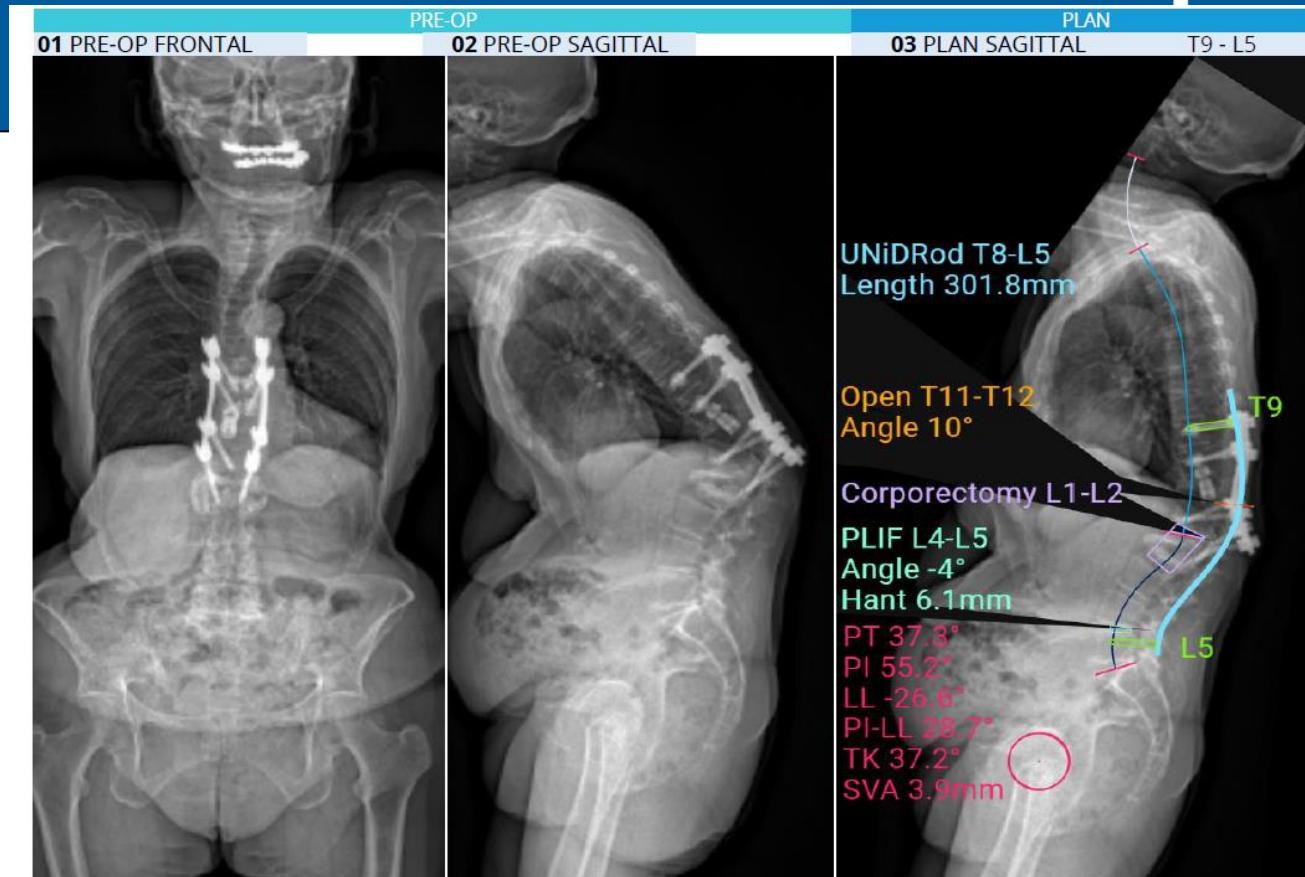
Case #4



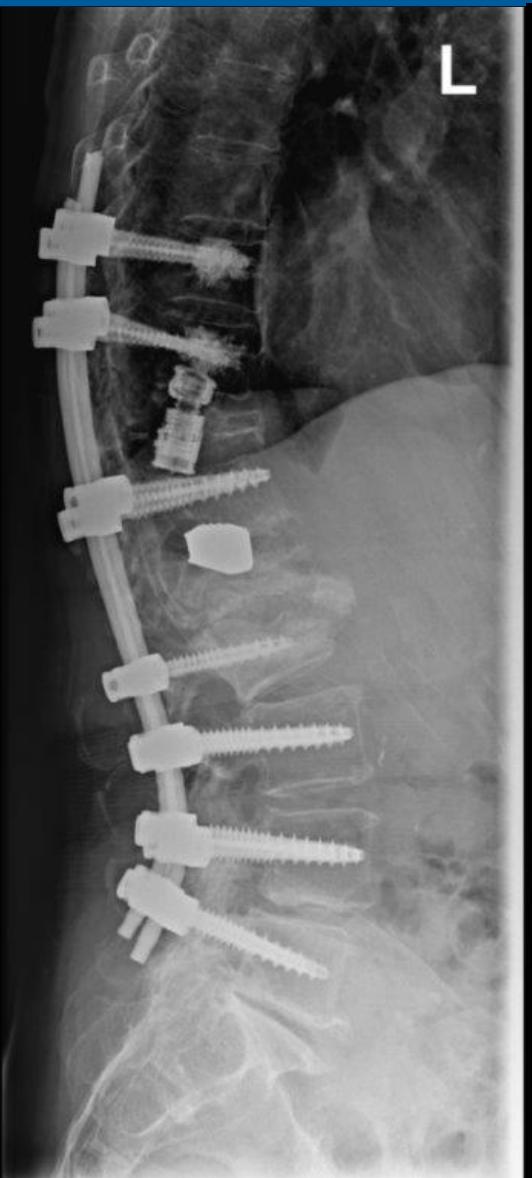








| STRATEGY | | | | |
|---------------------------------|--------|------|-------------------------|---------|
| Spinopelvic parameters | PRE-OP | PLAN | CAGES | Levels |
| Pelvic Tilt (PT,°) | 32 | 37 | Corporectomy (13°,44mm) | L1-L2 |
