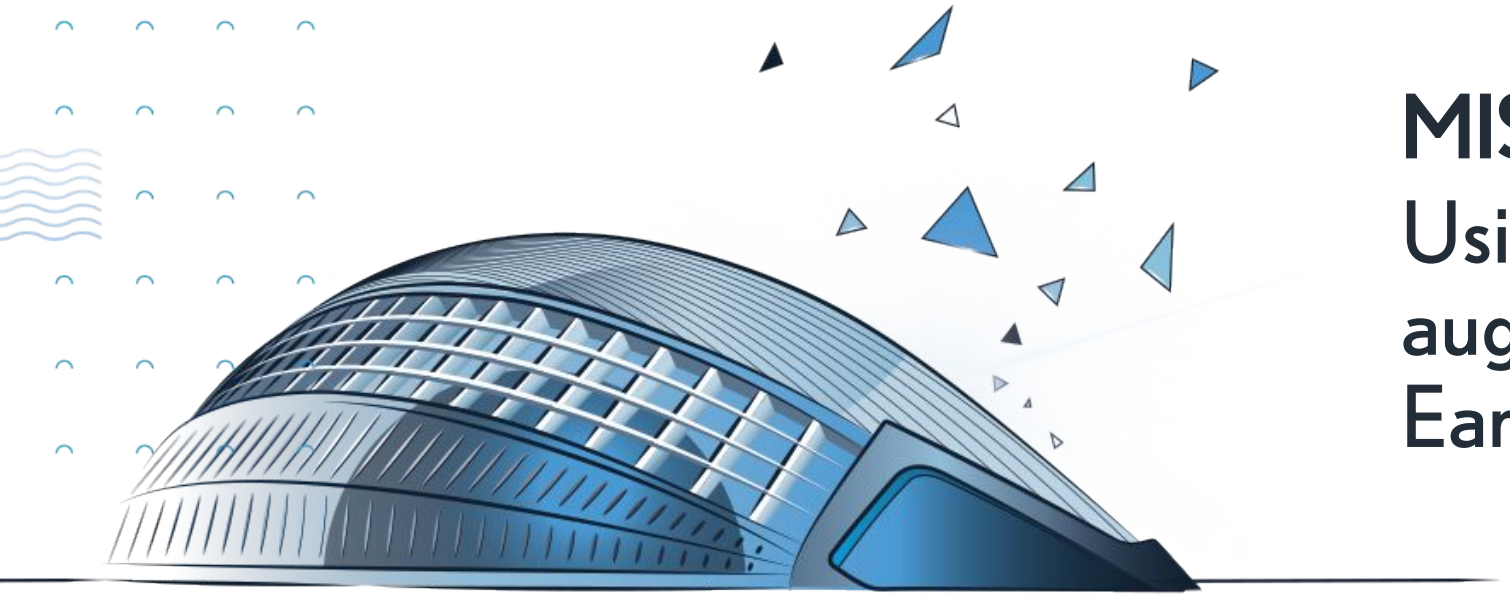
sense Spine Expert Network for Science & Education™



MIS deformity correction:
Using disruptive, AI-driven, augmented reality technology: Early clinical experiences

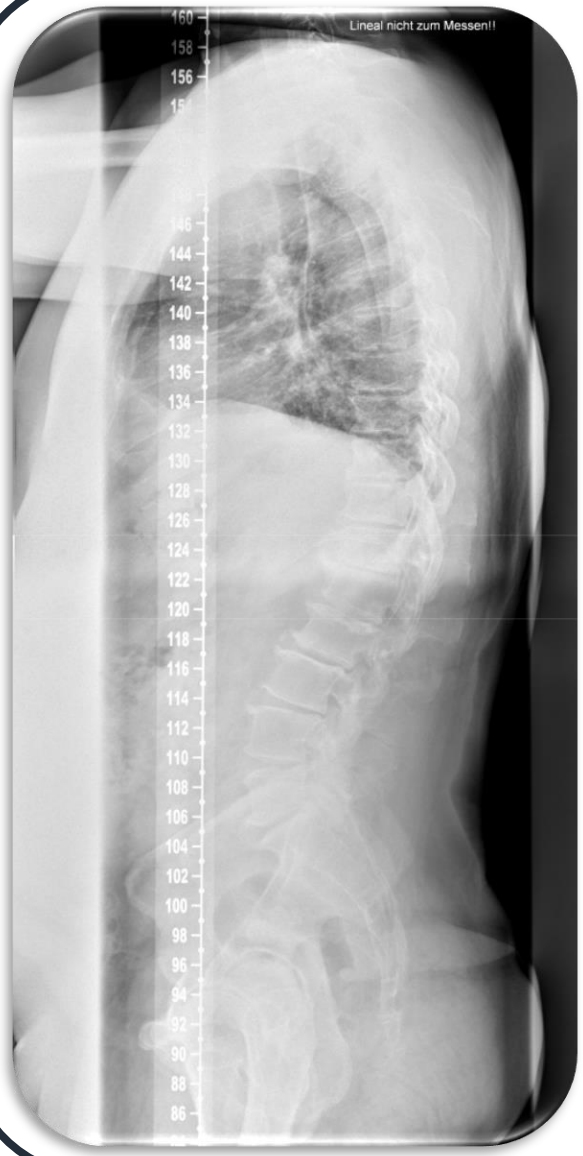
Dr. Philipp Kobbe

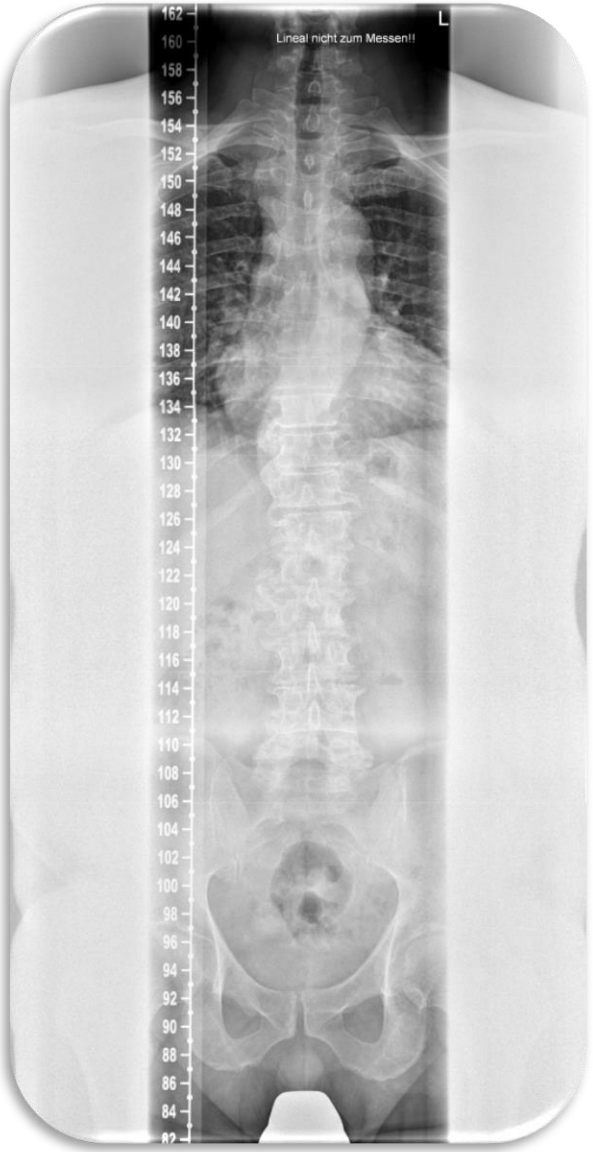
University Hospital Aachen

SENSE 2nd International Spine Expert Symposium

June 23 – 25, 2022 / Valencia – Spain

Case 1





Measurements	
Age	59
Pelvic Incidence (PI)	52
Sacral Slope (SS)	35
L1-S1 Lordosis	52
L4-S1 Lordosis	44
Global Tilt (GT)	11

The Global Alignmnet and Proportion (GAP) score is a PI-based individualized method of analyzing the sagittal plane that effectively predicts mechanical complications of surgery for adult spinal deformity.

Parameters	Results	Subgroups	Scores
Age Factor	59		0
RPV	-4.7°	Aligned	0
RLL	-9.2°	Aligned	0
LDI	85%	Hyperlordotic Maldistribution	3
RSA	1.0°	Aligned	0

GAP Score 3

Moderate Disproportion

The GAP score comprises the relative pelvic version (RPV= Measured minus Ideal SS), relative lumbar lordosis (RLL= Measured minus Ideal LL), lordosis distribution index (LDI= L4-S1 lower-arc lordosis / L1-S1 total lordosis x100), relative spinopelvic alignment (RSA= Measured minus Ideal GT), and an age factor (<60 vs ≥60).

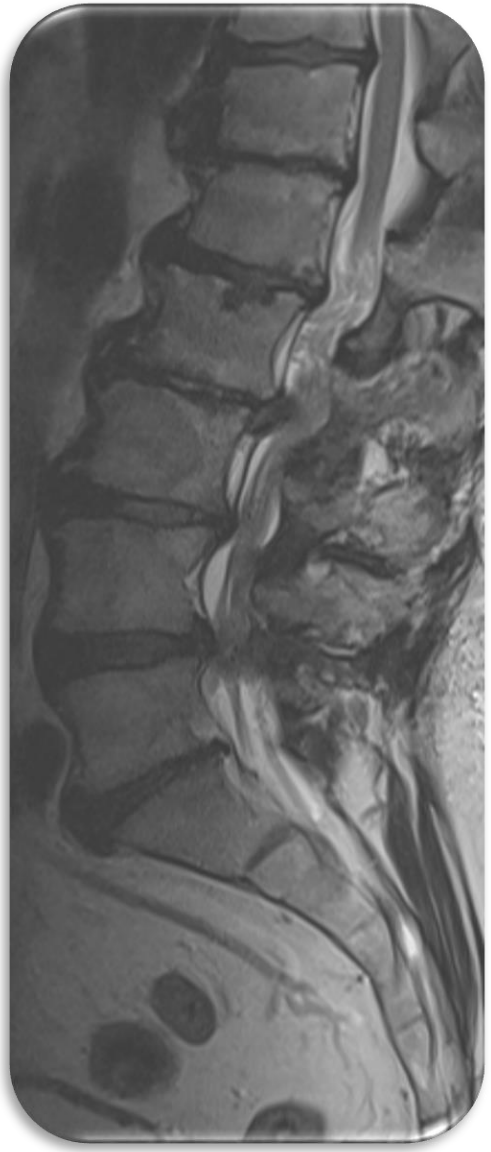
Preoperative Planning

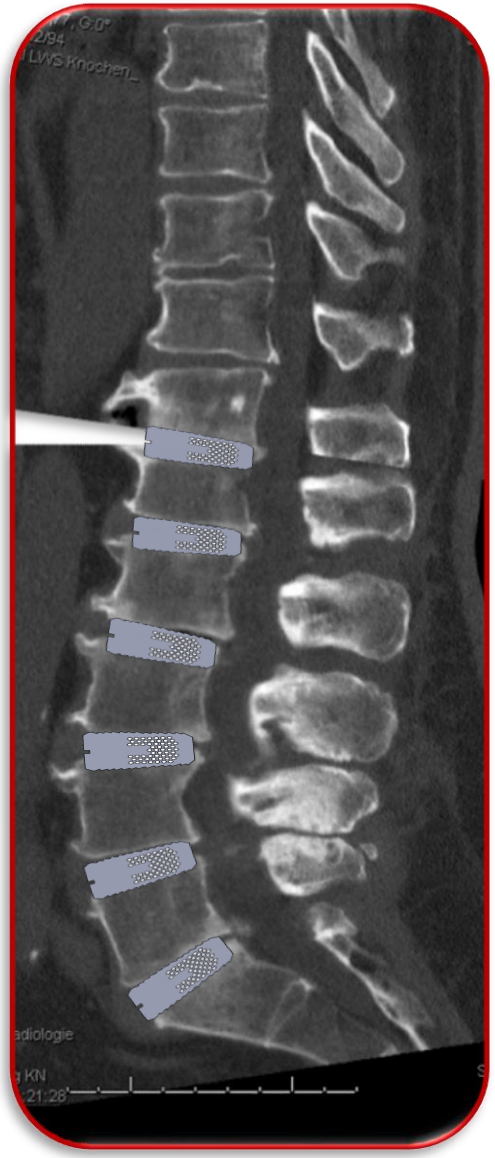
	Current Angles	Calculated 'Ideal's	Correction Required
SS	35.0°	39.7°	4.7°
L1-S1	52.0°	61.2°	9.2°
L4-S1	44.0°	37.4°	-6.6°
GT	11.0°	10.0°	-1.0°

The GAP score is a continuum of states that provides an individualized indication of pelvic version, magnitude and distribution of lumbar lordosis, and global spinopelvic alignment to assess disproportion compared with the calculated "ideal" for any given subject.

