Fundusze Europejskie dla Rozwoju Społecznego
Rzeczpospolita Polska
Dofinansowane przez Unię Europejską
NAWA NARODOWA AGENCJA WYMIANY AKADEMICKIEJ

DIERS Training

Arkadiusz Żurawski PhD

Fundusze Europejskie
dla Rozwoju Społecznego

Rzeczpospolita
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Spine & Posture Analysis – Why and How?

From the initial Problems to the idea…

(1) Follow-up measurements in scoliosis patients are required with high frequency

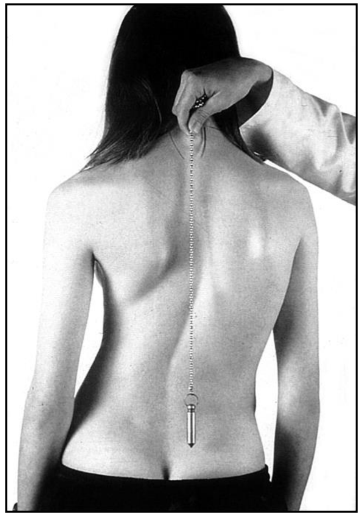
→ This results in a repeated exposure to radial radiation

The long-term risk of breast cancer in scoliosis patients is about 110% higher than the average risk for people not affected by scoliosis.

Nash, CL et al. (1979). Risks of exposure to X-rays in patients undergoing long-term treatment for scoliosis. J Bone Joint Surg, 61(3), 371-374.

(2) Low consensus between optical/palpation examination by the Medical Doctor and measured postural abnormities

Weigel S, Dullien S, Grifka J and Jansen P (2024) Comparison between rasterstereographic scan and orthopedic examination for posture assessment: an observational study. Front. Surg. 11:1461569. doi: 10.3389/fsurg.2024.1461569



High Need for radiation-free and objective spinal & posture analysis

1996

2005

2008

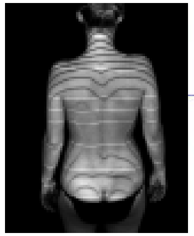
2011

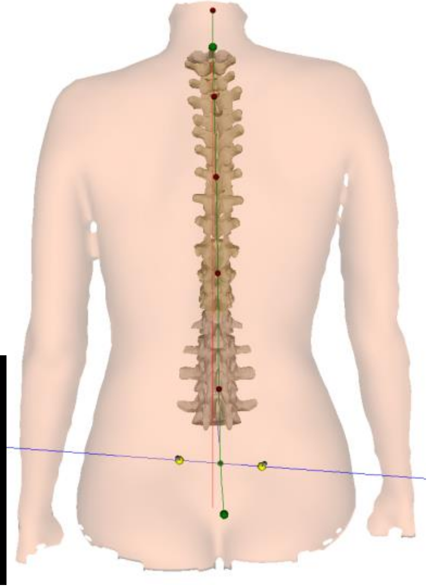
2019

2024

formetric I – 3D static

- First commercially available 3D-system, developped for clinical use
- Meets the demand for a radiation-free method for monitoring the progression of scolioses
- High accuracy in diagnostics, clinical studies, physiotherapy, rehabilitation and many more applications
- Single image, exposure time: 40 ms





Literatur:
Drerup/Hierholzer[37,42,44, 145]; Liljenquist[48]; Hackenberg[56,57]; Weiss [103]; Hackenberg/ Hierholzer [169]; Hierholzer[158]; Drerup [159]

1996

2005

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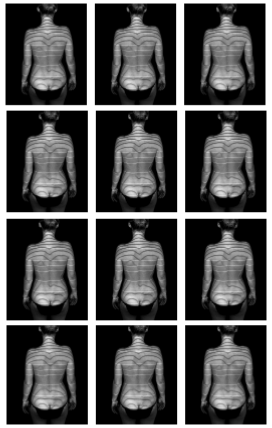
Averaging – 4D average

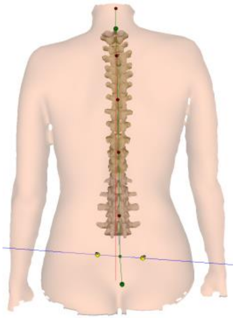
Postural Sway: Influence on Repeatability → Surface Measurement with higher reproducibility

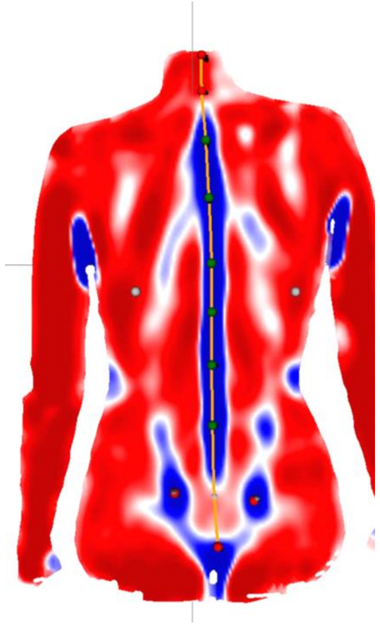
Range and Speed of Motion:

- Sagittal plane ca. 30 mm,
- Frontal plane ca. 10 mm
- Motion speed ca. 5mm / Sec.
- Average postural sway cycle: ca. 5,6 Sek.
- Breathing in and out: up to 8° difference in kyphosis

Measurement Time: 6 Sec. / 12 Images







Literatur:
Mardjetko [**80**]; Betsch[83]; Knott[**84**]; Mohokum [**73**]

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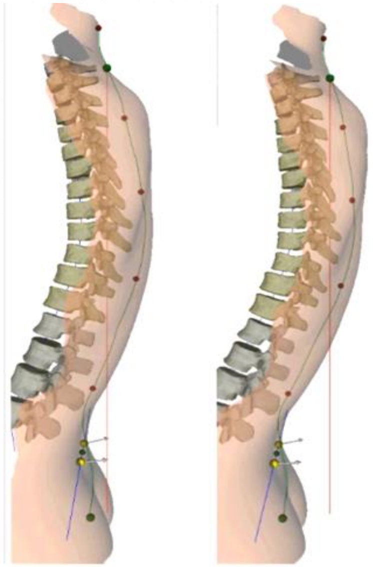
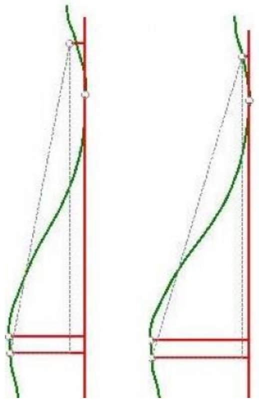
Functional 4D – Postural analysis

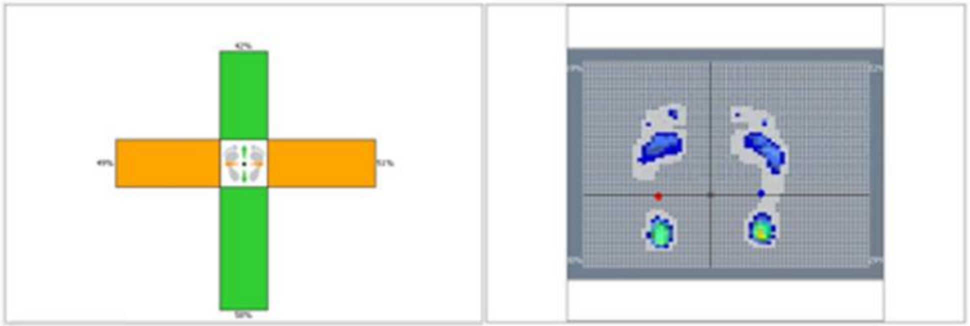
- Adding Pedography to the Posture Lab
- Measurement frequency up to 10 frames per second
- Measurement Time up to 2 Minutes
- Capturing changes in posture over the duration of the measurement





Possible Tests:

- Romberg-Test
- Matthiass-Test
- Flamingo-Test
- etc.



Literatur:
Hackenberg [**66**]; Drerup[54]; Betsch [**79**]

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2024

4D motion

Goal: Capturing the movement of spine and pelvis during locomotion

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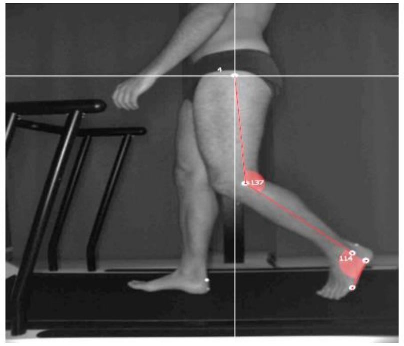
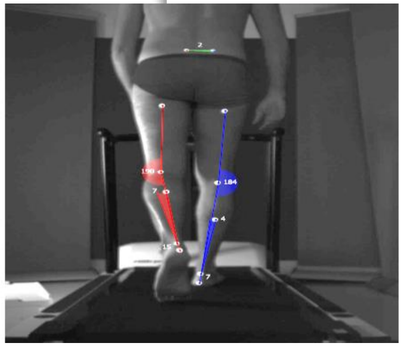
KU LEUVEN





Specifications 4D motion system:

- 60 Images per Second
- Dynamic Capturing of Spine and Pelvis
- Clinical User Interface
- Quick and Easy User Interface

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High Performance Lab

- **Highspeed Kameras, 240 frames/second**
- **Pressure Measurement acquisition at high frequency**

→ Measurements up to 30 km/h

→ Mainly for use in high performance and professional athletes

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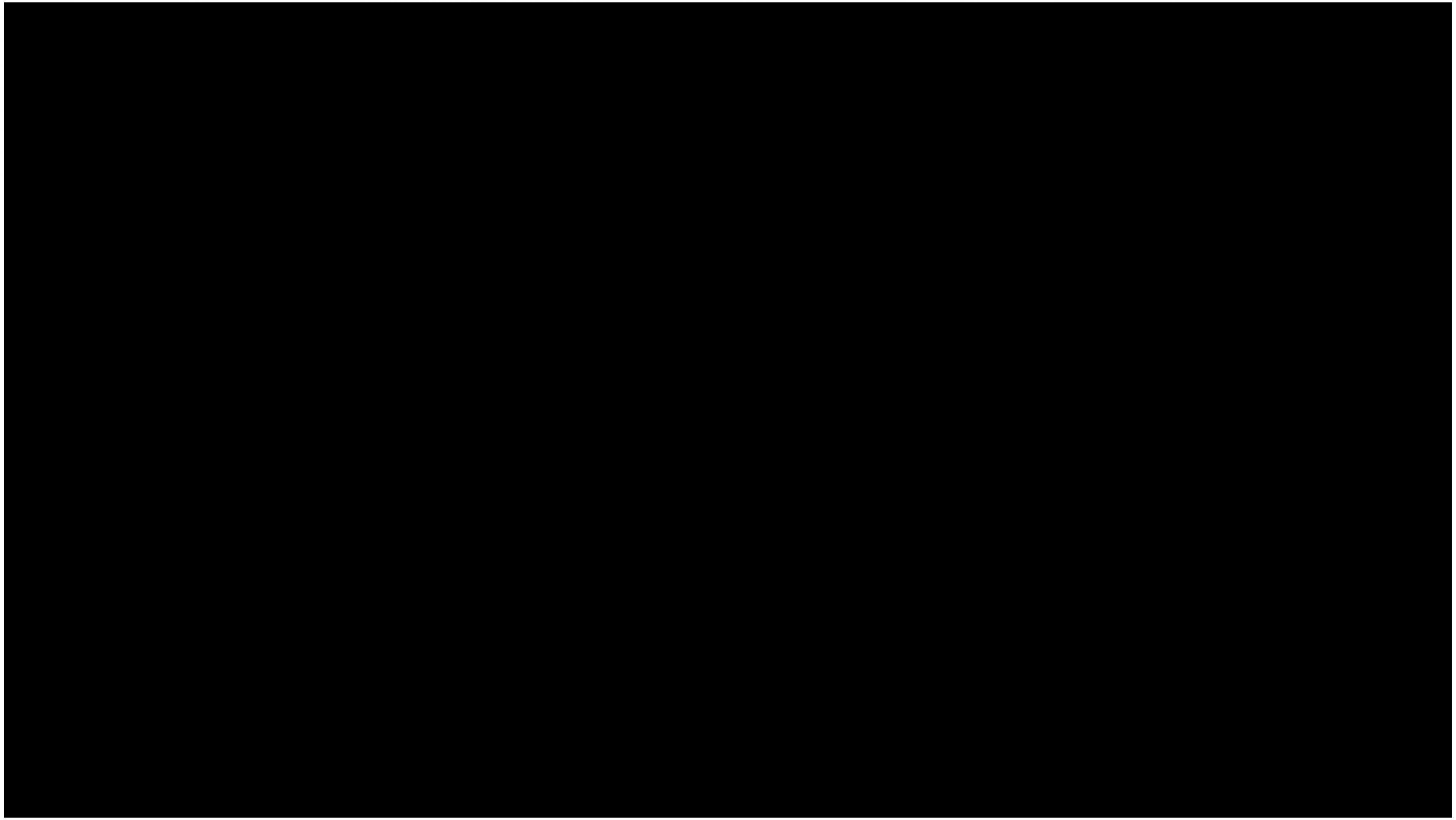

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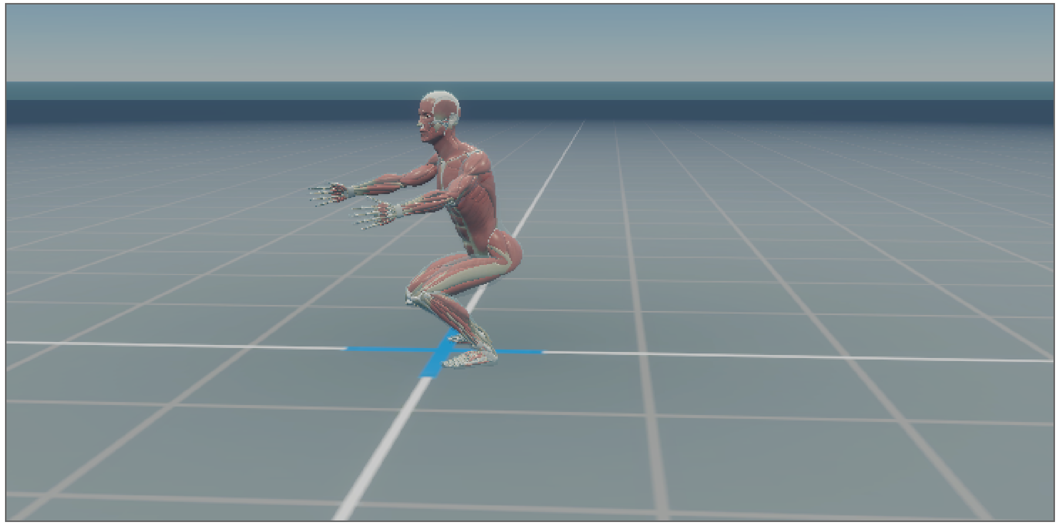
Free²Move

- Intertial Sensors
- Motion Capturing of Human Movement
- Return to Sports
- Ergonomics
- Functional Testing

Measuring position



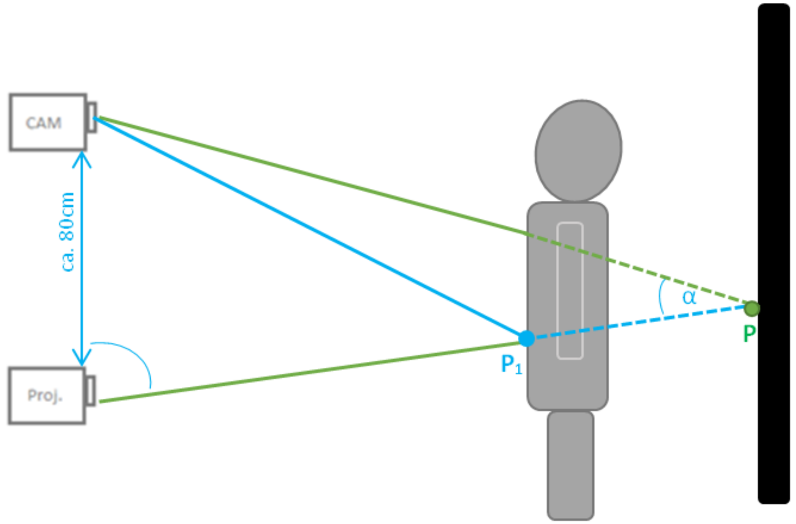
Deep Squat

-

-

Functional deviations	Left	Right	Norm
Hip flexion	100°	94°	min. 80°
Knee flexion	111°	113°	min. 80°
trunk inclination	25°		max. 45°
Knee adduction	7°	4°	max. 6°
Hip adduction	0°	0°	max. 8°
ankle dorsiflexion	44°	43°	max. 30°

DIERS Formetric – Technical Principles



Optical triangulation – Raster-Stereography

Based on the physical principle of Moiré Topography.

A projector projects a pattern of parallel stripes onto the back of a patient.

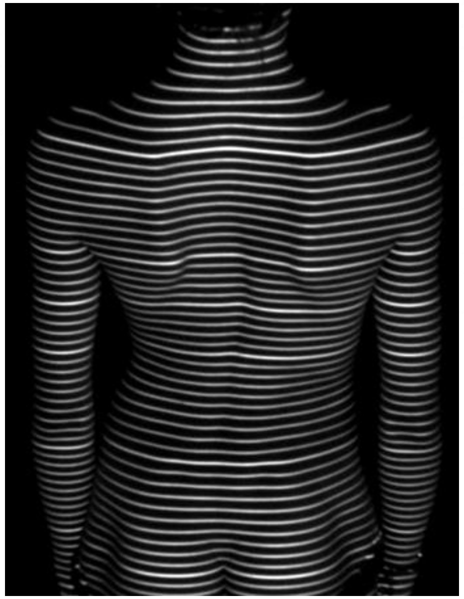
The individual calibration makes it possible to assign a camera pixel to each measurement point on the fringe projection (explained here by the example point **P**).

The example point changes its position depending on the trunk depth of the patient (example point **P1**).

This also changes the pixel through which the measuring point is recorded in the camera (**blue l**ine).

This spatial change can be calculated mathematically. This results in exact three-dimensional coordinates for the measuring points.

However, this requires an exact geometry that is guaranteed by the orientation and design of the system.



Technical Specification

Camera

Exposure time : 16 ms

Pixel size : ~ 0.6 mm x 0.6 mm

Fringe projection

Width : 400 mm (666 pixels/ strip)

Number of strips : 80

→ >50.000 measuring points

Accuracy in measuring point localization: x-/y direction (surface) → 0.1 - 0.2 mm
z-direction (depth) → ~0.3 mm

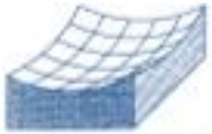
The accuracy of the automatic fixed point detection ranges between 0.8 und 1.0 mm.

Drerup, B.; Hierholzer, E. (1987). Movement of the human pelvis and displacement of related anatomical landmarks on the body surface. Journal of applied Biomechanics 20, 971-977.

Drerup, B.; Hierholzer, E. (1987). Automatic Localization of anatomical landmarks on the back surface and construction of a body-fixed coordinate system. J. Biomech. (20), 961-970.

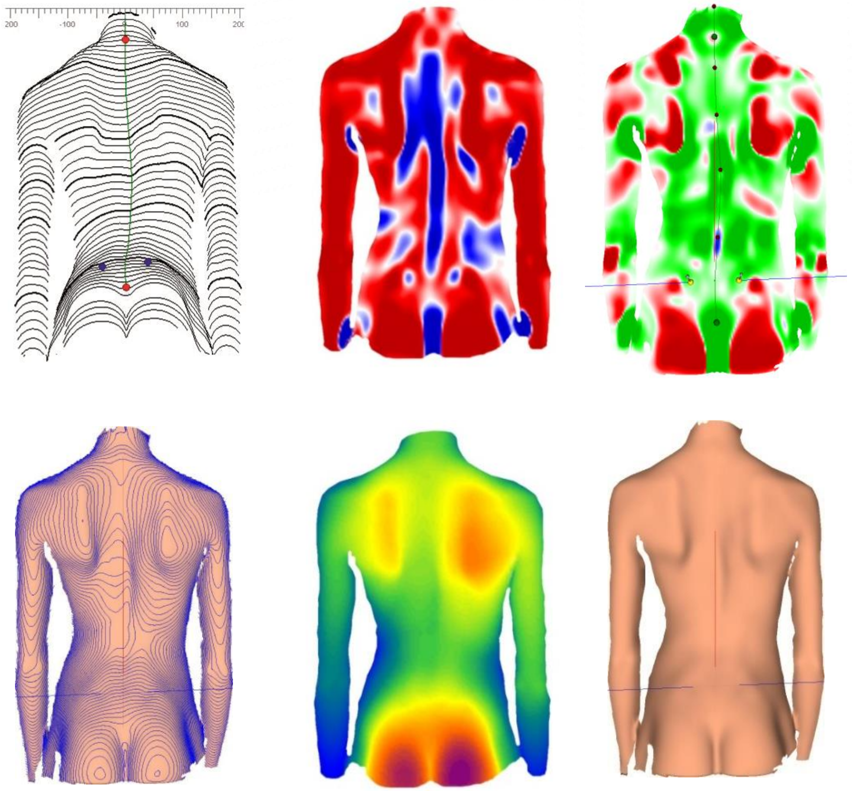
Technical Specification – Surface Topography

Convex

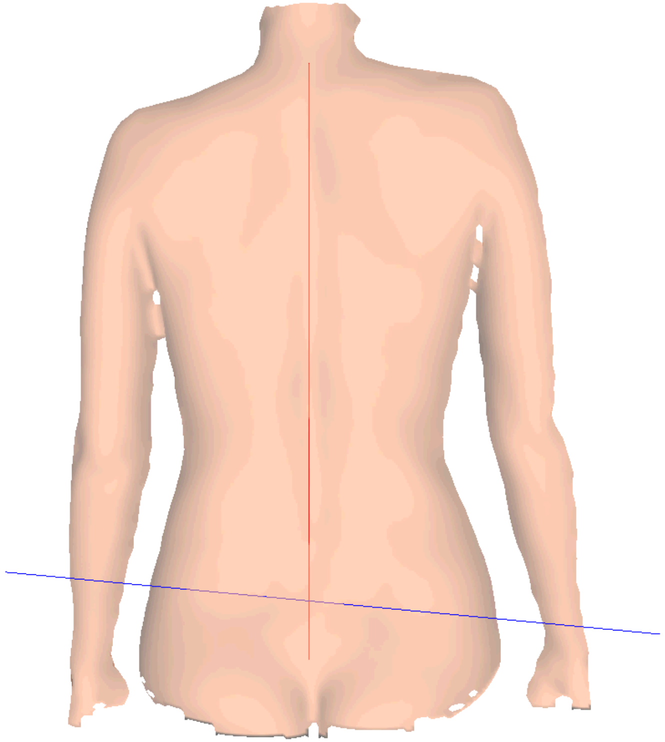


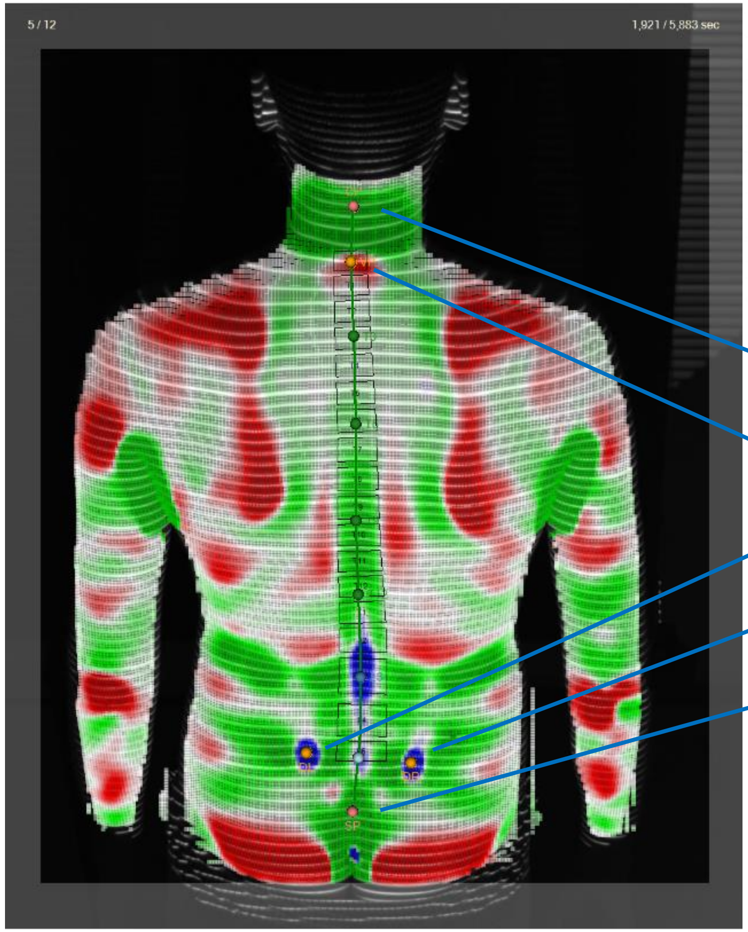
concave

Saddle-shaped



3D Surface





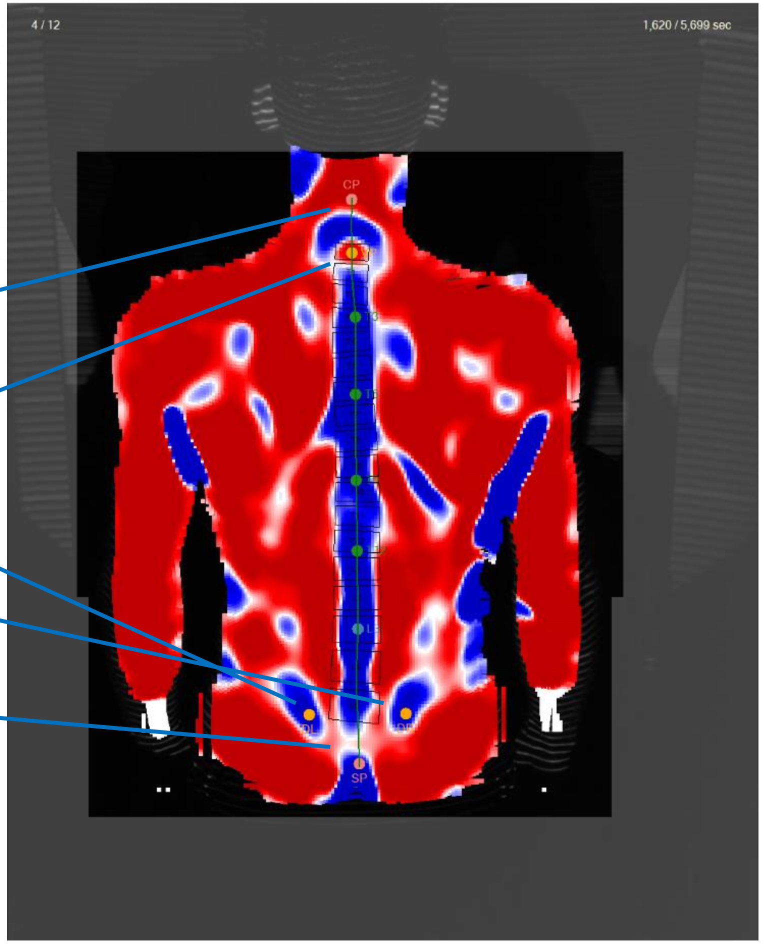
CP – cervical point

VP – vertebra prominens (C7)

DL – dimple left (linkes Grübchen)

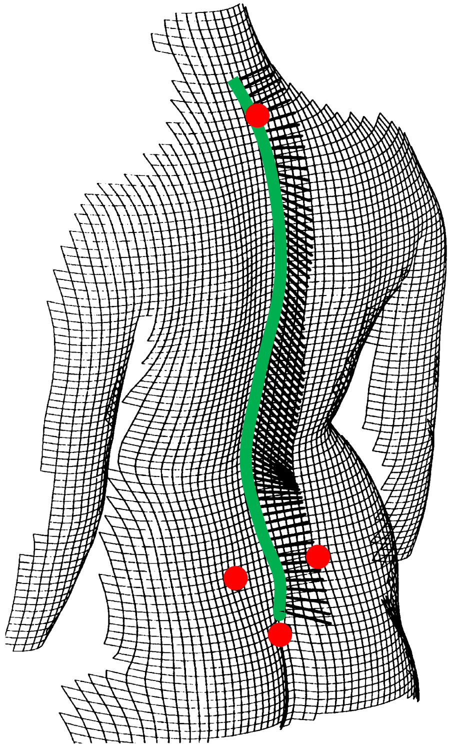
DR – dimple right (rechts Grübchen)

SP – sacrum point



Correlation model of Turner-Smith & Drerup

Turner-Smith, A.; Harris, J.; Houghton, G.; Jefferson, R. (1988). A method for analysis of back shape in scoliosis. J Biomech; 21(6), 497-509

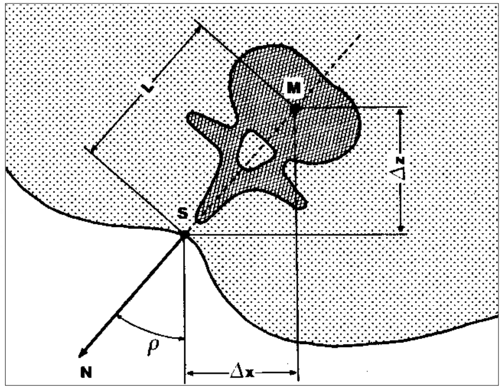


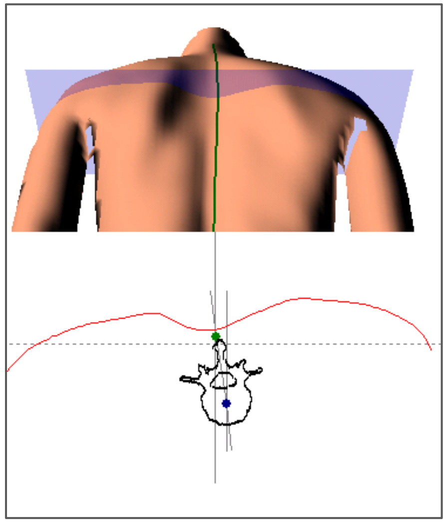
Describes the relationship between the surface and the underlying bony structure of spinous processes.

C7, lumbar dimples, sacrum point

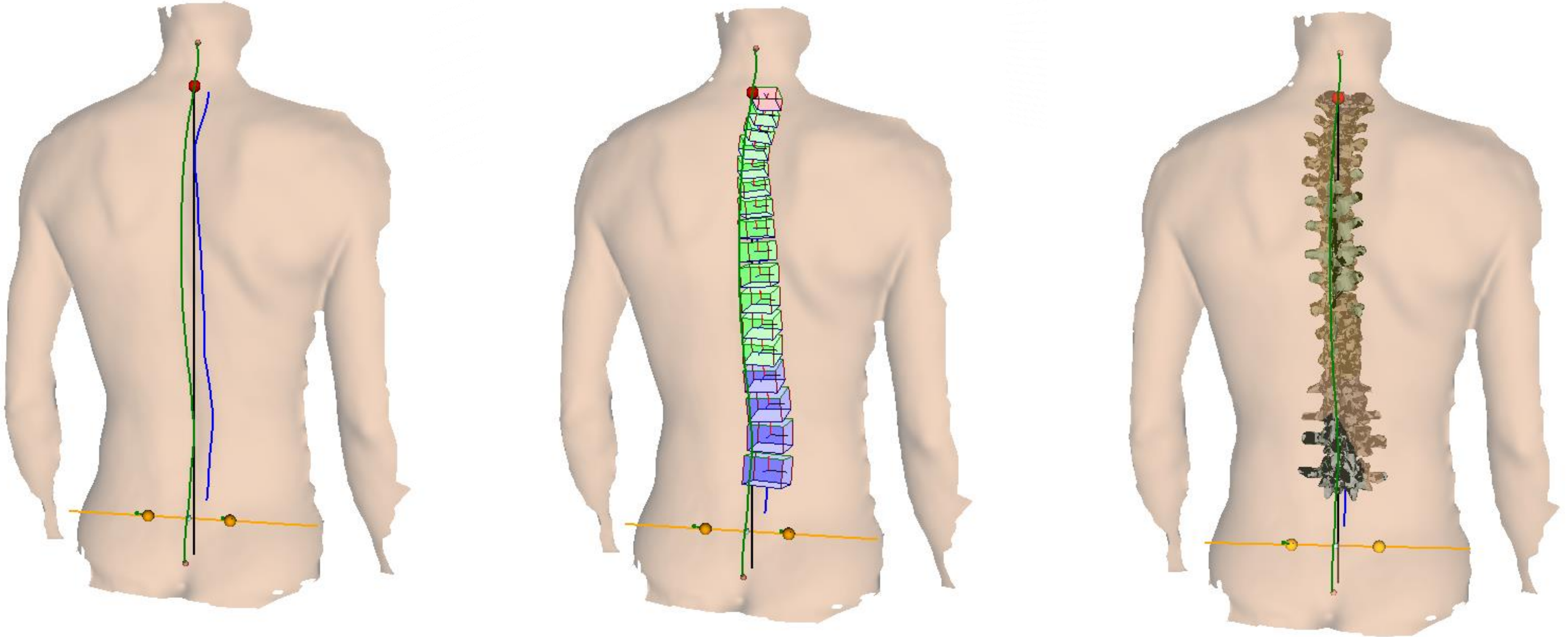
Line of symmetry

Rotation of each vertebral body on the line of symmetry.





Spine Model



Reliability & Validation

Meta-analysis of the validity and reliability of rasterstereographic measurements of spinal posture

Nikolas Leon Krott[1] · Michael Wild[2] · Marcel Betsch[1]

Received: 11 January 2020 / Revised: 25 March 2020 / Accepted: 28 March 2020 / Published online: 10 April 2020

Systematic Review

Reliability and Validity of Scoliosis Measurements Obtained with Surface Topography Techniques: A Systematic Review

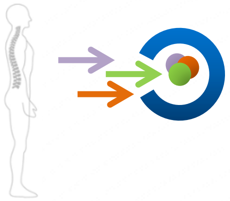
Xinyu Su, Rui Dong, Zhaoyong Wen and Ye Liu *

School of Sport Science, Beijing Sport University, Beijing 100084, China
* Correspondence: liuye_tg@163.com

Article

Three-Dimensional Spinal Evaluation Using Rasterstereography in Patients with Adolescent Idiopathic Scoliosis: Is It Closer to Three-Dimensional or Two-Dimensional Radiography?

Anne Tabard-Fougère [1,*], Charlotte de Bodman [1], Amira Dhouib [2], Alice Bonnefoy-Mazure [3], Stéphane Armand [3] and Romain Dayer [1]



Reliability

Interobserver reliability : $0.918 < r > 0.988$ (0.95 CI)

Intraobserver reliability : $0.792 < r > 0.975$ ($p = 0.001$)

Schülein, Samuel, et al. "Rasterstereographic evaluation of interobserver and intraobserver reliability in postsurgical adolescent idiopathic scoliosis patients." Journal of spinal disorders & techniques 26.4 (2013): E143-E149.

Intra- & interday reliability : $0.972 < r > 0.991$ (0.95 CI)

Guidetti, Laura, et al. "Intra-and interday reliability of spine rasterstereography." BioMed research international 2013 (2013).

Intertester reliability : $0.937 < r > 0.987$ (0.95 CI)

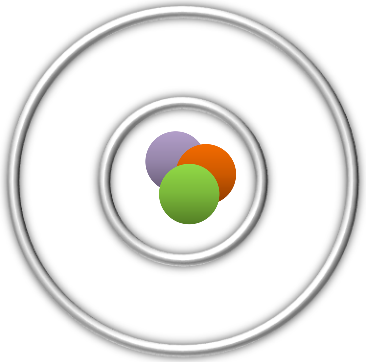
Intratester reliability : $0.884 < r > 0.992$ (0.95 CI)

Mohokum, M. et al. (2010). Reproducibility of rasterstereography for kyphotic and lordotic angles, trunk length, and trunk inclination: a reliability study. Spine, 35(14), 1353-1358.