| Pelvic Incidence (PI,°) | 55 | 55 | PLIF (4°,6mm) | L4-L5 |
| Sacral 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 |



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Z: 28496,0, B: 62704,0
0



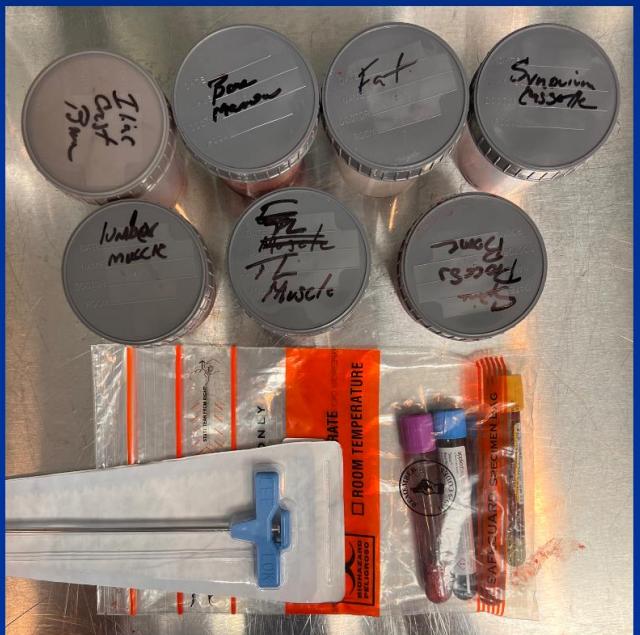
Planung

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!!!