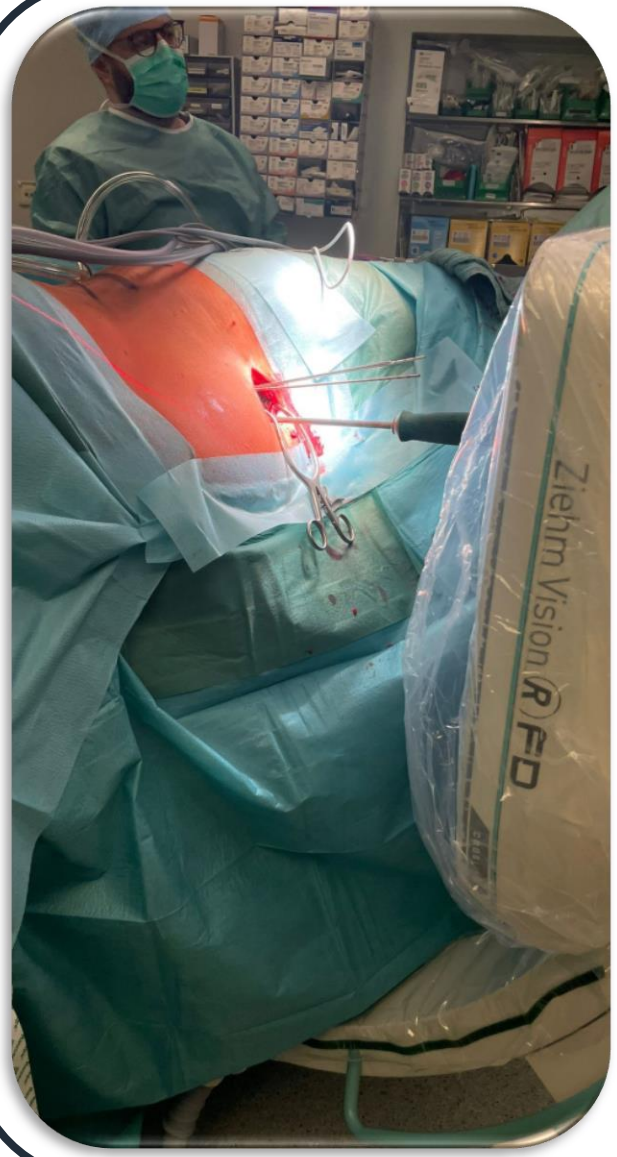
Setting surgical goals in the sagittal plane on the basis of the proportional indices reflected by the GAP score may decrease the rate of mechanical complications. Pubmed Link

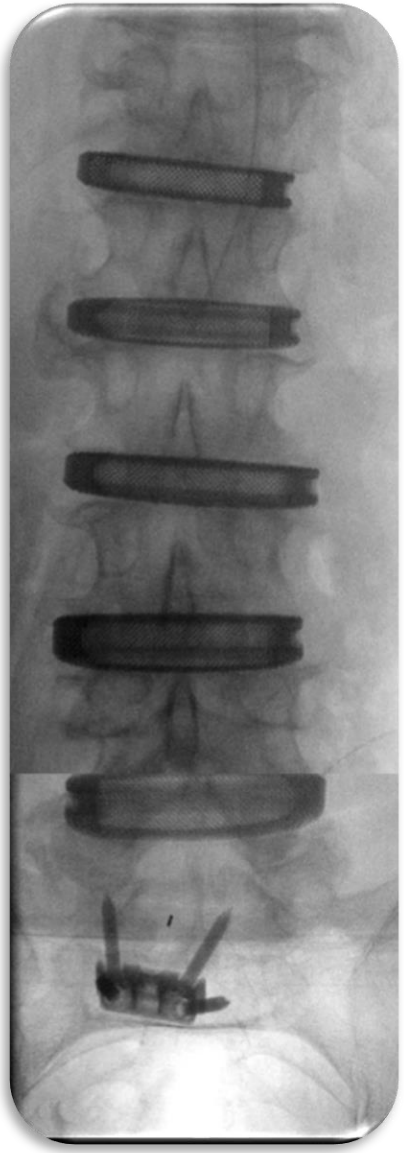
Case 1

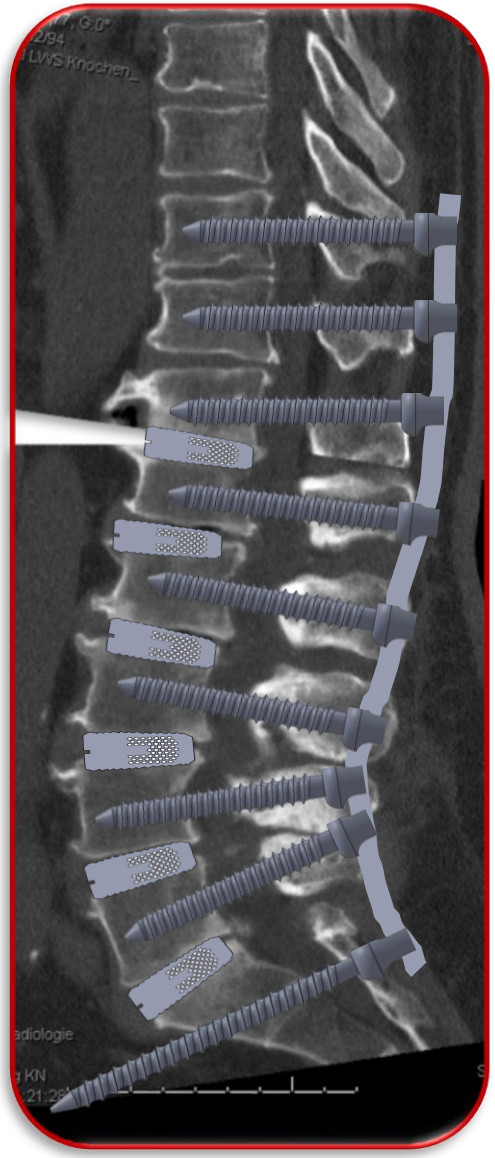




Case 1







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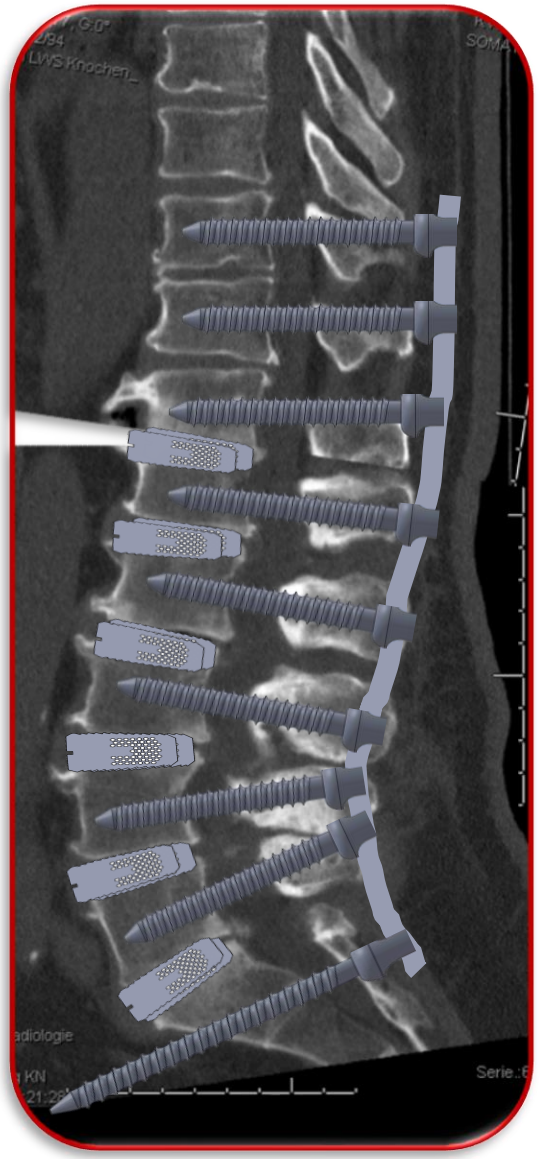
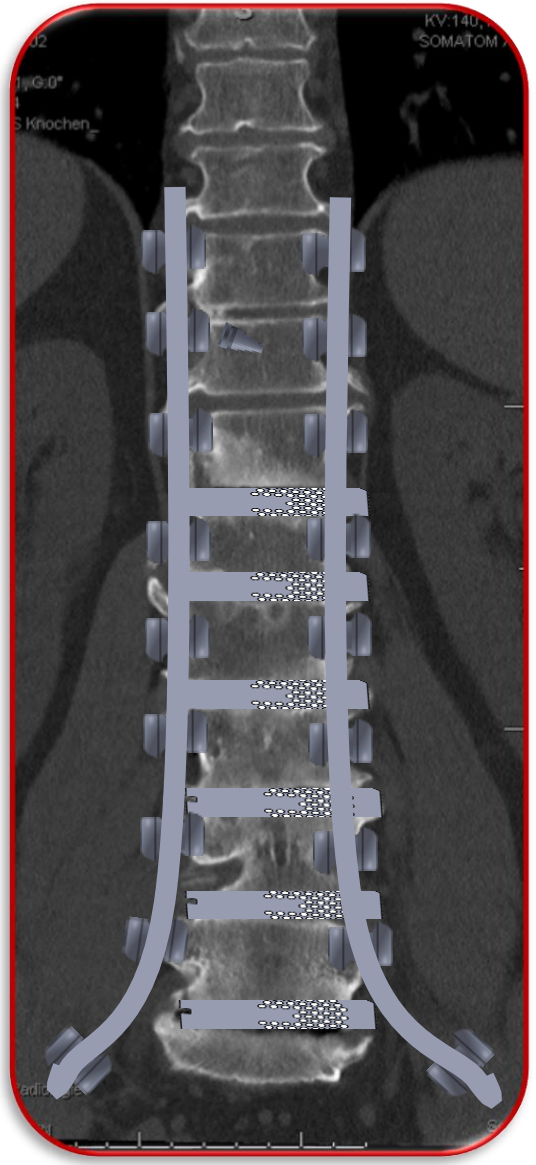
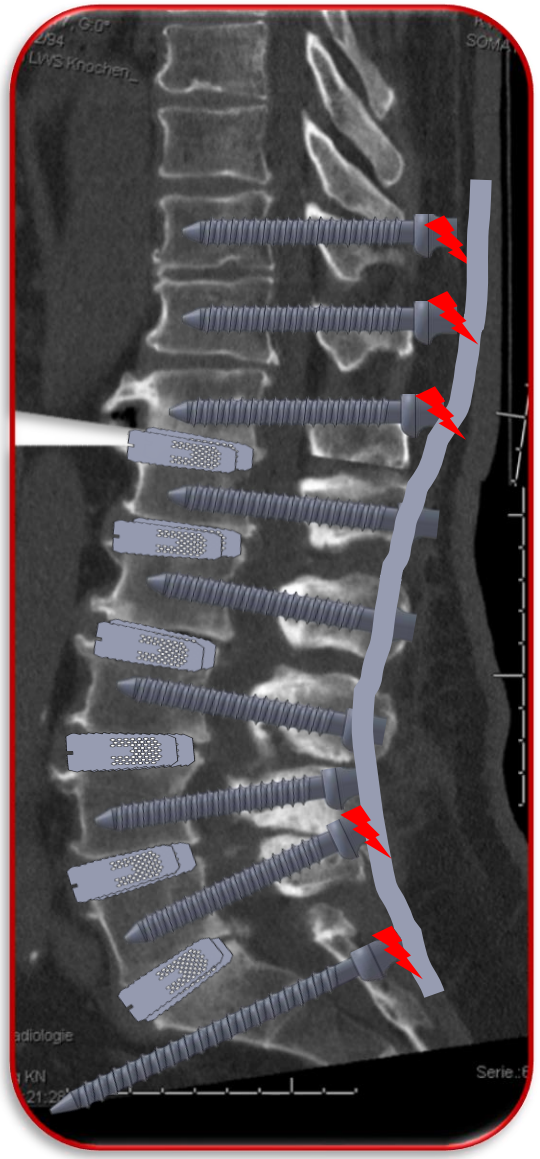
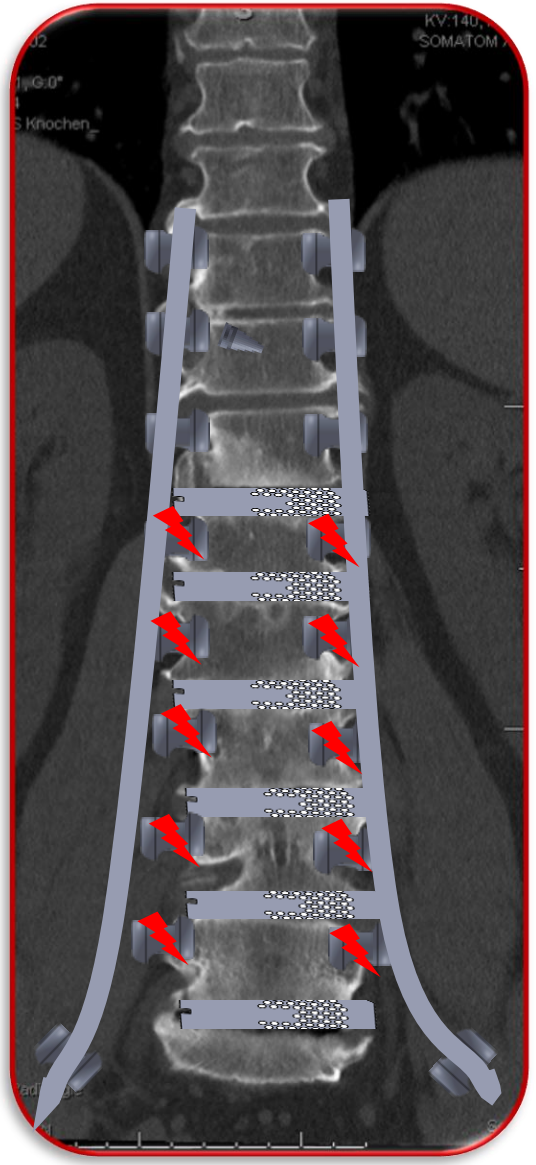