Table 1 Meta-analytic results indicating overall effect sizes for reliability and validity assessments of spinal posture parameters

Parameters	Reliability			
	r	95% CI	*z*	*p*
Trunk length	.98	.96, .99	12.72	< .001
Trunk inclination	.97	.89, .99	6.06	< .001
Thoracic kyphosis angle	.92	.85, .96	9.02	< .001
Lumbar lordosis angle	.95	.92, .97	13.81	< .001
Scoliosis angle	.96	.79, .99	4.35	< .001
Pelvic obliquity	.98	.82, .99	4.06	< .001
Pelvic torsion	.92	.55, .99	3.21	.001

Krott et al., 2020



Validity – DIERS Formetric vs. Radiography

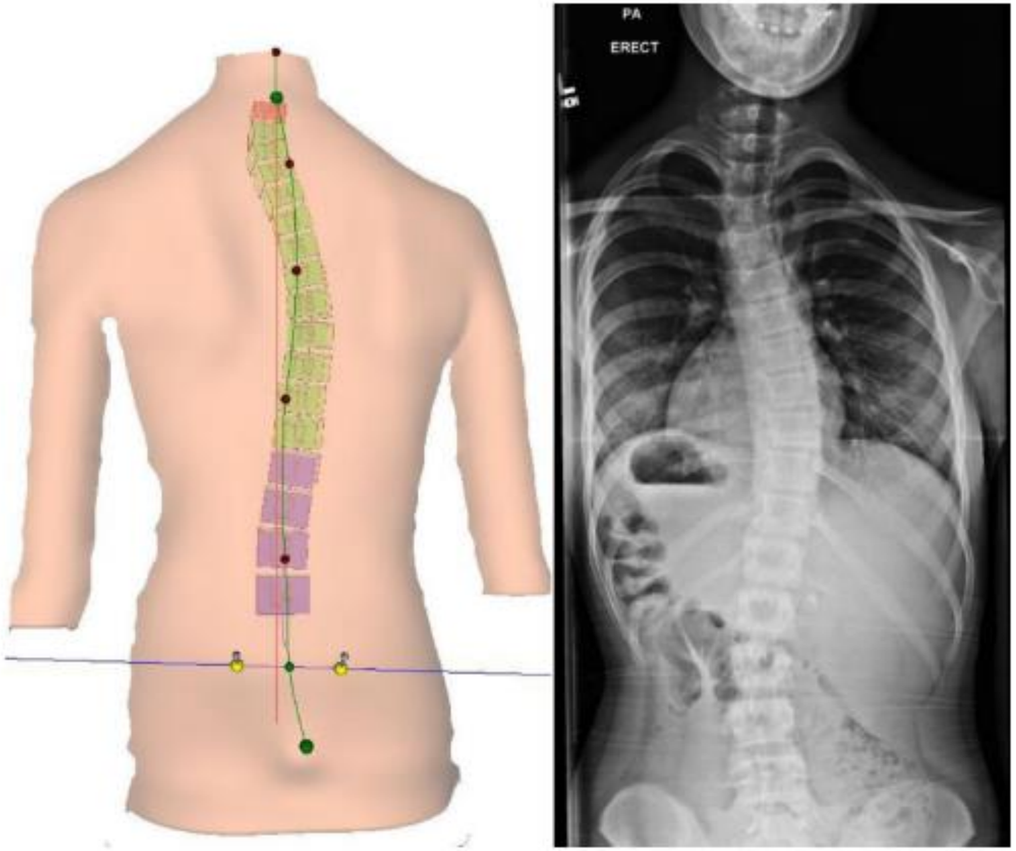


Fig. 2. Example of a 3D reconstruction next to a corresponding x-ray.

Validity

Correlation Values

Overall correlations vs 2D radiography: r ≈ 0.60–0.95

- Study Tabard (2023): r=0.89 (2D), r=0.93 (3D)
- Study Coneys (2024): r ≈ 0.7 for thoracic kyphosis
- Study Tabard (2019): r = 0.75 for kyphosis and 0.6 for lordosis
- Meta-analysis (Krott, 2020): r > 0.70 for all parameters

Table 1 Meta-analytic results indicating overall effect sizes for reliability and validity assessments of spinal posture parameters

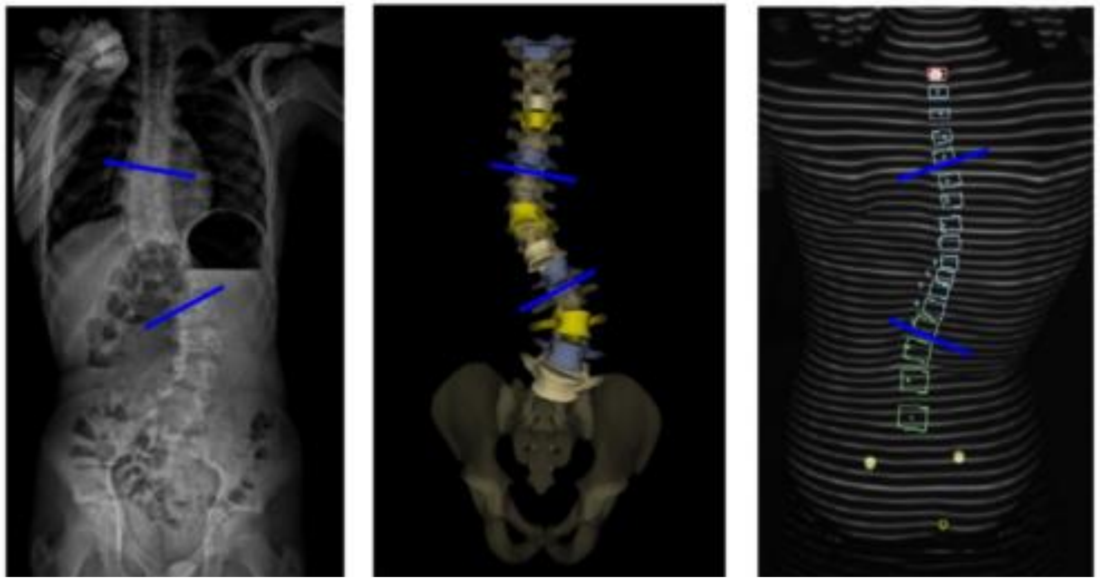
Parameters	Validity			
	r	95% CI	*z*	*p*
Trunk length				
Trunk inclination				
Thoracic kyphosis angle	.75	.64, .83	8.90	<.001
Lumbar lordosis angle	.71	.57, .82	7.00	<.001
Scoliosis angle	.82	.61, .92	5.15	<.001
Pelvic obliquity	.27	.04, .48	2.30	.022

Systematic biases depend on curve severity

- Mild curves: Formetric overestimates compared to radiography (factor ≈ 1.2)
- Moderate/severe curves: Formetric underestimates (factor ≈ 0.80)
- Typical mean differences: ~5°

Validity – Formetric vs. 3D Radiography

2D Radiography 3D Radiography Rasterstereography



Article

Three-Dimensional Spinal Evaluation Using Rasterstereography in Patients with Adolescent Idiopathic Scoliosis: Is It Closer to Three-Dimensional or Two-Dimensional Radiography?

Anne Tabard-Fougère [1,*], Charlotte de Bodman [1], Amira Dhouib [2], Alice Bonnefoy-Mazure [3], Stéphane Armand [3] and Romain Dayer [1]

DIERS BIOMEDICAL SOLUTIONS

Validity – Formetric vs. 3D Radiography

Table 2. Systems' comparison results of major curve scoliosis angle for all, mild, and moderate/severe (M./S.) curves.

		Raster vs. 2D XR	Raster vs. 3D XR	3D vs. 2D XR
Major curve scoliosis angle				
Mean diff. deg.	All (53)	6.4 (4.7)	7.5 (6.4)	7.8 (7.6) *
	Mild (33)	4.3 (3.5)	5.2 (3.9) **	3.5 (2.7) **
	M./S. (20)	9.7 (4.7)	11.2 (7.9) **	14.8 (7.9) **
Correlation r (95% CI)	All (53)	0.89 (0.81; 0.94)	0.93 (0.89; 0.96)	0.93 (0.88; 0.96)
	Mild (33)	0.63 (0.36; 0.80)	0.77 (0.57; 0.87)	0.82 (0.66; 0.91)
	M./S. (20)	0.64 (0.28; 0.84)	0.83 (0.61; 0.93)	0.61 (0.23; 0.83)
Agreement ICC (95% CI)	All (53)	0.94 (0.90; 0.97)	0.94 (0.90; 0.97)	0.92 (0.87; 0.96)
	Mild (33)	0.75 (0.49; 0.88)	0.79 (0.59; 0.90)	0.88 (0.75; 0.94)
	M./S. (20)	0.77 (0.42; 0.91)	0.76 (0.41; 0.91)	0.47 (−0.33; 0.79)

Values were compared using paired Student *t*-tests. Level of significance was reported as * for *p*-value < 0.05 and ** for *p*-value < 0.01. Deg. is degrees, ICC is the single measure two-way intraclass correlation coefficient, r is the Pearson correlation coefficient, 95% CI is 95% confidence intervals, mean diff is the mean difference between each system, XR is radiography, and raster is rasterstereography.

Validity + Reliability Conclusion

Keep in mind…

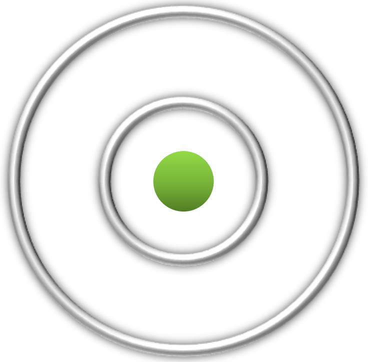
- Typical mean differences of ~5-8° with correlations > 0.7 compaired to radiography

At the same time…

- Very high values of reliability (r > 0.9)

Conclusion

- Formetric does not replace X-Ray for diagnostics / surgery decision making
- Calculate Intraindividual Correlation
- Use Formetric for high-frequent Follow Ups and mild deformities



DIERS BIOMEDICAL SOLUTIONS

Current Study Situation – Examples for research with the DIERS Formetric System

Prediction/Control of Scoliosis Progression

Patel, M. et al. (2024). 3D Back Contour Metrics in Predicting Idiopathic Scoliosis Progression: Retrospective Cohort Analysis, Case Series Report and Proof of Concept. *Children (Basel)*

Correlation of Posture with Migraine

Ozudogru Celik, T., Gorgulu, U., Kenar, S. G., Koca, N., Yalcin, E., Koymen, I., & Yasar, E. (2024). Evaluation of forward head posture and thoracic kyphosis in migraine. *Journal of Clinical Neuroscience, 119, 17-21. https://doi.org/https://doi.org/10.1016/j.jocn.2023.11.018*

Influence of craniofacial muscle status on Posture

Castellano, M., Lilli, C., Barbato, E., Santilli, V., & Galluccio, G. (2016). Craniofacial asymmetry in non-syndromic orthodontic subjects: clinical and postural evaluation. CRANIO®, 34(3), 144-154. https://doi.org/10.1179/2151090315Y.0000000009

Functional Status in elementary school

Albertsen, I. M., Dettmann, K., Babin, K., Stücker, R., Schröder, J., Zech, A., & Hollander, K. (2018). Spinal postural changes during the modified Matthiass test in healthy children. Der Orthopäde, 47(7), 567-573. https://doi.org/10.1007/s00132-018-3558-z

Evaluation of joint replacement surgery

Jöllenbeck, T., Pietschmann, J., Gerdesmeyer, R., & Hunfeld, A. (2023). Effects of joint replacement on spinal movement. *Orthopadie (Heidelb), 52(8), 652-661. https://doi.org/10.1007/s00132-023-04405-2 (Auswirkungen von Huft- und Knie-TEP auf die Wirbelsaulenbewegung.)*

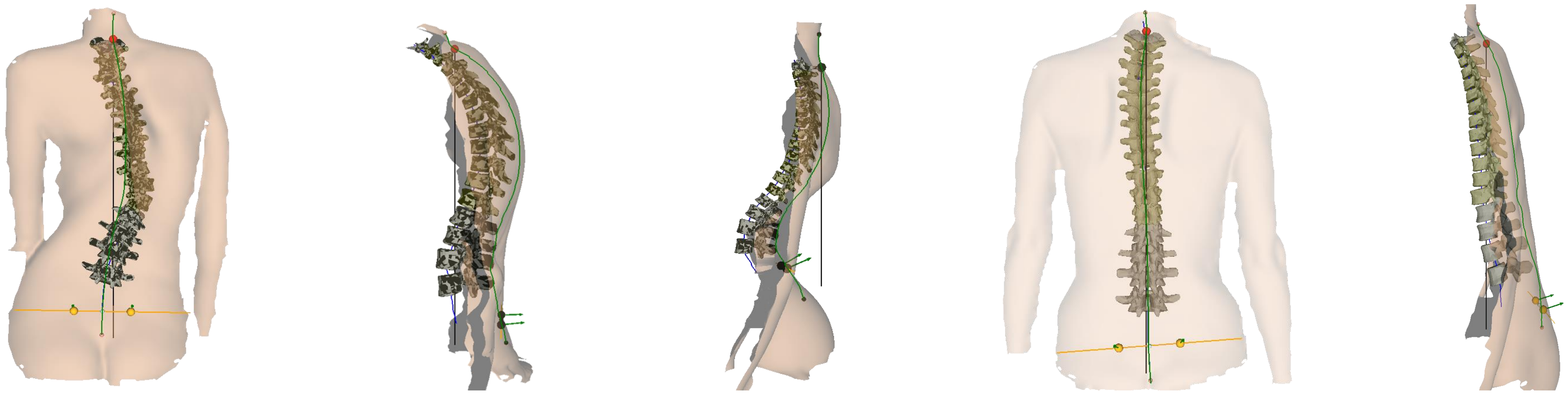
Application in clinical practice

1 Analysing the posture

2 Long-term follow-up

3 Therapy recommendations and evaluation

4 'Reaction diagnostics'



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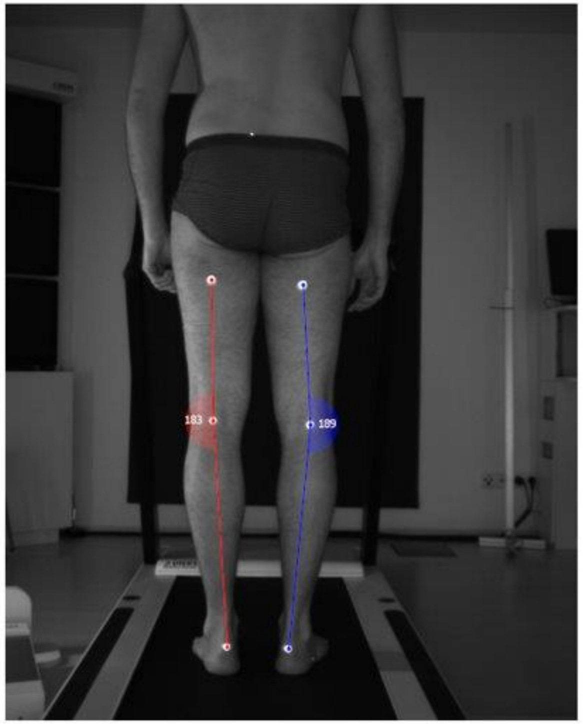
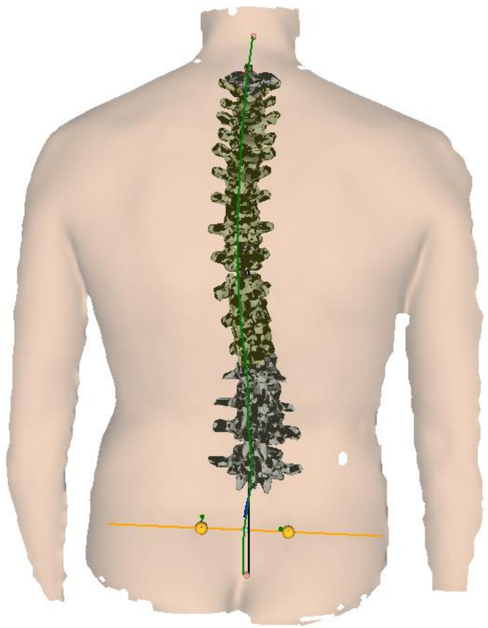
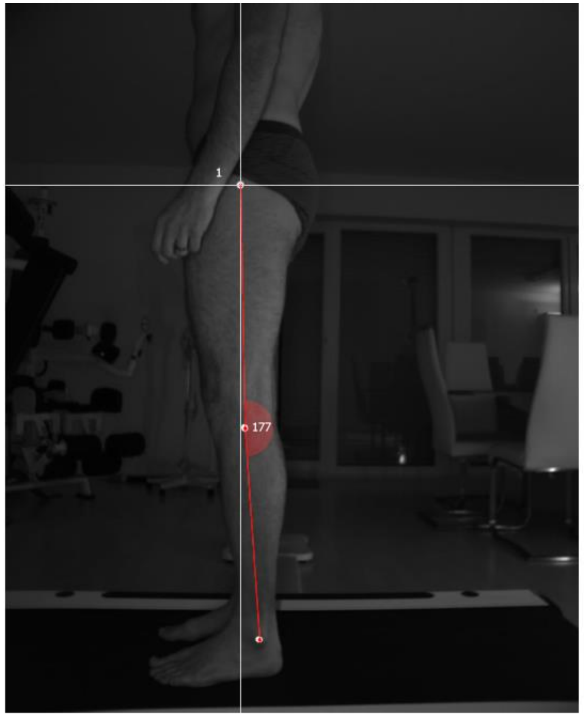
Posture Lab – Full Body Posture

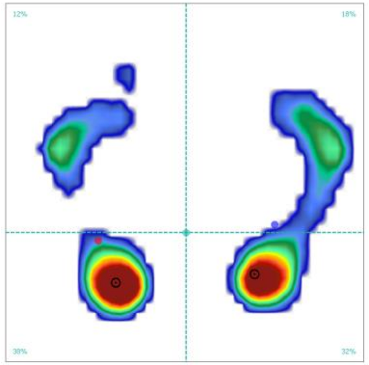
Theoretical Background



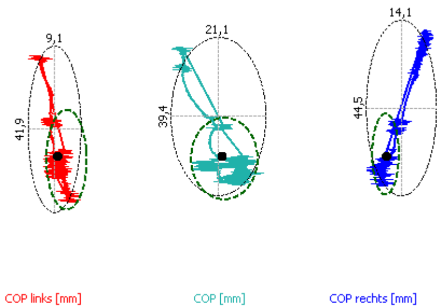




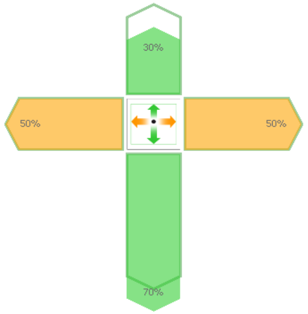
DURCHSCHNITTS-MATRIX



COP-BEWEGUNG

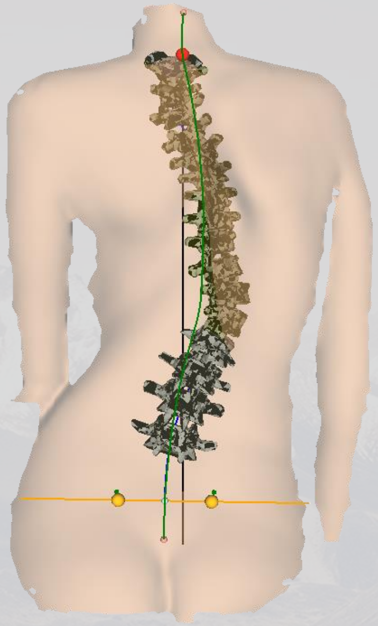


GEWICHTSVERTEILUNG



Posture Analysis – Why?

- Progression control on postural weakness
- Connection to muscular imbalance
- (surgically treated) Postural corrections
- Dysfunctional Asymmetries



Scoliosis

Lateral Deviation (max):	70 mm R
Surface Rotation (max):	35° L
Scoliosis Angle:	56°
Pelvic Obliquity :	0 mm R

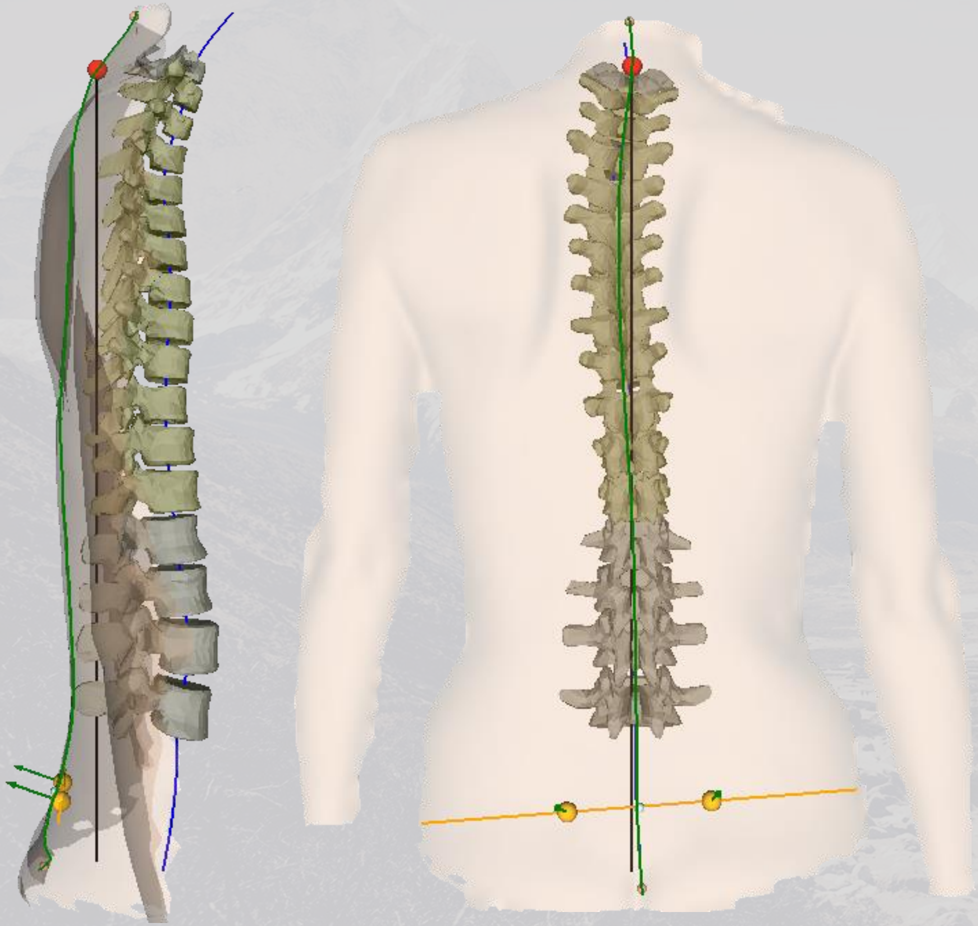
Scheuermann's Disease

Kyphosis Angle:	81°
Flèche Cervicale:	112 mm
Flèche Lombaire:	49 mm

Hyperlordosis

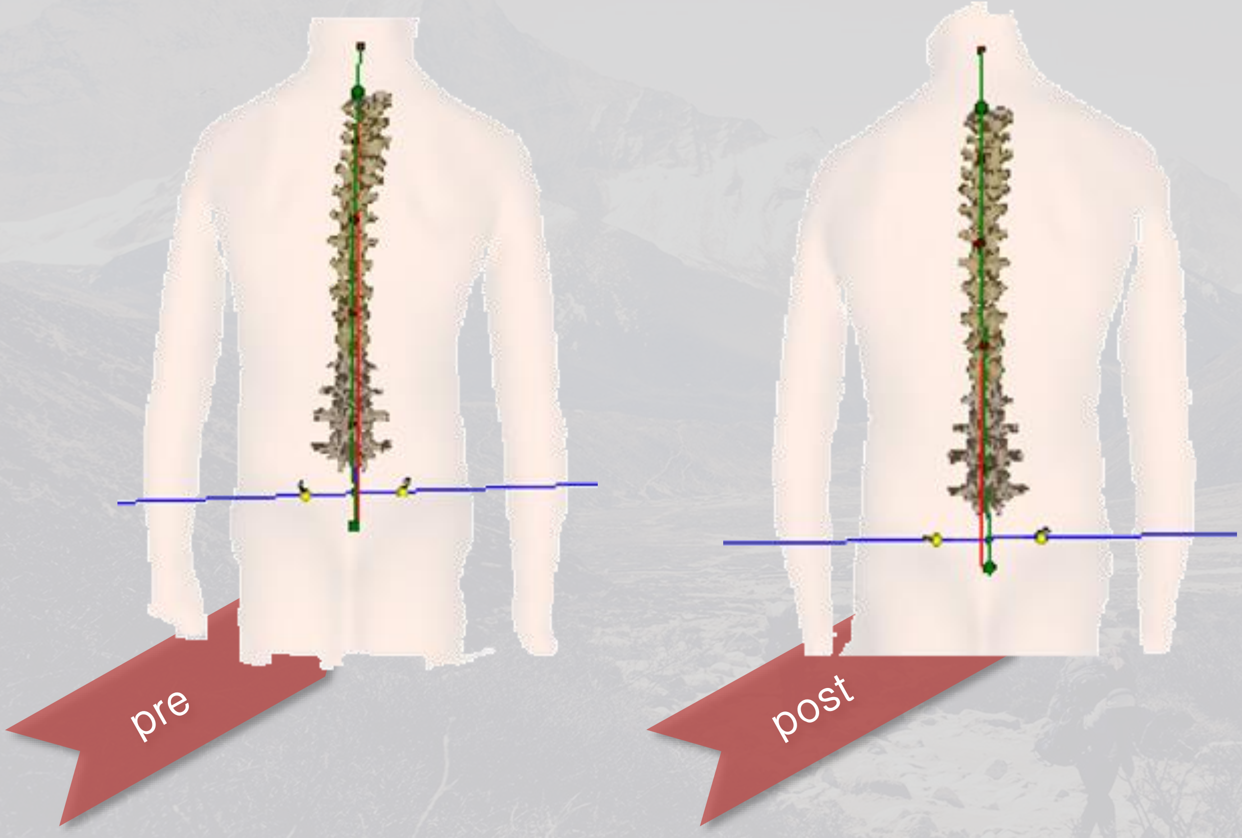
Lordosis Angle:	72°
Trunk Inclination:	11° R
Flèche Lombaire:	81 mm

Application



Posture assessment

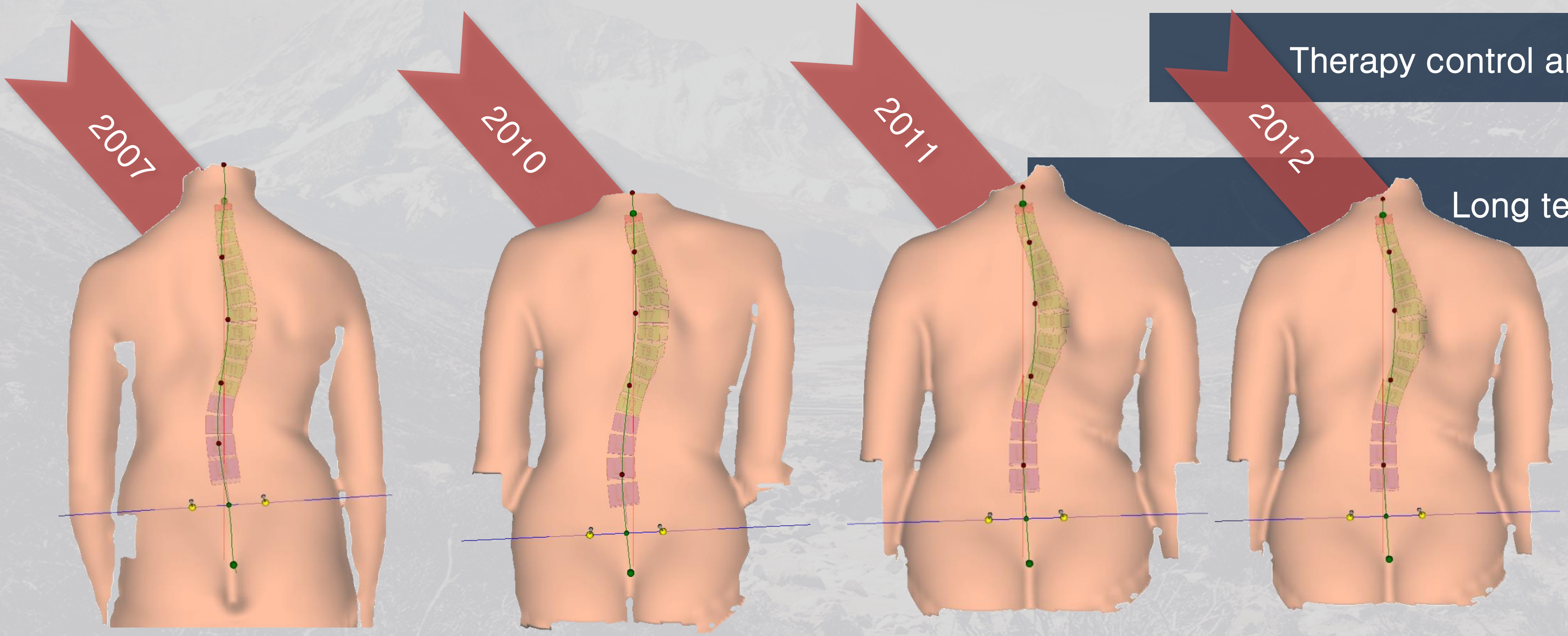
Application



Posture assessment

Therapy control and evaluation

Application

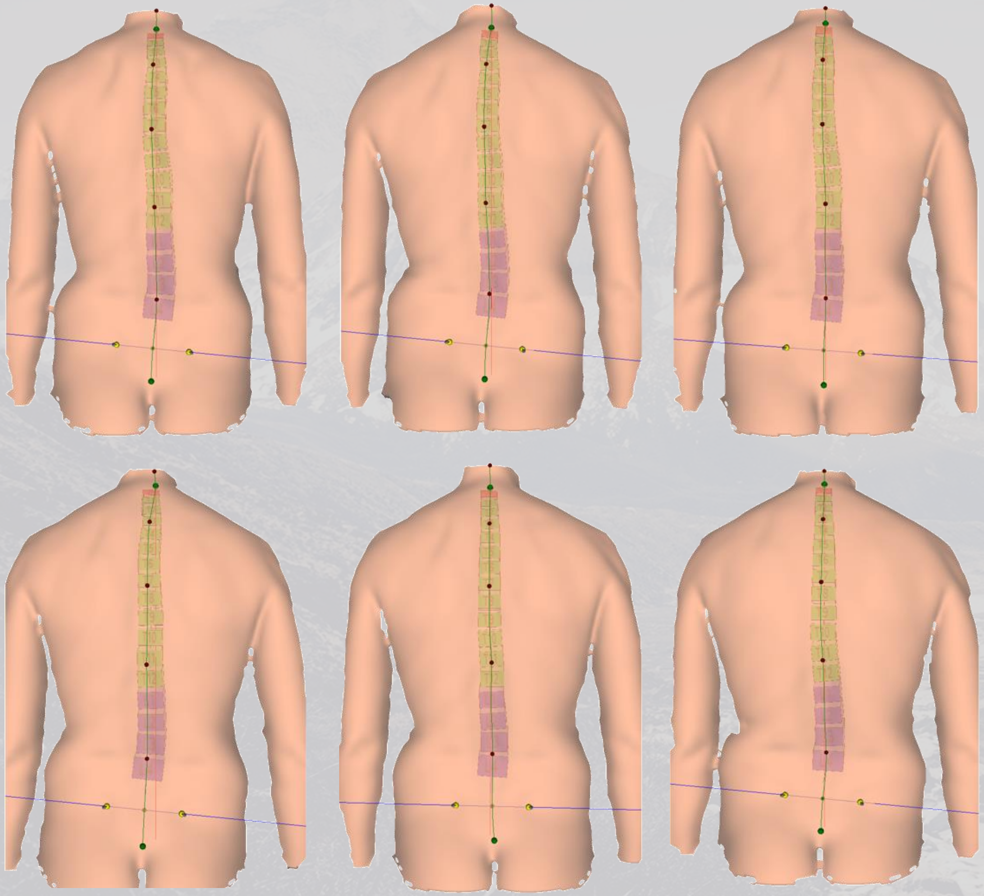


Posture assessment

Therapy control and evaluation

Long term follow-up

Application



Posture assessment

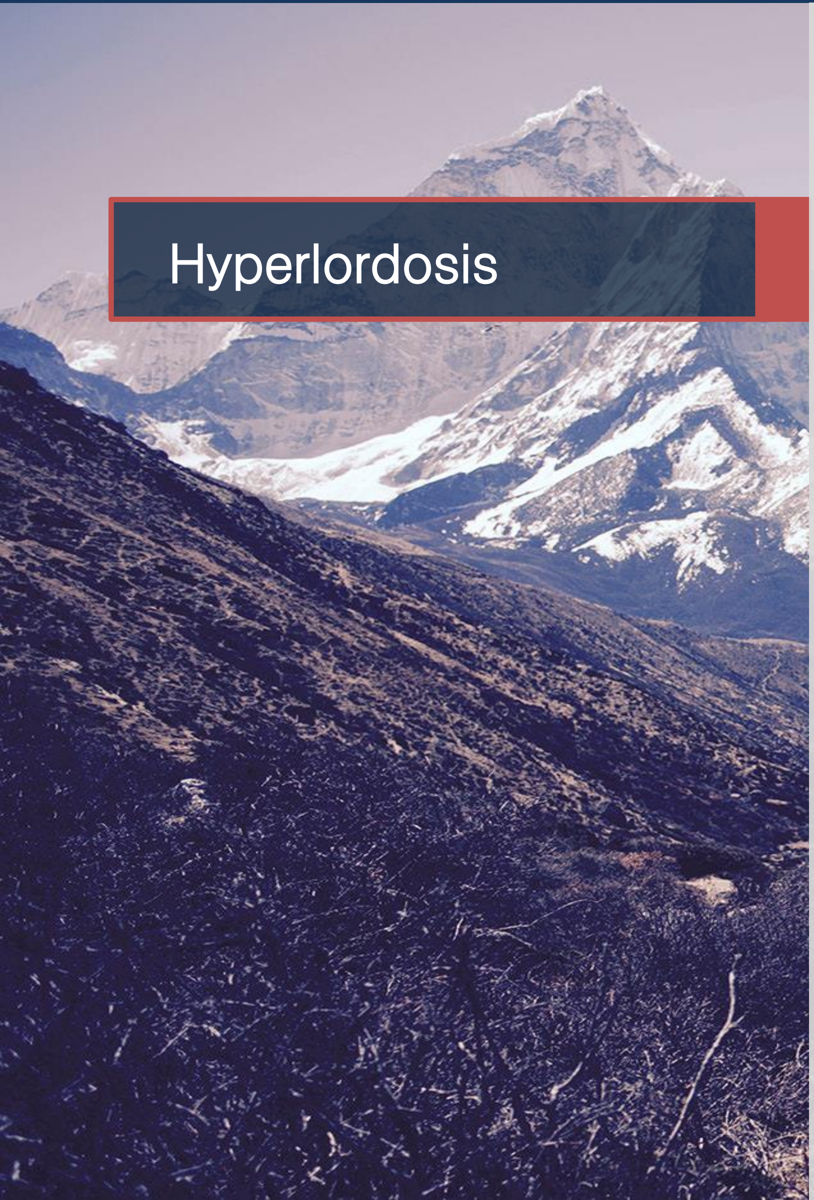
Therapy control and evaluation

Long term follow-up

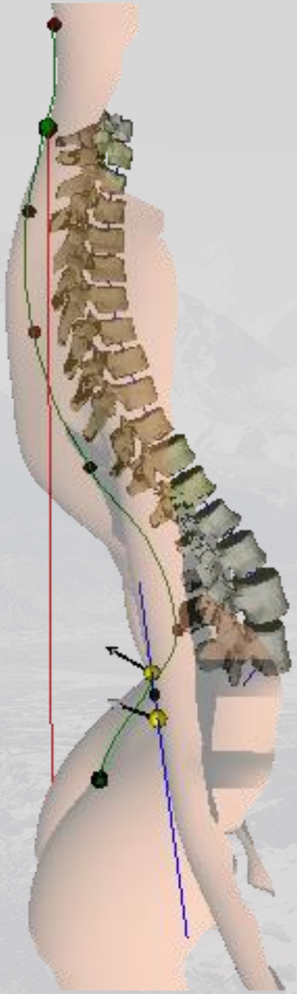
‚Reaction diagnostics‘

Posture Assessment

Posture Assessment



Hyperlordosis

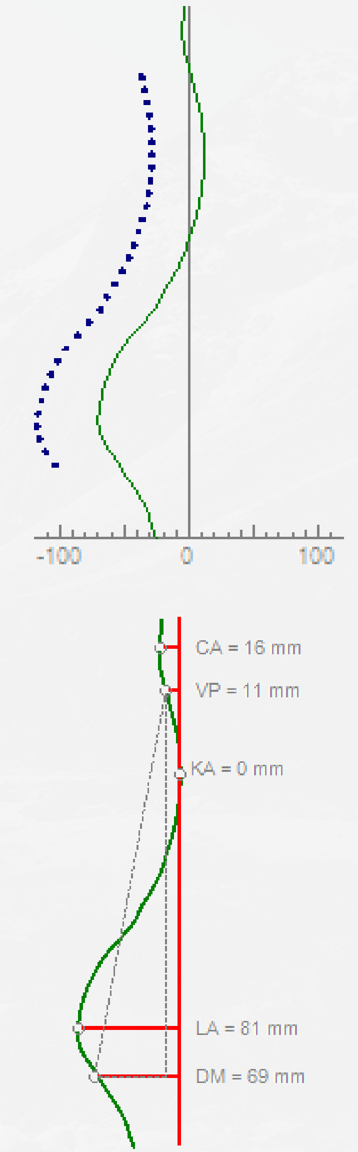


Core parameters:

Lordosis Angle: 71,9°

Trunk Inclination: 11° rw

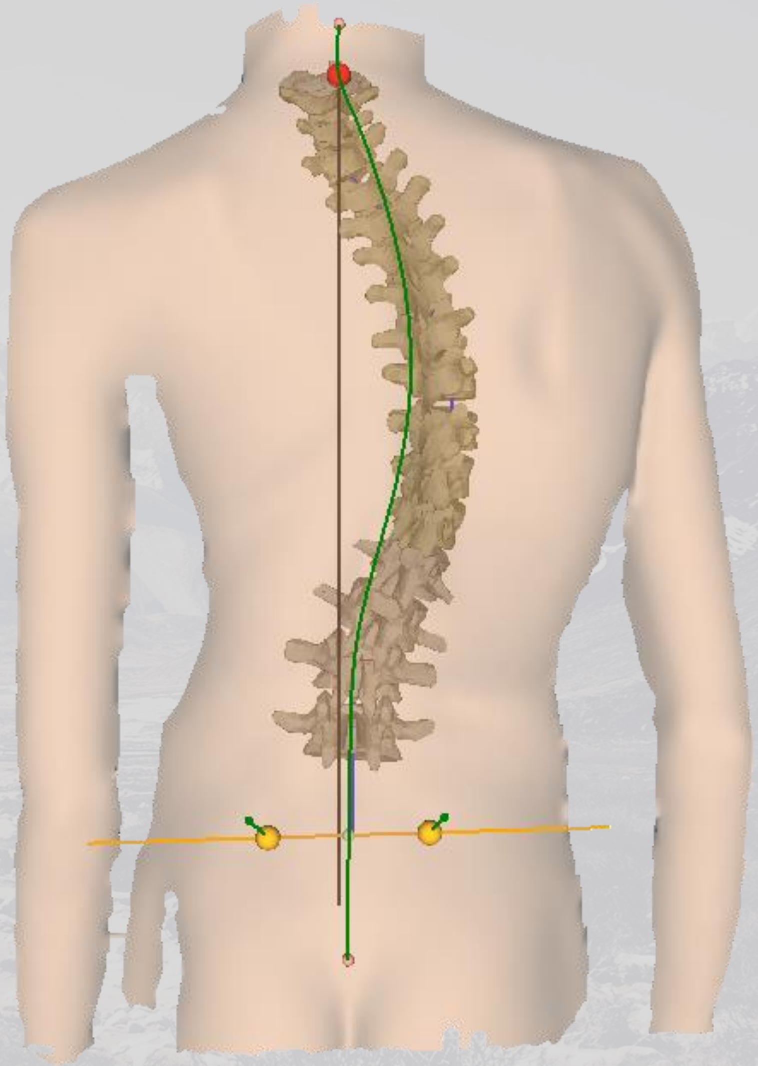
Flèche Lombaire: 81 mm

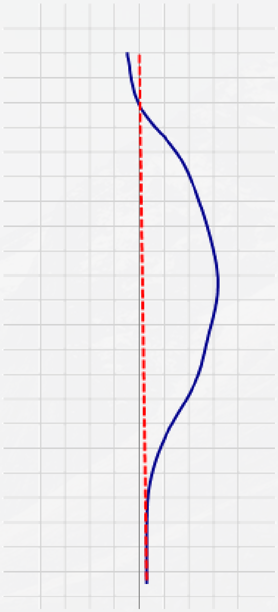


Posture Assessment

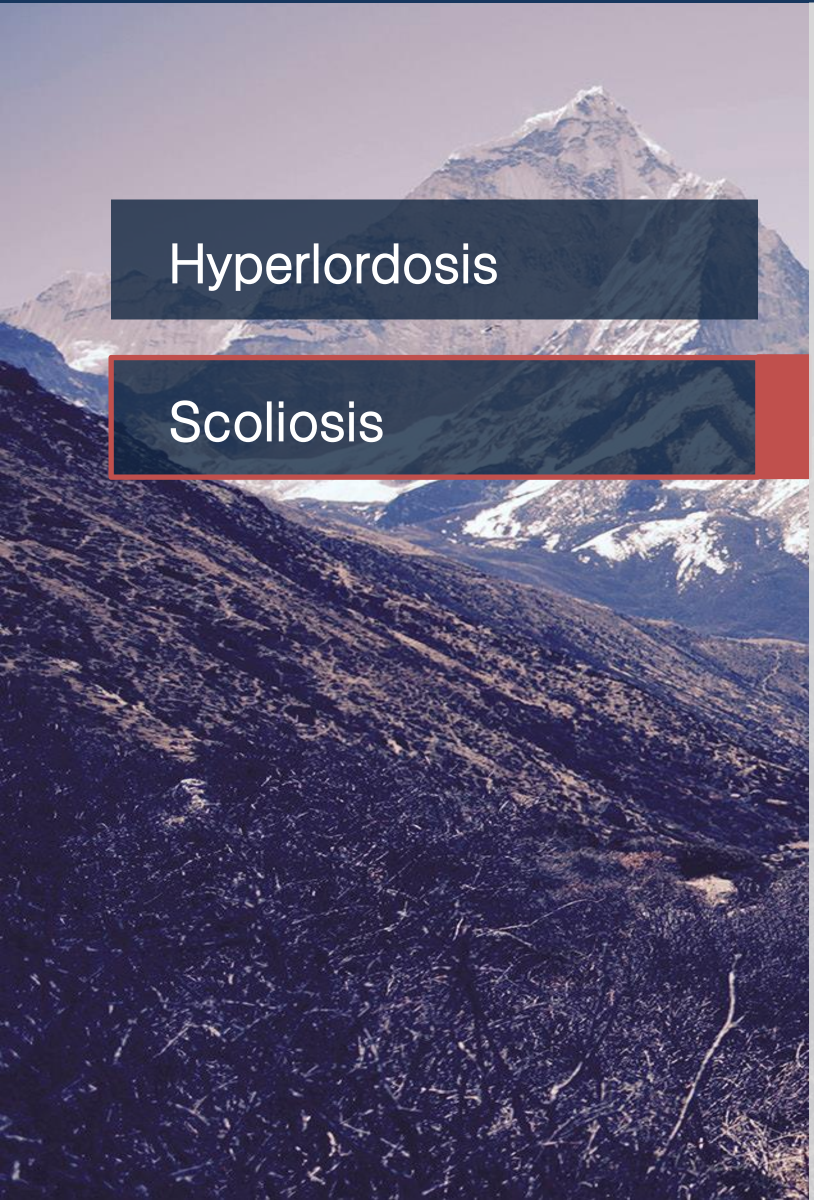
Hyperlordosis

Scoliosis





Posture Assessment



Hyperlordosis

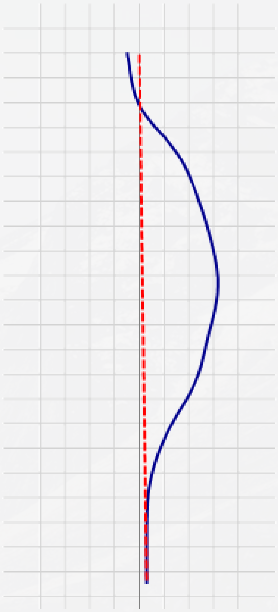
Scoliosis

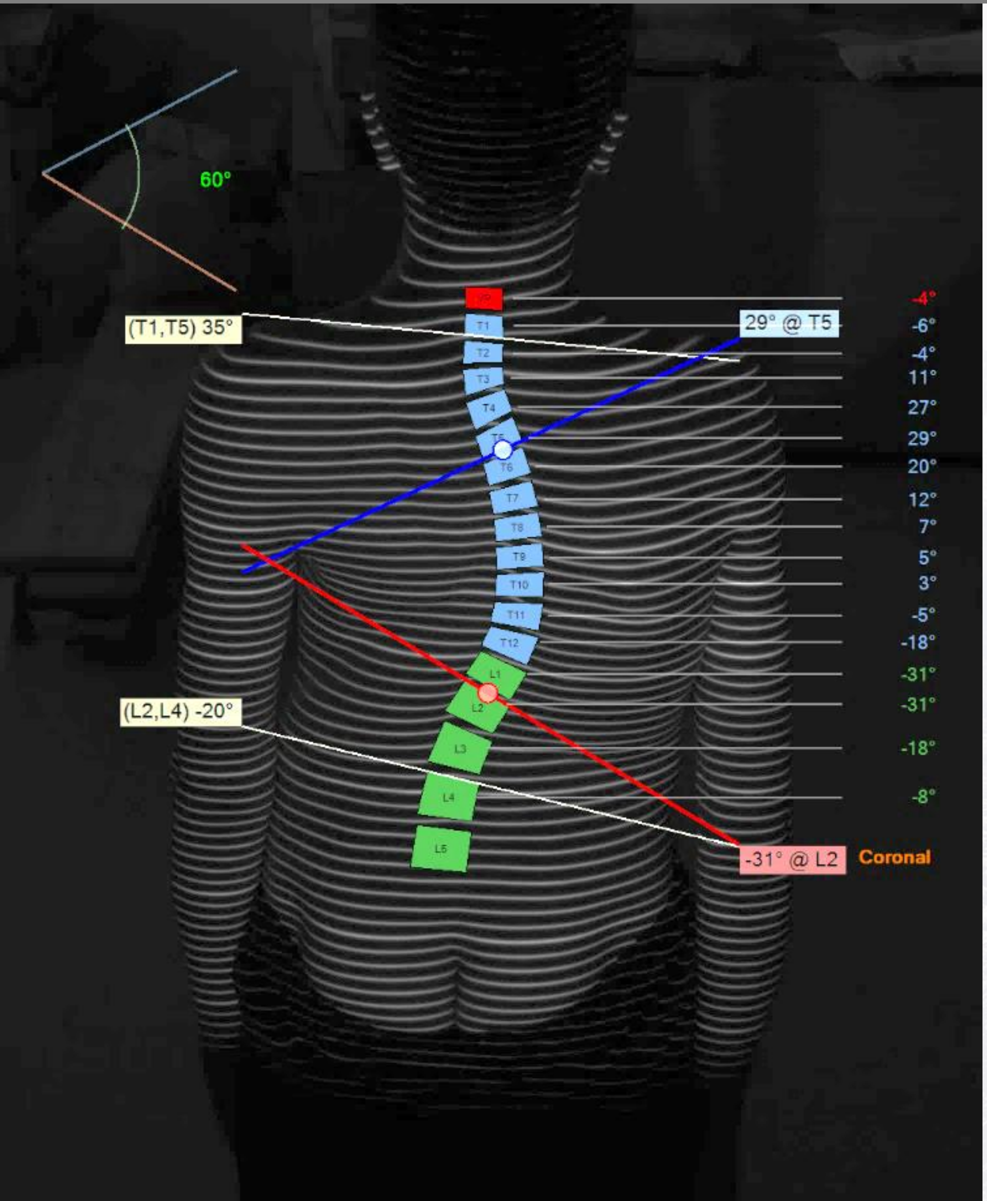
Core parameters:

Lateral deviation (max):	63 mm R (T9)
Surface Rotation (max):	21° L (T9)
Coronal Imbalance:	3 mm L
Pelvis Obliquity:	3 mm R

S-shaped Scoliosiswith an apex point at T9.

Max. counter rotation of 17° R (T2) turns C7 closer to neutral.





Differences caused by

- Morphologic differences between bone and spine model
- 2D vs. 3D

How to use?

- Start with setting an intra-individual correlation
- First: Baseline exam formetric & x-Ray
- Compare Cobb- und Scoliosis Angle
- Individual difference can be taken as reference for further formetric exams
- Reduce x-Ray, don't replace!

Hyperlordosis

Scoliosis

Difference between SA and CA
(n=193)

[…] reproducibility for each ST parameter […] was strong (icc = 0.855–0.944)

[…] average difference of 5.8 degrees in the thoracic spine and 8.8 degrees in the lumbar spine between ST Cobb angle estimates and radiographs

The utility of ST is in the reproducible quantification of deformity ***after the initial radiograph has been taken****. This has the potential to make longitudinal assessment of change in deformity without serial radiographs.*

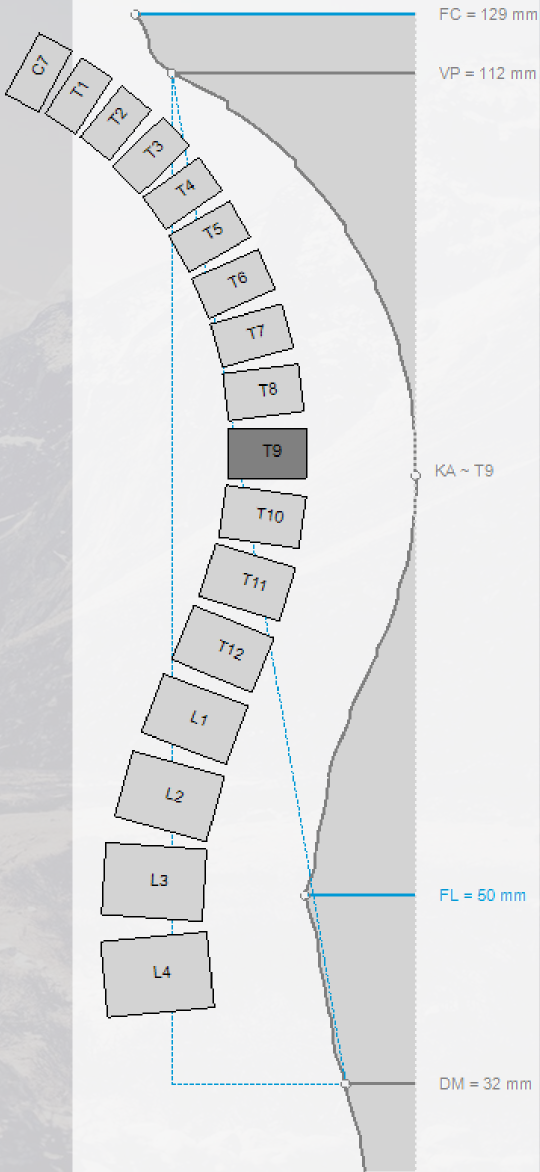
Knott, P.; Sturm, P.; Lonner, B.; Cahill, P.; Betsch, M.; McCarthy, R.; Kelly, M.; Lenke, L.; Betz, R. (2016). Multicenter comparison of 3D spinal measurements using surface topography with those from conventional radiography. Spine deformity, 4(2), 98-103.

Posture Assessment

- Hyperlordosis
- Scoliosis
- Scheuermann‘s dis.

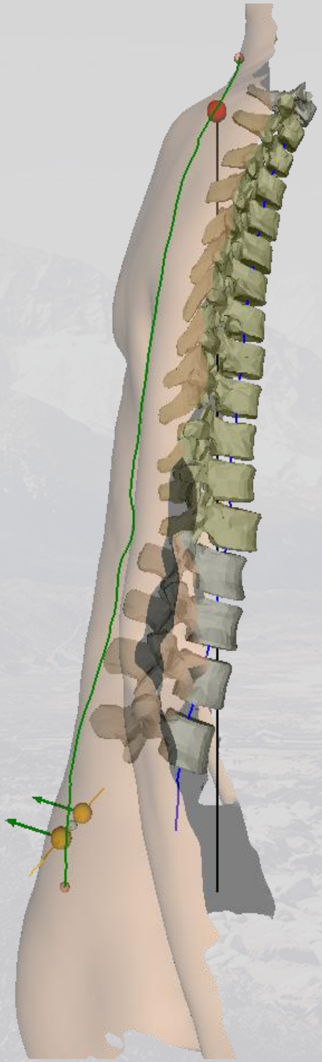
Core parameters:

Kyphosis Angle:	81°
Flèche Cervicale:	112 mm
Flèche Lombaire:	49 mm



Posture Assessment

- Hyperlordosis
- Scoliosis
- Scheuermann‘s dis.
- Flat back



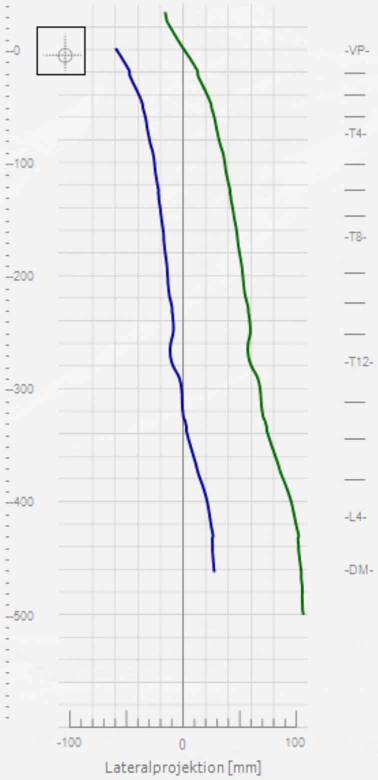
Core parameters:

Kyphosis Angle: 24°
Lordosis Angle: 5°

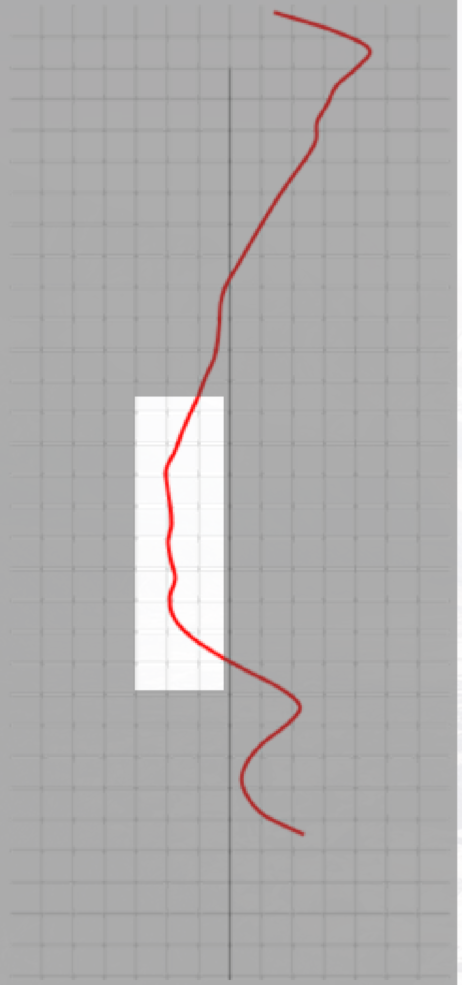
Lumbar fusion L3 to L5.
Causing lumbar lordosis to vanish.

As a result, thoracic spine also flatens in order to compensate for worsened shock absorption kinematics.

Visible via sagittal profile and tilt.



- Hyperlordosis
- Scoliosis
- Scheuermann‘s dis.
- **Flat back**



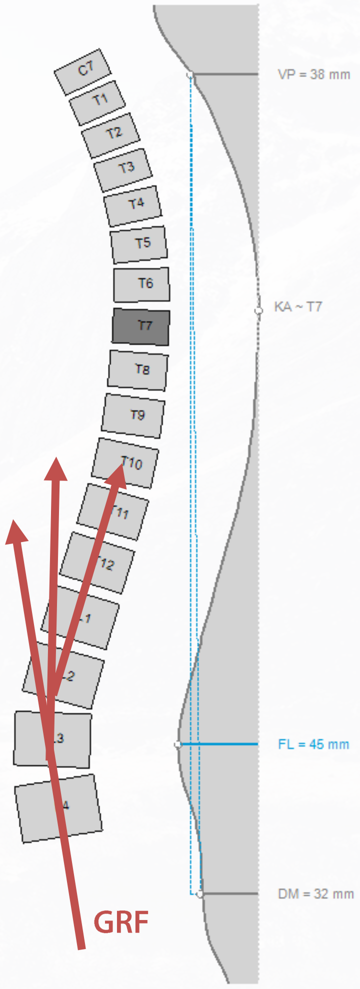
Tilt:

Sagittal **bending position** of each segment

Primary task of sagittal balance:

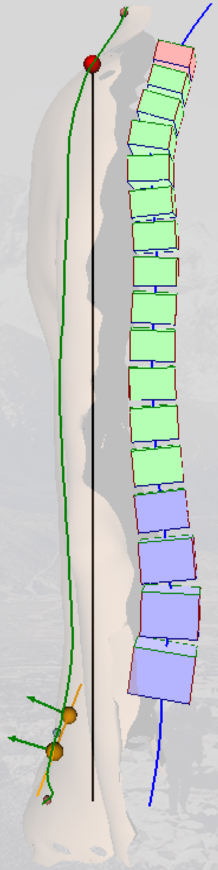
- **Balance COM**
- **Shock absorption**

in a preferably energy saving way.



Posture Assessment

- Hyperlordosis
- Scoliosis
- Scheuermann's dis.
- Flat back
- Thoracic lordosis



Core parameters?

Kyphosis Angle: 40°

Lordosis Angle: 21°

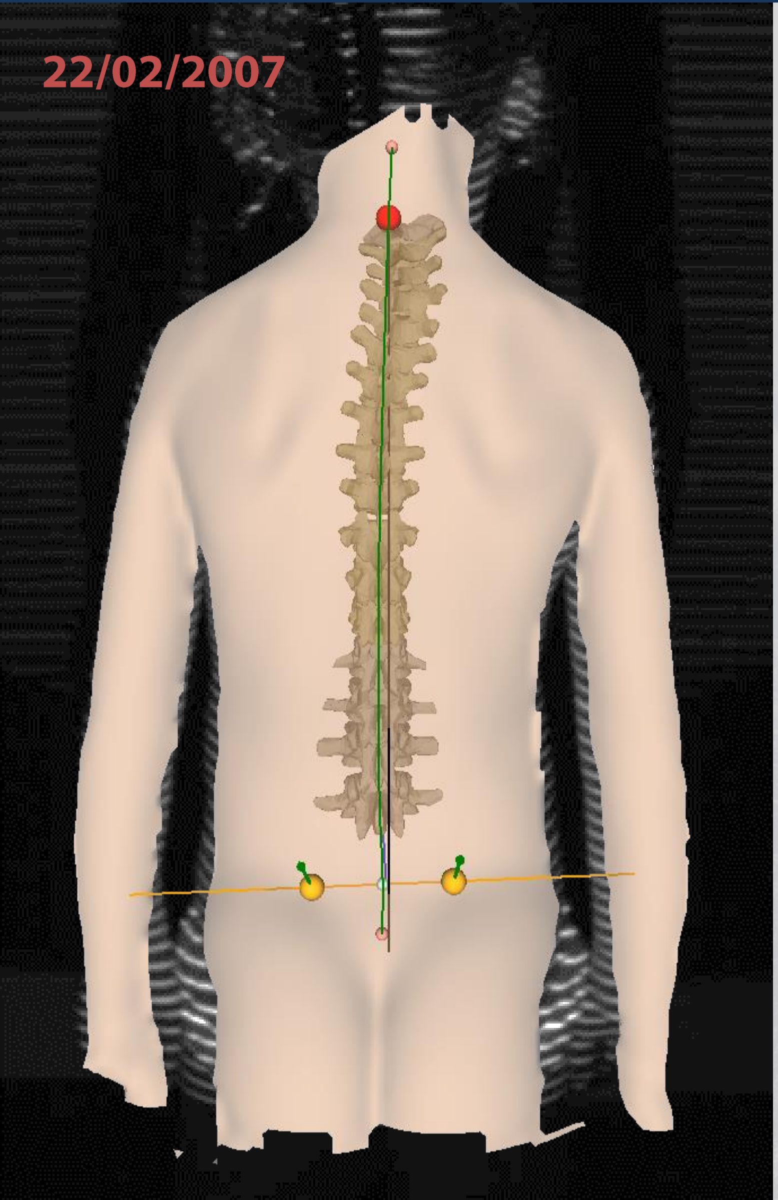
No real parameter, but observable via sagittal profile and the negative curvature in the thoracic spine.

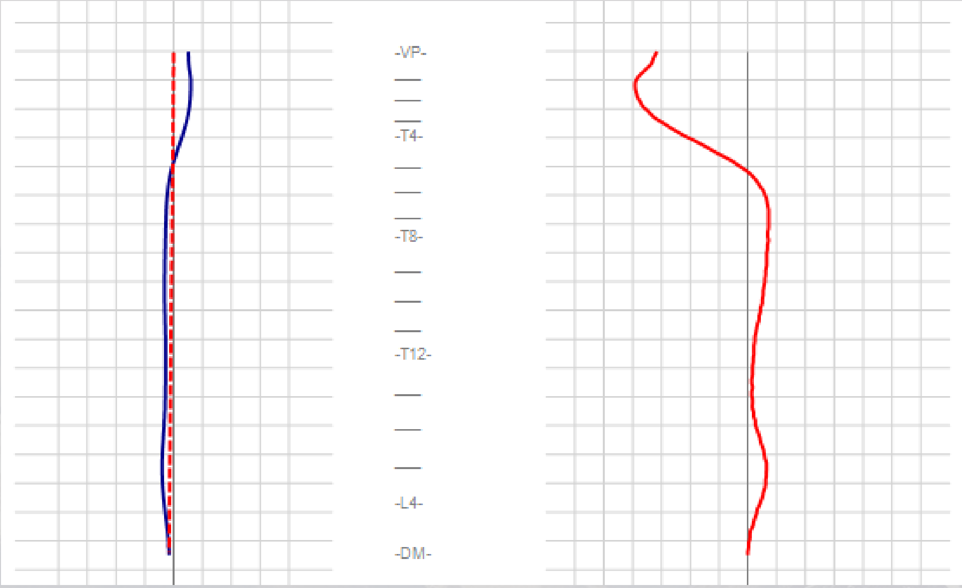
Application

Therapy control and evaluation

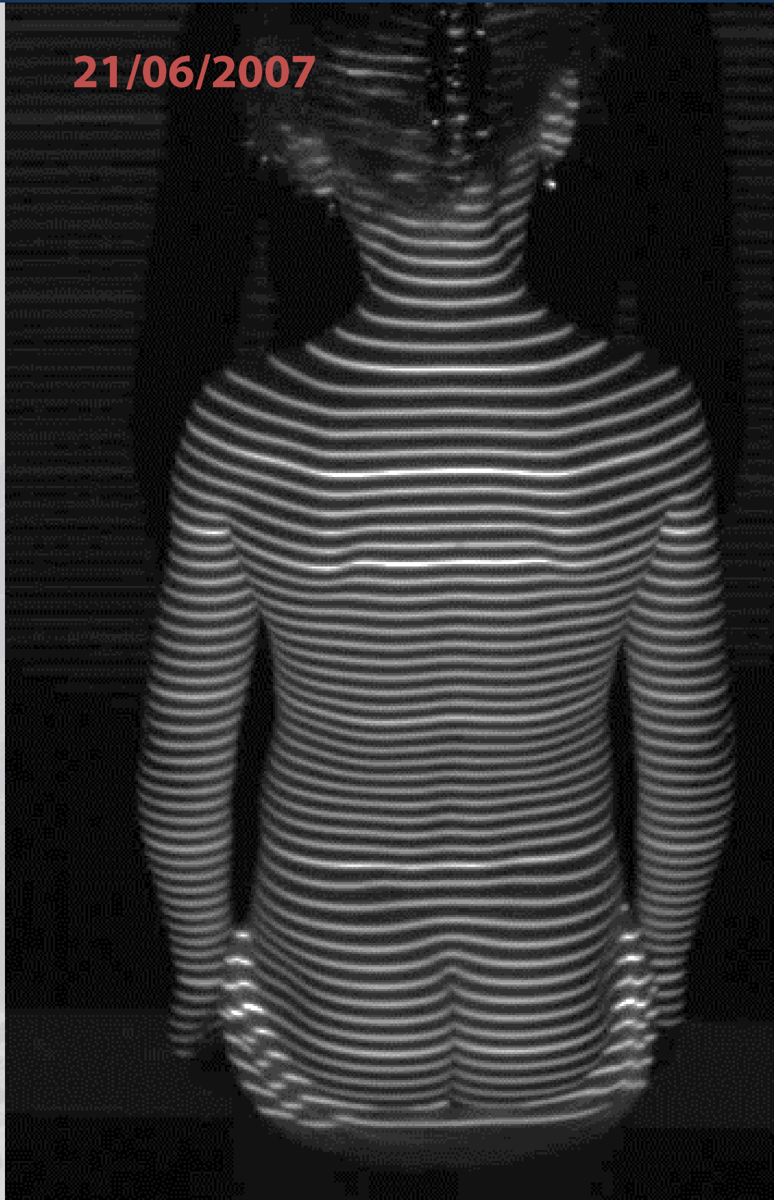
Therapy control and evaluation

22/02/2007





21/06/2007

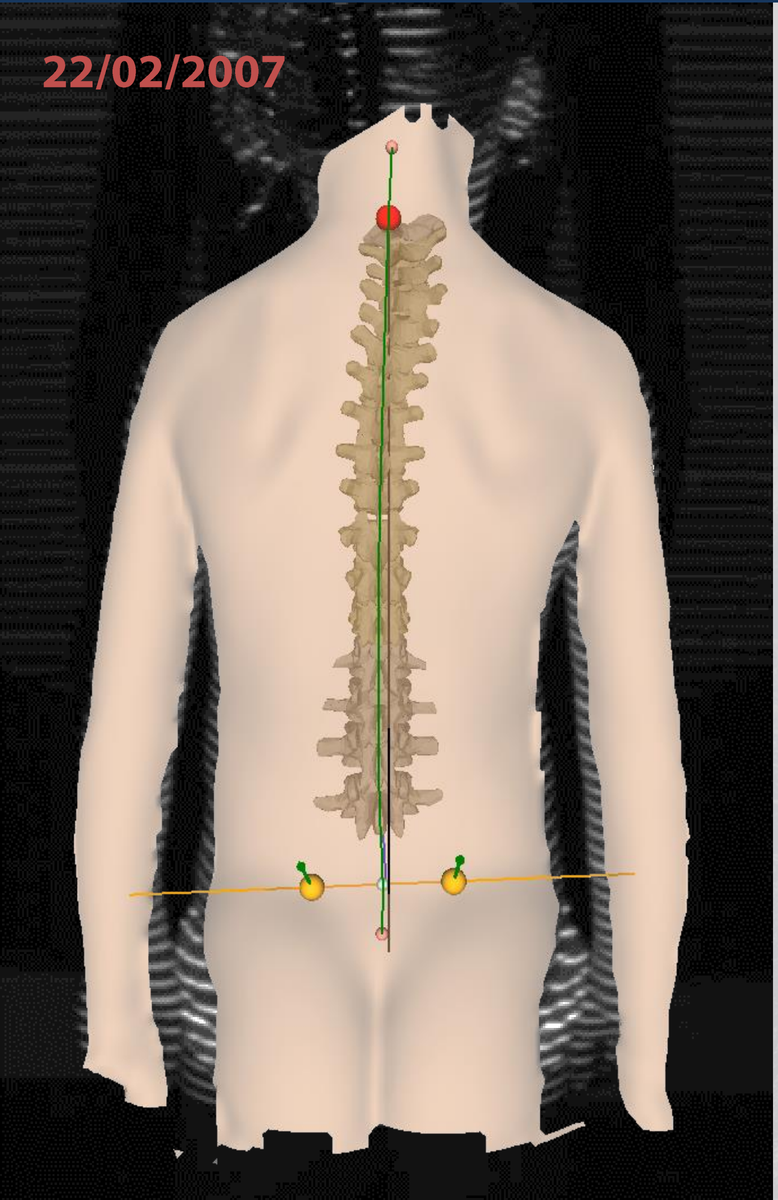


Scoliotic deformity* (pre)

Baseline exam 22/02/2007

Lateral Deviation (- max):	11 mm L (T7)
Surface Rotation (+max):	1° R (T8)
Surface Rotation (- max):	16° L (T2)

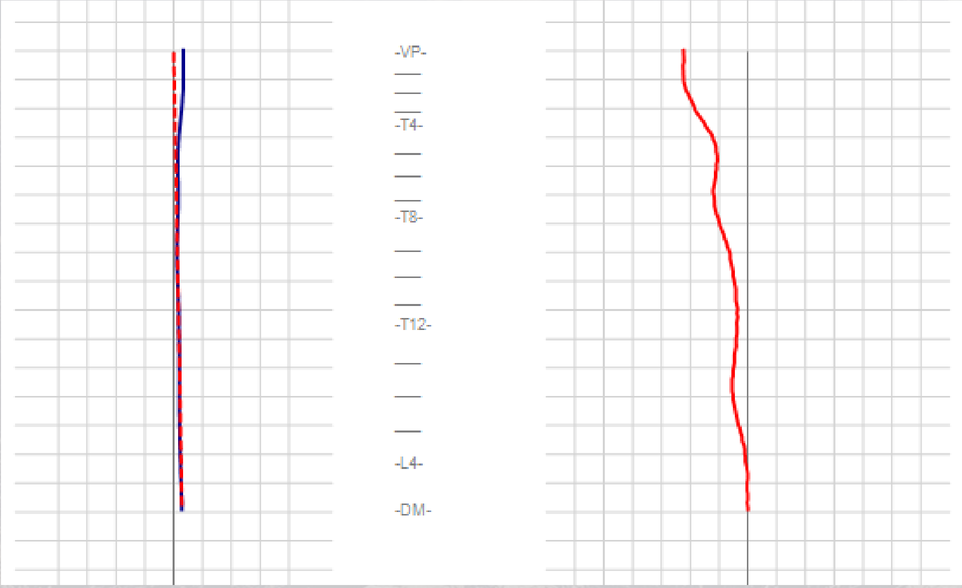
Therapy control and evaluation

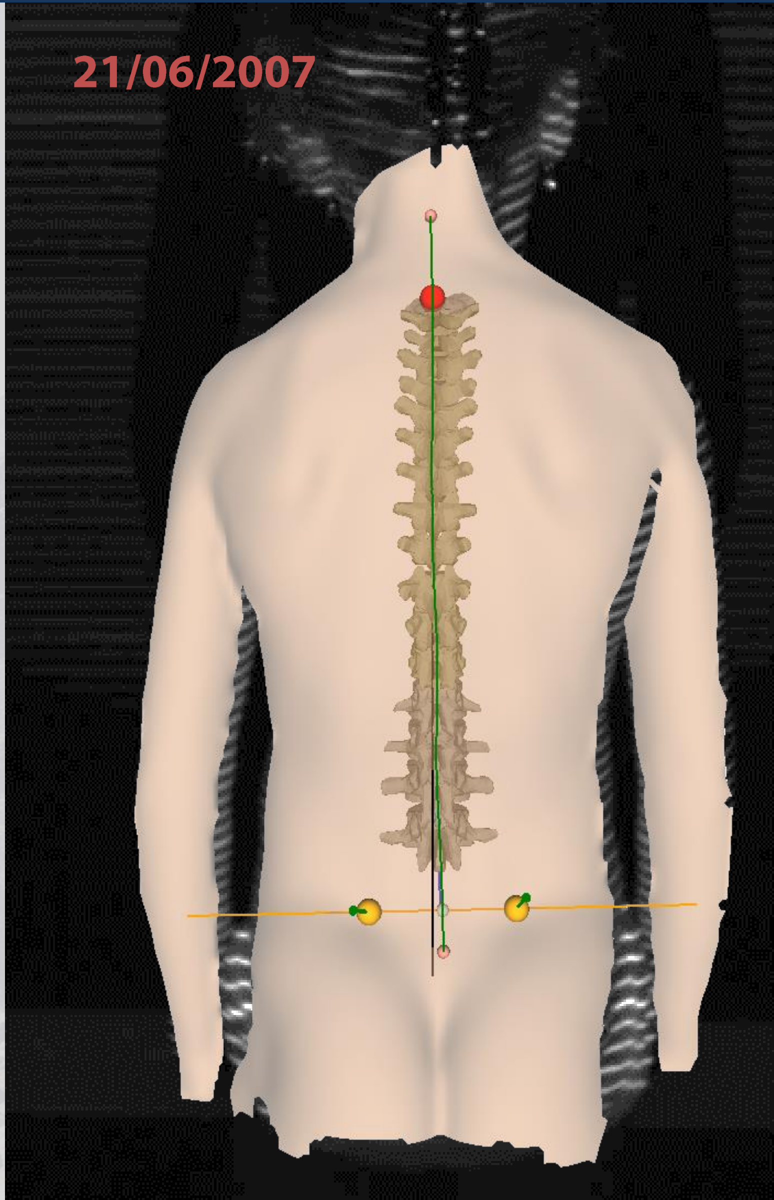


Scoliotic deformity* (post)

Control exam 21/06/2007

Lateral Deviation (- max):	4 mm L (T9)
Surface Rotation (+max):	1° R (DM)
Surface Rotation (- max):	10° L (T2)