New Data – OMICS, Digital Phenotyping



- Bone marrow
- Fat
- Muscle
- Iliac Bone
- Disc
- Synovium/FJ
- Spinal Bone
- Blood
- WGS
- Metabolomics
- Transcription

ORIGINAL ARTICLE

Check for updates

Digital Phenotyping in Patients with Spine Disease: A Novel Approach to Quantifying Mobility and Quality of Life

David J. Cote¹, Ian Barnett², Jukka-Pekka Onnela², Timothy R. Smith¹

■ OBJECTIVE: To identify trends in mobility and daily pain scalable approach to assess mobility and quality of life of

Table 1. Continued

| Variable | n (%) or Mean ± 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) |

Table 2. Daily Smartphone Mobility and Sociability Features Collected by Digital Phenotyping

| Variable | n (%) or Mean ± SD |
|--|------------------------------|
| Demographic data | |
| Male gender | 48 (45.7) |
| Age | 52.0 ± 14.0 |
| Surgery | 55 (52.4) |
| Site of disease | |
| Cervical | 35 (33.3) |
| Thoracic | 6 (5.7) |
| Lumbar | 64 (60.1) |
| Passive data collection | |
| GPS days | 82.5 ± 68.4 |
| Active data collection | |
| Daily survey response rate | |
| Mean | 43.4 |
| 25%–75% quantile | 23.2–69.8 |
| Weekly survey response rate | |
| Mean | 73.2 |
| 25%–75% quantile | 50.6–100.0 |
| Change in pain score, all patients | |
| Mean | −1.3 |
| Start to end score | From 4.96 to 3.66 |
| Daily digital phenotypes ^a | |
| Time spent at home (minutes) | 927.1 (623.9–1242.8) |
| Distance travelled (meters) | 51,989.1 (18,691.9–97,833.3) |
| Radius of gyration (meters) | 32,18.8 (846.8–8881.9) |
| Maximum diameter (meters) | 13,828.1 (4867.5–29,382) |
| Maximum distance from home (meters) | 13,296.5 (46,12.7–29,285.7) |
| No. of significant locations visited | 2 (1–3) |
| Average flight length (meters) | 236.0 (160.1–334.9) |
| SD of flight length (meters) | 296.4 (173.3–487.3) |
| Average flight duration (seconds) | 42.7 (32.0–74.3) |
| SD of flight duration (seconds) | 98.2 (56.9–257.1) |
| Fraction of the day not moving | 0.88 (0.79–0.94) |
| Significant location entropy | 0 (0–0.28) |
| Missing GPS data (minutes) | 1349.7 (1327.7–1379.2) |
| Circadian routine (0, low, 1, high) | 0.59 (0.42–0.71) |
| Weekend/day stratified circadian routine | 0.61 (0.44–0.73) |
| No. of outgoing texts | 4 (0–14) |
| Total outgoing text length (characters) | 165 (0–756) |
| Texting out degree | 1 (0–3) |
| Continues | |

ORIGINAL ARTICLE

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An epigenetic clock for human skeletal muscle

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Tissue Banking

An epigenetic clock for human skeletal muscle

Figure A shows a Venn diagram with 337 unique genes in Pan-muscle and 16 unique genes in Muscle.

Table A shows a heatmap of gene expression levels across different samples.

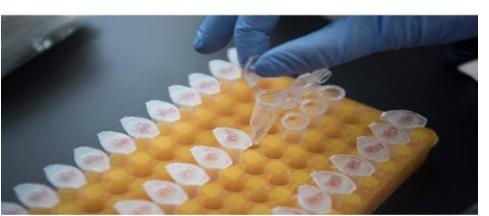
Figure B shows a screenshot of a GitHub repository for the Muscle Epigenetic Age Test.

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.