Case 1





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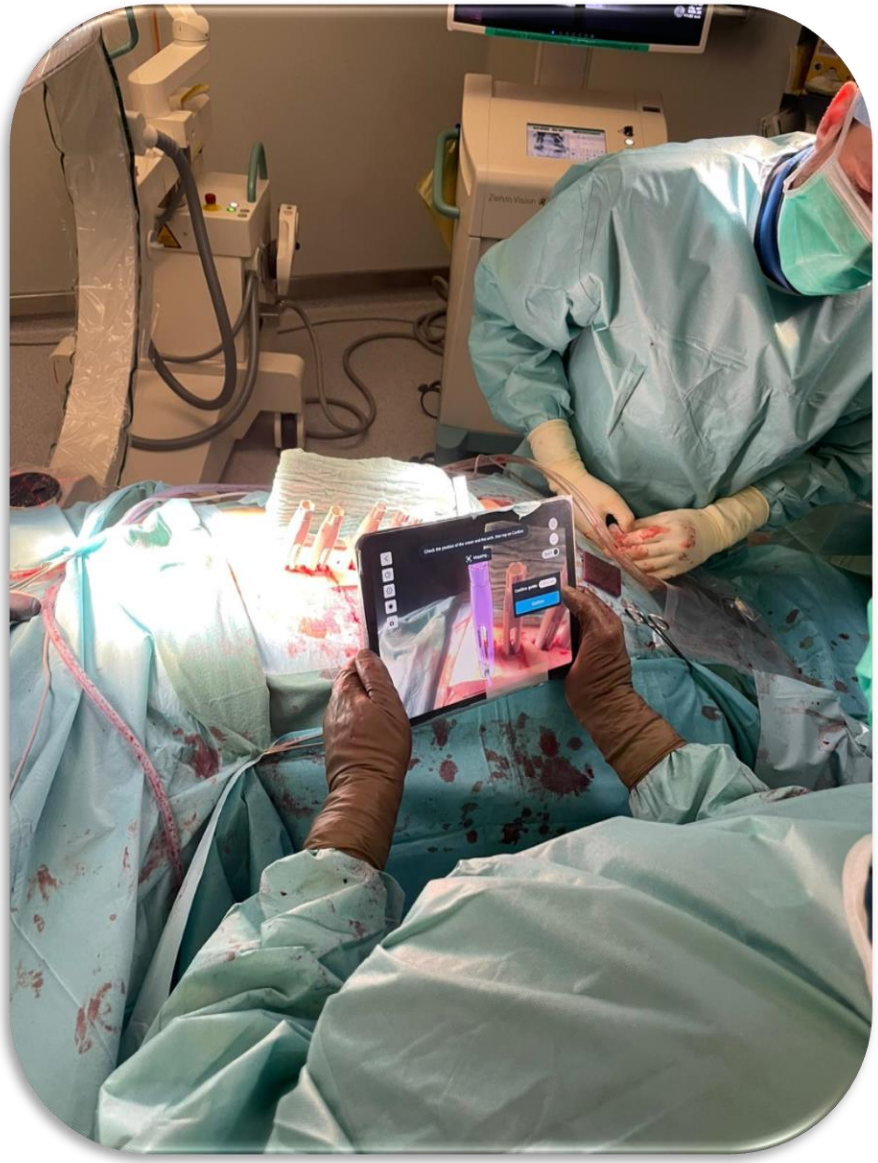

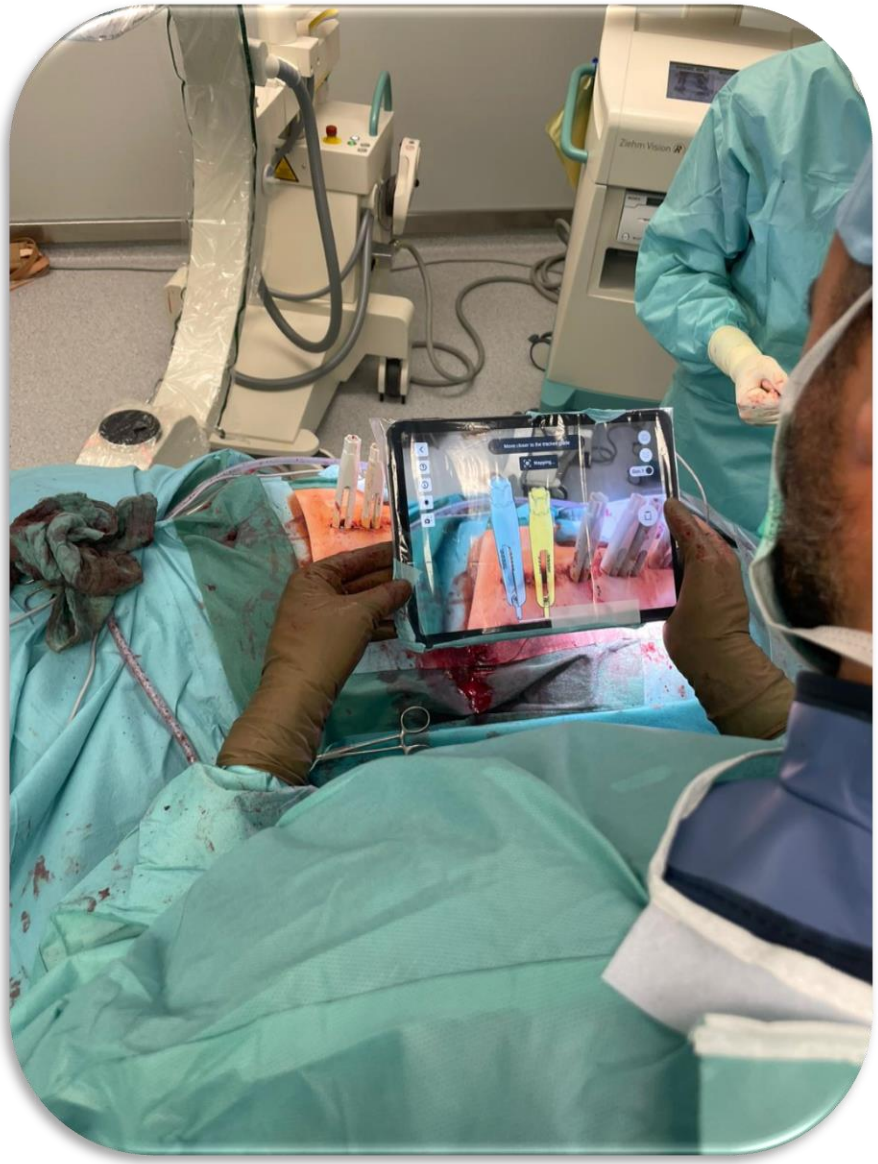

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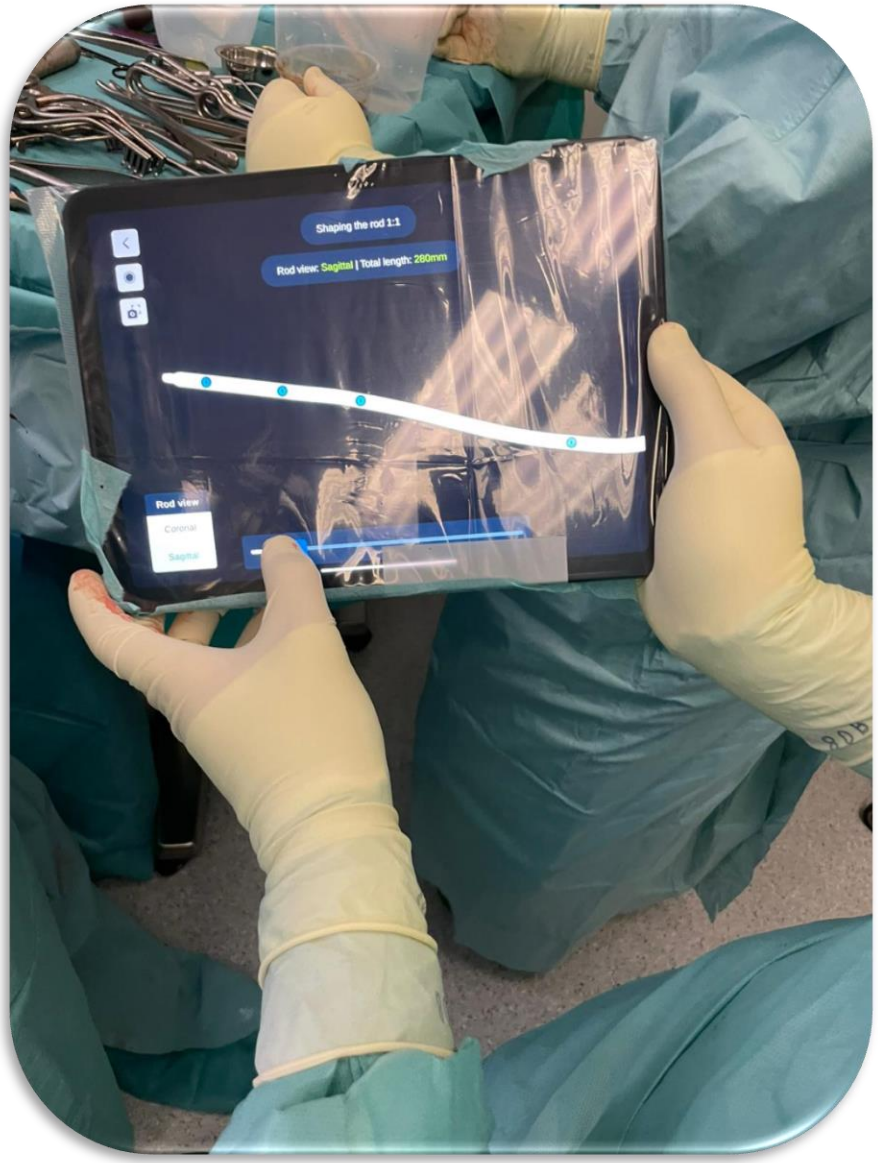
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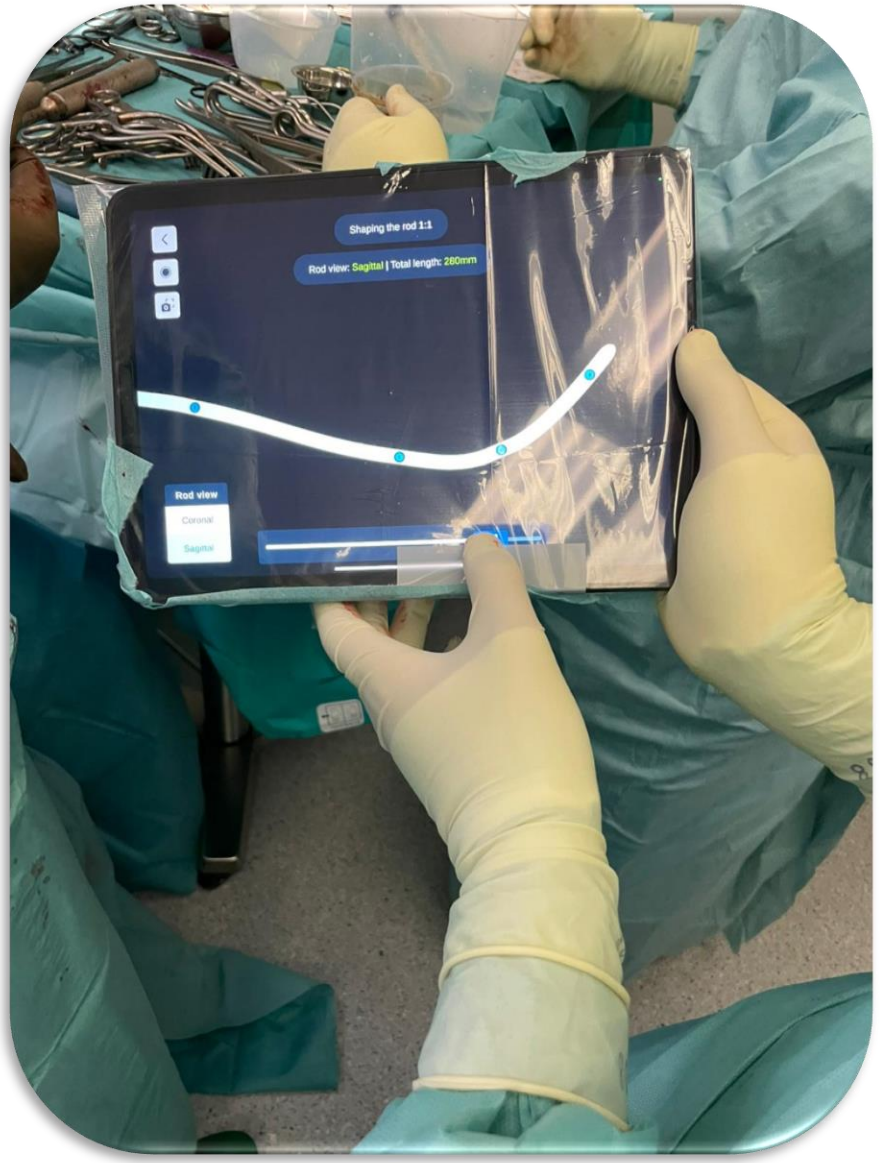
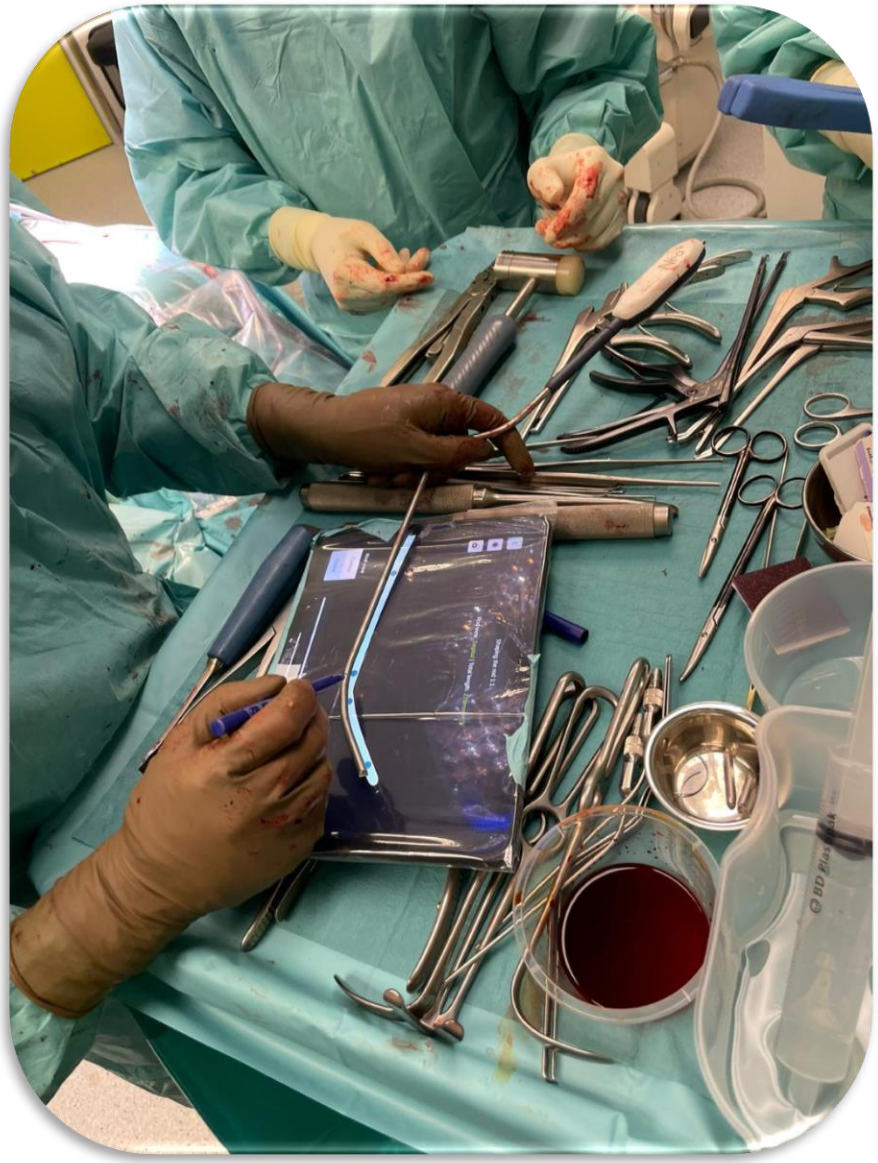
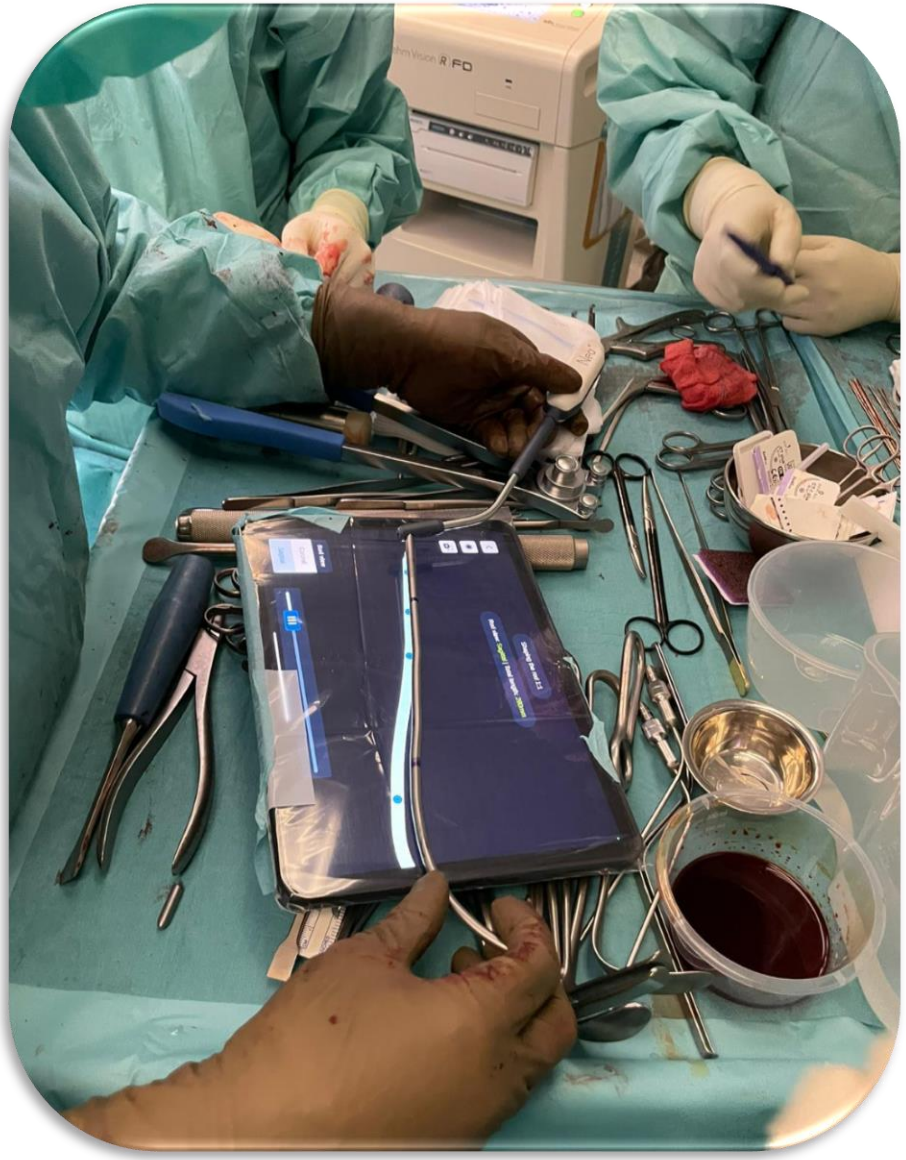
Rod view
Coronal
Sagittal