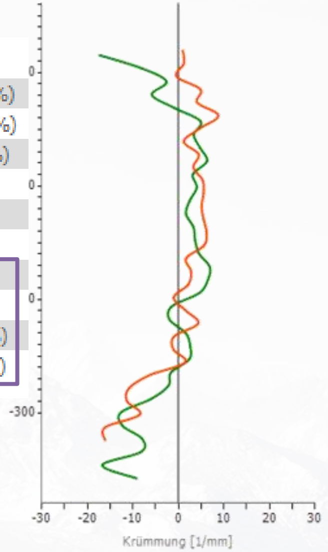


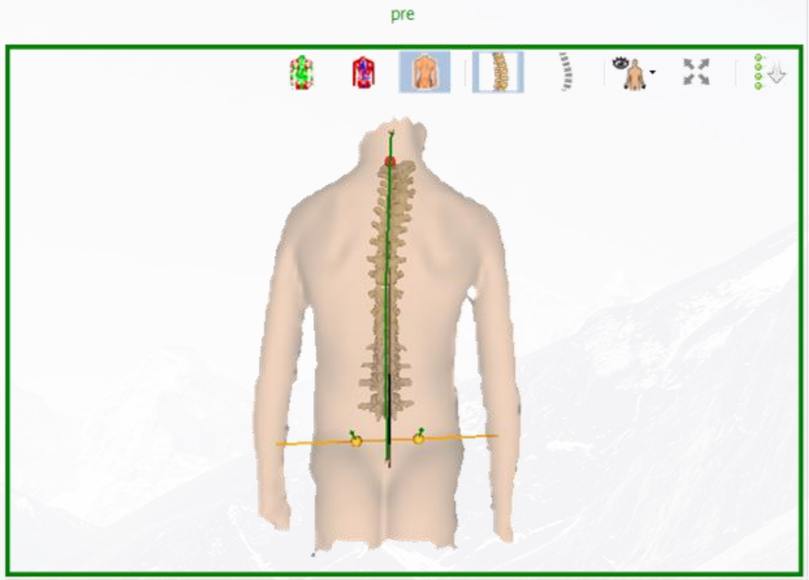


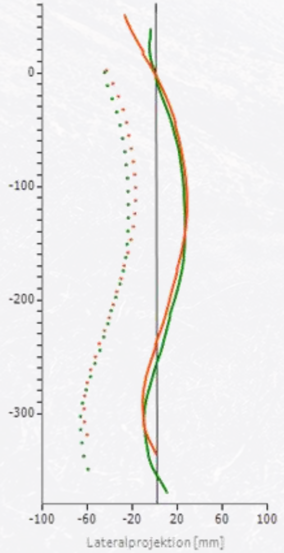
Therapy control and evaluation

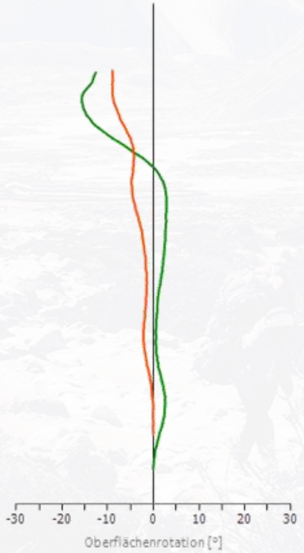
Physiotherapie

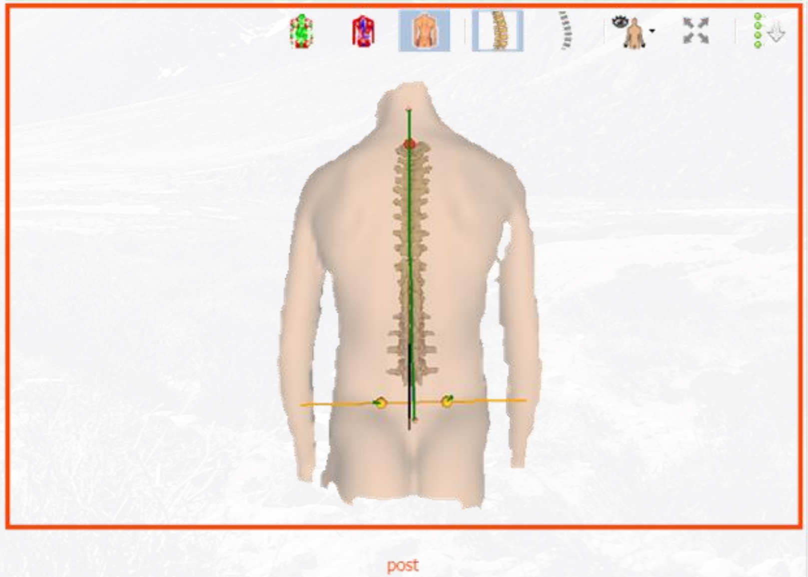
Name	3D statisch 22.02.2007 16:47 pre Unit	Value	3D statisch 21.06.2007 16:35 post Value	Unit	Diff. [1&2]
Sagittal Imbalance VP-DM	mm	5	11	mm	6 mm (+120%)
Coronal Imbalance VP-DM	mm R	3	6	mm L	9 mm L (-300%)
Pelvic Obliquity	mm R	3	2	mm R	1 mm R (-33%)
Pelvic Torsion DL-DR	°	0	2	° R	2 ° R
Kyphotic Angle ICT-ITL (max)	°	37	46	°	9 ° (+24%)
Lordotic Angle ITL-ILS (max)	°	44	40	°	4 ° (-9%)
Vertebral Rotation (+max)	° R (~T7)	3	1	° R	2 ° R (-67%)
Vertebral Rotation (-max)	° L (~T2)	15	8	° L (~T1)	7 ° L (-47%)
Apical Deviation VP-DM (+max)	mm R (~T2)	3	0	mm (~T1)	3 mm (-100%)
Apical Deviation VP-DM (-max)	mm L (~T7)	11	4	mm L (~T9)	7 mm L (-64%)











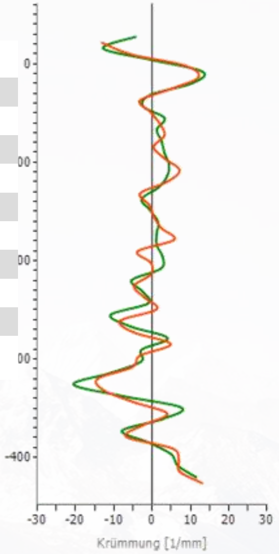
Therapy control and evaluation

Brace treatment

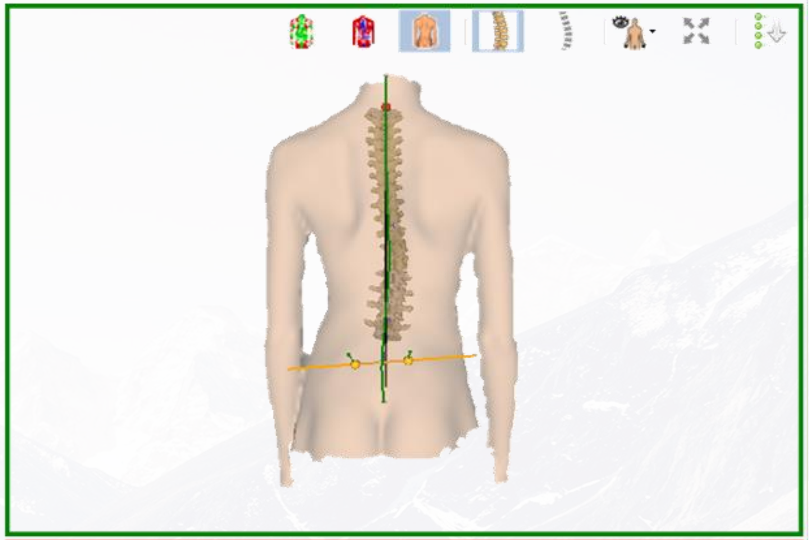
4D average 09.10.2008 12:31 Pat. 2: Scoliosis after taking brace off

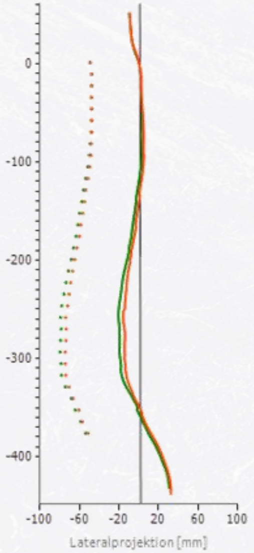
4D average 09.10.2008 16:29 Pat. 2: wi...

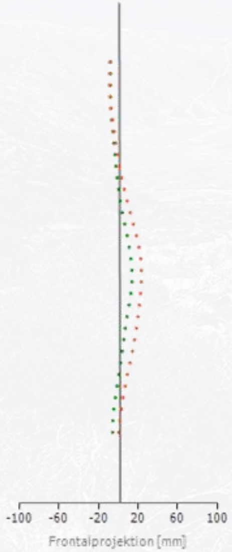
Name	Unit	Value	Value	Unit	Diff. [1&2]
Sagittal Imbalance VP-DM	° P	1	1	° P	0 ° P (-0%)
Coronal Imbalance VP-DM	mm R	8	3	mm R	5 mm R (-63%)
Pelvic Obliquity	mm R	5	2	mm R	3 mm R (-60%)
Pelvic Torsion DL-DR	° L	1	2	° L	1 ° L (+100%)
Kyphotic Angle ICT-ITL (max)	°	26	25	°	1 ° (-4%)
Lordotic Angle ITL-ILS (max)	°	38	35	°	3 ° (-8%)
Vertebral Rotation (+max)	° R (~C7)	9	6	° R (~C7)	3 ° R (-33%)
Vertebral Rotation (-max)	° L (~T9)	15	17	° L (~T9)	2 ° L (+13%)
Apical Deviation VP-DM (+max)	mm R (~T10)	23	28	mm R (~T10)	5 mm R (+22%)
Apical Deviation VP-DM (-max)	mm (~T1)	0	0	mm (~C7)	0 mm

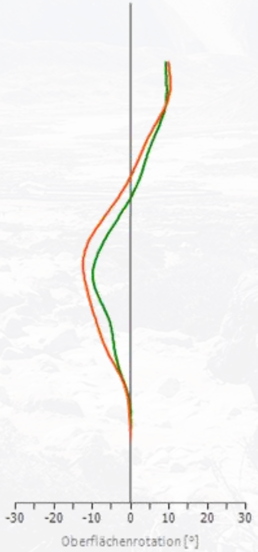


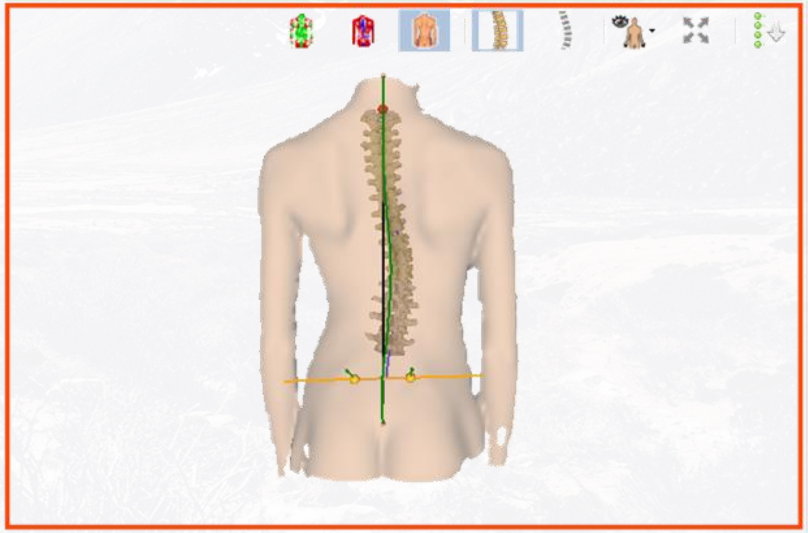
Pat. 2: Scoliosis after taking brace off





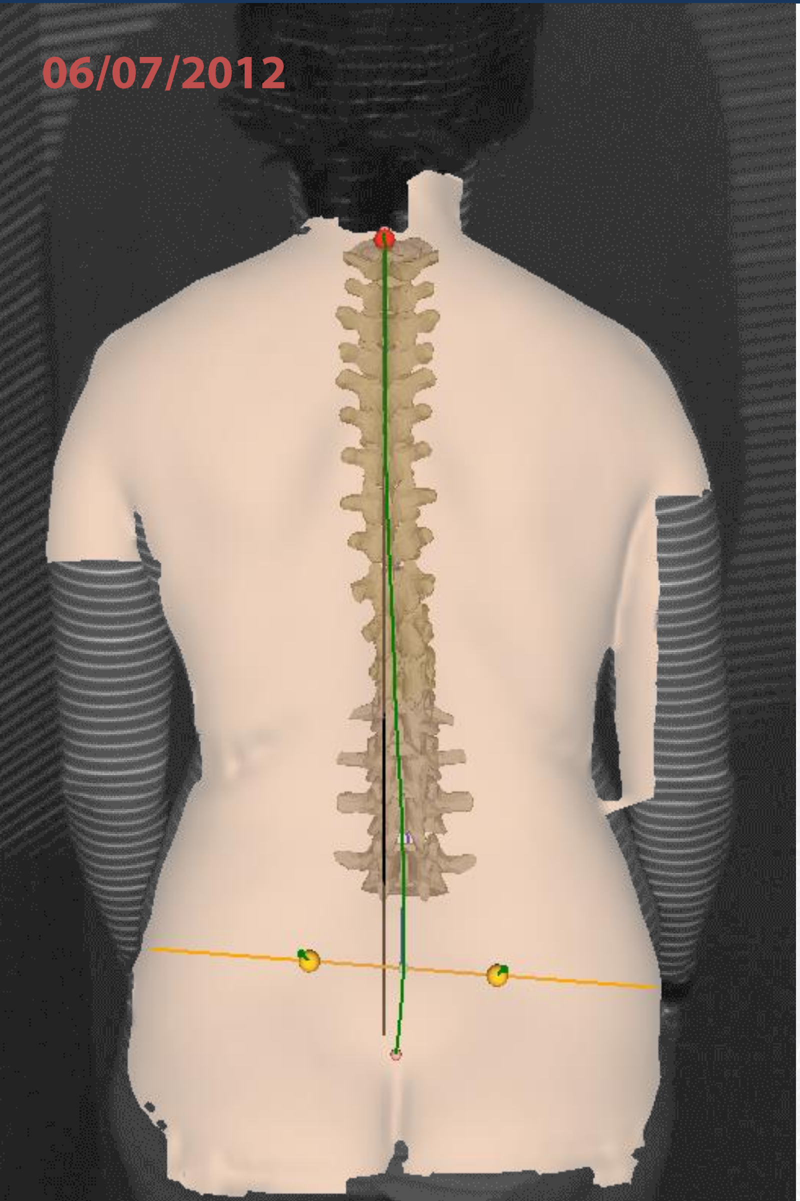


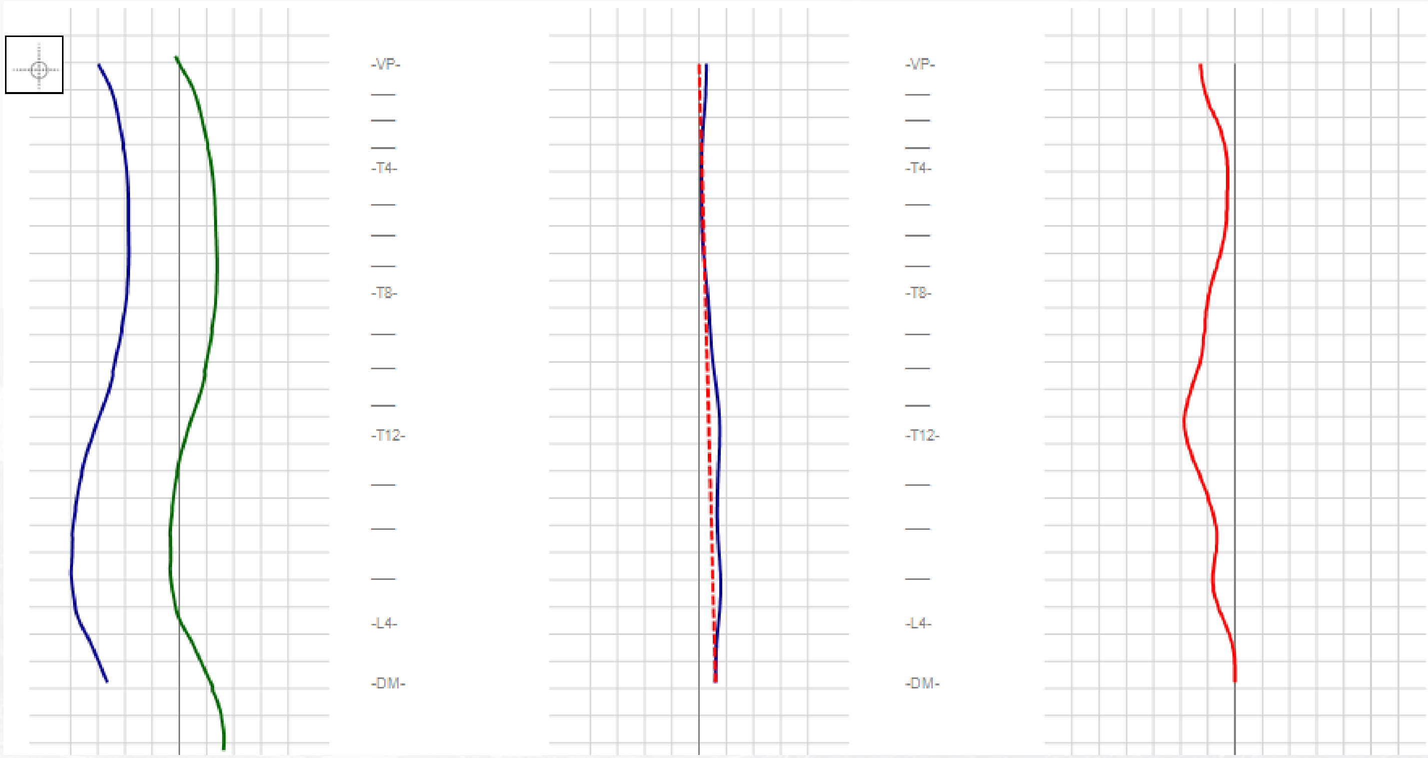




Pat. 2: without brace for 4 hours

Therapy control and evaluation



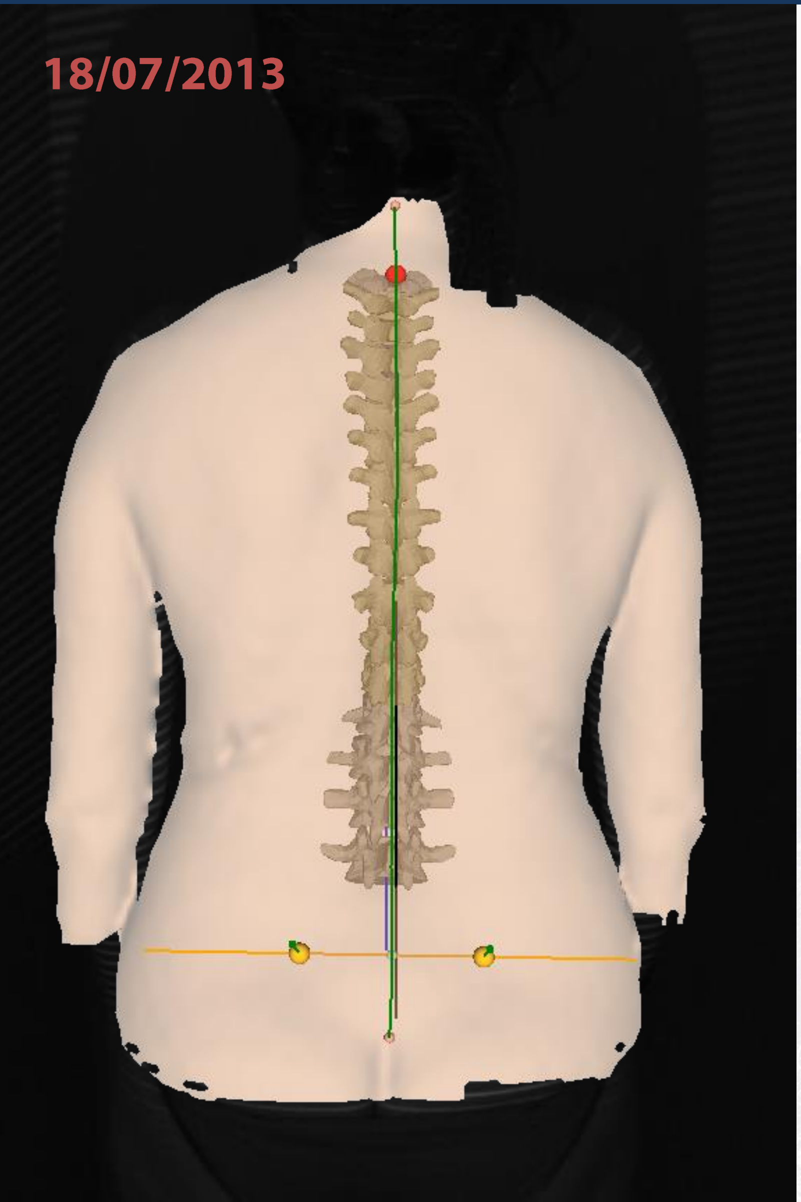


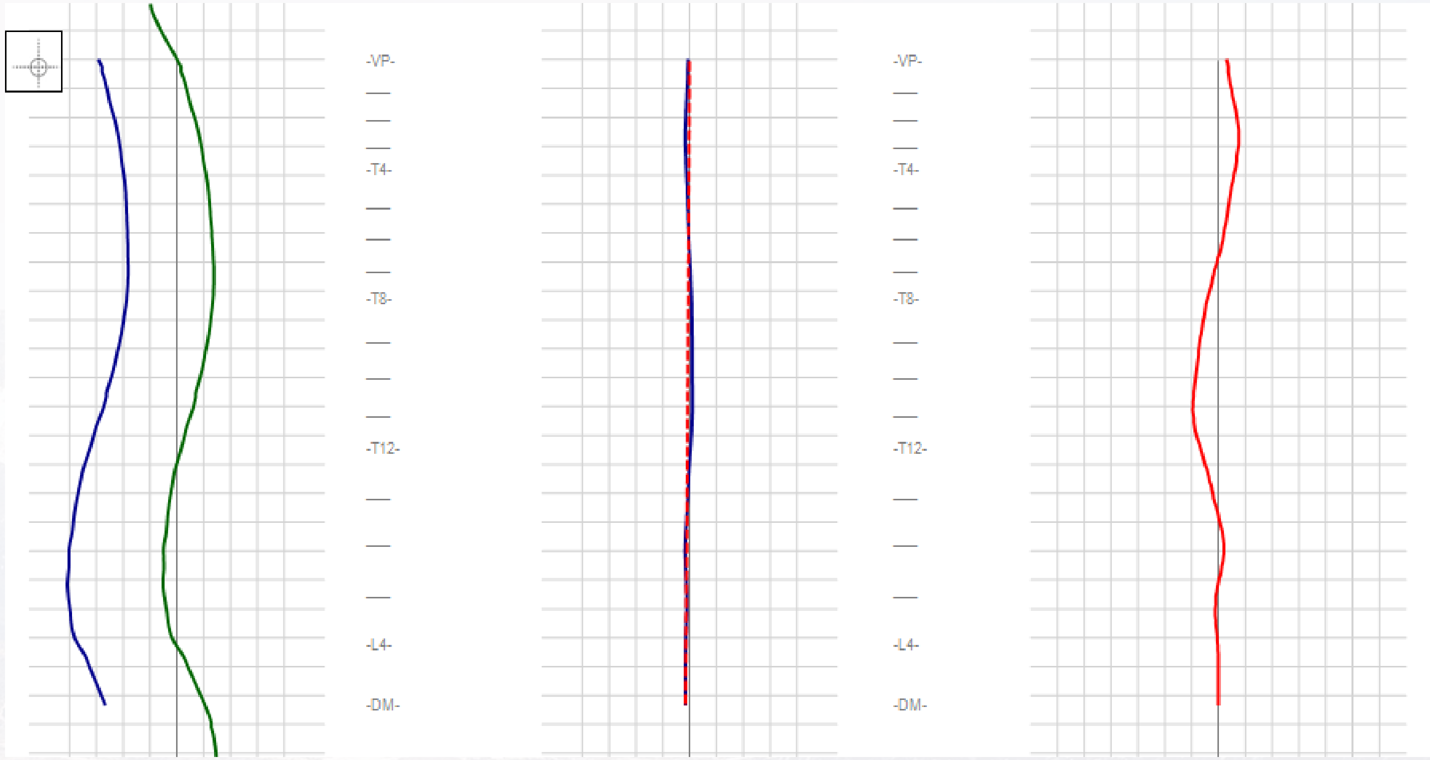
Baseline exam:

Coronal Imbalance:	12 mm L
Pelvic Obliquity:	9 mm L
Surface Rotation (- max):	7° L (T12)

Therapy control and evaluation

Sensomotoric Insoles





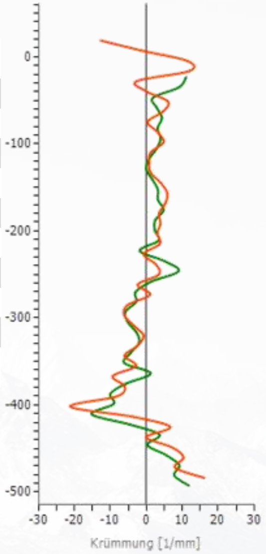
1 year post:

Coronal Imbalance:	3 mm R
Pelvic Obliquity:	3 mm L
Surface Rotation (- max):	2° L (T12)

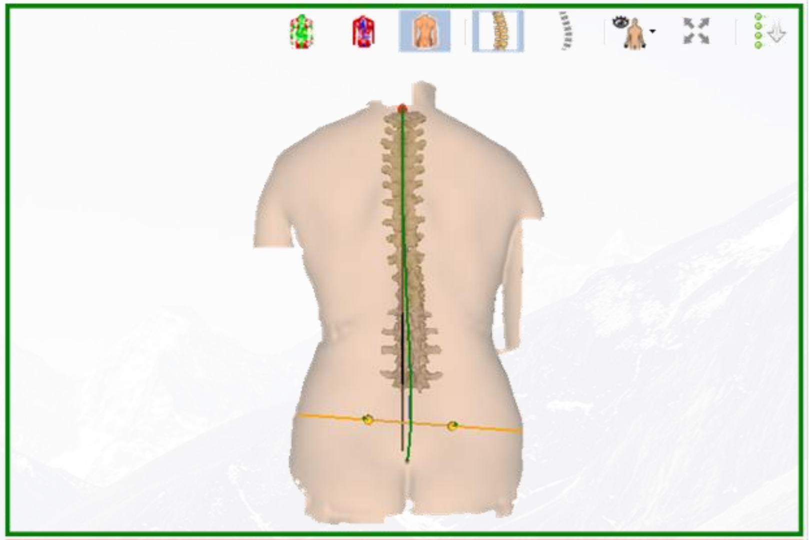
Therapy control and evaluation

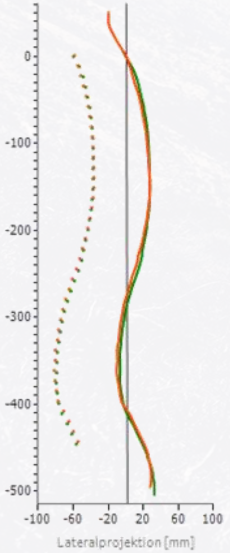
4D average 06.07.2012 12:55 Habitual Standing — 4D average 18.07.2013 10:19 Insole, Sh...

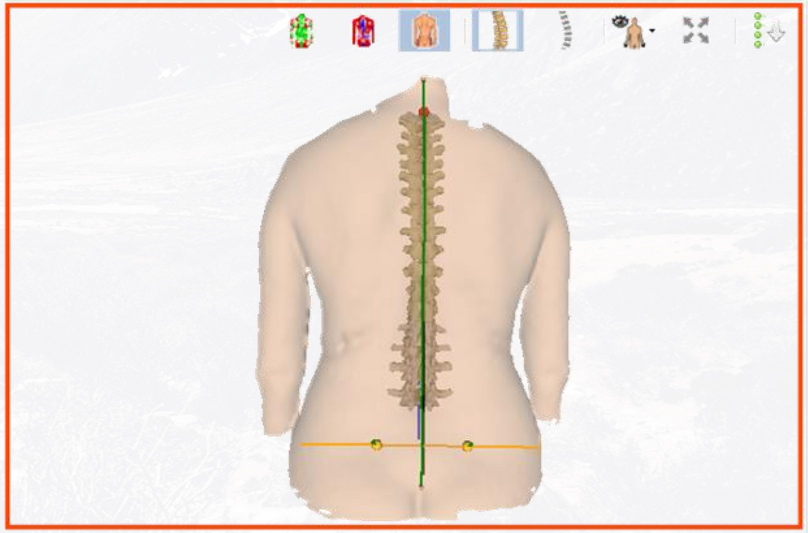
Name	Unit	Value	Value	Unit	Diff. [1&2]
Sagittal Imbalance VP-DM	° P	2	2	° P	0 ° P (-0%)
Coronal Imbalance VP-DM	mm L	12	3	mm R	15 mm R (-125%)
Pelvic Obliquity	mm L	9	3	mm L	6 mm L (-67%)
Pelvic Torsion DL-DR	° R	2	2	° L	4 ° L (-200%)
Kyphotic Angle ICT-ITL (max)	°	42	46	°	4 ° (+10%)
Lordotic Angle ITL-ILS (max)	°	45	45	°	0 ° (-0%)
Vertebral Rotation (+max)	°	0	5	° R (~T3)	5 ° R
Vertebral Rotation (-max)	° L (~T12)	7	2	° L (~T11)	5 ° L (-71%)
Apical Deviation VP-DM (+max)	mm R (~T12)	6	4	mm R (~T11)	2 mm R (-33%)
Apical Deviation VP-DM (-max)	mm L (~T5)	5	2	mm L (~T3)	3 mm L (-60%)