China's sitting on a goldmine of genetic data – and it doesn't want to share

By Jessie Yeung, CNN
Published 4:23 PM PDT, Fri Aug 11, 2023



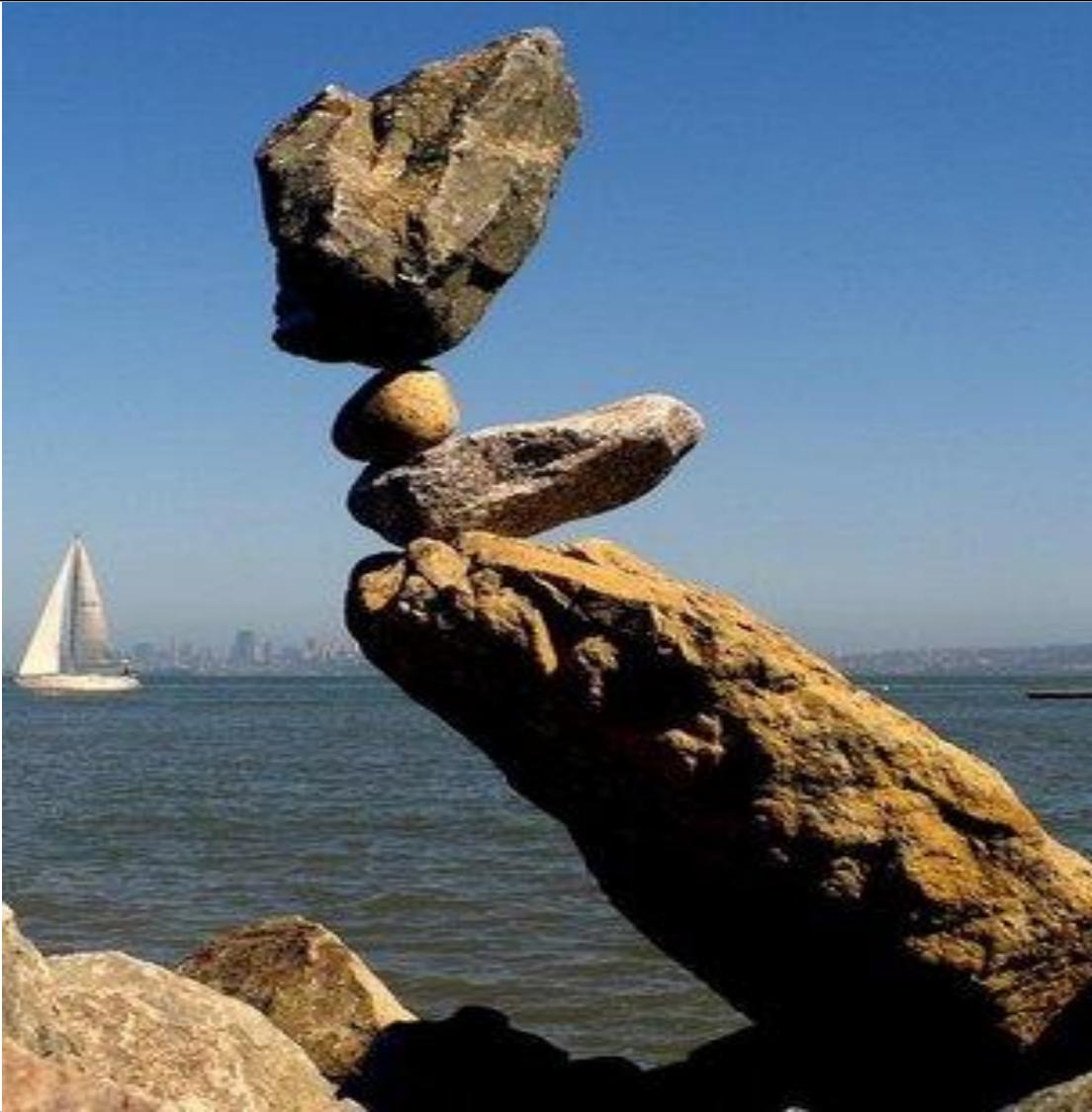
We Liang/ICHPL Imaginechina/AP

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,

| 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 |
| 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 |

Es ist alles eine Frage des Gleichgewichts





Immer eine Frage der BALANCE

Unsere Hoffnung