Shaping the rod 1:1
Rod view: Sagittal | Total length: 280mm
Rod view
Coronal
Sagittal

ADVISE™





ADVISE™

Case 1

Measurements	
Age	59
Pelvic Incidence (PI)	52
Sacral Slope (SS)	40
L1-S1 Lordosis	53
L4-S1 Lordosis	42
Global Tilt (GT)	19

The Global Alignmnet and Proportion (GAP) score is a PI-based individualized method of analyzing the sagittal plane that effectively predicts mechanical complications of surgery for adult spinal deformity.

Parameters	Results	Subgroups	Scores
Age Factor	59		0
RPV	0.3°	Aligned	0
RLL	-8.2°	Aligned	0
LDI	79%	Aligned	0
RSA	9.0°	Aligned	0

GAP Score 0

Proportioned Spine

The GAP score comprises the relative pelvic version (RPV= Measured minus Ideal SS), relative lumbar lordosis (RLL= Measured minus Ideal LL), lordosis distribution index (LDI= L4-S1 lower-arc lordosis / L1-S1 total lordosis x100), relative spinopelvic alignment (RSA= Measured minus Ideal GT), and an age factor (<60 vs ≥60).

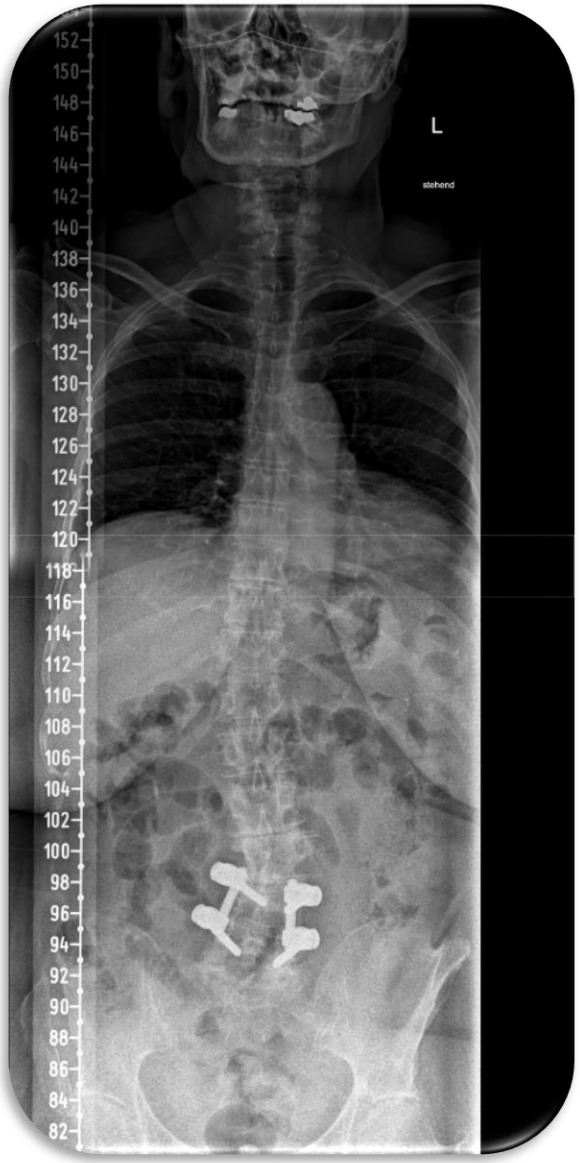
Preoperative Planning

	Current Angles	Calculated 'Ideal's	Correction Required
SS	40.0°	39.7°	-0.3°
L1-S1	53.0°	61.2°	8.2°
L4-S1	42.0°	37.4°	-4.6°
GT	19.0°	10.0°	-9.0°

The GAP score is a continuum of states that provides an individualized indication of pelvic version, magnitude and distribution of lumbar lordosis, and global spinopelvic alignment to assess disproportion compared with the calculated "ideal" for any given subject.

Setting surgical goals in the sagittal plane on the basis of the proportional indices reflected by the GAP score may decrease the rate of mechanical complications. Pubmed Link

Case 2



Measurements	
Age	59
Pelvic Incidence (PI)	59
Sacral Slope (SS)	28
L1-S1 Lordosis	39
L4-S1 Lordosis	20
Global Tilt (GT)	29

Parameters	Results	Subgroups	Scores
Age Factor	59		0
RPV	-15.8°	Severe Retroversion	3
RLL	-26.6°	Severe Hypolordosis	3
LDI	51%	Aligned	0
RSA	15.7°	Moderate Positive Mallignment	1

Preoperative Planning

	Current Angles	Calculated 'Ideal's	Correction Required
SS	28.0°	43.8°	15.8°
L1-S1	39.0°	65.6°	26.6°
L4-S1	20.0°	40.0°	20.0°
GT	29.0°	13.3°	-15.7°

GAP Score 7

Severe Disproportion

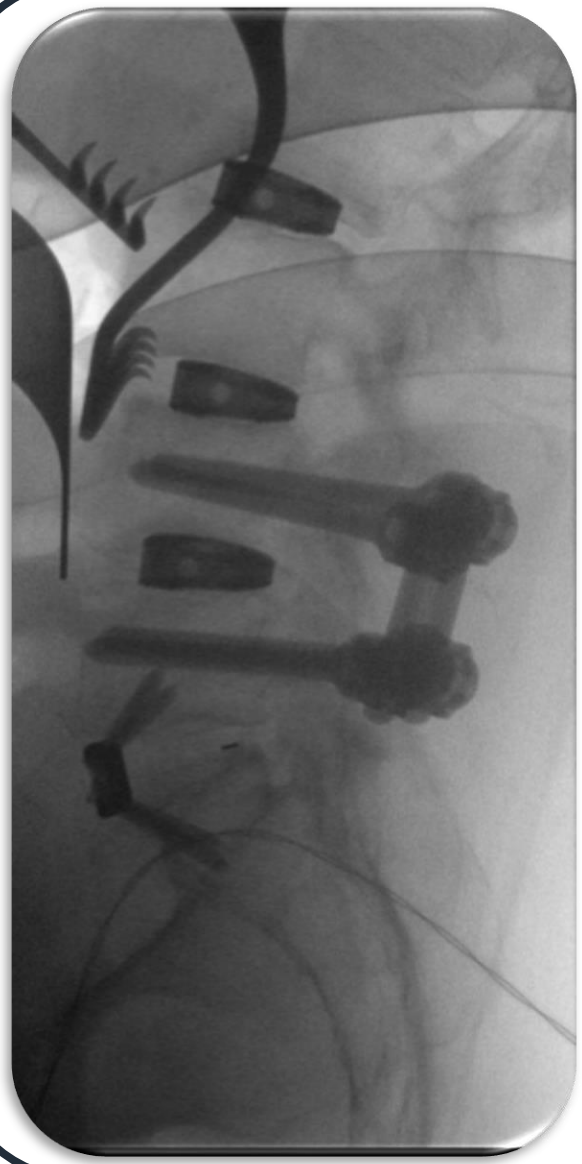
The Global Alignmnet and Proportion (GAP) score is a PI-based individualized method of analyzing the sagittal plane that effectively predicts mechanical complications of surgery for adult spinal deformity.

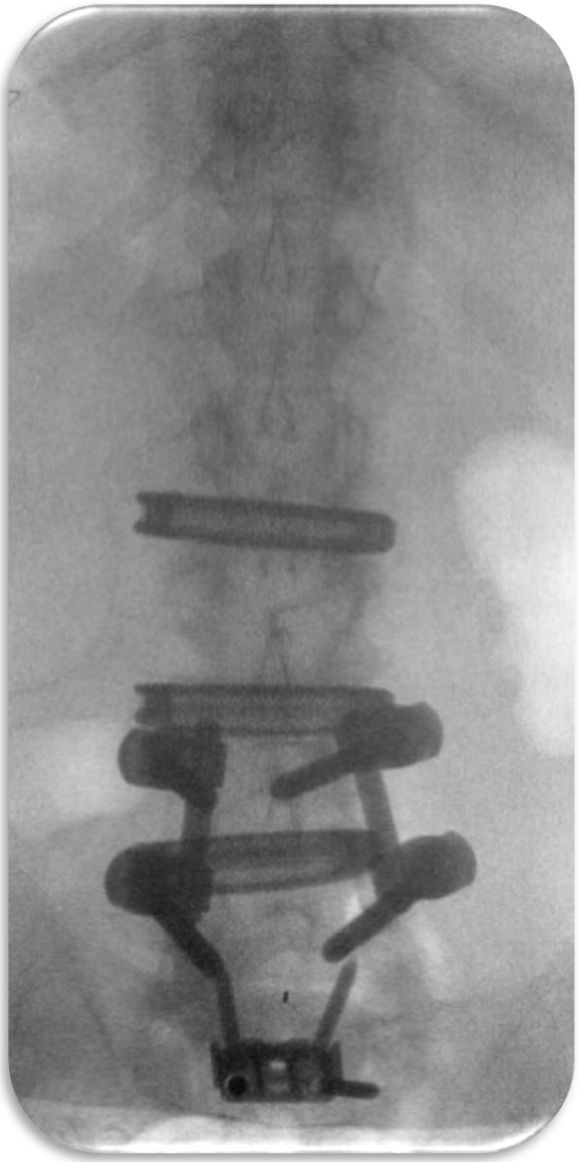
The GAP score comprises the relative pelvic version (RPV= Measured minus Ideal SS), relative lumbar lordosis (RLL= Measured minus Ideal LL), lordosis distribution index (LDI= L4-S1 lower-arc lordosis / L1-S1 total lordosis x100), relative spinopelvic alignment (RSA= Measured minus Ideal GT), and an age factor (<60 vs ≥60).

The GAP score is a continuum of states that provides an individualized indication of pelvic version, magnitude and distribution of lumbar lordosis, and global spinopelvic alignment to assess disproportion compared with the calculated "ideal" for any given subject.