Habitual Standing



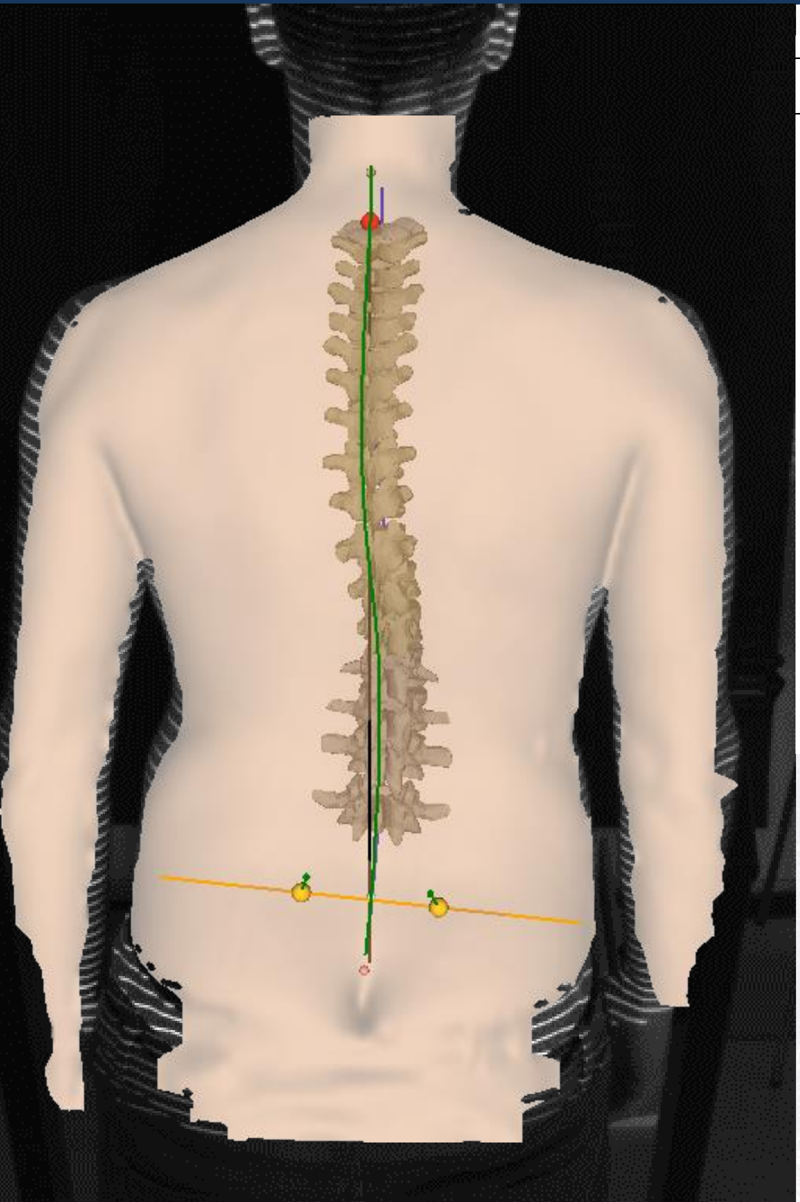


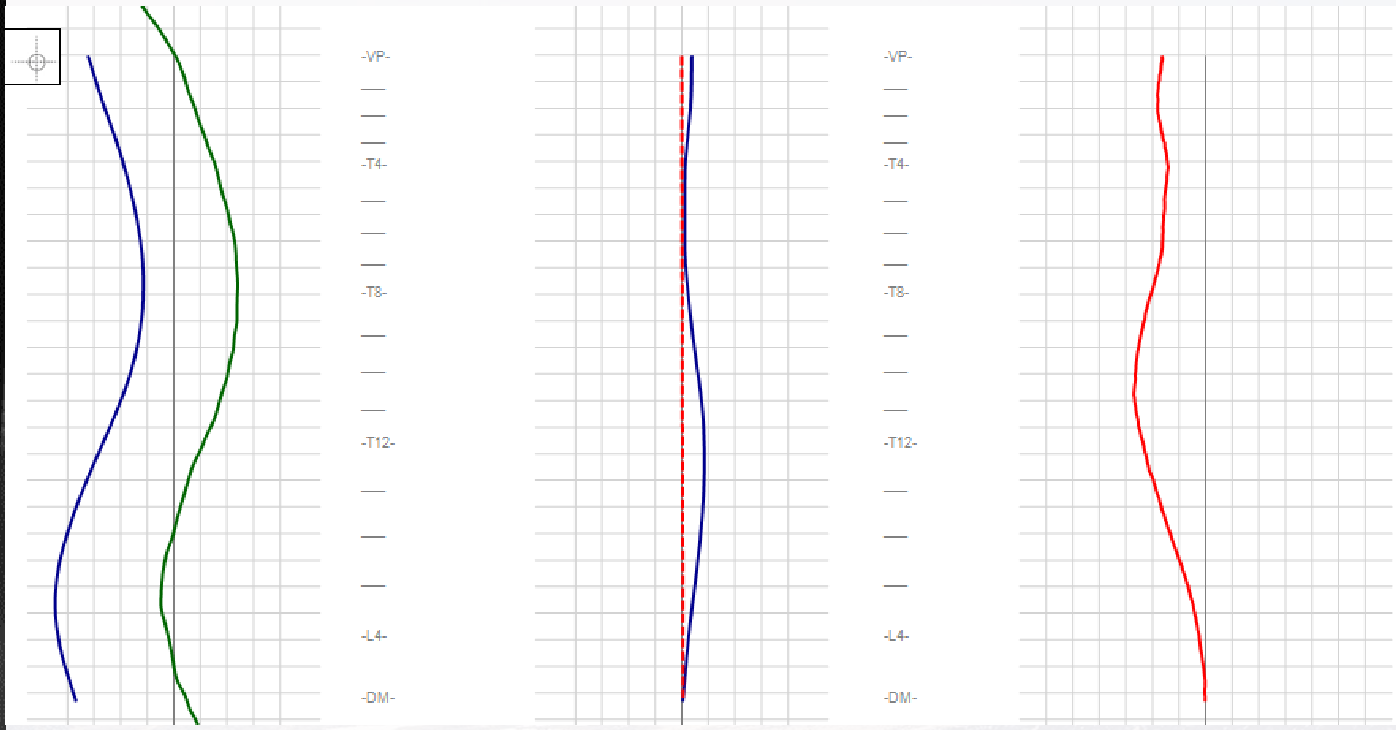


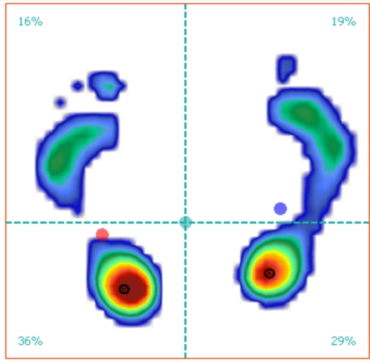
Insole, Shoes, Occlusal splint

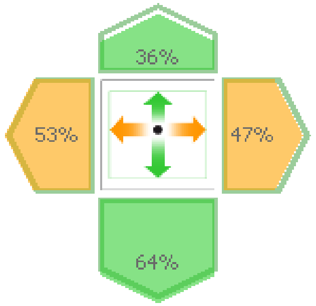
Therapy control and evaluation

Exercises







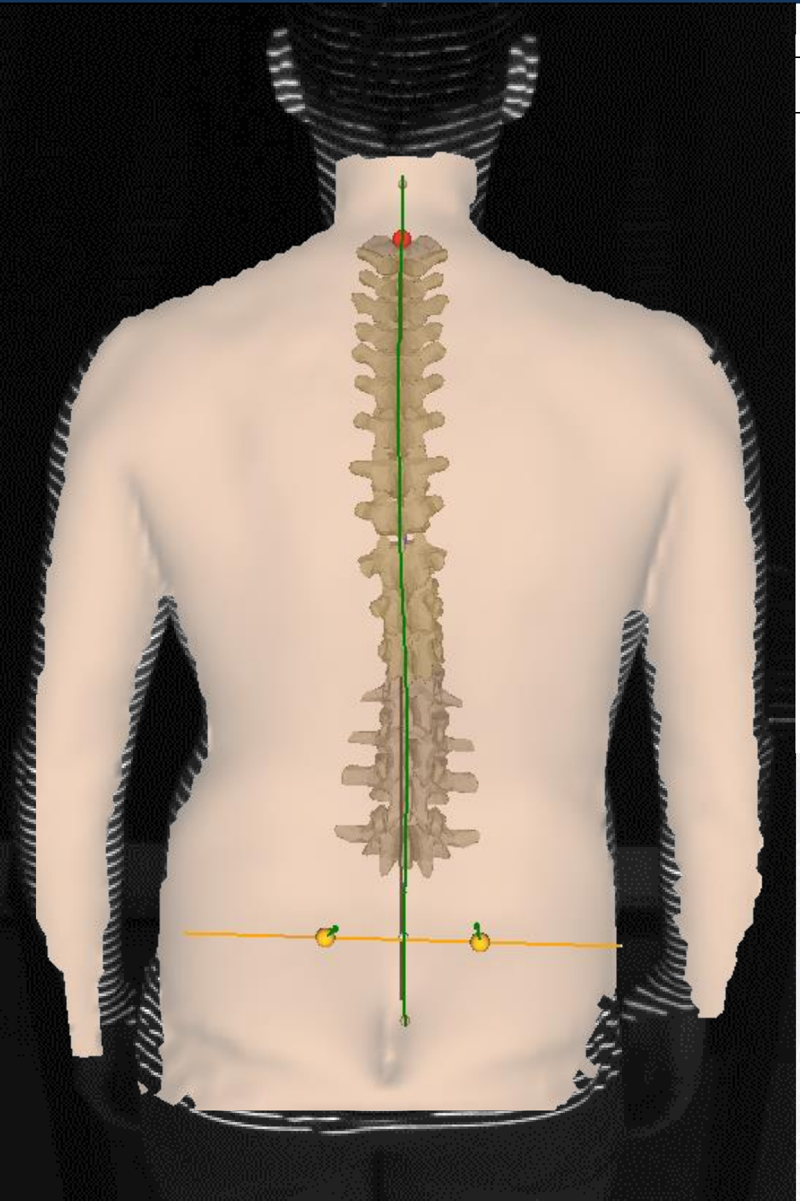


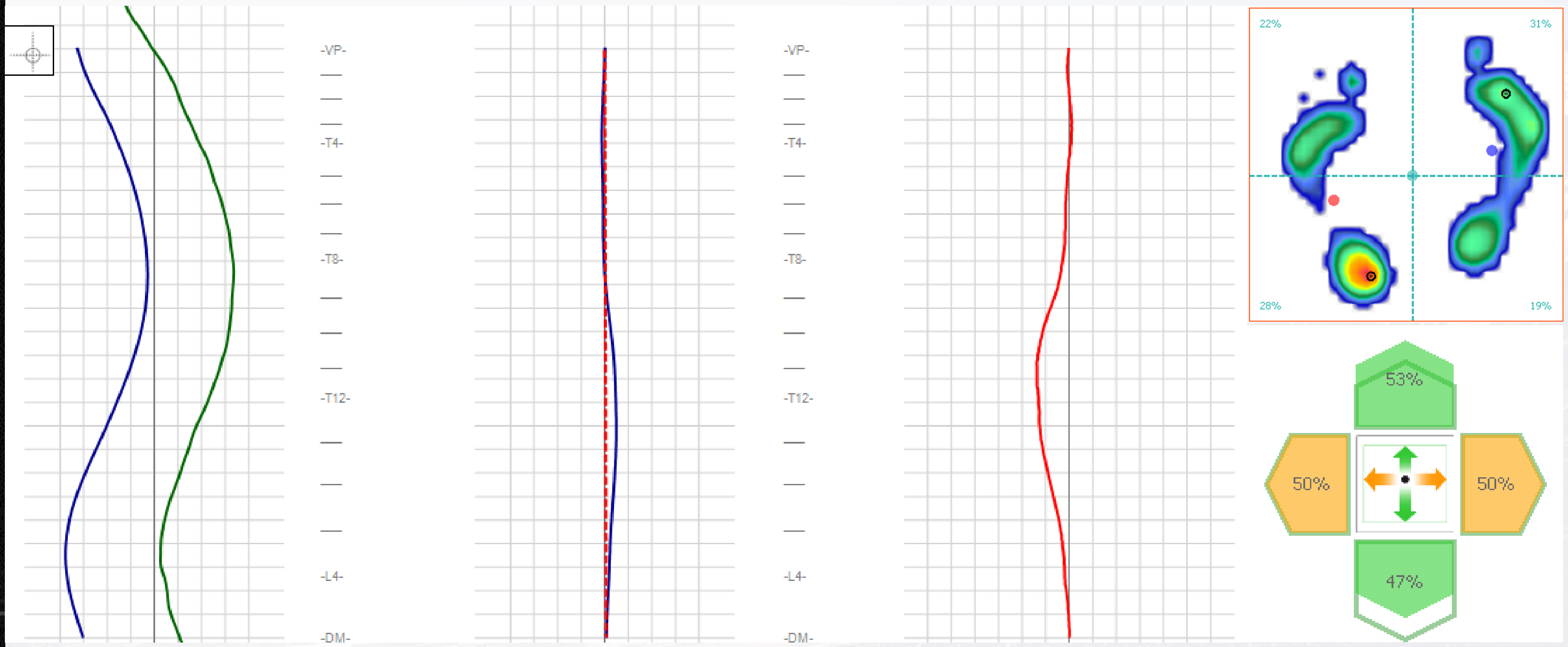
Lumbar block/ acute:

Trunk Inclination:	2° R
Pelvic Obliquity:	10 mm L
Surface Rotation (- max):	11° L

Therapy control and evaluation

Exercises





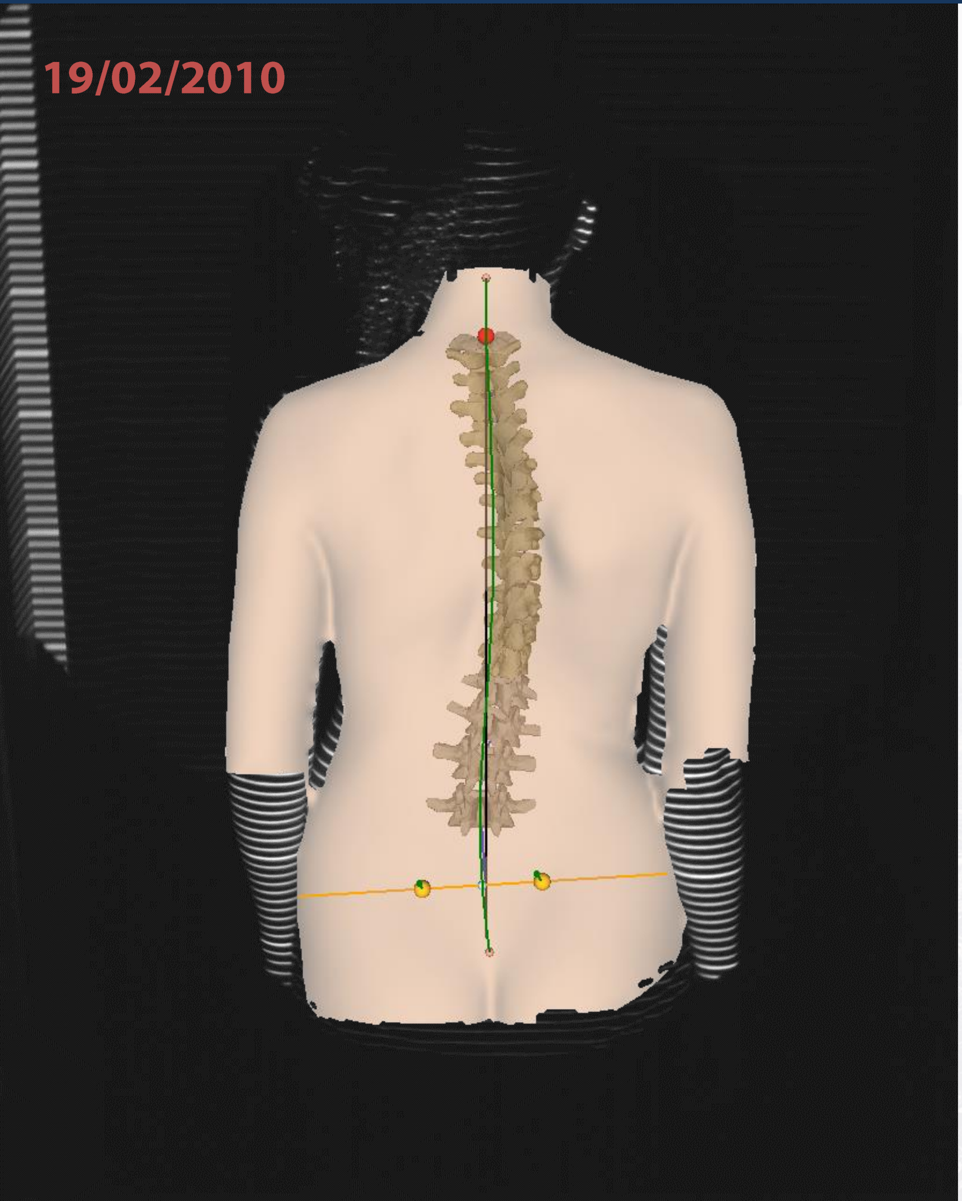
Lumbar block/ after exercises:

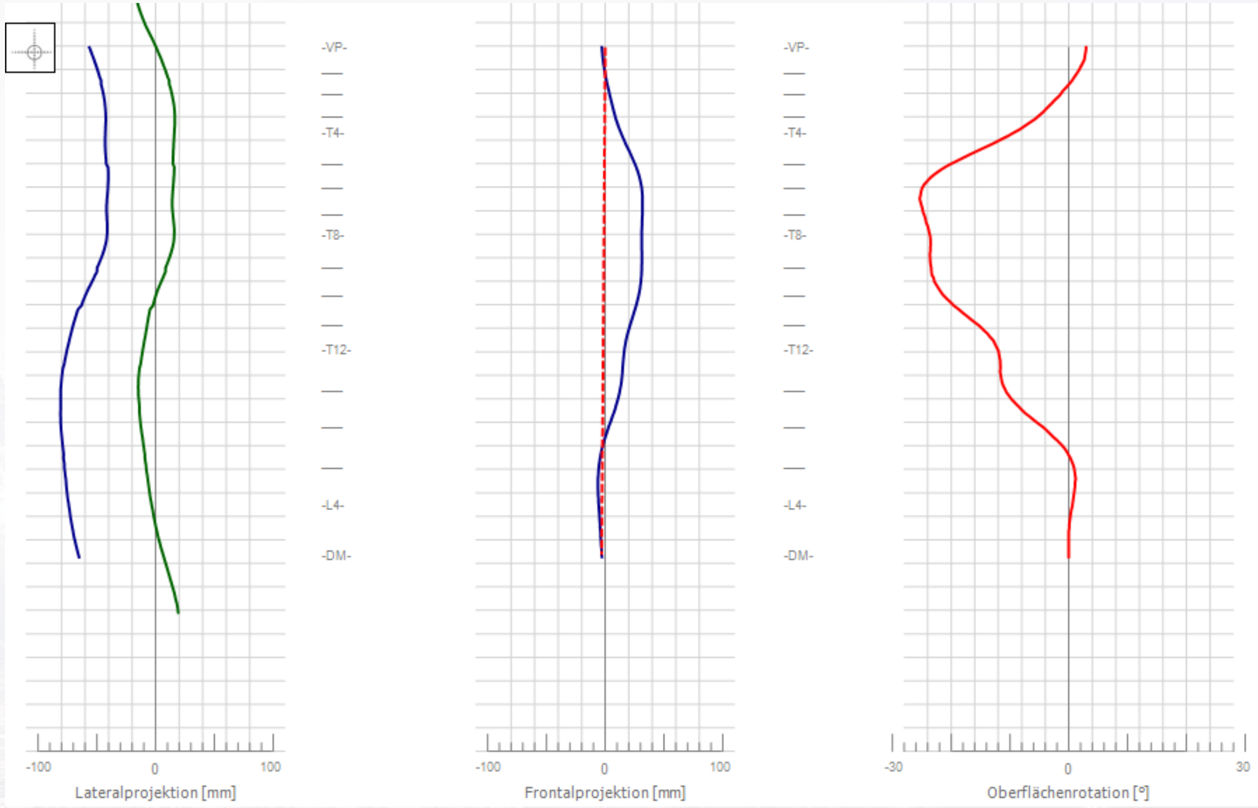
Trunk Inclination:	4° I
Pelvic Obliquity:	4 mm L
Surface Rotation (- max):	6° L

Long term follow-up

Long term follow-up

Scoliosis, fem., *1993

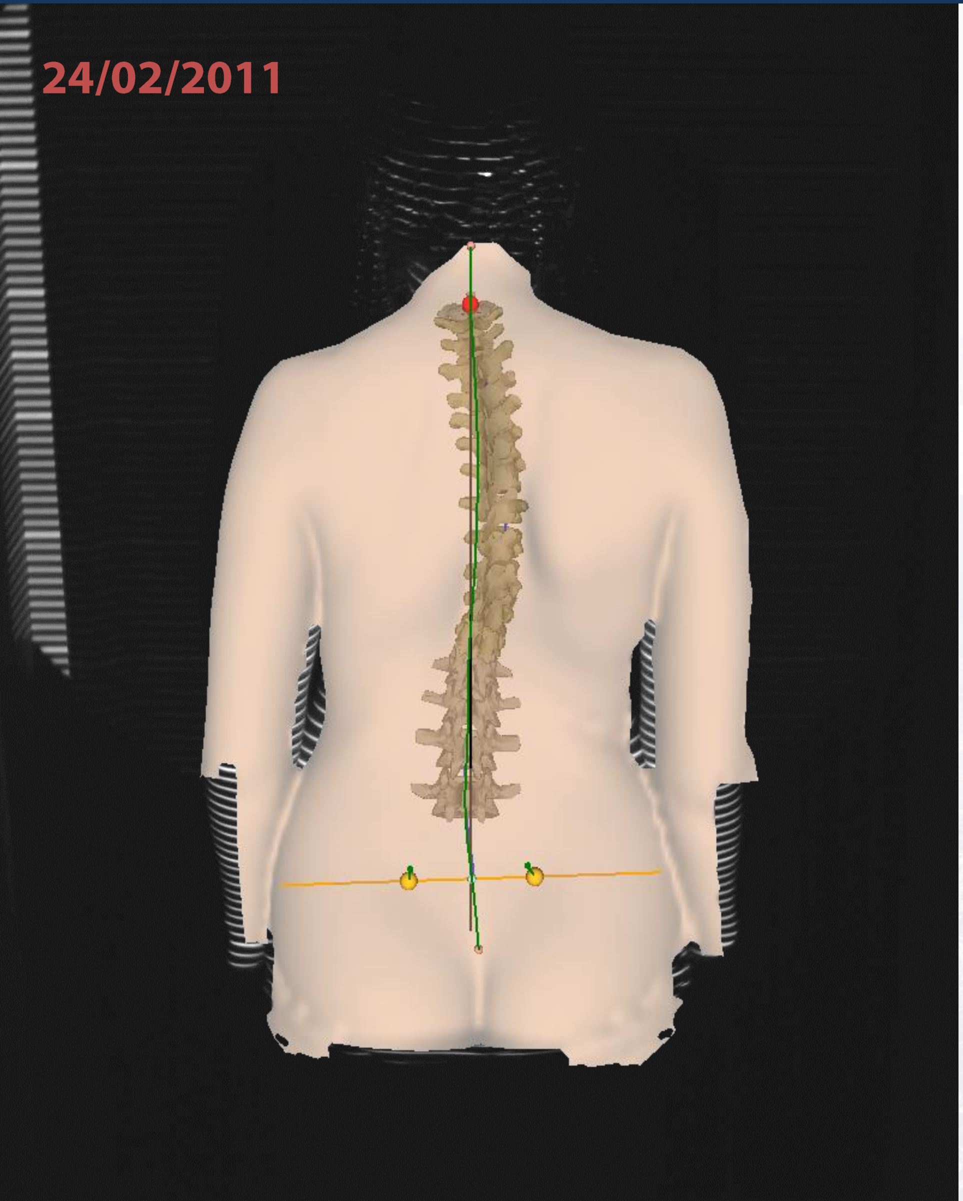


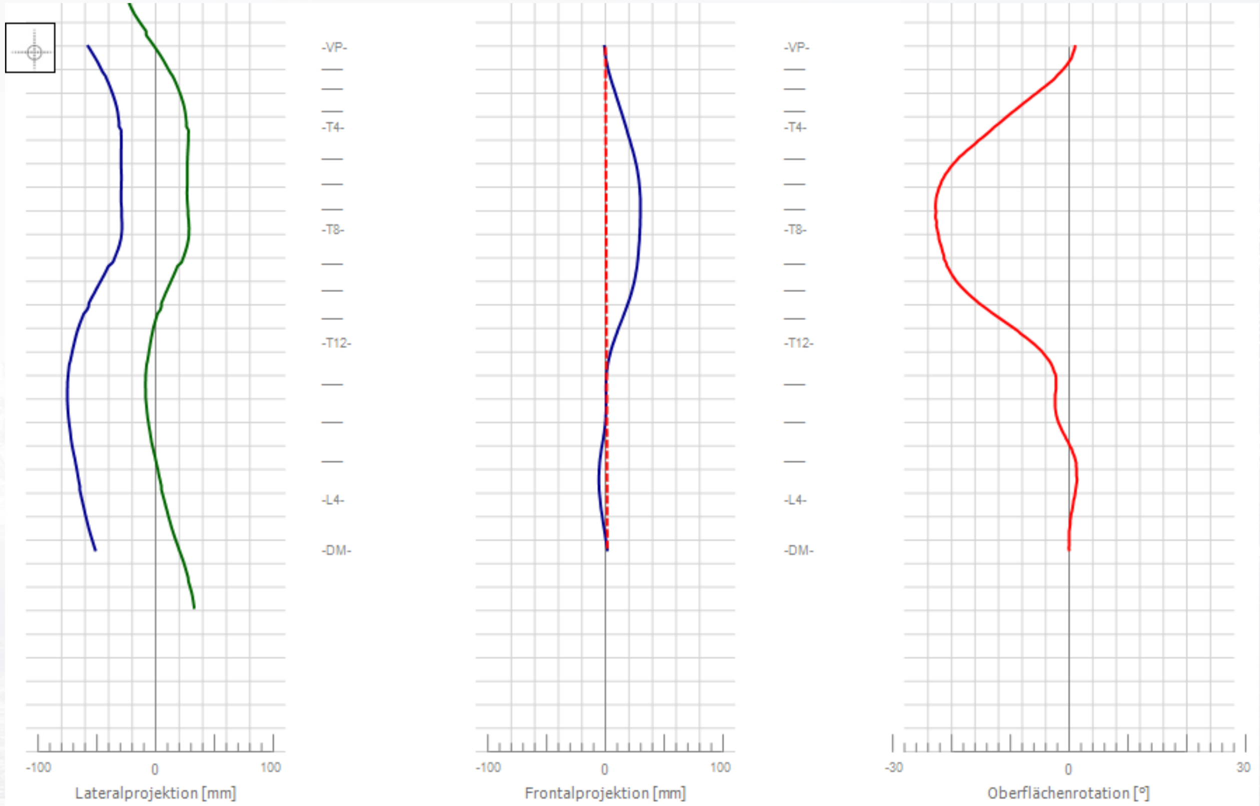


Lateral Deviation (+max):	35 mm R (T6)
Lateral Deviation (- max):	3 mm L (L3)
Surface Rotation (+max):	2° R (L3)
Surface Rotation (- max):	26° L (T6)

Long term follow-up

Scoliosis, fem., *1993



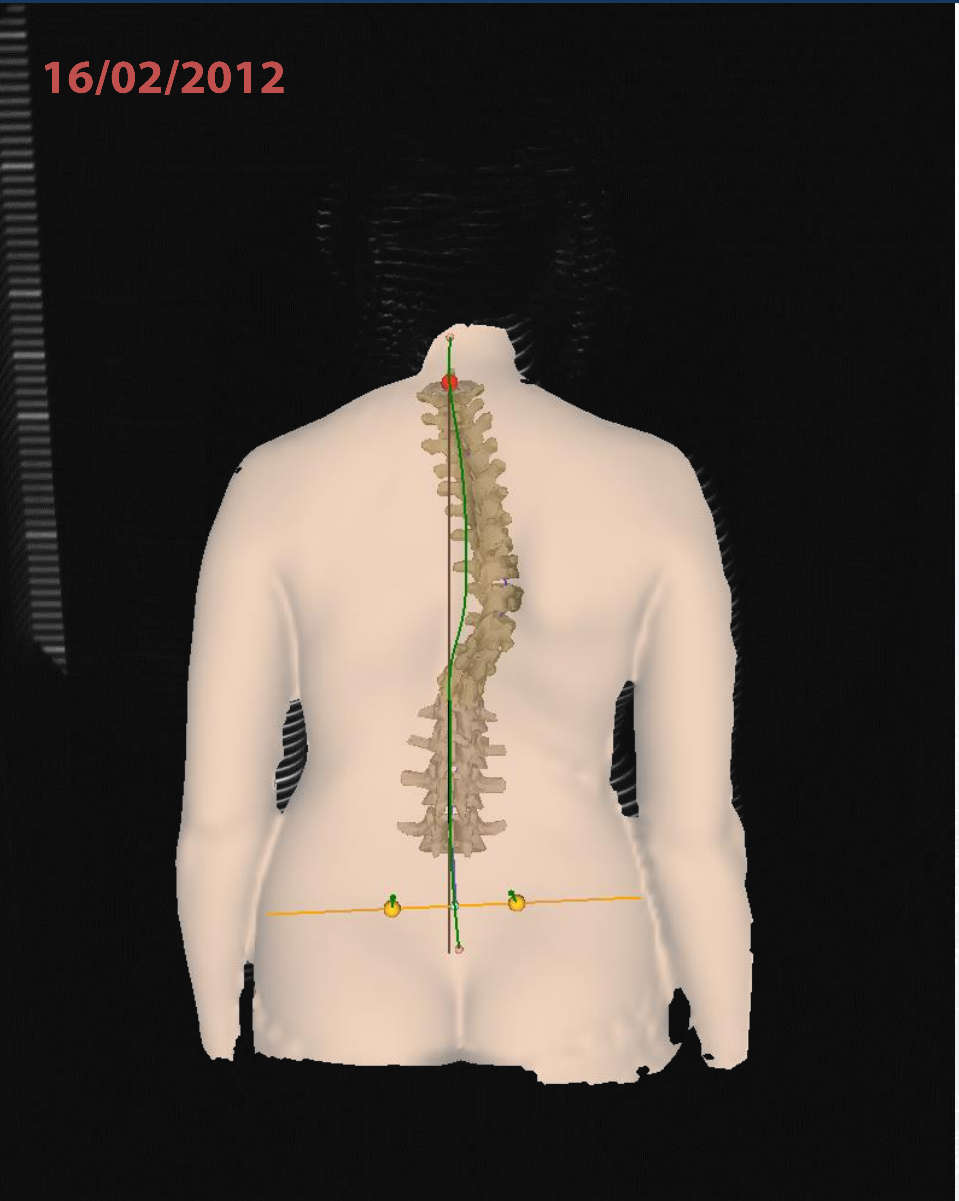


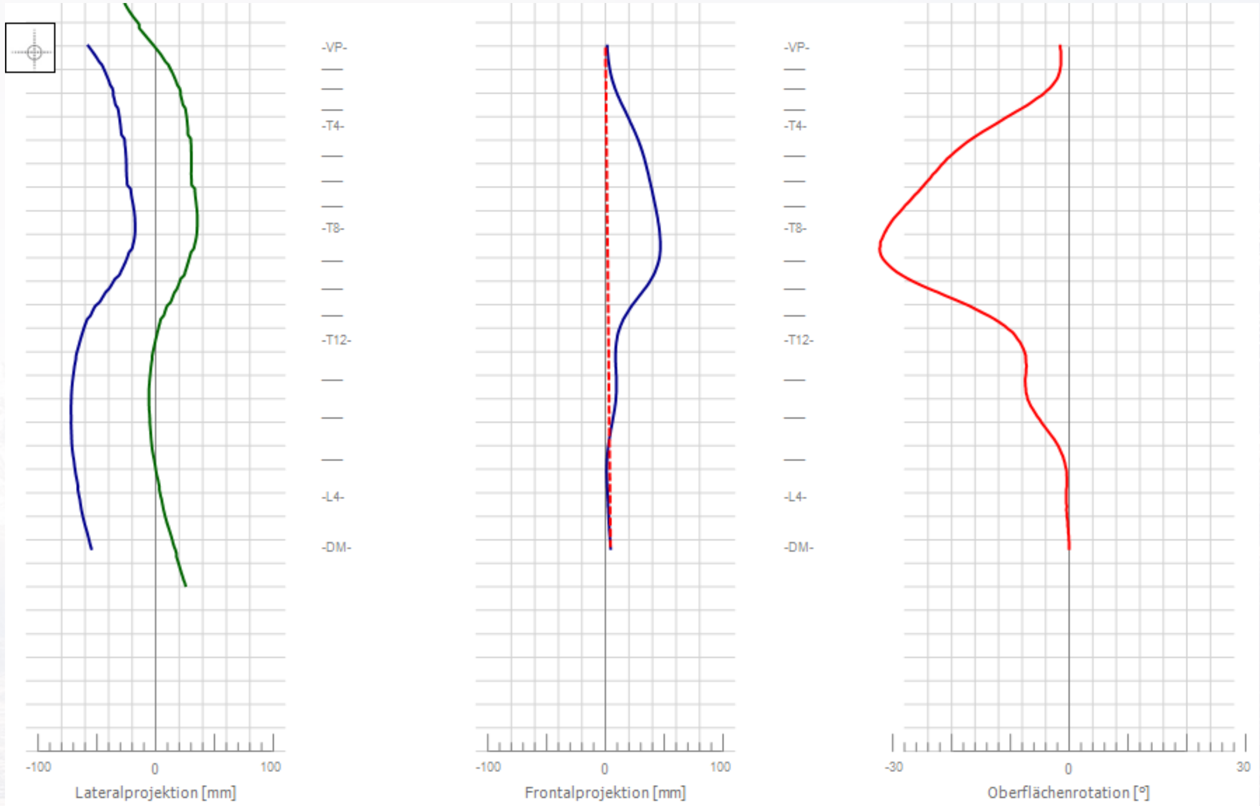
Lateral Deviation (+max): 30 mm R (T7)
Lateral Deviation (- max): 7 mm L (L4)

Surface Rotation (+max): 2° R (L3)
Surface Rotation (- max): 22° L (T7)

Long term follow–up

Scoliosis, fem., *1993



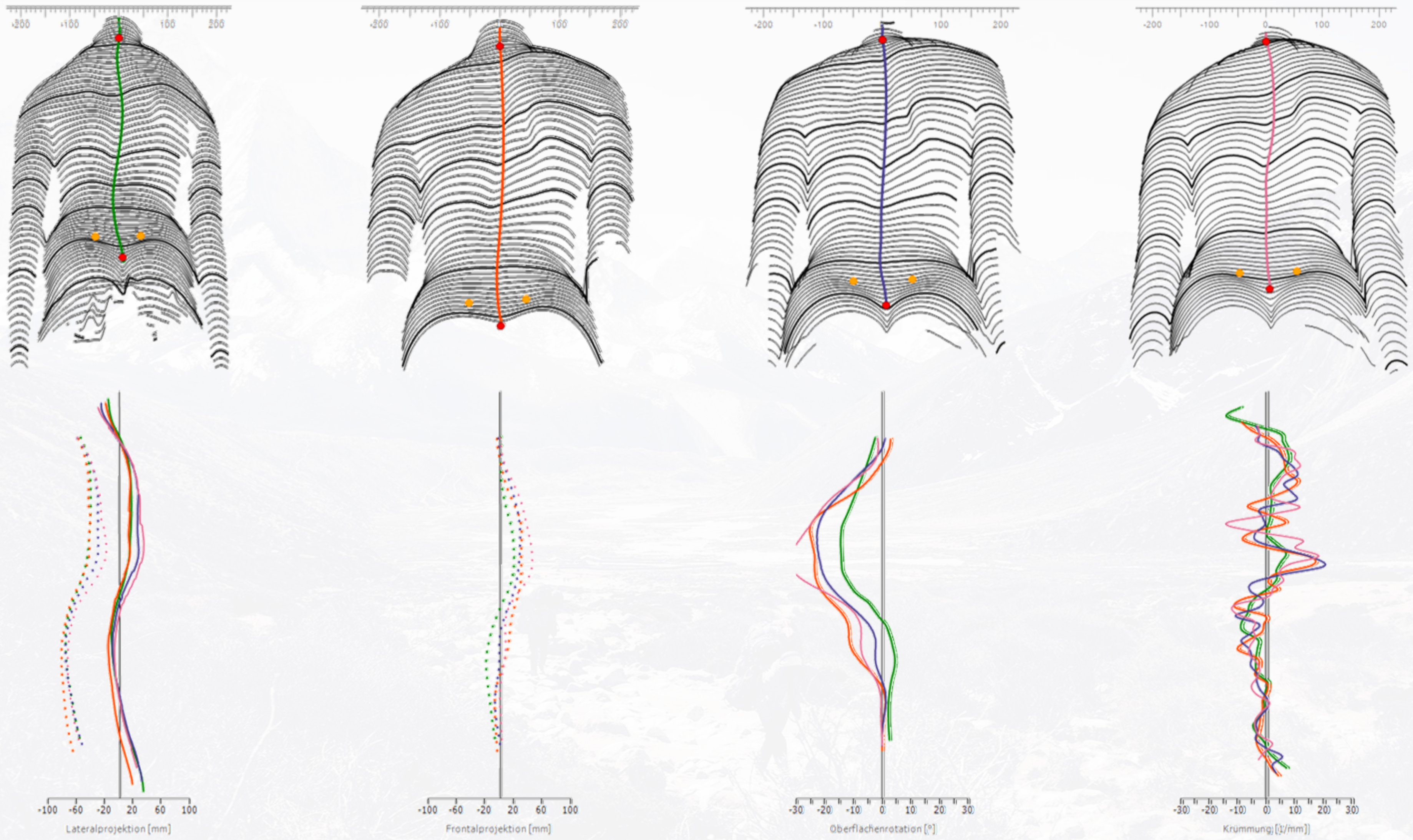


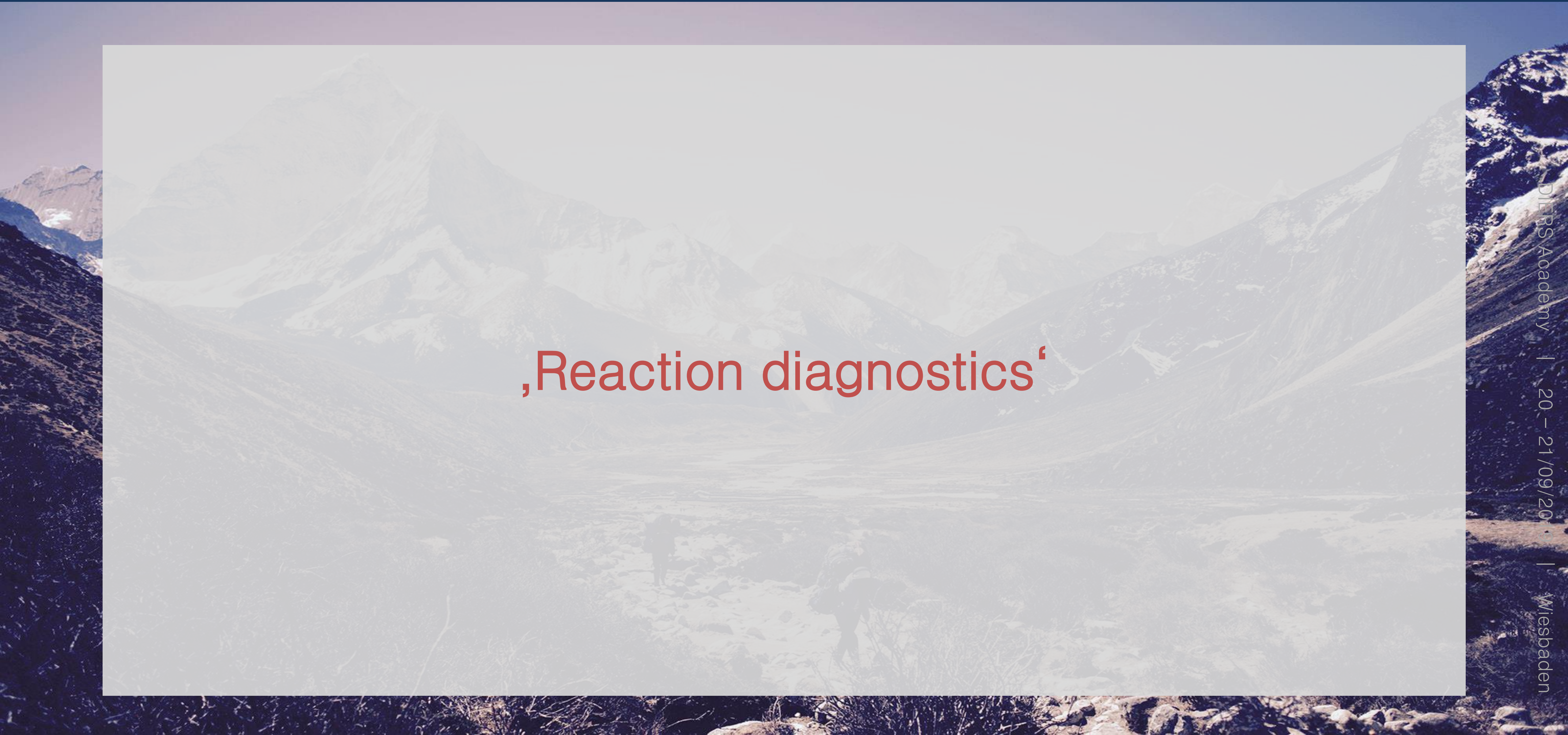
Lateral Deviation (+max):	44 mm R (T9)
Lateral Deviation (- max):	3 mm L (L3)
Surface Rotation (+max):	0°
Surface Rotation (- max):	32° L (T9)

Long term follow-up

Scoliosis, fem., *1993

14/04/2007 | 19/02/2010 | 24/02/2011 | 16/02/2012

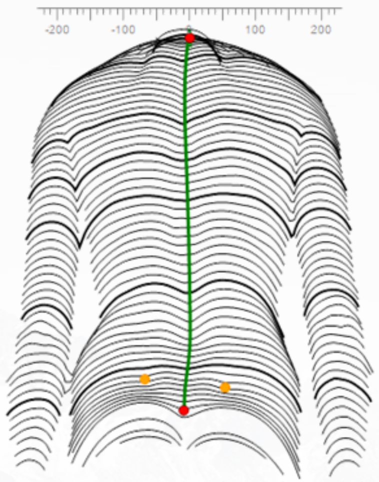


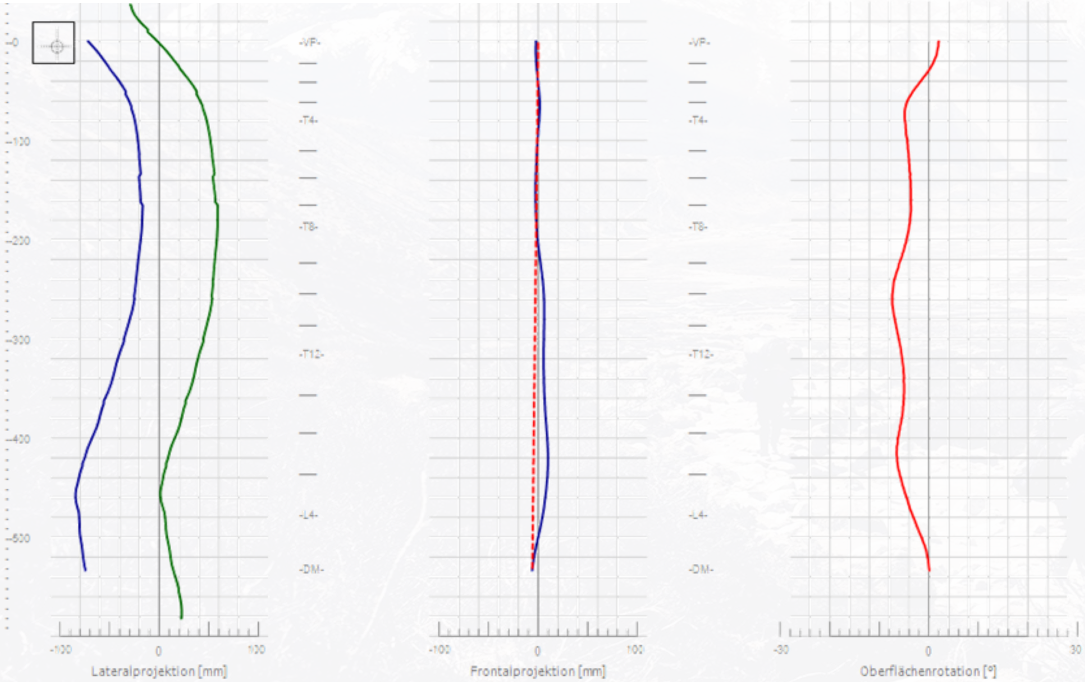


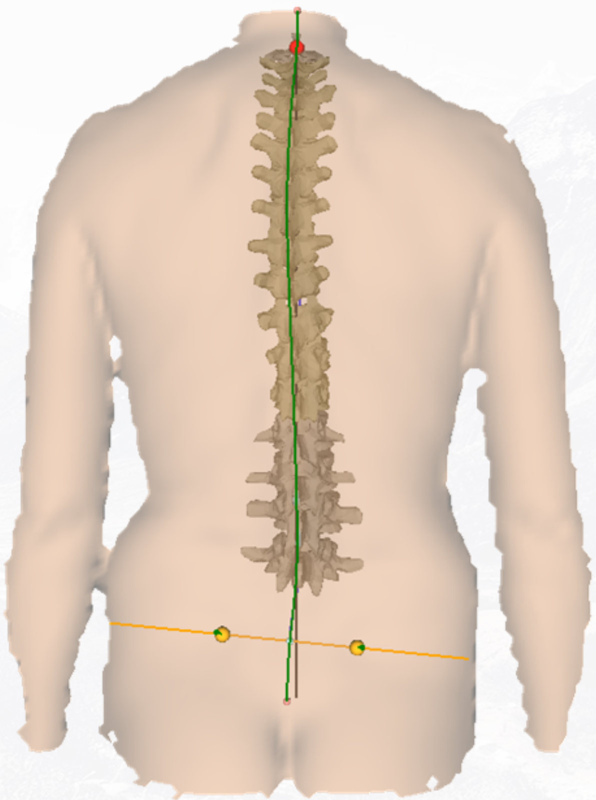
‚Reaction diagnostics'

‚Reaction diagnostics'

Name	Value	Unit
Trunk Length VP-DM	531	mm
Dimple Distance DL-DR	120	mm
Sagittal Imbalance VP-DM	1	° P
Coronal Imbalance VP-DM	6	mm R
Pelvic Obliquity	12	mm L
Pelvic Torsion DL-DR	2	° L
Kyphotic Angle ICT-ITL (max)	62	°
Lordotic Angle ITL-ILS (max)	34	°
Vertebral Rotation (+max)	2	° R
Vertebral Rotation (-max)	7	° L
Apical Deviation VP-DM (+max)	15	mm R
Apical Deviation VP-DM (-max)	0	mm







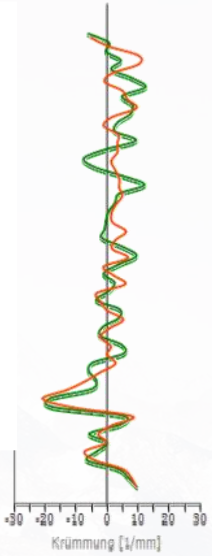
Baseline exam

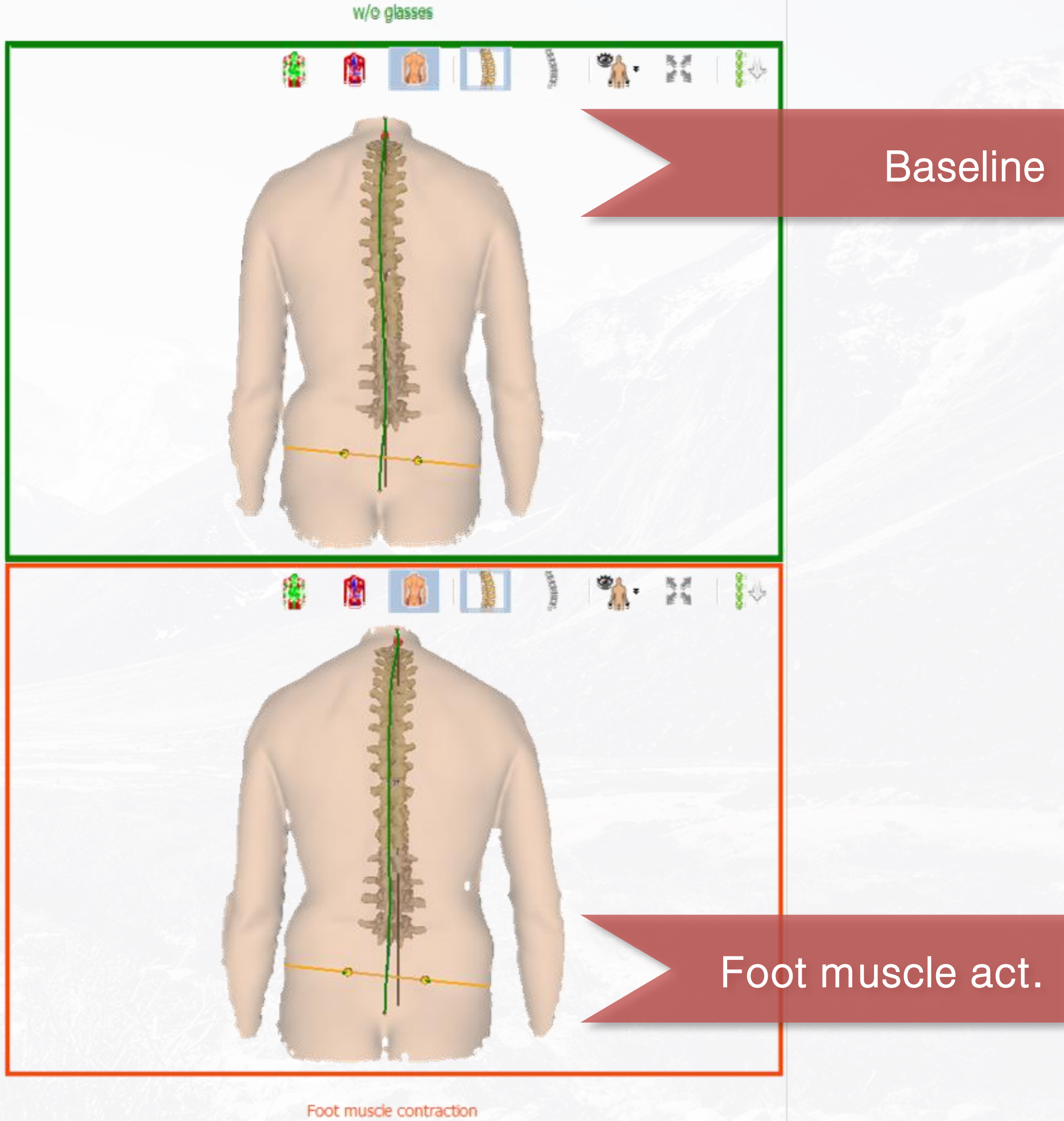
‚Reaction diagnostics‘

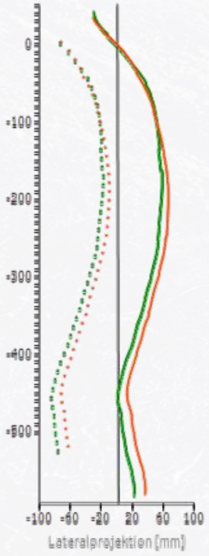
4D average 11.11.2010 12:21 w/o glasses

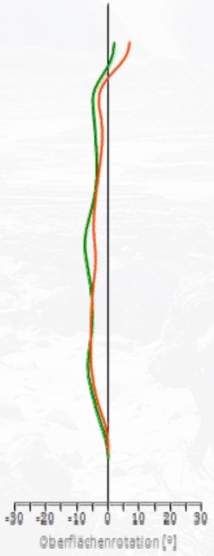
4D average 11.11.2010 12:24 Foot muscl...

Name	Unit	Value	Value	Unit	Diff. [1&2]
Sagittal Imbalance VP-DM	° P	1	2	° P	1 ° P (+100%)
Coronal Imbalance VP-DM	mm R	6	18	mm R	12 mm R (+200%)
Pelvic Obliquity	mm L	12	12	mm L	0 mm L (-0%)
Pelvic Torsion DL-DR	° L	2	0	°	2 ° (-100%)
Kyphotic Angle ICT-ITL (max)	°	62	61	°	1 ° (-2%)
Lordotic Angle ITL-ILS (max)	°	34	33	°	1 ° (-3%)
Vertebral Rotation (+max)	° R	2	6	° R	4 ° R (+200%)
Vertebral Rotation (-max)	° L	7	6	° L	1 ° L (-14%)
Apical Deviation VP-DM (+max)	mm R	15	11	mm R	4 mm R (-27%)
Apical Deviation VP-DM (-max)	mm	0	0	mm	0 mm







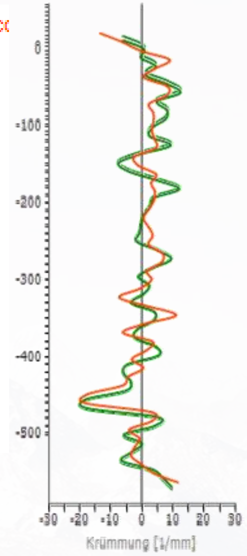


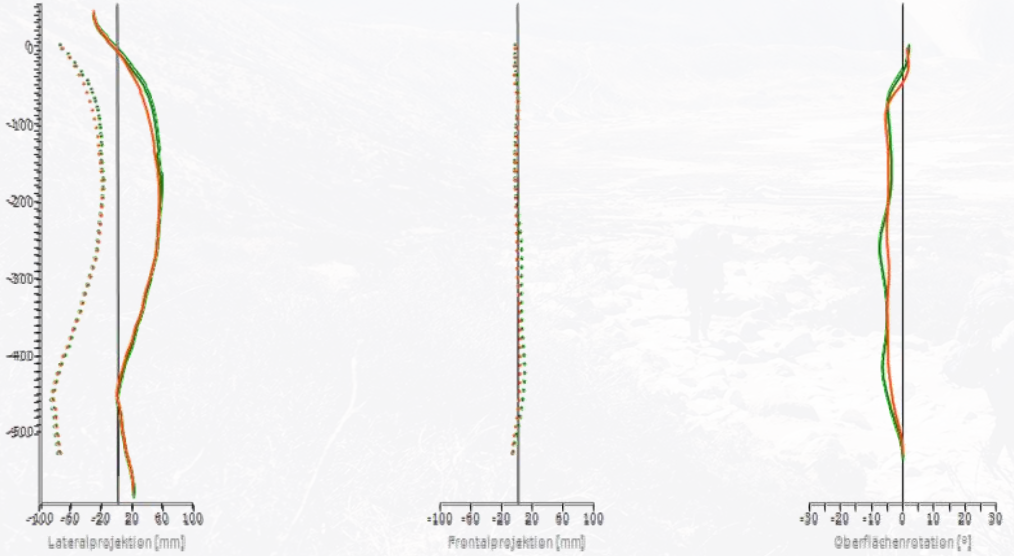
‚Reaction diagnostics‘

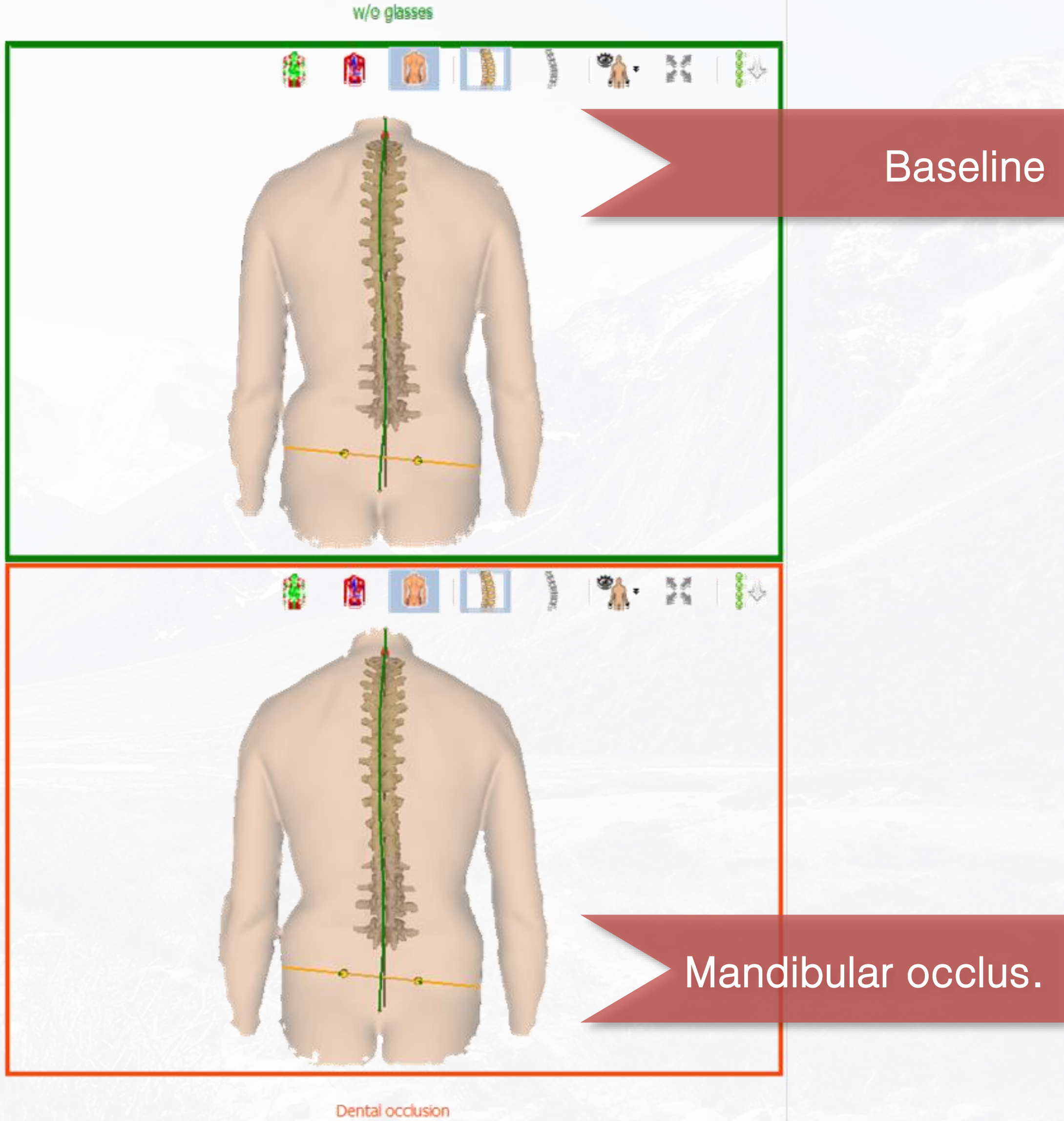
4D average 11.11.2010 12:21 w/o glasses

4D average 11.11.2010 12:27 Dental occ

Name	Unit	Value	Value	Unit	Diff. [1&2]
Sagittal Imbalance VP-DM	° P	1	1	° P	0 ° P (-0%)
Coronal Imbalance VP-DM	mm R	6	6	mm R	0 mm R (-0%)
Pelvic Obliquity	mm L	12	12	mm L	0 mm L (-0%)
Pelvic Torsion DL-DR	° L	2	1	° L	1 ° L (-50%)
Kyphotic Angle ICT-ITL (max)	°	62	59	°	3 ° (-5%)
Lordotic Angle ITL-ILS (max)	°	34	33	°	1 ° (-3%)
Vertebral Rotation (+max)	° R	2	2	° R	0 ° R (-0%)
Vertebral Rotation (-max)	° L	7	6	° L	1 ° L (-14%)
Apical Deviation VP-DM (+max)	mm R	15	9	mm R	6 mm R (-40%)
Apical Deviation VP-DM (-max)	mm	0	2	mm L	2 mm L





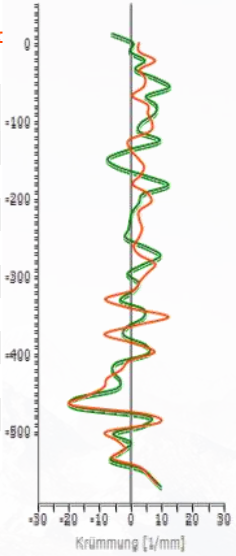


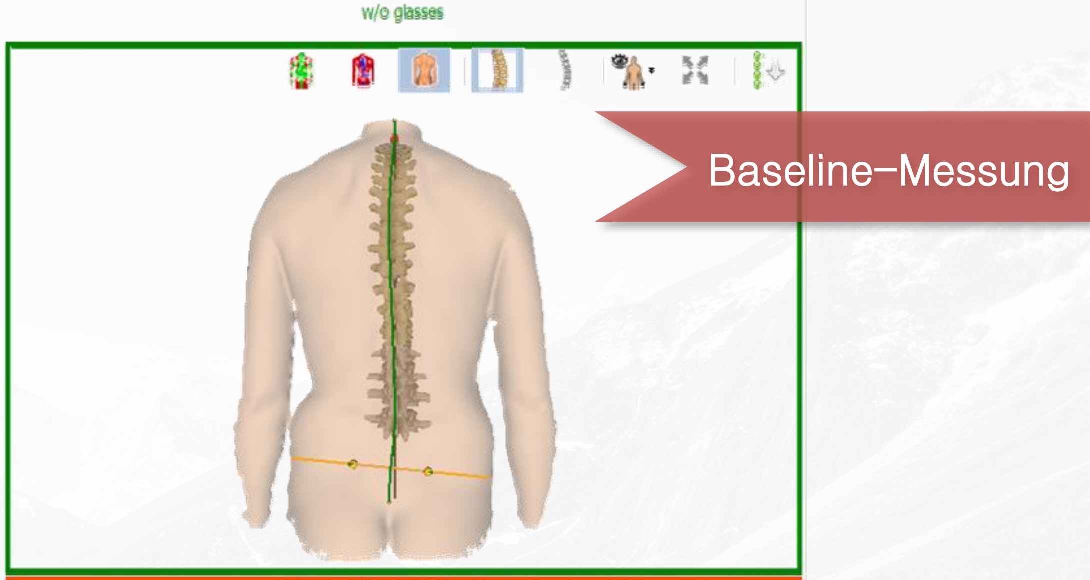
‚Reaction diagnostics‘

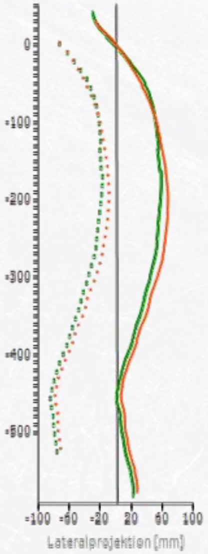
4D average 11.11.2010 12:21 w/o glasses

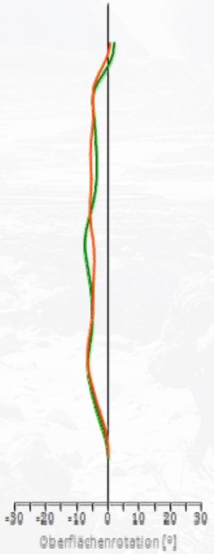
4D average 11.11.2010 12:30 Cotton ro

Name	Unit	Value	Value	Unit	Diff. [1&2]
Sagittal Imbalance VP-DM	° P	1	2	° P	1 ° P (+100%)
Coronal Imbalance VP-DM	mm R	6	4	mm R	2 mm R (-33%)
Pelvic Obliquity	mm L	12	12	mm L	0 mm L (-0%)
Pelvic Torsion DL-DR	° L	2	0	°	2 ° (-100%)
Kyphotic Angle ICT-ITL (max)	°	62	60	°	2 ° (-3%)
Lordotic Angle ITL-ILS (max)	°	34	36	°	2 ° (+6%)
Vertebral Rotation (+max)	° R	2	0	°	2 ° (-100%)
Vertebral Rotation (-max)	° L	7	7	° L	0 ° L (-0%)
Apical Deviation VP-DM (+max)	mm R	15	14	mm R	1 mm R (-7%)
Apical Deviation VP-DM (-max)	mm	0	0	mm	0 mm









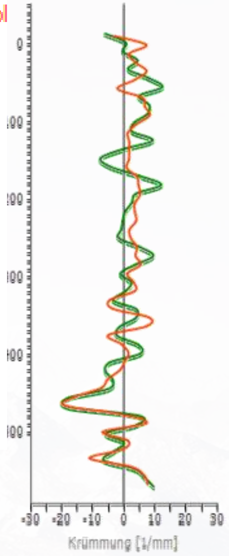
Cotton rolls slightly fixated by molars on both sides

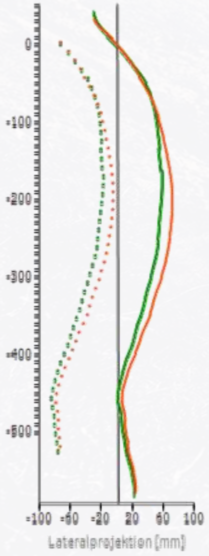
‚Reaction diagnostics‘

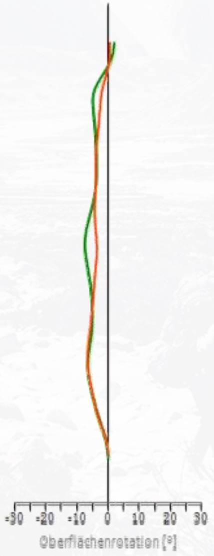
4D average 11.11.2010 12:21 w/o glasses

4D average 11.11.2010 12:31 Cotton rol

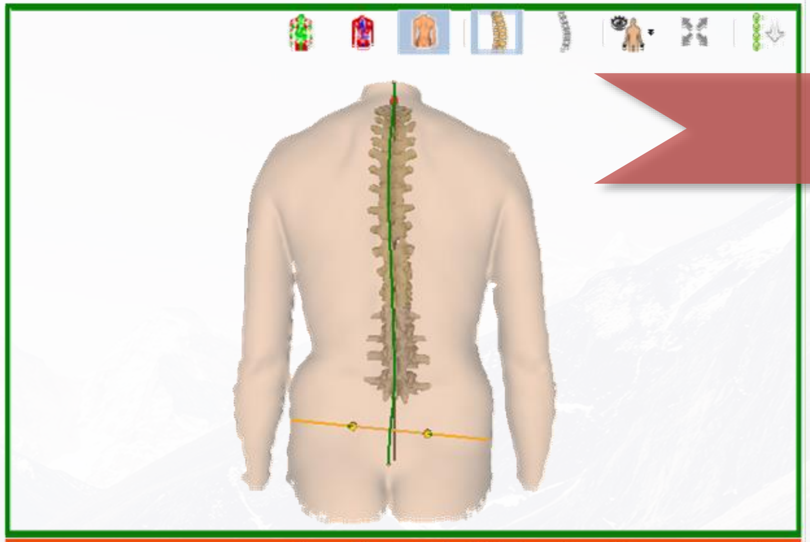
Name	Unit	Value	Value	Unit	Diff. [1&2]
Sagittal Imbalance VP-DM	° P	1	1	° P	0 ° P (-0%)
Coronal Imbalance VP-DM	mm R	6	3	mm R	3 mm R (-50%)
Pelvic Obliquity	mm L	12	12	mm L	0 mm L (-0%)
Pelvic Torsion DL-DR	° L	2	3	° L	1 ° L (+50%)
Kyphotic Angle ICT-ITL (max)	°	62	64	°	2 ° (+3%)
Lordotic Angle ITL-ILS (max)	°	34	36	°	2 ° (+6%)
Vertebral Rotation (+max)	° R	2	0	°	2 ° (-100%)
Vertebral Rotation (-max)	° L	7	7	° L	0 ° L (-0%)
Apical Deviation VP-DM (+max)	mm R	15	13	mm R	2 mm R (-13%)
Apical Deviation VP-DM (-max)	mm	0	0	mm	0 mm







w/o glasses



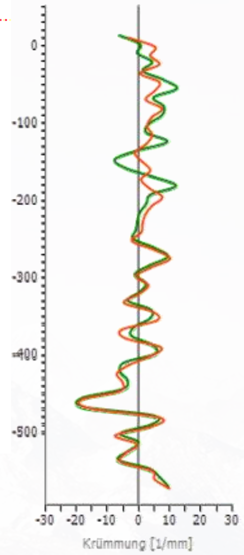
Baseline

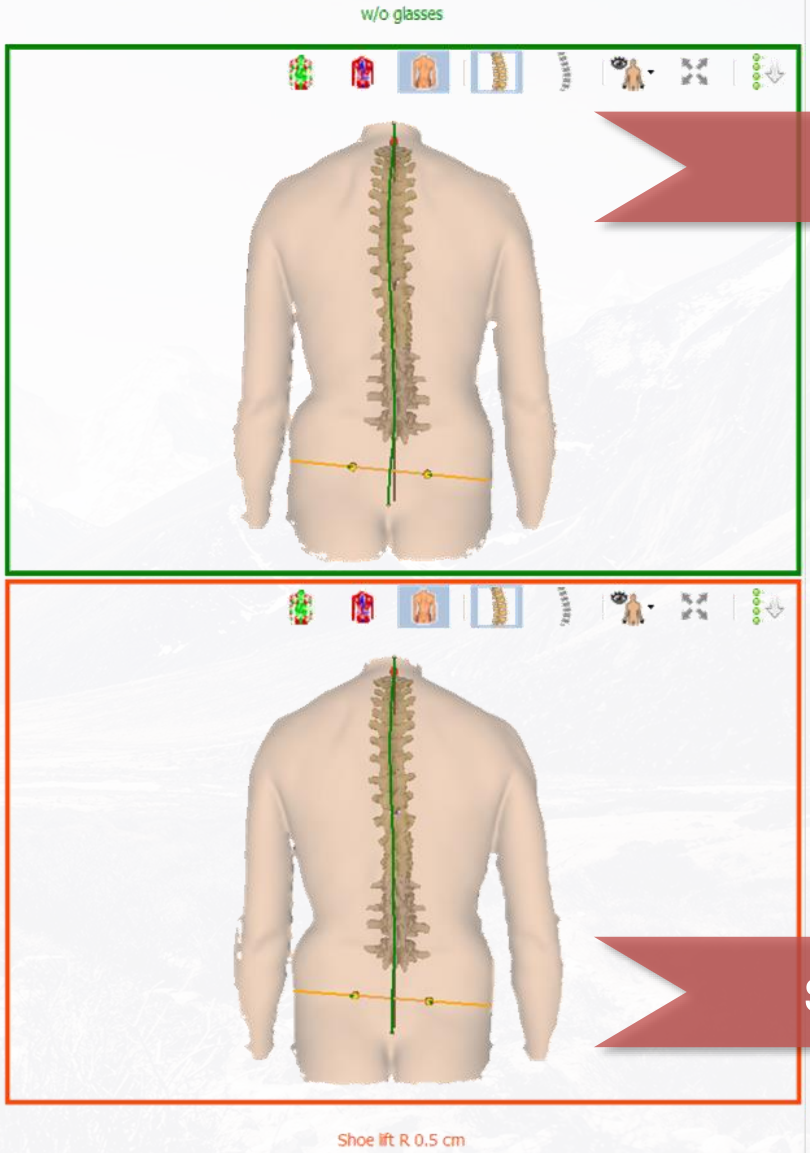
Cotton roll Incisors

Cotton roll slightly fixated by central incisor

‚Reaction diagnostics‘

Name	Unit	Value	Value	Unit	Diff. [1&2]
	4D average 11.11.2010 12:21 w/o glasses		4D average 11.11.2010 12:08 Shoe lift ..		
Sagittal Imbalance VP-DM	° P	1	2	° P	1 ° P (+100%)
Coronal Imbalance VP-DM	mm R	6	3	mm R	3 mm R (-50%)
Pelvic Obliquity	mm L	12	9	mm L	3 mm L (-25%)
Pelvic Torsion DL-DR	° L	2	0	°	2 ° (-100%)
Kyphotic Angle ICT-ITL (max)	°	62	61	°	1 ° (-2%)
Lordotic Angle ITL-ILS (max)	°	34	35	°	1 ° (+3%)
Vertebral Rotation (+max)	° R	2	2	° R	0 ° R (-0%)
Vertebral Rotation (-max)	° L	7	6	° L	1 ° L (-14%)
Apical Deviation VP-DM (+max)	mm R	15	12	mm R	3 mm R (-20%)
Apical Deviation VP-DM (-max)	mm	0	1	mm L	1 mm L



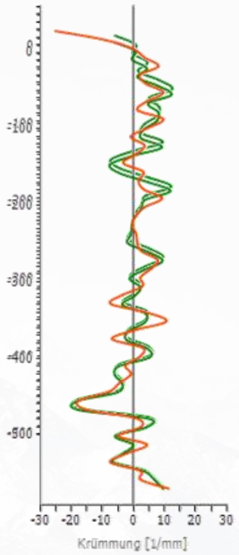


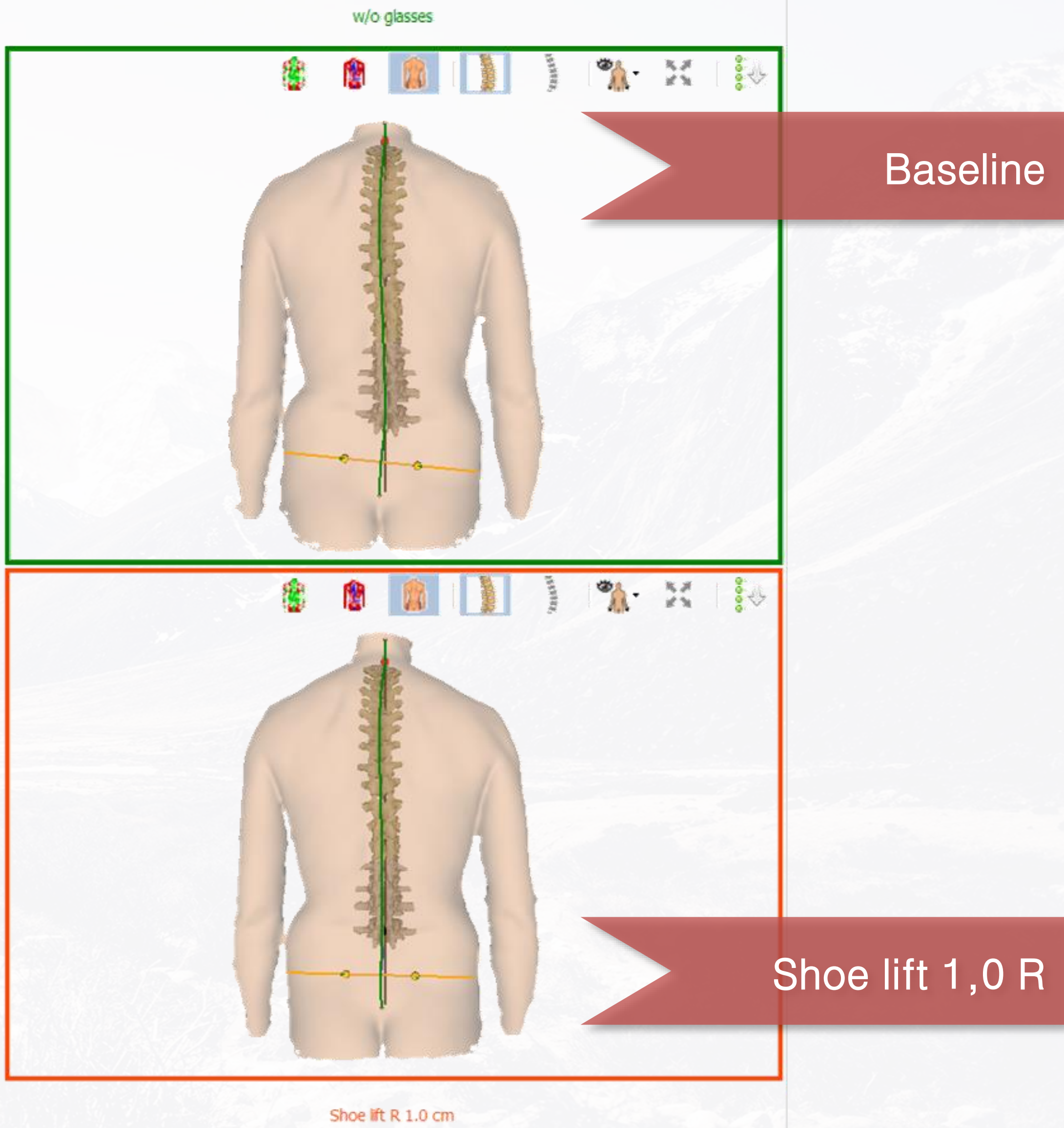
Baseline

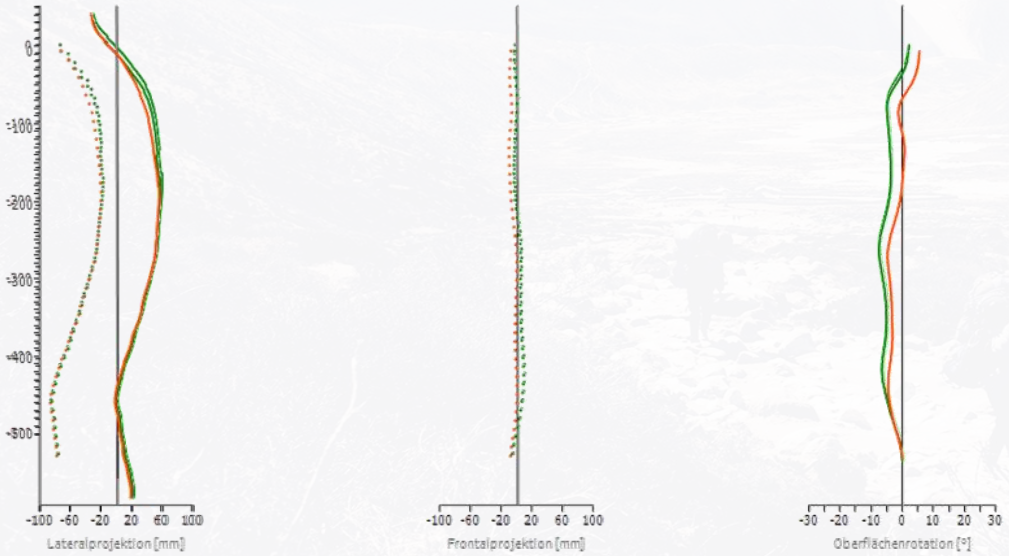
Shoelift 0,5 R

‚Reaction diagnostics'

	4D average 11.11.2010 12:21 w/o glasses		4D average 11.11.2010 12:09 Shoe lift .		
Name	Unit	Value	Value	Unit	Diff. [1&2]
Sagittal Imbalance VP-DM	° P	1	1	° P	0 ° P (-0%)
Coronal Imbalance VP-DM	mm R	6	8	mm R	2 mm R (+33%)
Pelvic Obliquity	mm L	12	3	mm L	9 mm L (-75%)
Pelvic Torsion DL-DR	° L	2	3	° L	1 ° L (+50%)
Kyphotic Angle ICT-ITL (max)	°	62	62	°	0 ° (-0%)
Lordotic Angle ITL-ILS (max)	°	34	34	°	0 ° (-0%)
Vertebral Rotation (+max)	° R	2	6	° R (~C7)	4 ° R (+200%)
Vertebral Rotation (-max)	° L	7	5	° L (~T10)	2 ° L (-29%)
Apical Deviation VP-DM (+max)	mm R	15	9	mm R (~L3)	6 mm R (-40%)
Apical Deviation VP-DM (-max)	mm	0	2	mm L (~T6)	2 mm L





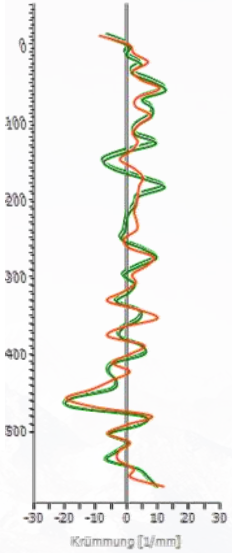


‚Reaction diagnostics‘

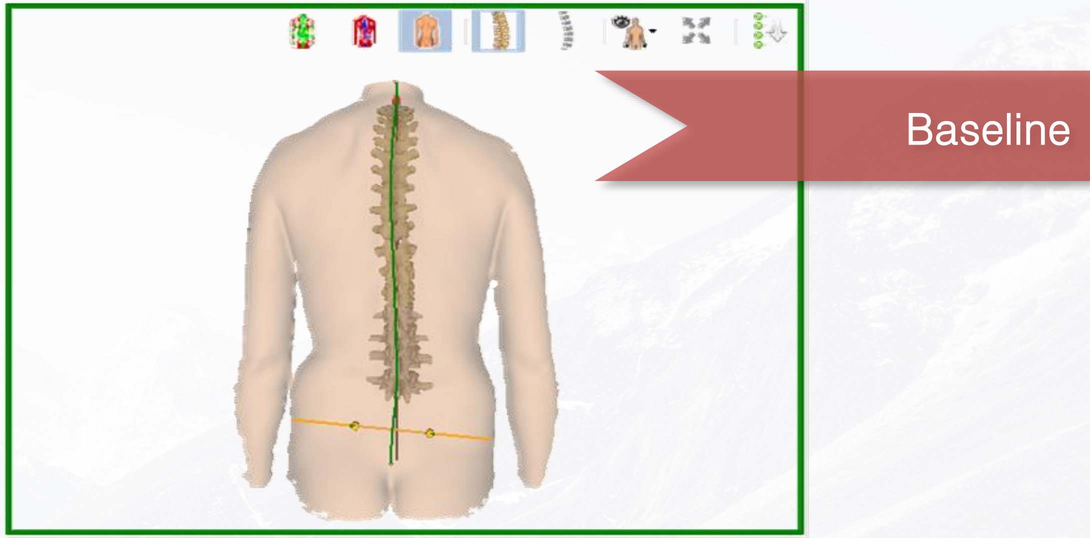
4D average 11.11.2010 12:21 w/o glasses

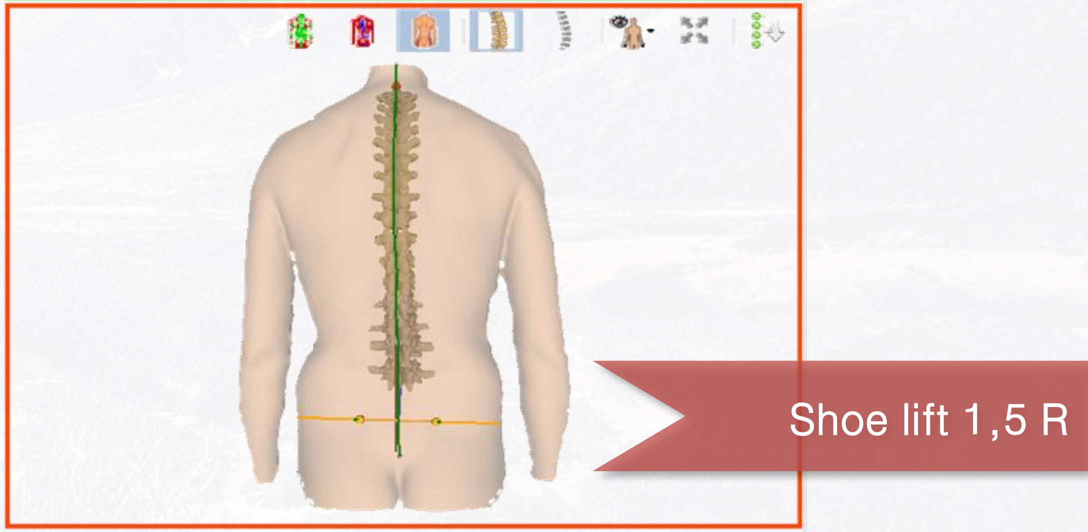
4D average 11.11.2010 12:16 Shoe lift ...