Setting surgical goals in the sagittal plane on the basis of the proportional indices reflected by the GAP score may decrease the rate of mechanical complications.
Pubmed Link

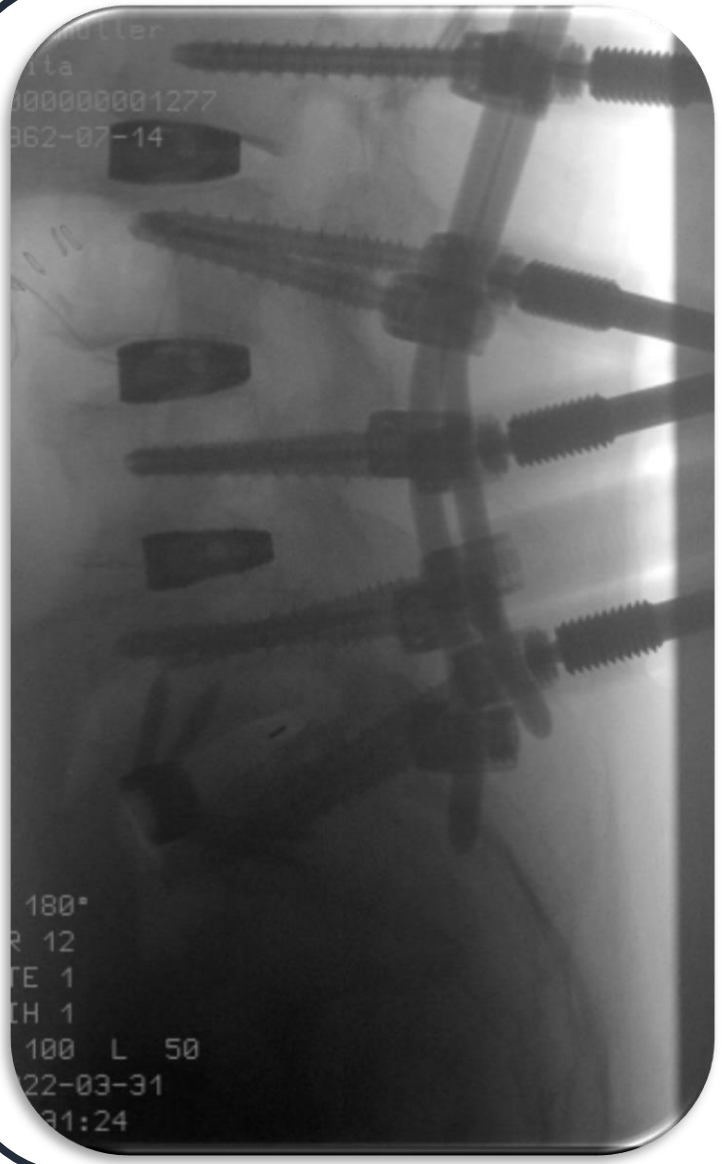
Case 2

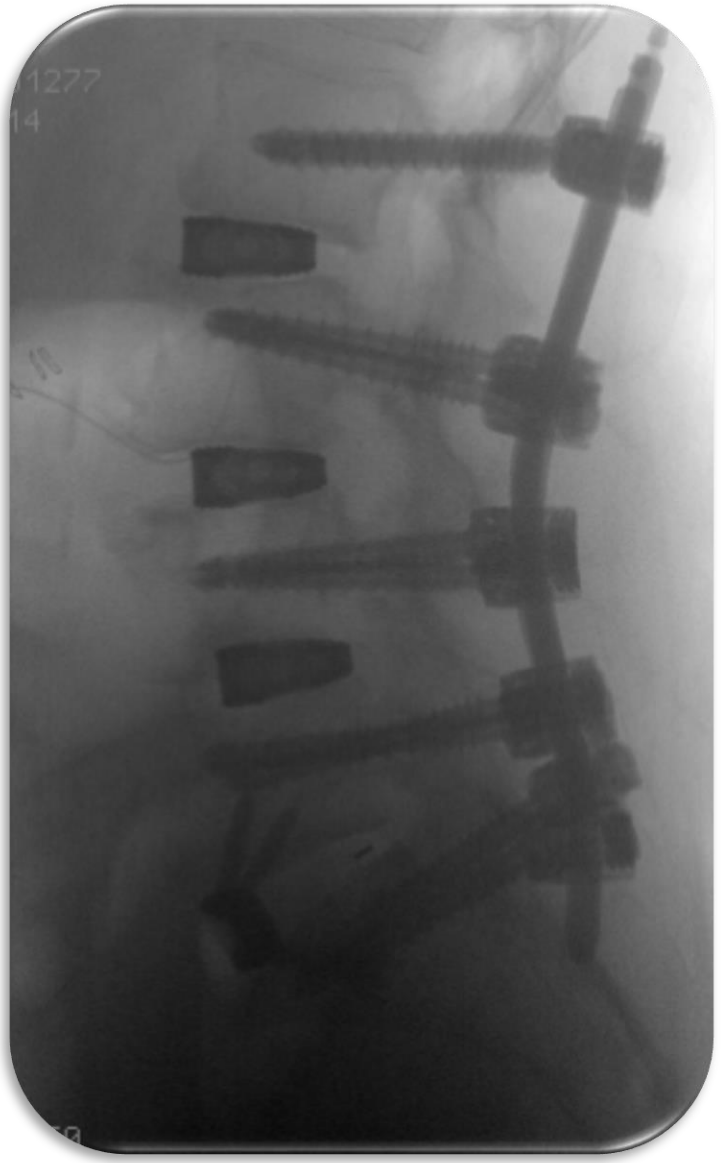


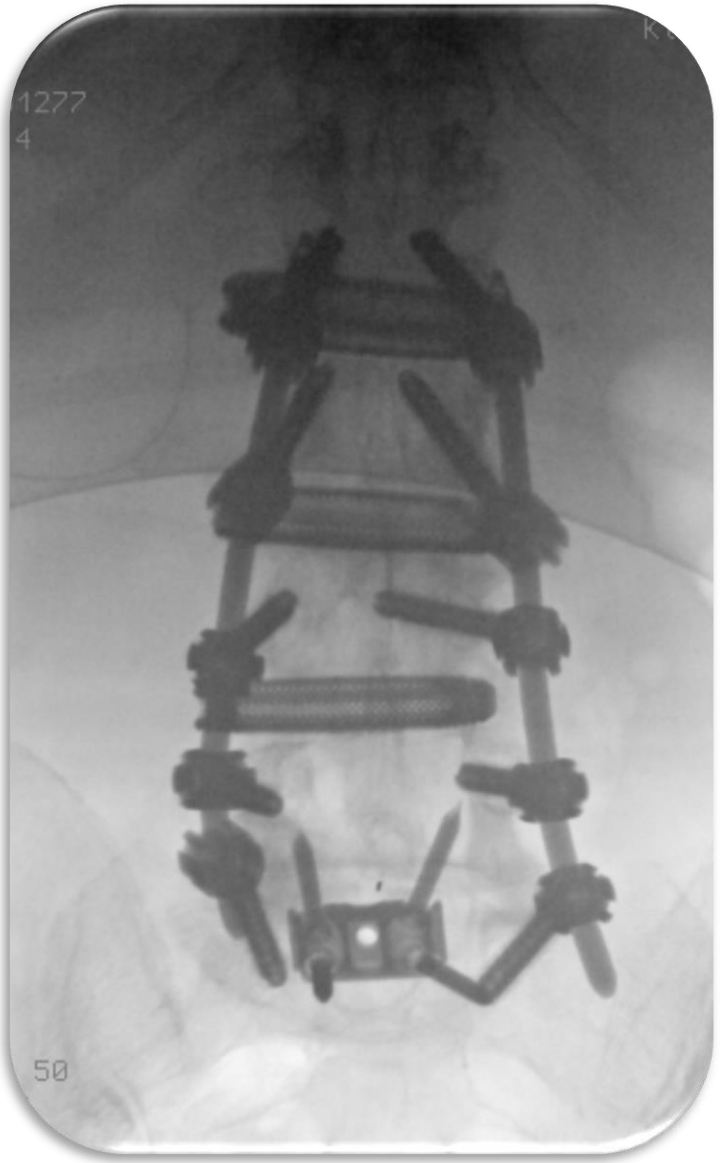


Case 2

Case 2







Case 2

Measurements	
Age	59
Pelvic Incidence (PI)	59
Sacral Slope (SS)	35
L1-S1 Lordosis	52
L4-S1 Lordosis	28
Global Tilt (GT)	23

The Global Alignmnet and Proportion (GAP) score is a PI-based individualized method of analyzing the sagittal plane that effectively predicts mechanical complications of surgery for adult spinal deformity.

Parameters	Results	Subgroups	Scores
Age Factor	59		0
RPV	-8.8°	Moderate Retroversion	2
RLL	-13.6°	Aligned	0
LDI	54%	Aligned	0
RSA	9.7°	Aligned	0

GAP Score 2

Proportioned Spine

The GAP score comprises the relative pelvic version (RPV= Measured minus Ideal SS), relative lumbar lordosis (RLL= Measured minus Ideal LL), lordosis distribution index (LDI= L4-S1 lower-arc lordosis / L1-S1 total lordosis x100), relative spinopelvic alignment (RSA= Measured minus Ideal GT), and an age factor (<60 vs ≥60).

Preoperative Planning	Current Angles	Calculated 'Ideal's	Correction Required
SS	35.0°	43.8°	8.8°
L1-S1	52.0°	65.6°	13.6°
L4-S1	28.0°	40.0°	12.0°
GT	23.0°	13.3°	-9.7°

The GAP score is a continuum of states that provides an individualized indication of pelvic version, magnitude and distribution of lumbar lordosis, and global spinopelvic alignment to assess disproportion compared with the calculated "ideal" for any given subject.

Setting surgical goals in the sagittal plane on the basis of the proportional indices reflected by the GAP score may decrease the rate of mechanical complications. Pubmed Link

Case 3

Subgroups	Scores
	1
Moderate Retroversion	2
Severe Hypolordosis	3
Hyperlordotic Maldistribution	3
Severe Positive Malalignment	3

Preoperative Planning

	Current Angles	Calculated 'Ideal's	Correction Required
SS	23.0°	35.0°	12.0°
L1-S1	31.0°	56.3°	25.3°
L4-S1	25.0°	34.3°	9.3°
GT	28.0°	6.1°	-21.9°

P Score 12

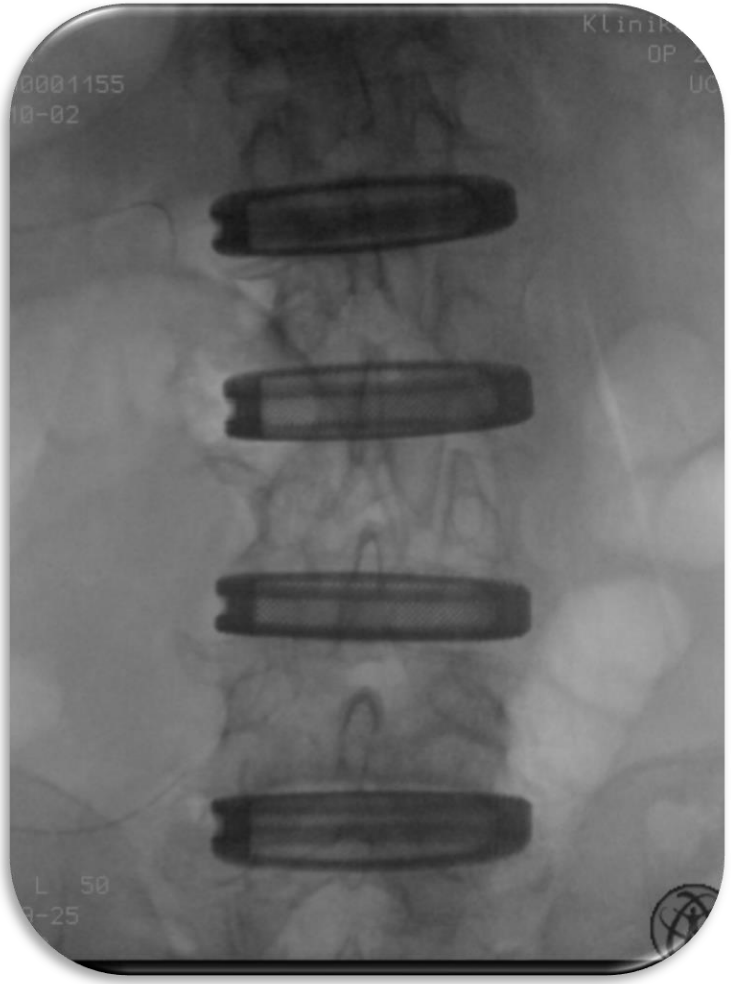
Disproportion

ve pelvic version (RPV= Measured minus Ideal SS), sured minus Ideal LL), lordosis distribution index L1-S1 total lordosis x100), relative spinopelvic leal GT), and an age factor (<60 vs ≥60).

The GAP score is a continuum of states that provides an individualized indication of pelvic version, magnitude and distribution of lumbar lordosis, and global spinopelvic alignment to assess disproportion compared with the calculated "ideal" for any given subject.