Name	Unit	Value	Value	Unit	Diff. [1&2]
Sagittal Imbalance VP-DM	° P	1	2	° P	1 ° P (+100%)
Coronal Imbalance VP-DM	mm R	6	3	mm L	9 mm L (-150%)
Pelvic Obliquity	mm L	12	3	mm L	9 mm L (-75%)
Pelvic Torsion DL-DR	° L	2	1	° R	3 ° R (-150%)
Kyphotic Angle ICT-ITL (max)	°	62	58	°	4 ° (-6%)
Lordotic Angle ITL-ILS (max)	°	34	33	°	1 ° (-3%)
Vertebral Rotation (+max)	° R	2	0	°	2 ° (-100%)
Vertebral Rotation (-max)	° L	7	6	° L	1 ° L (-14%)
Apical Deviation VP-DM (+max)	mm R	15	8	mm R	7 mm R (-47%)
Apical Deviation VP-DM (-max)	mm	0	1	mm L	1 mm L

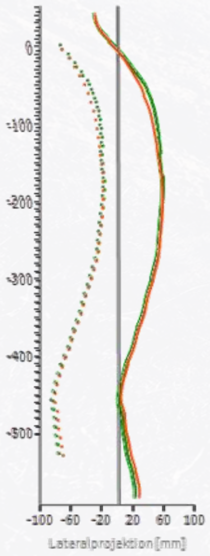


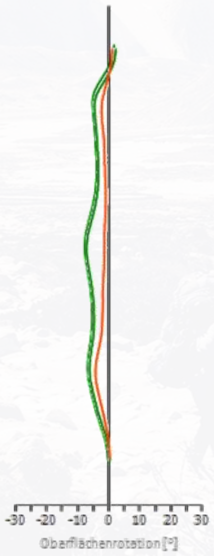
w/o glasses

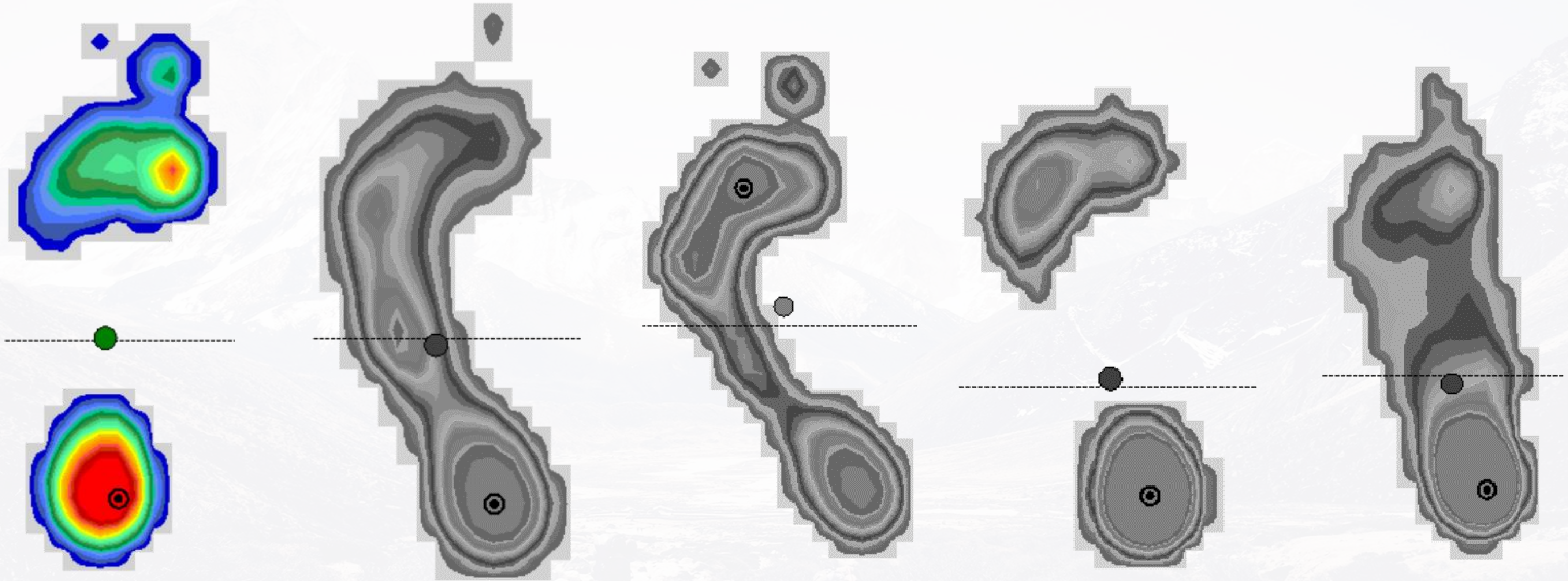




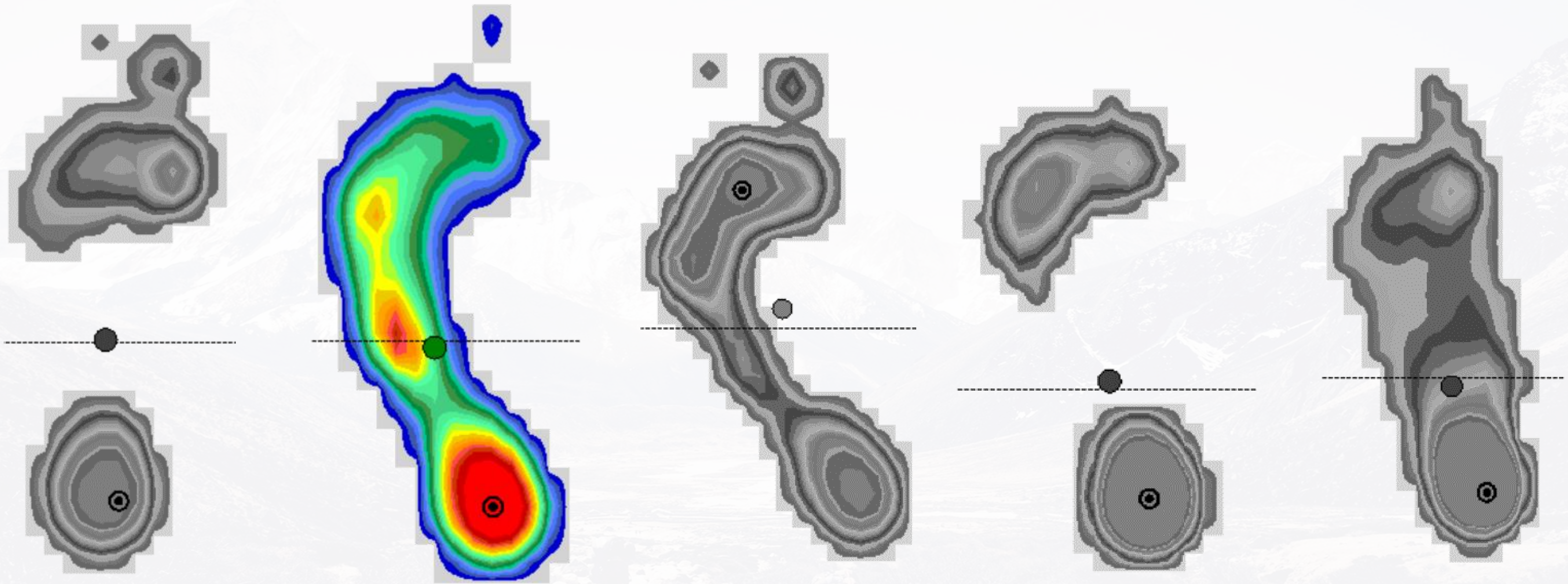
Shoe lift R 1.5 cm



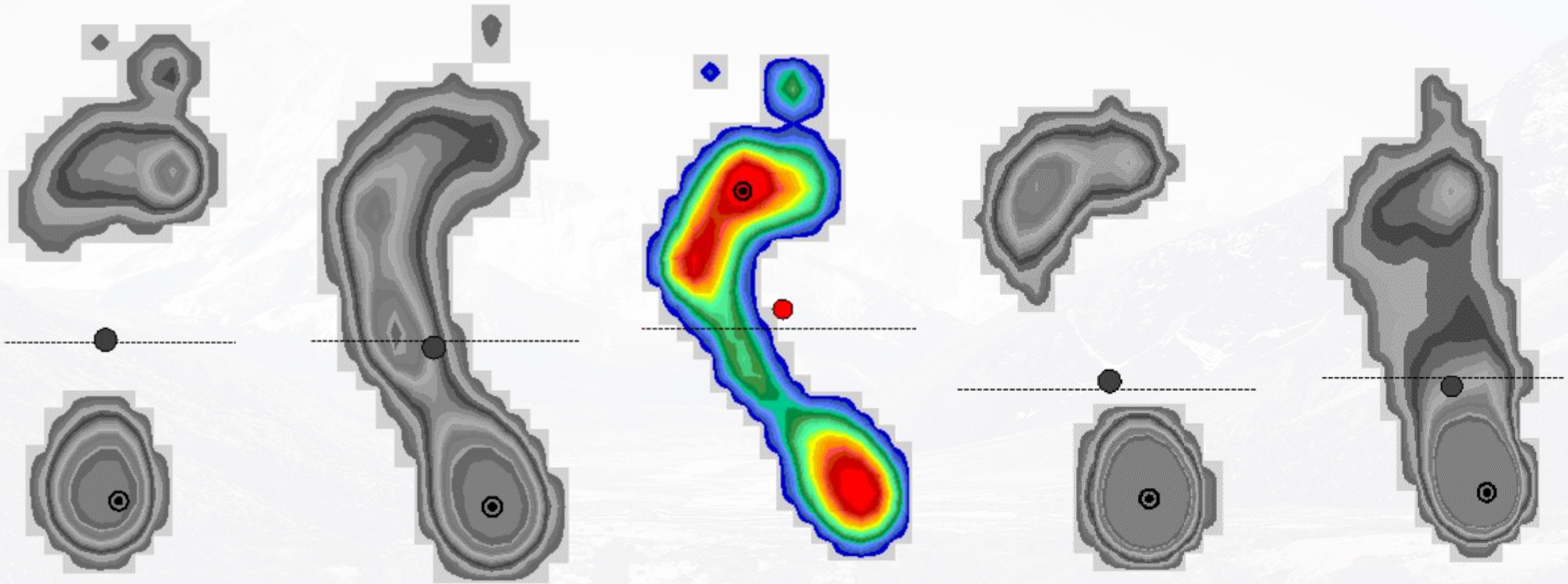




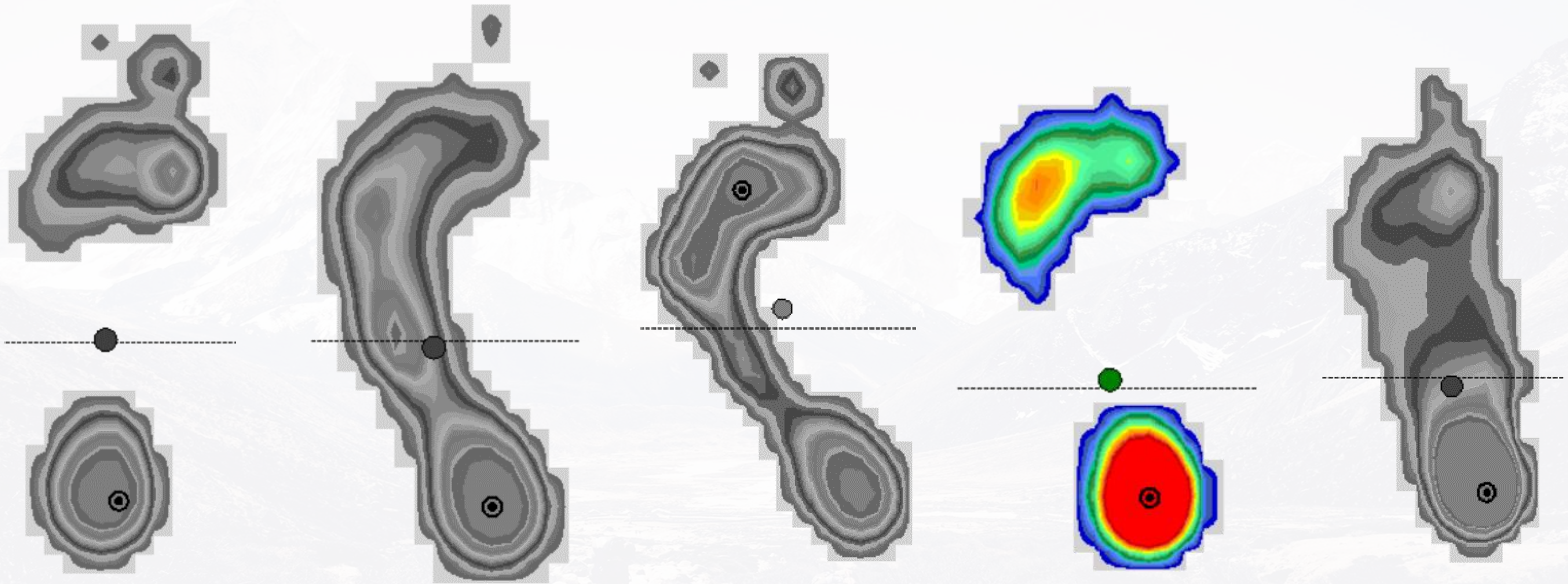
Foot eversion



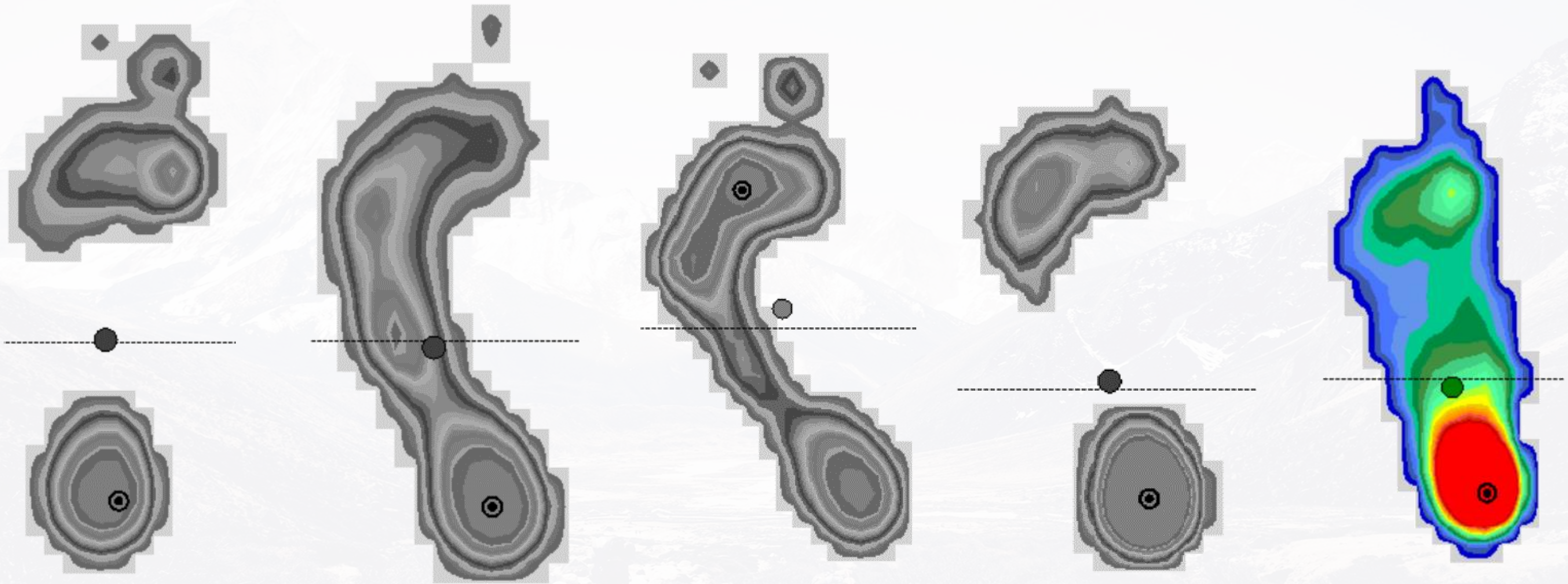
Low arch



Splay foot



High arch

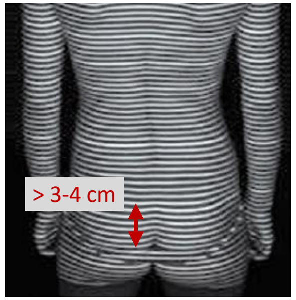


Flat foot

Posture Lab – Static Spine Measurement

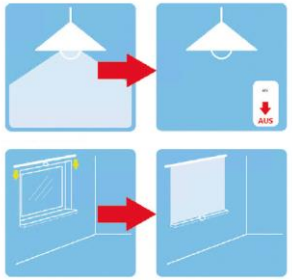
Practical Application

Preparation



Surroundings:

- Set Up DICAM
- Room Conditions



Patient:

- Take shoes off
- Take all clothes off, except underpants
- Lower the underpants half way down buttocks
- Tie up hair
- Jewelry off (Earrings, Necklaces, etc.)
- Abnormalities on the skin surface?

Patient Positioning

(1) Habitual Position
(2) Slightly lowered view
(3) Arms relaxed besides body
(4) Feet apart, hip width
(5) Heels more or less parallel
(6) Legs straight but not hyperextended

! As much as necessary,

as little as possible!

System preparation & Measurement

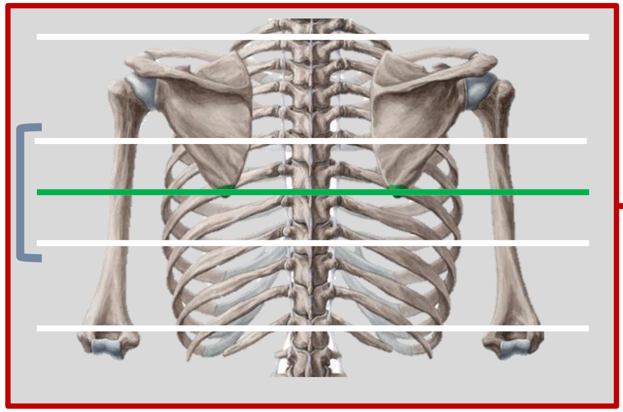
System

- Projection of Stripes Starts
- Adapt height
- Using Markers?

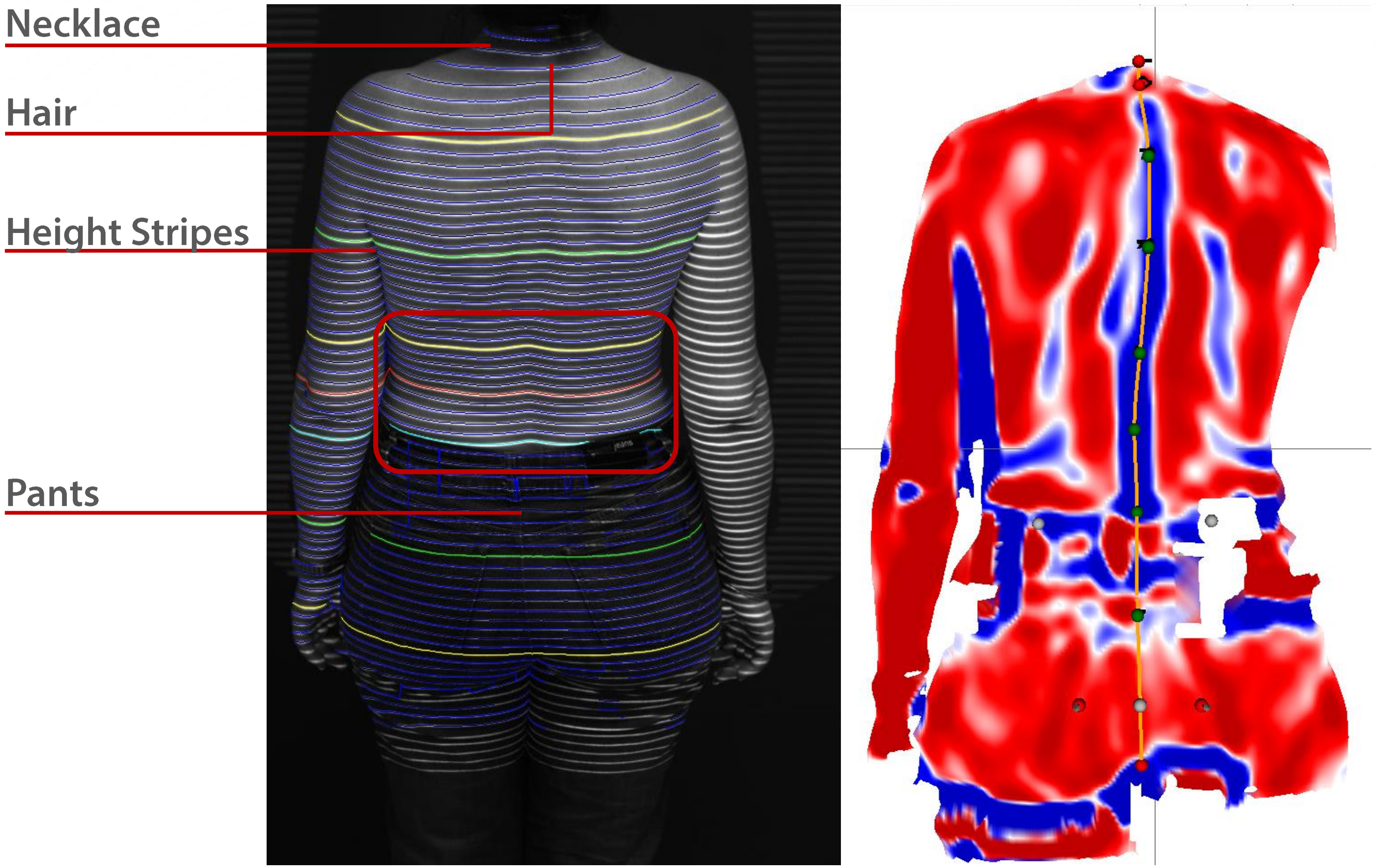
→ Start Measurement

Watch-out's

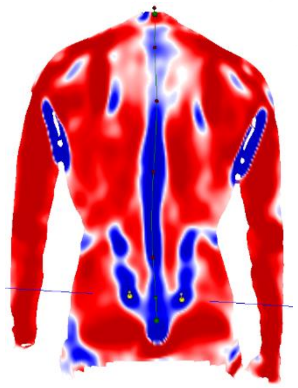
- Behaviour of patient
- Ambient Light
- 3D-Modell



Sources of Error



When to use Markers?



No useful results despites editing?
→ use reflective Marker(s)

If possible, do not use Markers!

When using reflective markers instead of the automated anatomical landmark positions

→ Statistical error for the anatomical landmarks is ca. 10 times larger!

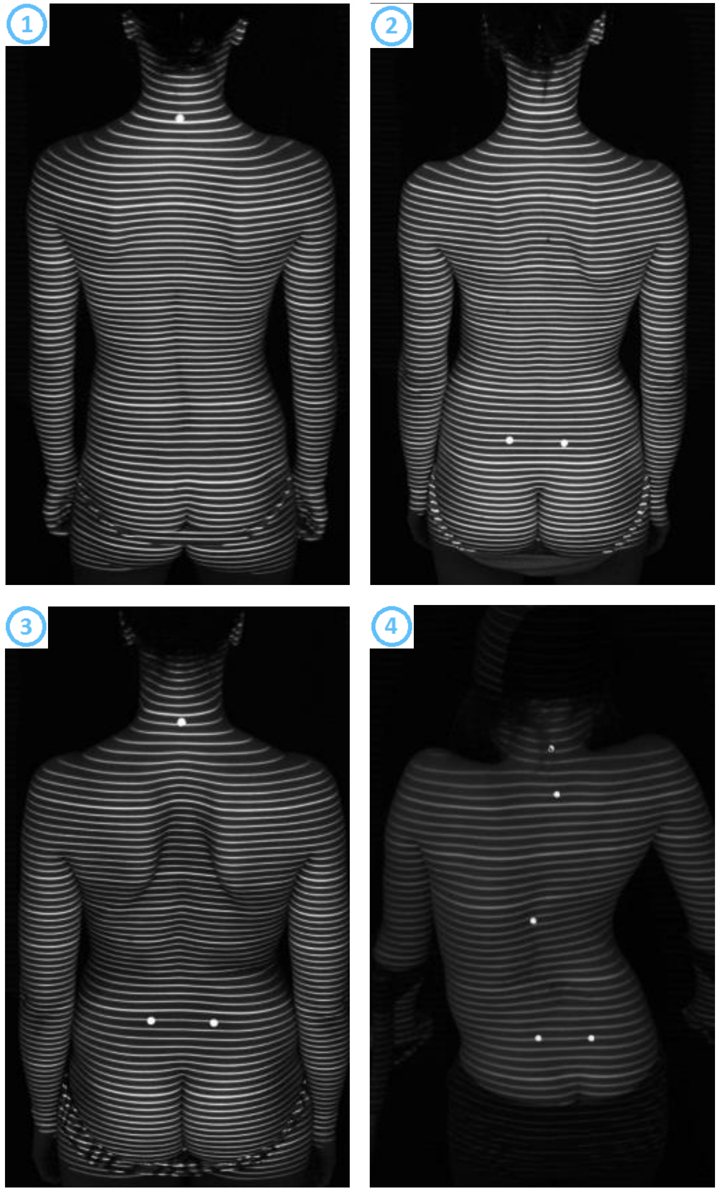
Marker positioning possibilities:

(1) Vertebra prominens (VP)

(2) Both SIPS (DL & DR)

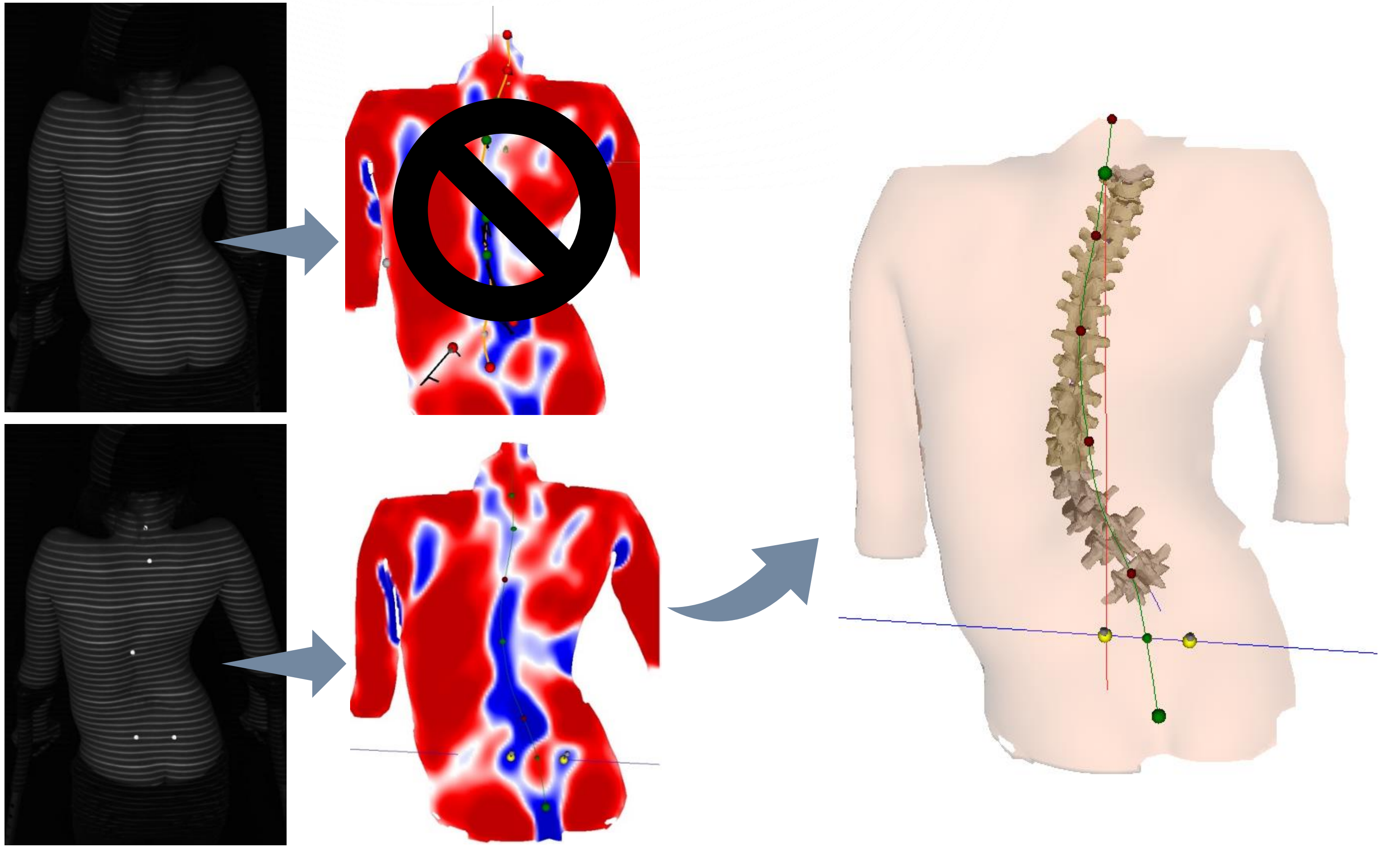
(3) Extra Markers in case of large spinal deformations

→ extra Markers to be placed on Processus Spinosus Line



How to use extra (additional) Markers

- Extreme Spinal Deformations
- Scoliosises with large Cobb Angle(s)
- Paradoxical Results
- Insufficient correlation between the surface of the back and the spine (f.e. tumors, swellings, etc.)

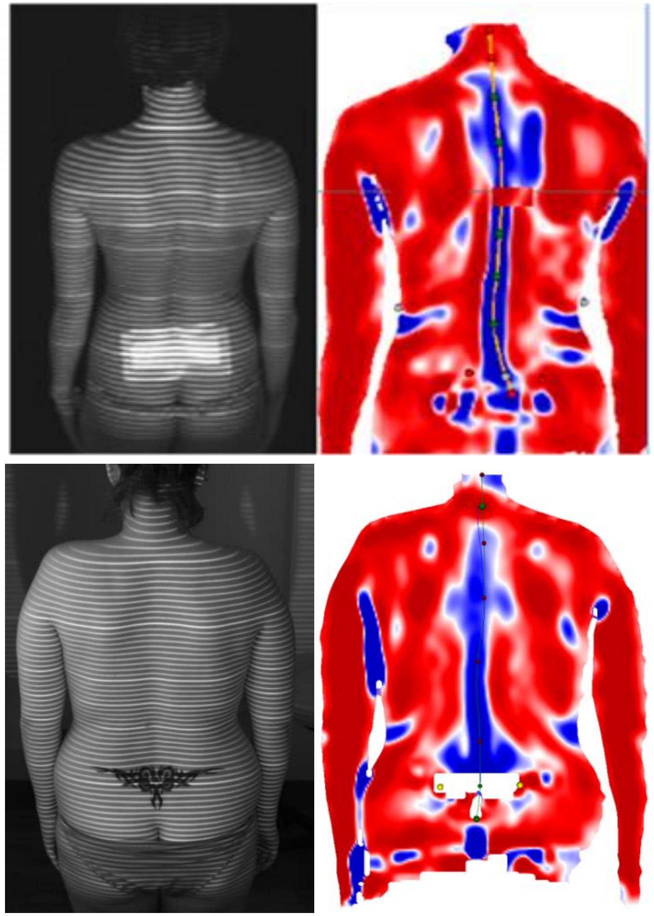


Remarks

Who is not measurable?

1-2% of all patients can not be measured!