Setting surgical goals in the sagittal plane on the basis of the proportional indices reflected by the GAP score may decrease the rate of mechanical complications. Pubmed Link

Case 3



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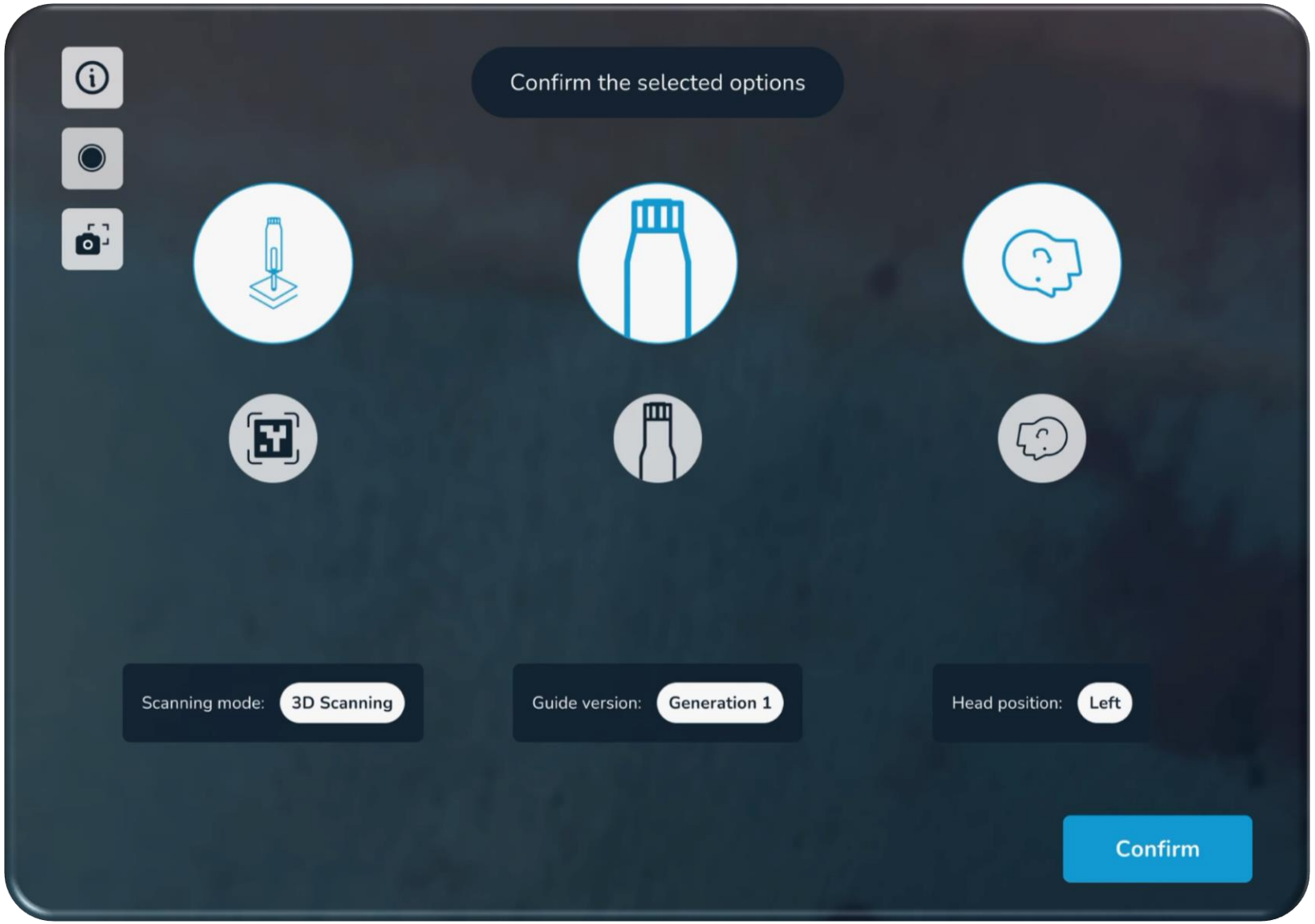
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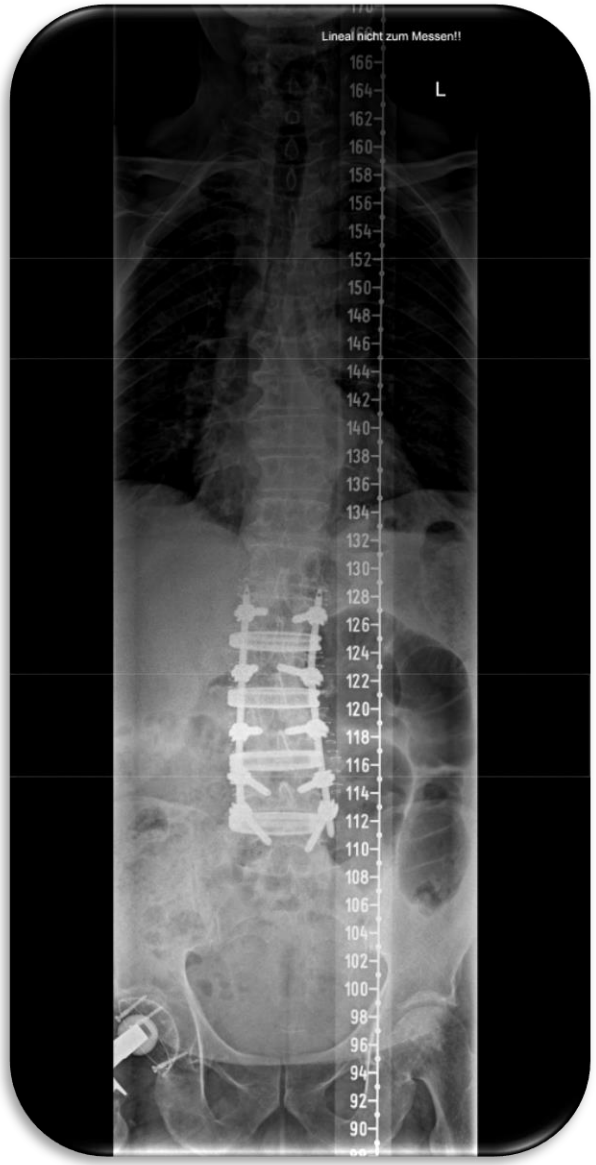
Confirm

Case 3



Measurements	
Age	76
Pelvic Incidence (PI) ⓘ	44
Sacral Slope (SS) ⓘ	38
L1-S1 Lordosis ⓘ	46
L4-S1 Lordosis ⓘ	33
Global Tilt (GT) ⓘ	18

The Global Alignmnet and Proportion (GAP) score is a PI-based individualized method of analyzing the sagittal plane that effectively predicts mechanical complications of surgery for adult spinal deformity.

Parameters	Results	Subgroups	Scores
Age Factor ⓘ	76		1
RPV ⓘ	3.0°	Aligned	0
RLL ⓘ	-10.3°	Aligned	0
LDI ⓘ	72%	Aligned	0
RSA ⓘ	11.9°	Moderate Positive Mallignment	1

ⓘ GAP Score 2

Proportioned Spine

The GAP score comprises the relative pelvic version (RPV= Measured minus Ideal SS), relative lumbar lordosis (RLL= Measured minus Ideal LL), lordosis distribution index (LDI= L4-S1 lower-arc lordosis / L1-S1 total lordosis x100), relative spinopelvic alignment (RSA= Measured minus Ideal GT), and an age factor (<60 vs ≥60).

Preoperative Planning	Current Angles	Calculated 'Ideal's	Correction Required
SS	38.0°	35.0°	-3.0°
L1-S1	46.0°	56.3°	10.3°
L4-S1	33.0°	34.3°	1.3°
GT	18.0°	6.1°	-11.9°

The GAP score is a continuum of states that provides an individualized indication of pelvic version, magnitude and distribution of lumbar lordosis, and global spinopelvic alignment to assess disproportion compared with the calculated "ideal" for any given subject.

Setting surgical goals in the sagittal plane on the basis of the proportional indices reflected by the GAP score may decrease the rate of mechanical complications. Pubmed Link

Case 4

Subgroups	Scores
	1
derate Retroversion	2
derate Hypolordosis	2
ordotic Maldistribution	3
te Positive Mallignment	1

core 9

roportion

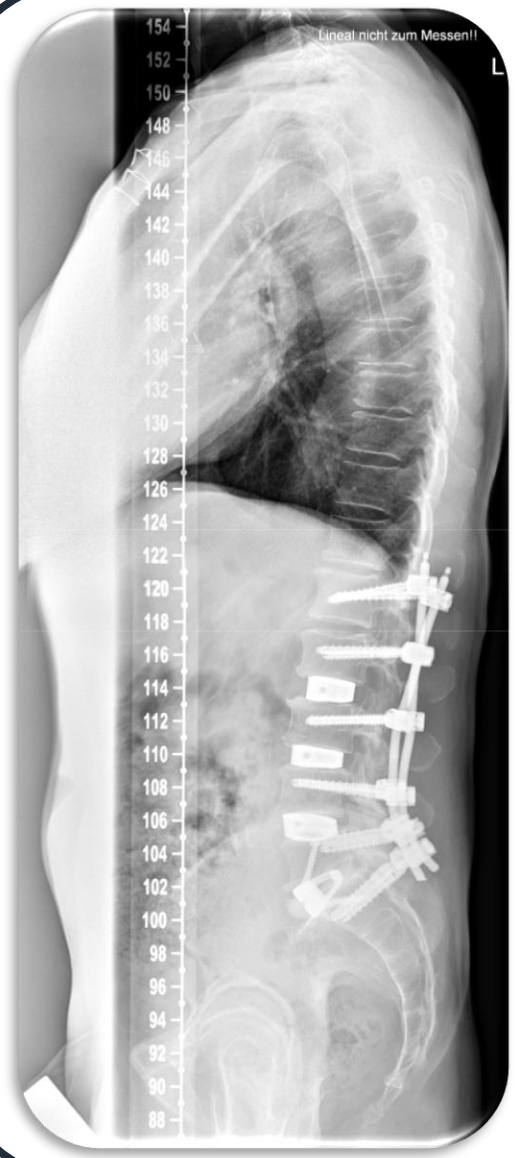
version (RPV= Measured minus Ideal SS), nus Ideal LL), lordosis distribution index tal lordosis x100), relative spinopelvic and an age factor (<60 vs ≥60).

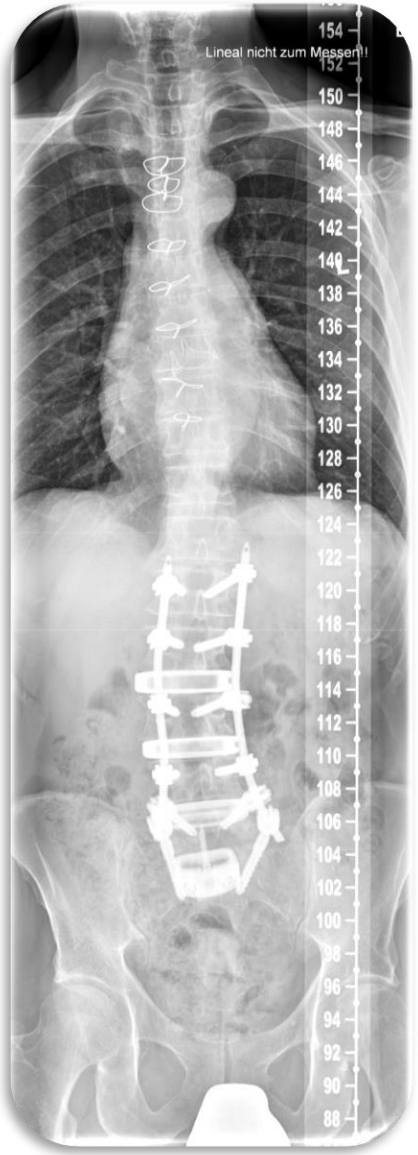
Preoperative Planning	Current Angles	Calculated 'Ideal's	Correction Required
SS	38.0°	49.1°	11.1°
L1-S1	53.0°	71.2°	18.2°
L4-S1	43.0°	37.7°	-5.3°
GT	31.0°	17.6°	-13.4°

The GAP score is a continuum of states that provides an individualized indication of pelvic version, magnitude and distribution of lumbar lordosis, and global spinopelvic alignment to assess disproportion compared with the calculated "ideal" for any given subject.

Setting surgical goals in the sagittal plane on the basis of the proportional indices reflected by the GAP score may decrease the rate of mechanical complications. Pubmed Link

Case 4





Measurements	
Age	65
Pelvic Incidence (PI)	68
Sacral Slope (SS)	46
L1-S1 Lordosis	63
L4-S1 Lordosis	50
Global Tilt (GT)	26

The Global Alignmnet and Proportion (GAP) score is a PI-based individualized method of analyzing the sagittal plane that effectively predicts mechanical complications of surgery for adult spinal deformity.

Parameters	Results	Subgroups	Scores
Age Factor	65		1
RPV	-3.1°	Aligned	0
RLL	-8.2°	Aligned	0
LDI	79%	Aligned	0
RSA	8.4°	Aligned	0

GAP Score 1

Proportioned Spine

The GAP score comprises the relative pelvic version (RPV= Measured minus Ideal SS), relative lumbar lordosis (RLL= Measured minus Ideal LL), lordosis distribution index (LDI= L4-S1 lower-arc lordosis / L1-S1 total lordosis x100), relative spinopelvic alignment (RSA= Measured minus Ideal GT), and an age factor (<60 vs ≥60).

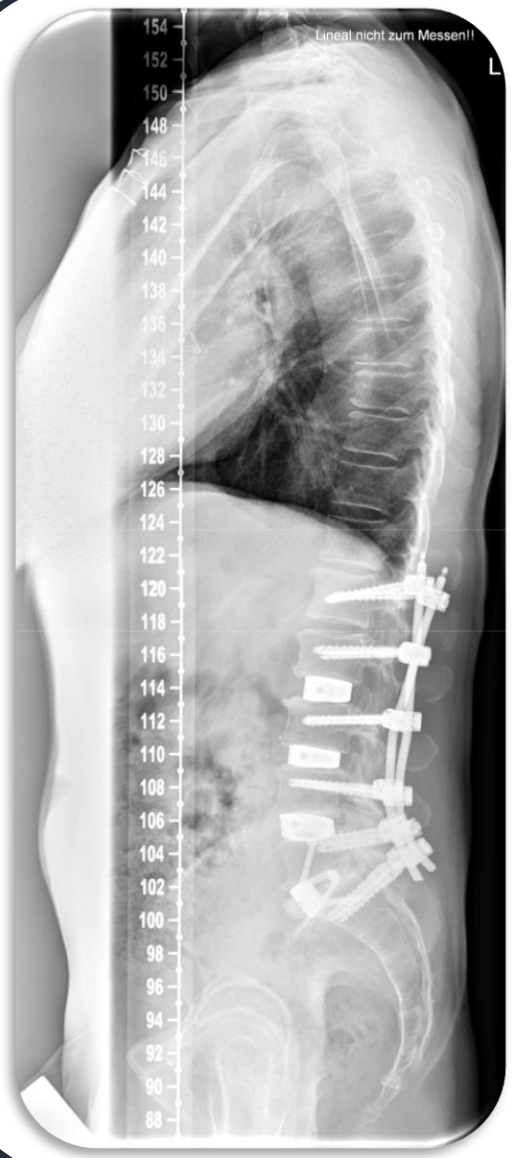
Preoperative Planning

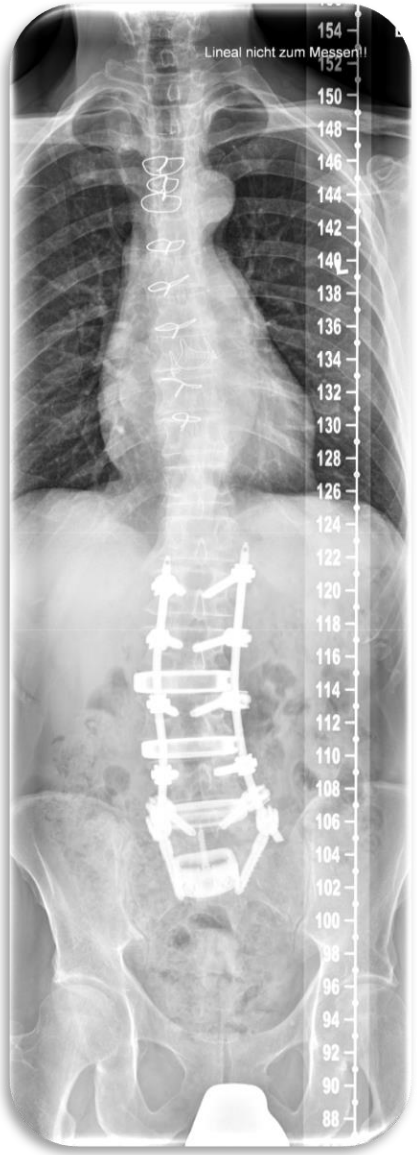
	Current Angles	Calculated 'Ideal's	Correction Required
SS	46.0°	49.1°	3.1°
L1-S1	63.0°	71.2°	8.2°
L4-S1	50.0°	37.7°	-12.3°
GT	26.0°	17.6°	-8.4°

The GAP score is a continuum of states that provides an individualized indication of pelvic version, magnitude and distribution of lumbar lordosis, and global spinopelvic alignment to assess disproportion compared with the calculated "ideal" for any given subject.

Setting surgical goals in the sagittal plane on the basis of the proportional indices reflected by the GAP score may decrease the rate of mechanical complications. Pubmed Link

Case 4





So far ….

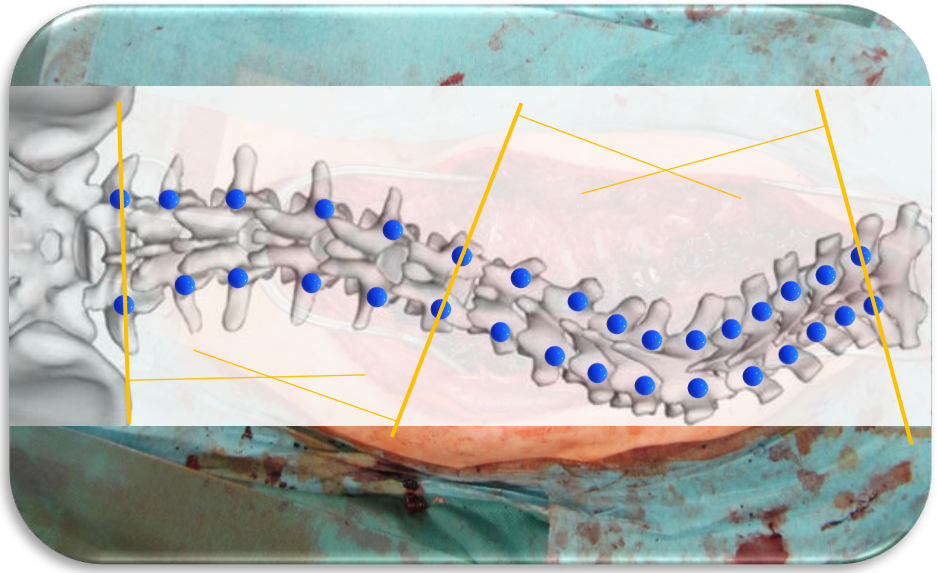
21 patients

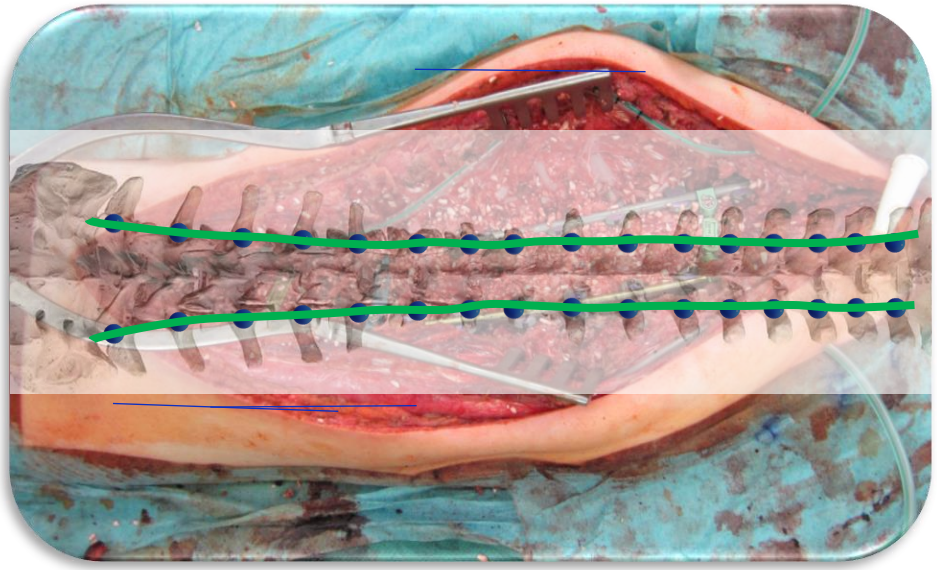
- Average follow-up of 4 months (1 to 7 months)
- LOS ⌀ 5,5 days
- No PJK / PJF so far

My feeling without evidence

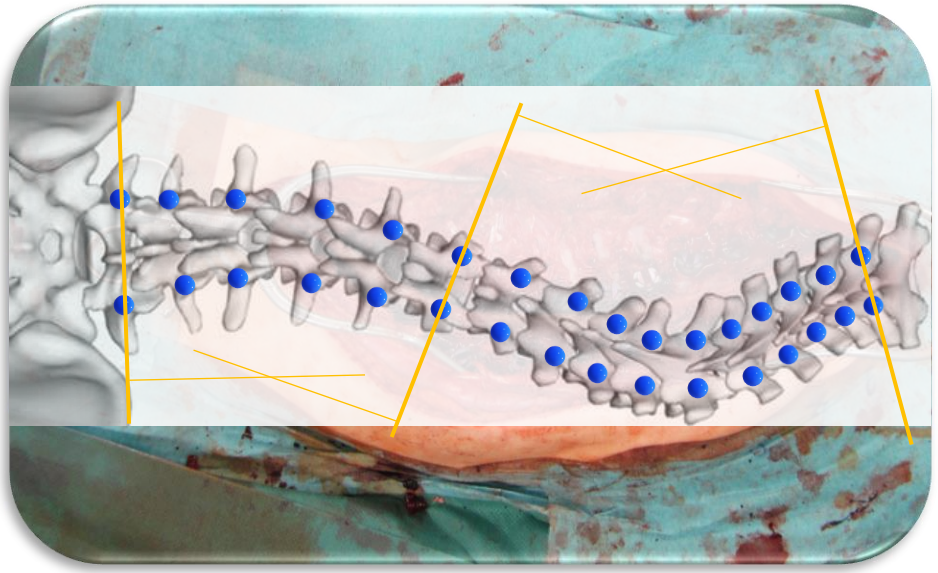
- Intraop time saving for long posterior percutaneous instrumentations
- Less radiation
- Less postsurgical pain
- Earlier mobilization

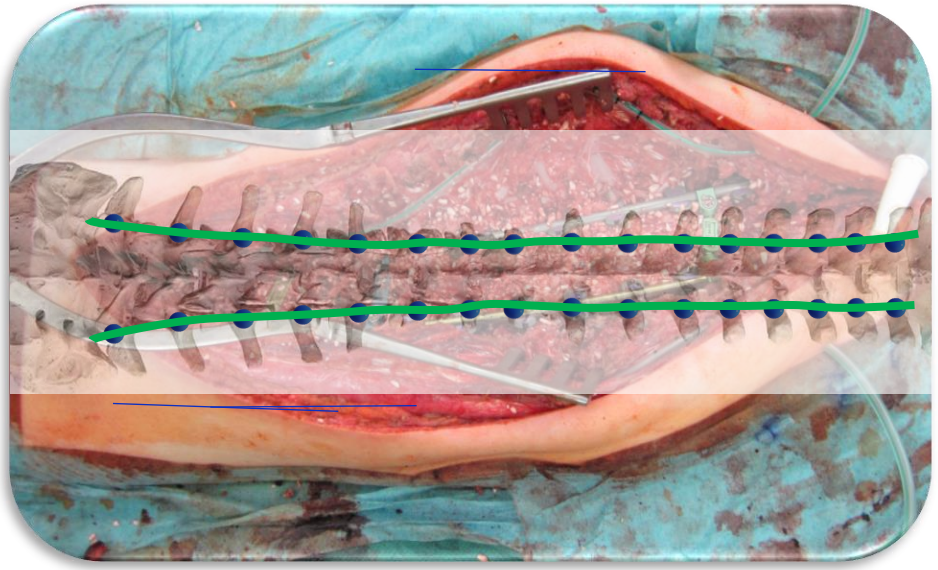
Imagine….

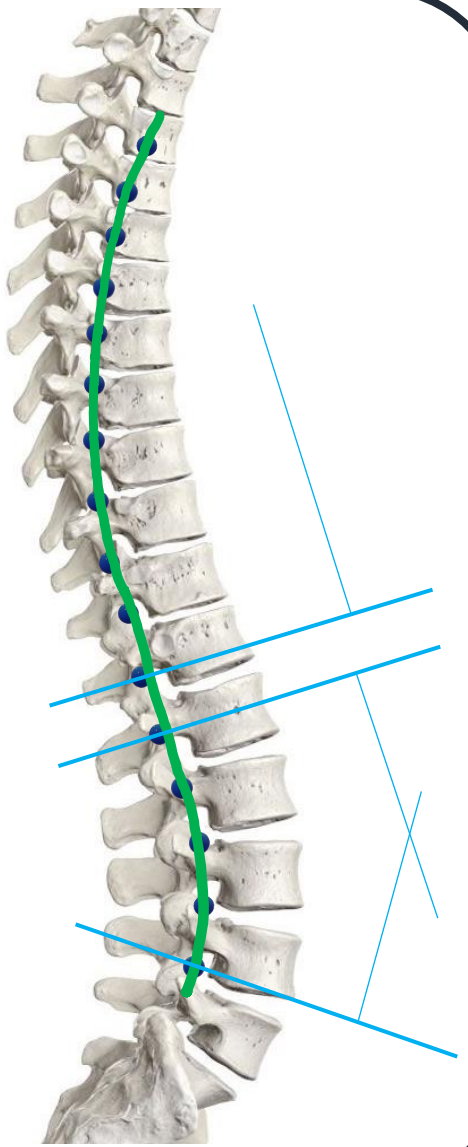




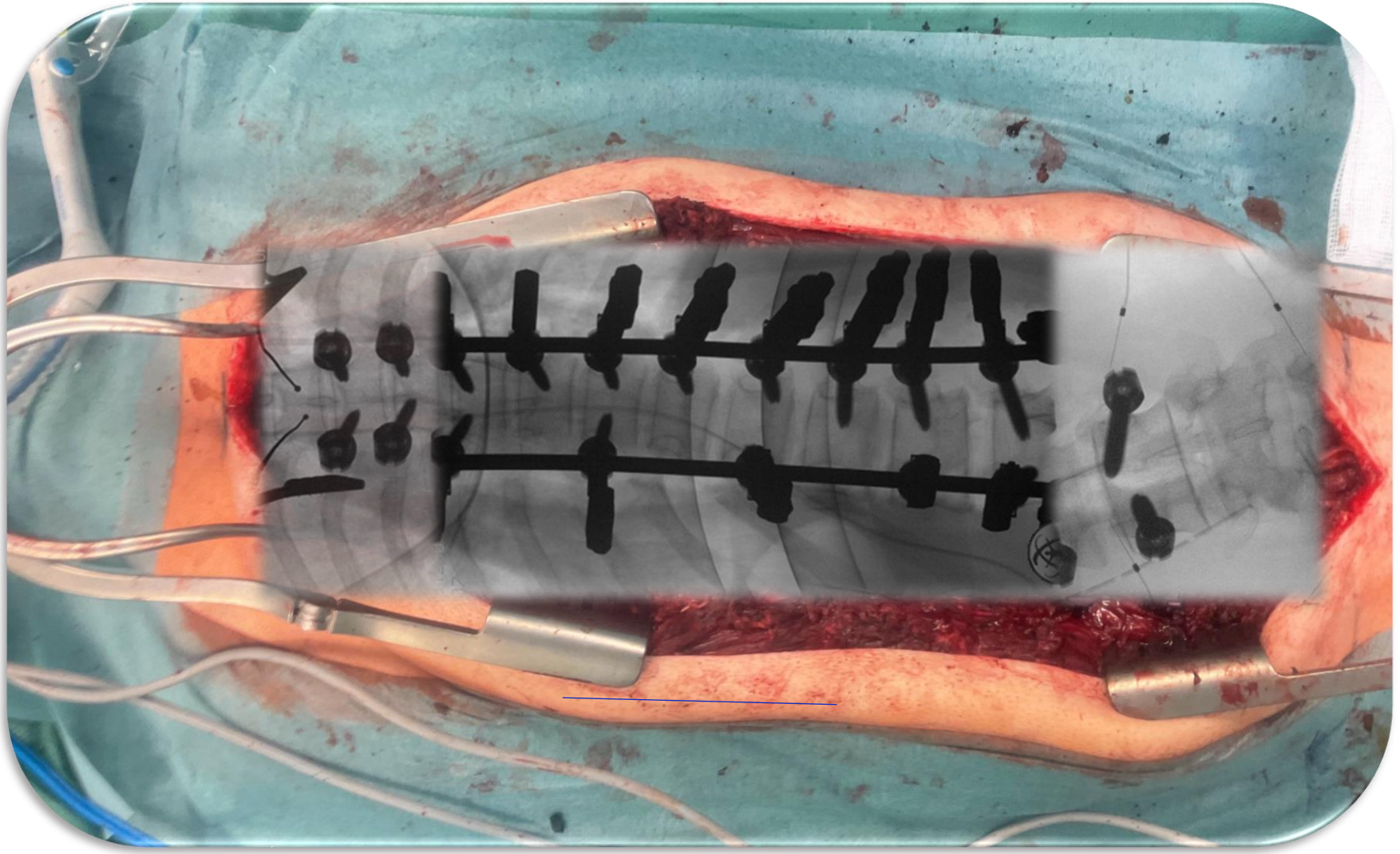
Imagine….



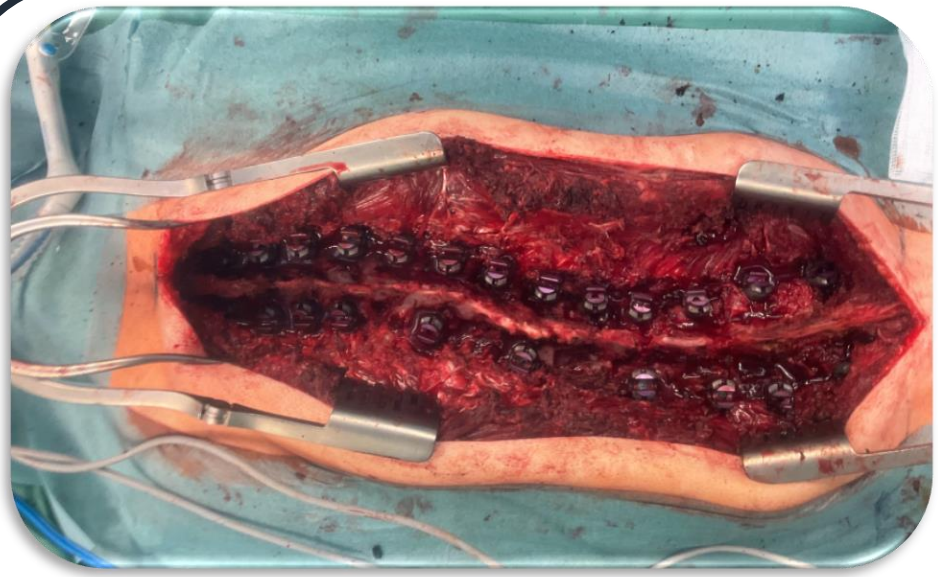


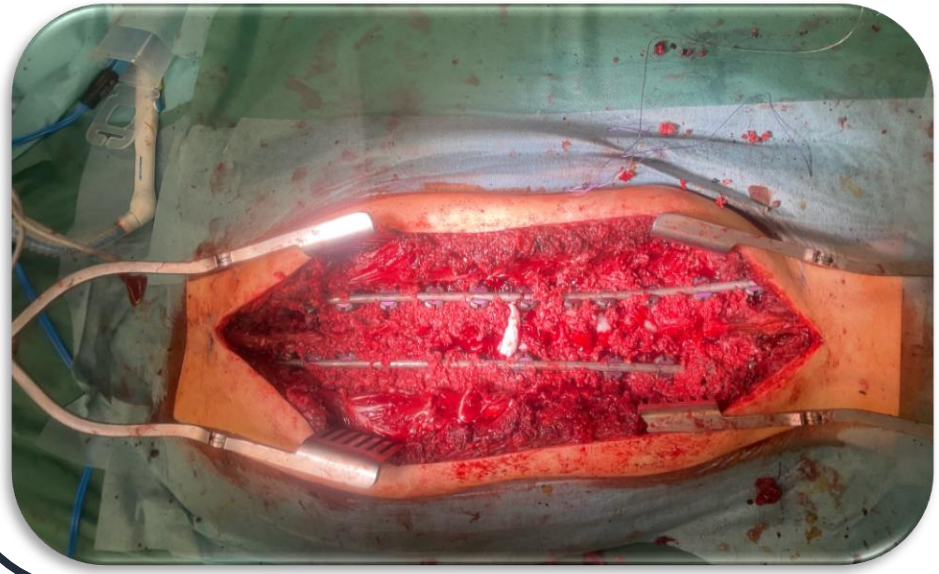


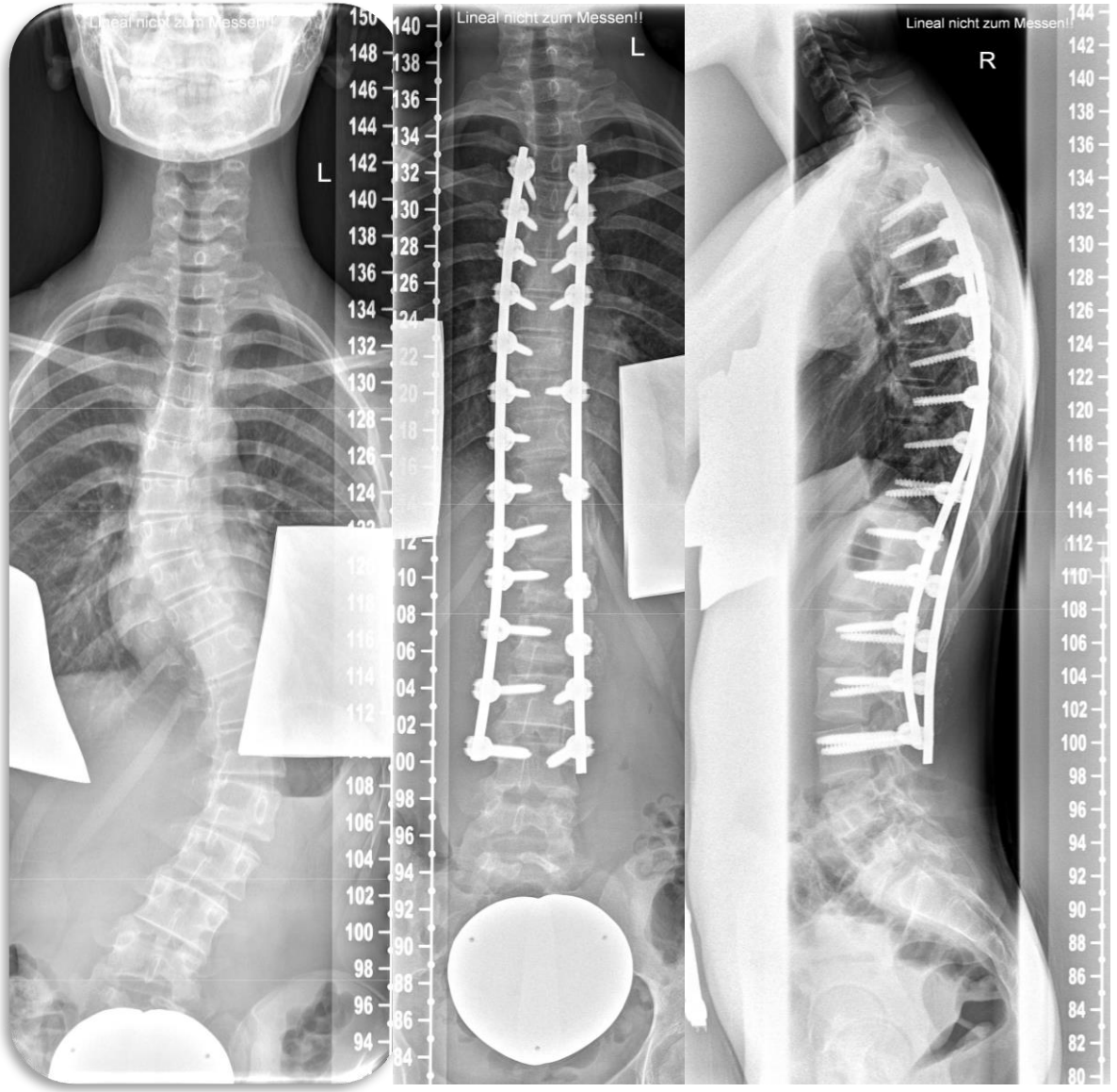
Imagine….



Imagine….



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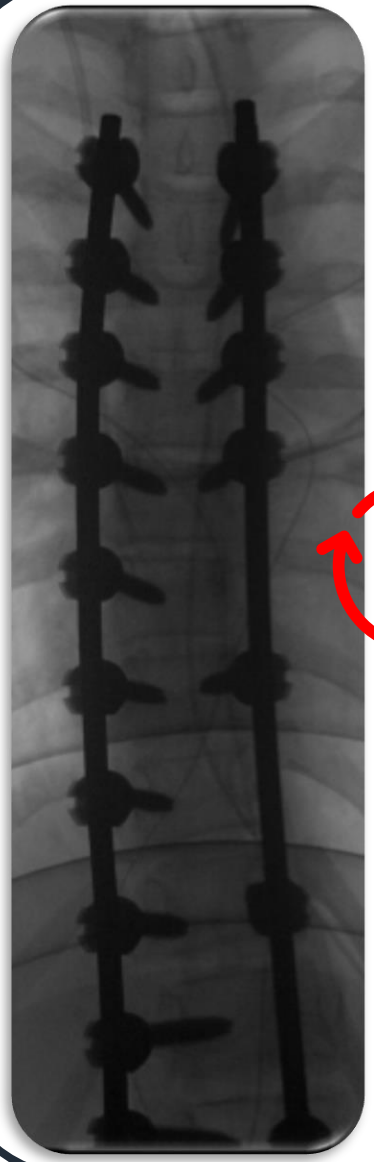
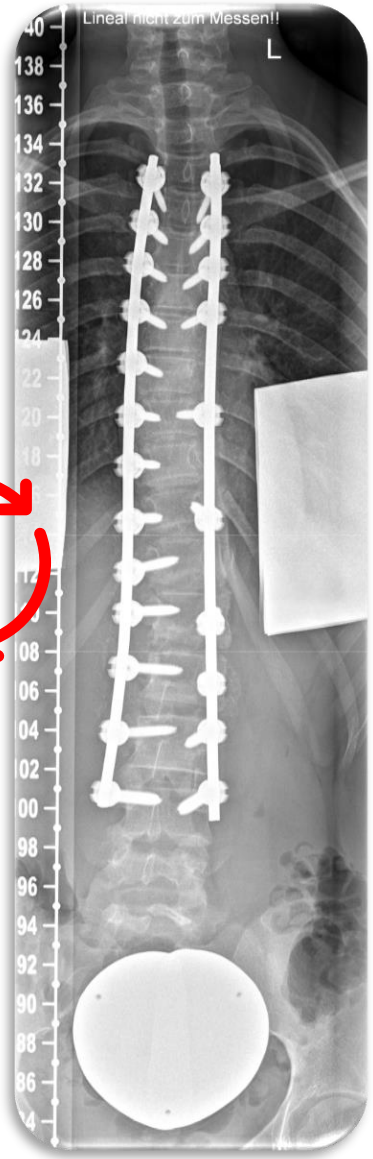
Imagine….





Pre-correction angles

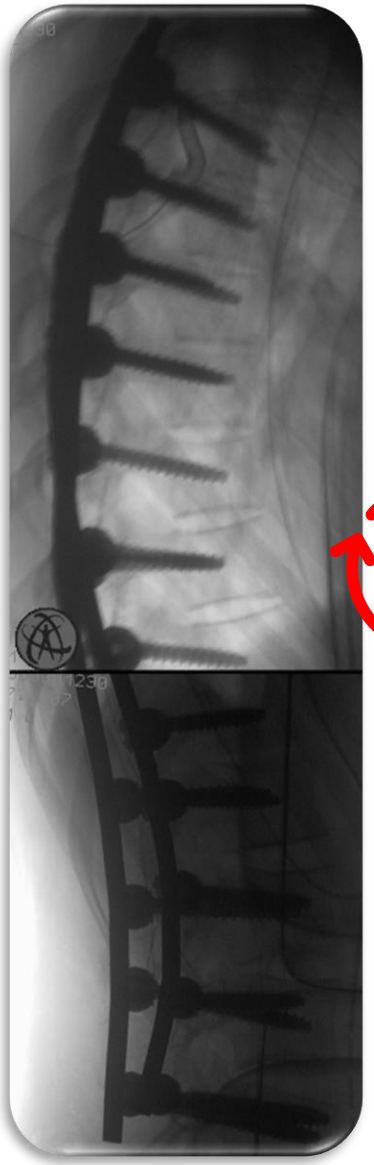
- Coronal angle 1
- Coronal angle 2
- Sagital angle 1
- Sagital angle 2

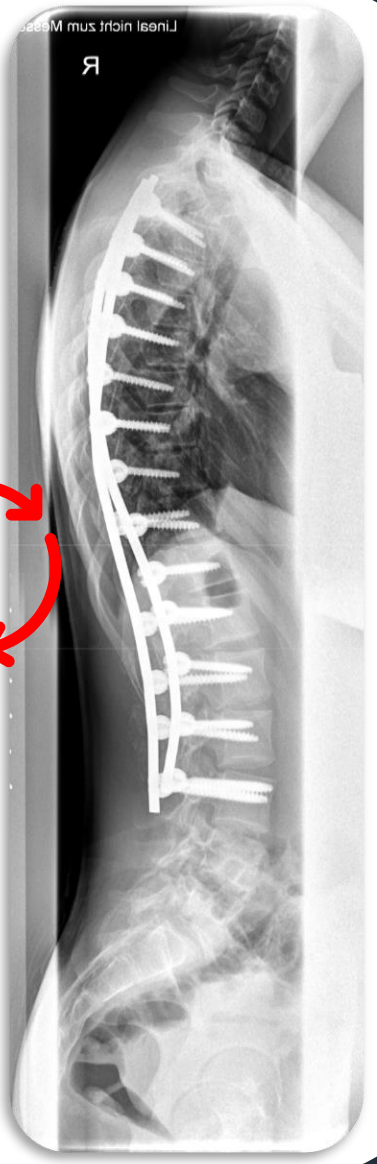
Post-correction angles

- Coronal angle 3
- Coronal angle 4
- Sagital angle 3
- Sagital angle 4

Post-correction achieved angles

- Coronal angle 5
- Coronal angle 6
- Sagital angle 5
- Sagital angle 6





Where to go….

Advise™

- **right now “just” a screw based measurement**
- **correlate screw/tower position with vertebra (image fusion)**
- **big data with self-learning Advise platform**
- **real-time intraoperative tracking of correction**
- **“bring our preop-planning to the table”**