- Severe Obesity
- Extremely dark skin tone
- Scare
- Adhesive plaster
- Tattoos
- A lot of hair



Fundusze Europejskie dla Rozwoju Społecznego
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DIERS Training – Motion Lab

Fundusze Europejskie dla Rozwoju Społecznego

Rzeczpospolita Polska

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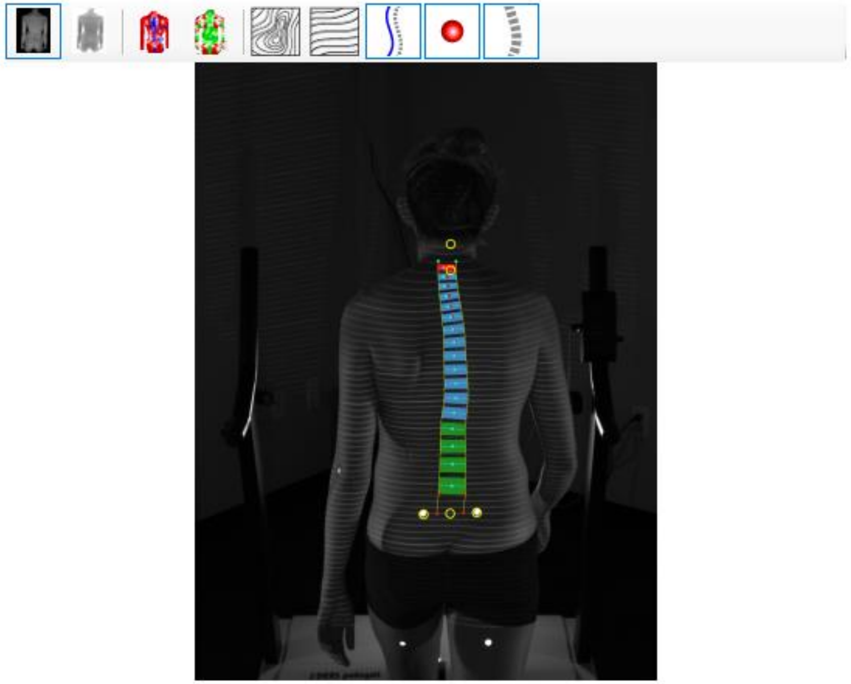
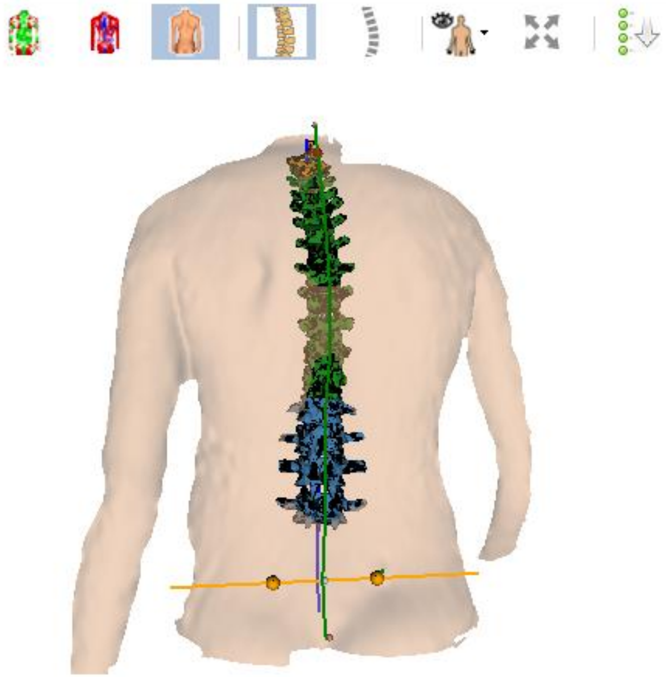
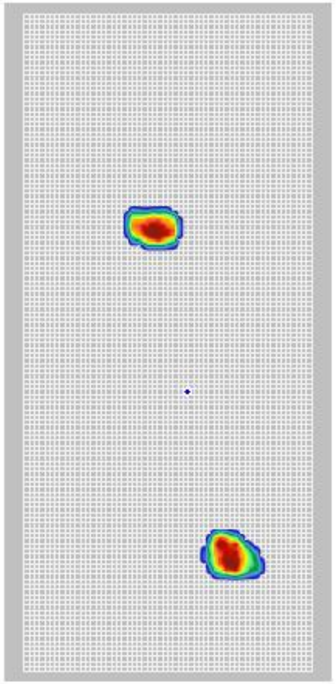
NARODOWA AGENCJA WYMIANY AKADEMICKIEJ

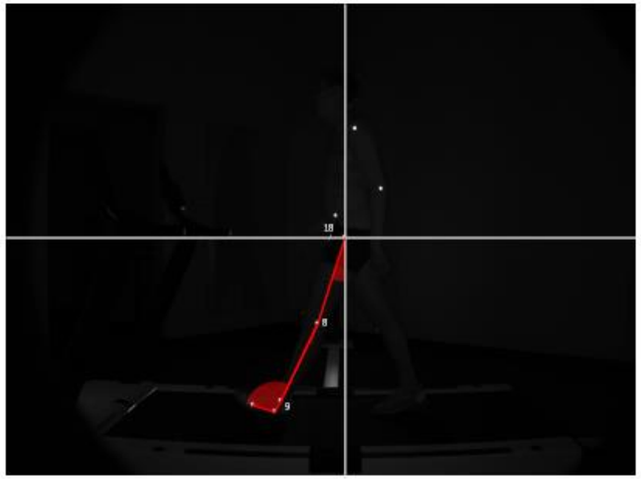
Motion Lab – Holistic Gait Analysis

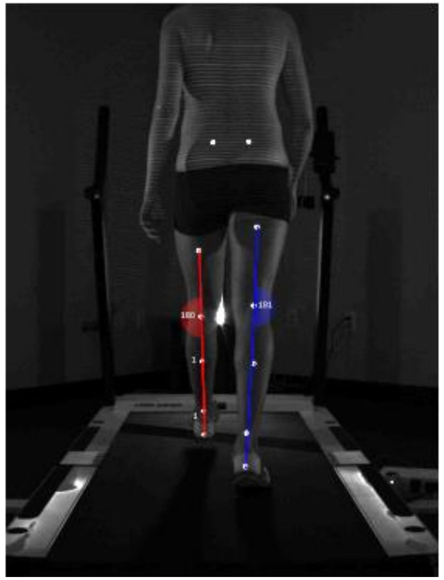
Theoretical Background

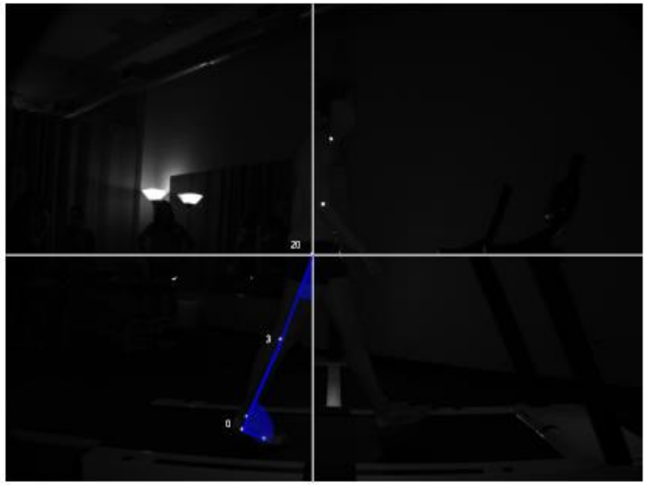


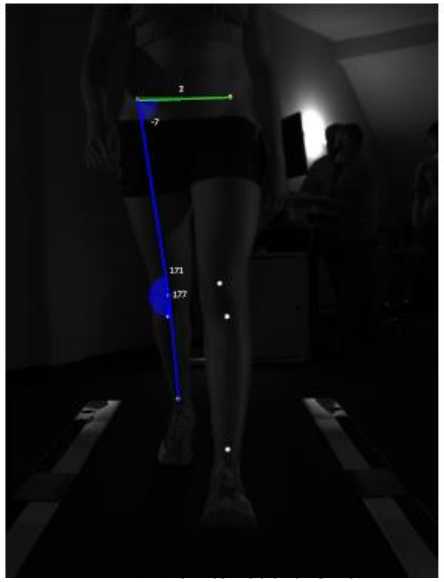






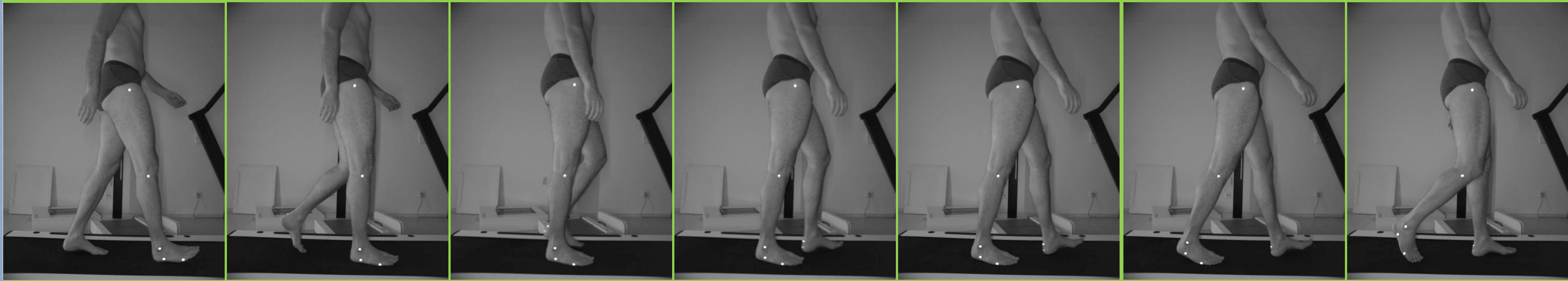






Gait Cycle

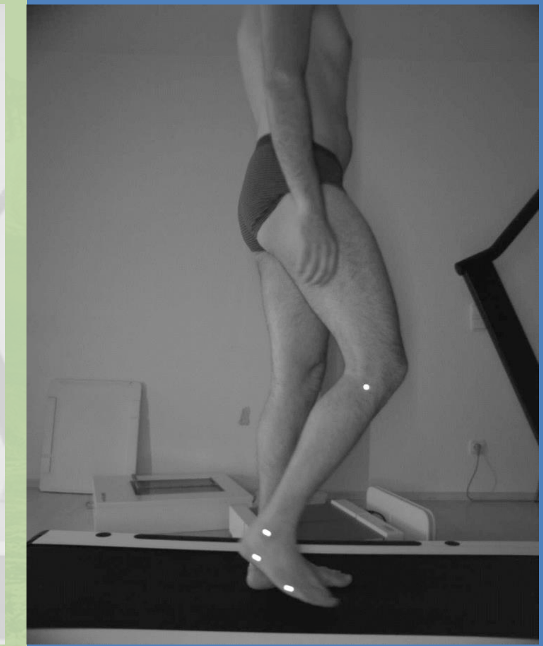
Stancephase – 60%



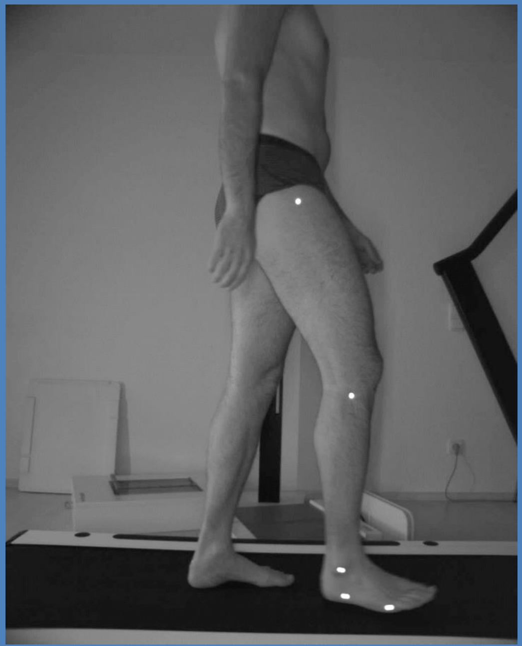
Initial Contact | Loading Response | Mid Stance (früh) | Mid Stance (Mitte) | Mid Stance (spät) | Terminal Stance | Pre Swing

Gait Cycle

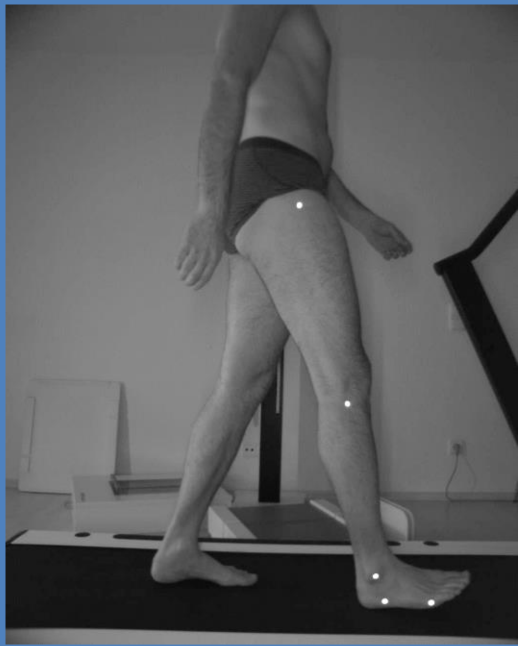
Swingphase – 40%



Initial Swing



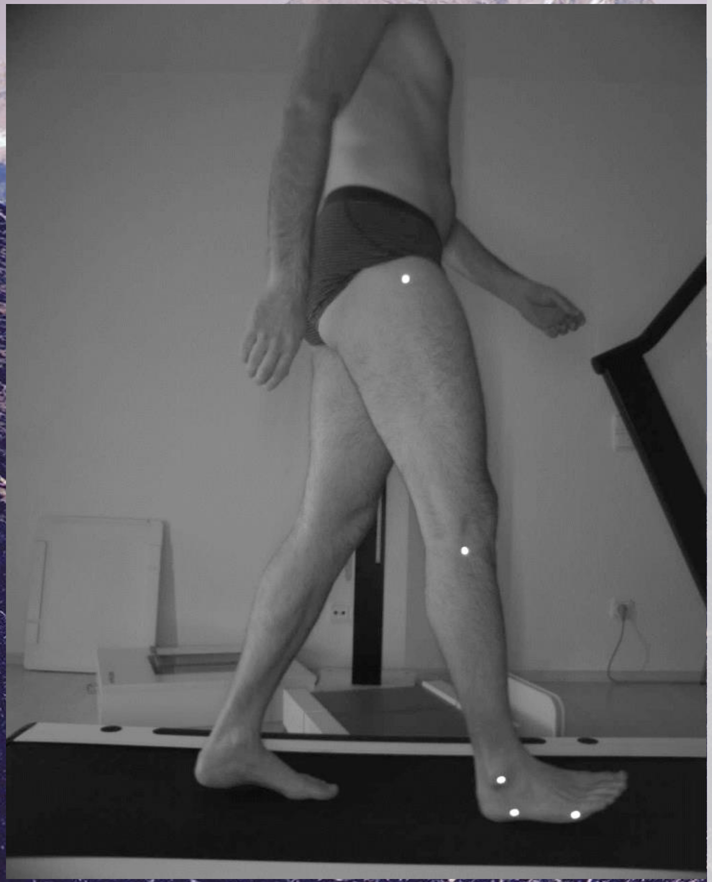
Mid Swing



Terminal Swing

Gait Cycle

Initial Contact



IC

Indicators:

First ground contact of the ipsilateral foot

Function:

Ground contact initiation, reaction to initiation of ground contact by the contralateral terminal Stance

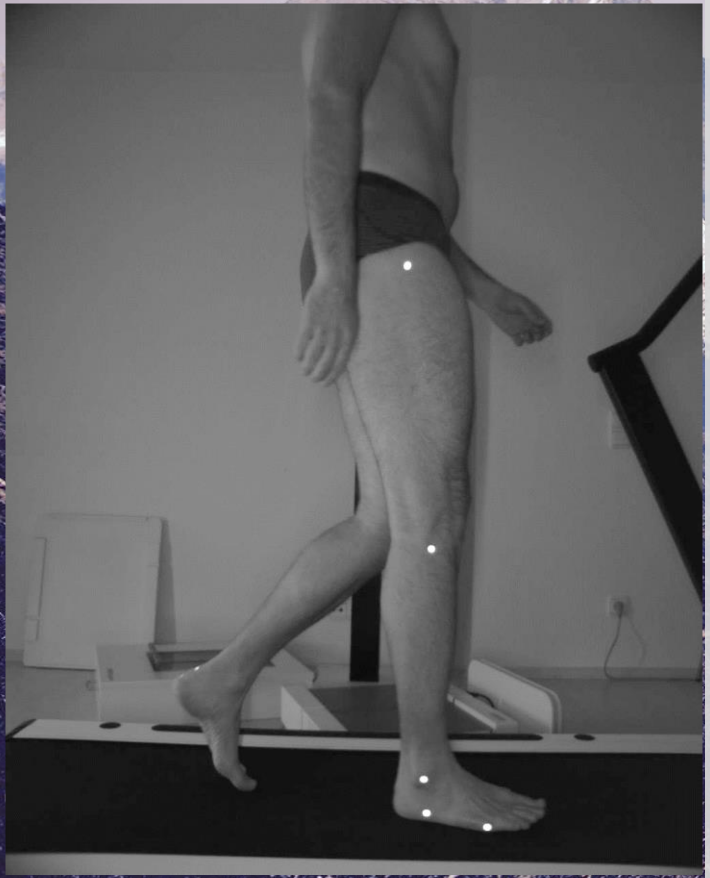
Kinematics:

Hip:	20°	Flexion
Knee:	5°	Flexion
Ankle:	0°	
Pelvis:	~5°	Forward Rotation

Active Muscles:

tibialis anterior, Hip flexors

Loading Response



LR

Indicators:

Last ground contact of the contralateral foot

Function:

Load transfer, reaction to initiation of ground contact by the contralateral terminal stance, preparation for single support, heel rocker

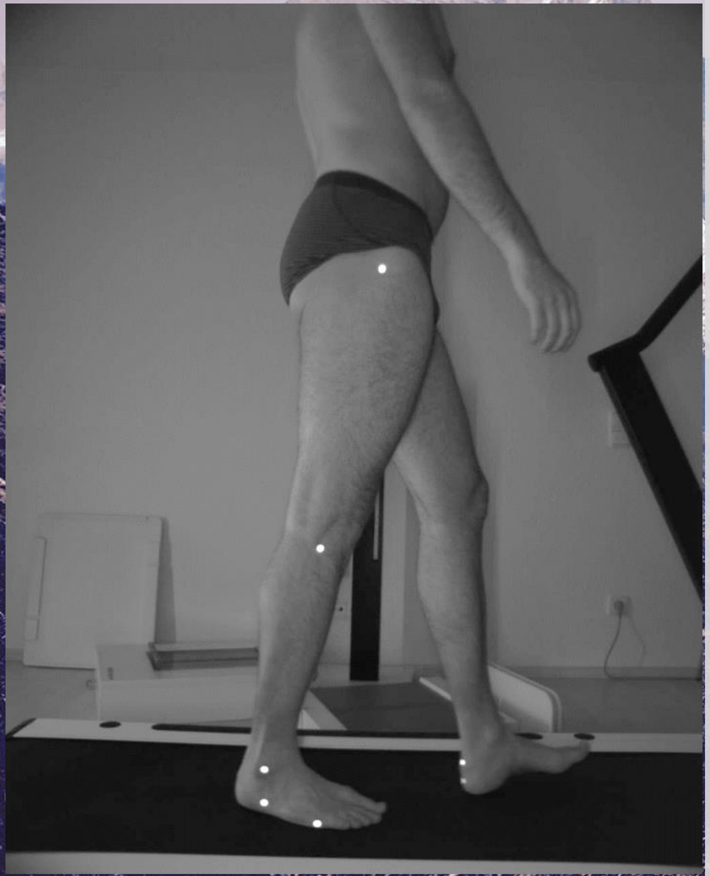
Kniematics:

Hip:	10°	Flexion
Knee:	15°	Flexion
Ankle:	5°	Plantarflexion
Pelvis:	~0°	

Active Muscles:

Glutaeus max, adductor mag., tensor fascia latae, glutaeus med., mm. vastii, tibialis anterior

Mid Stance



MSt

Indicators:

Full contact of the foot. Ends with last ground contact of the ipsilateral rear foot

Functions:

'Levering' the body's center of gravity from behind the support surface to the center, ankle rocker.Introduction of TSt & Forefoot Rocker, reduction of the support surface

Kinematics:

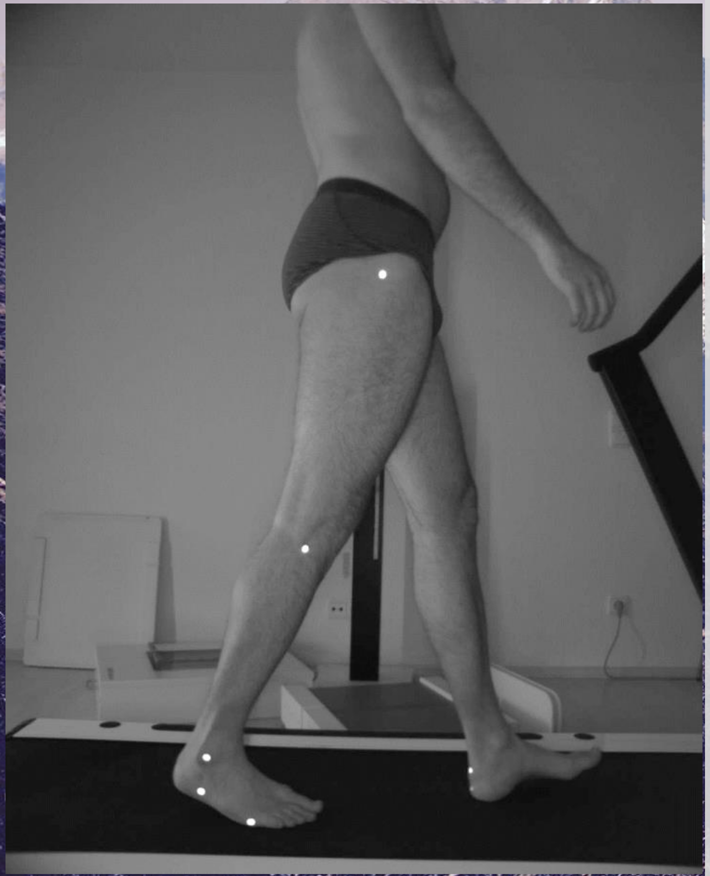
Hip:	0°	
Knee:	5°	Flexion
Ankle:	5°	Dorsiflexion
Pelvis:	~0-5°	Backward Rotation

Active Muscles:

Gluteal muscles, excentric loading m. gastrocnemius/soleus

Gait Cycle

Terminal Stance



TSt

Indicators:

Contralateral rear foot close to ground contact

Function:

Forefoot rocker, muscular activation of the plantar flexors: 'loading of the Achilles tendon', use of the anterior transverse arch of the foot to transfer forces to the hallux.

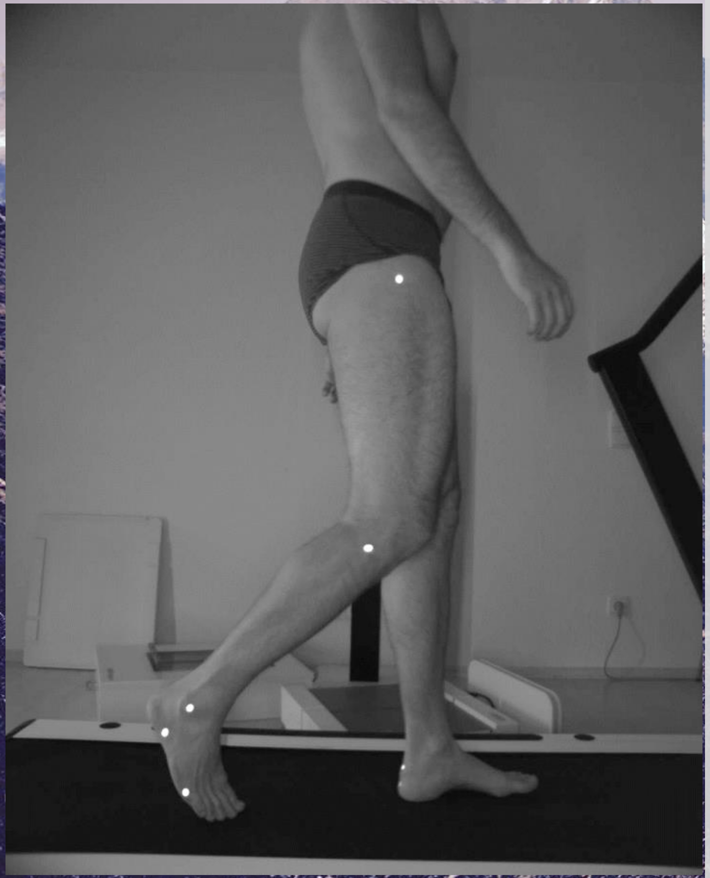
Kinematics:

Hip:	20°	Extension
Knee:	5°	Flexion
Ankle:	10°	Dorsiflexion
Pelvis:	~5°	Backward Rotation

Active Muscles:

Adductor long., biceps fem. brev., flex. hall. long., flex. dig. long., gastroc, tib. post., peronaeus long. et brev.

Pre Swing



PSw

Indicators:

Last ground contact of the ipislateral foot

Function:

Achilles recoil effect, controlled push-off, alignment of forces for contralateral single support

Kinematics:

Hip: 10° Extension

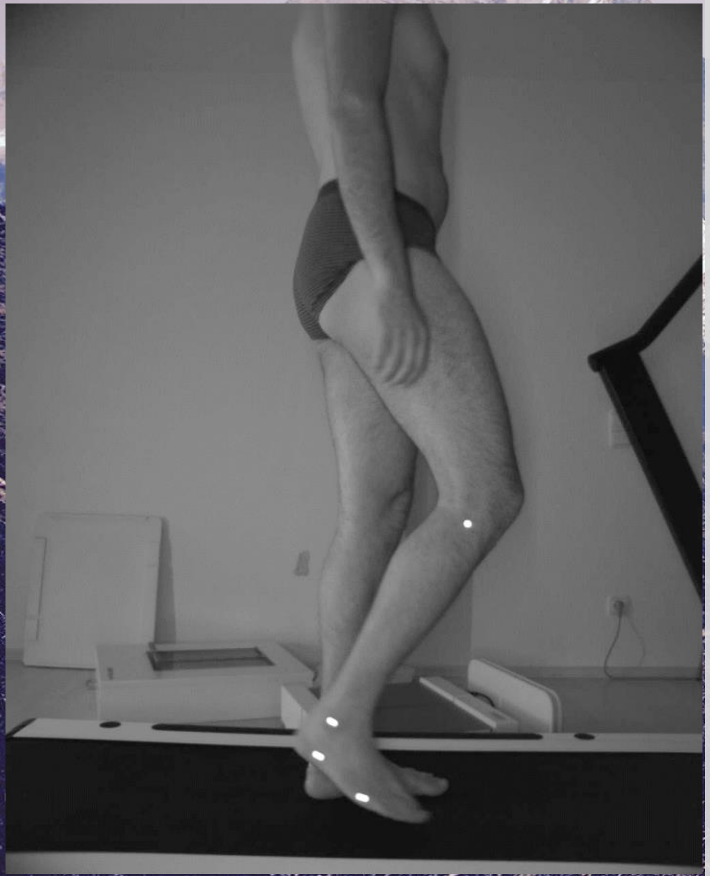
Knee: 30-40° Flexion

Ankle: 15° Plantarflexion

Active Muscles:

Iliopsoas, adductor long., rectus fem.

Initial Swing



ISw

Indicators:

Ipsilateral foot passes the standing leg

Function:

Swing set-up for efficient use of the contralateral ankle rocker

Kinematic:

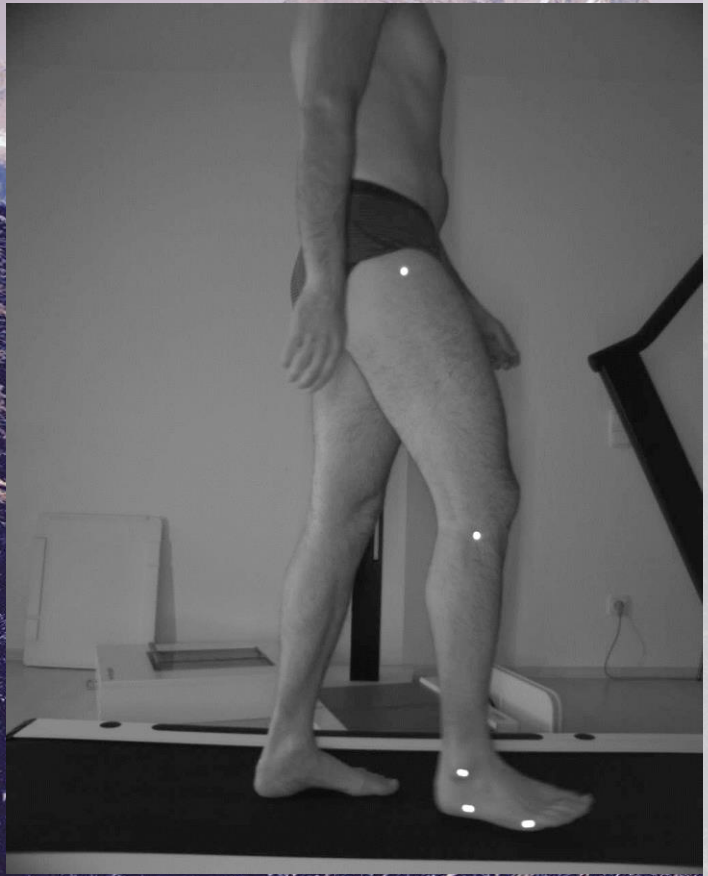
Hip:	15°	Flexion
Knee:	60°	Flexion
Ankle:	5°	Plantarflexion
Pelvis:	~0°	

Active Muscles:

illiopsoas, biceps fem. brev., gracilis, sartorius, ext. dig. long., ext. hall. long.

Gait Cycle

Mid Swing



MSw

Indicators:

Ipsilateral lower leg is vertical

Function:

Generation of a shearing movement to the contralateral side (stride length), transfer of momentum to support the contralateral forefoot rocker

Kinematic:

Hip: 25° Flexion

Knee: 25° Flexion

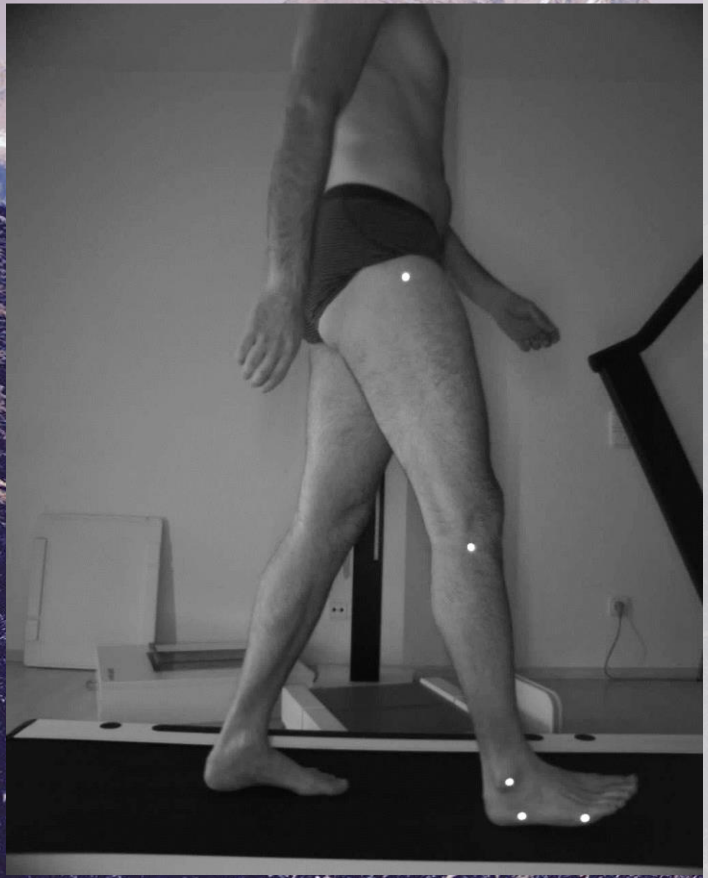
Ankle: 0°

Pelvis: ~0-5°

Active Muscles:

illiopsoas, biceps fem. brev., gracilis, sartorius, ext. dig. long., ext. hall. long.

Terminal Swing



TSw

Indicators:

Ipsilateral rear foot close to ground contact

Function:

Preparation IC, swing direction determines orientation of the ground reaction force to the left or right

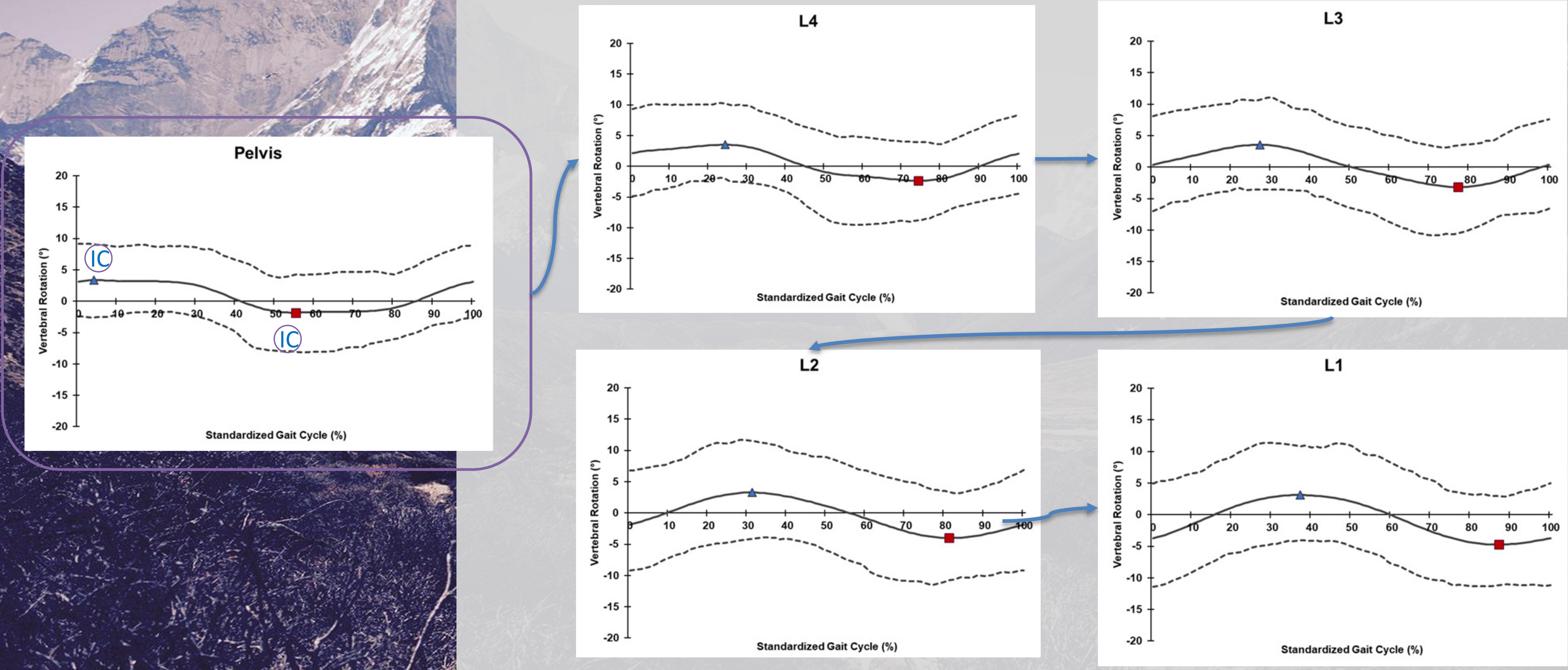
Kniematics:

Hip:	20°	Flexion
Knee:	5°	Flexion
Ankle:	0°	
Pelvis:	5°	Forwardrotation

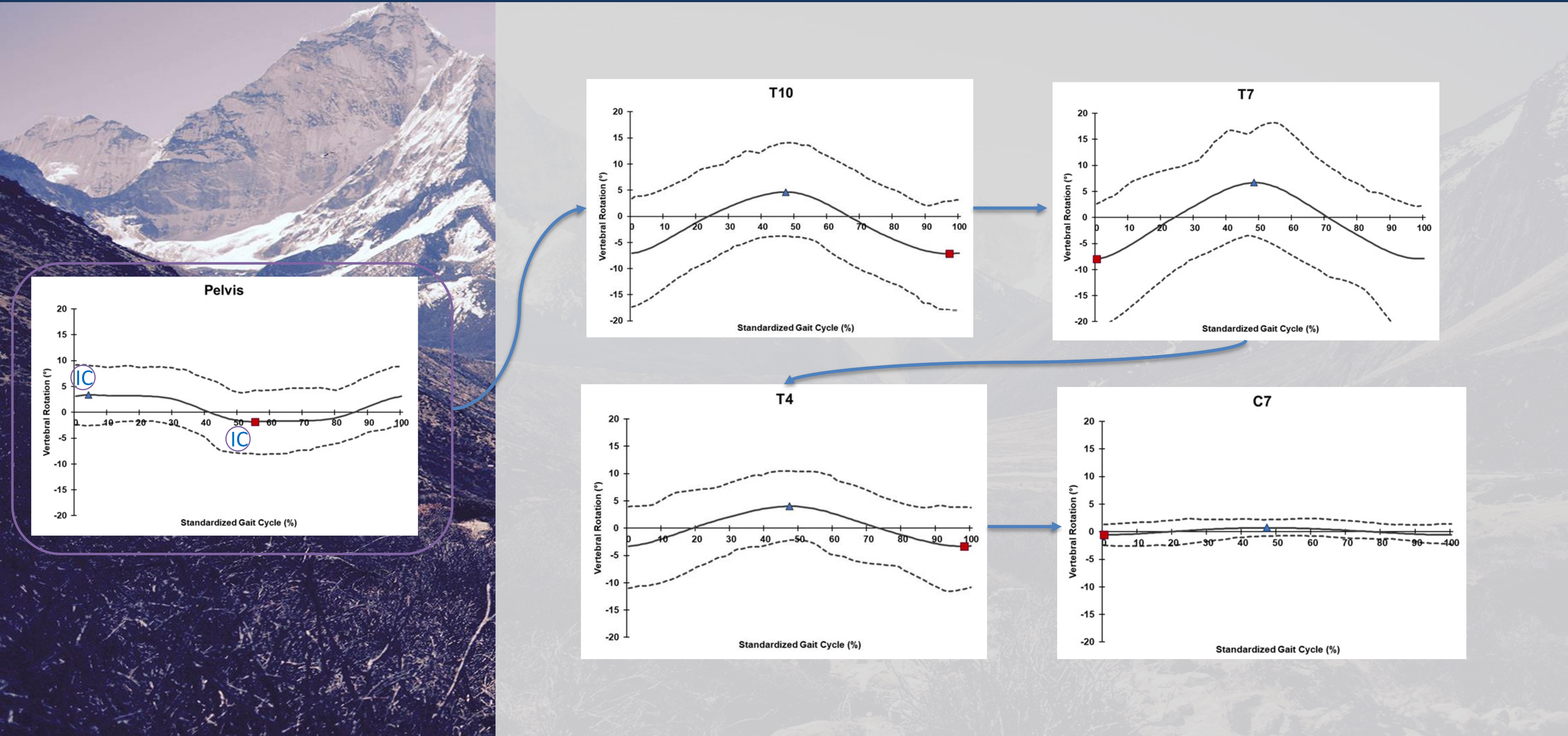
Active Muscles:

biceps fem. long., semimembranosus, semitendinosus

Spine Movement during the Gaitcycle



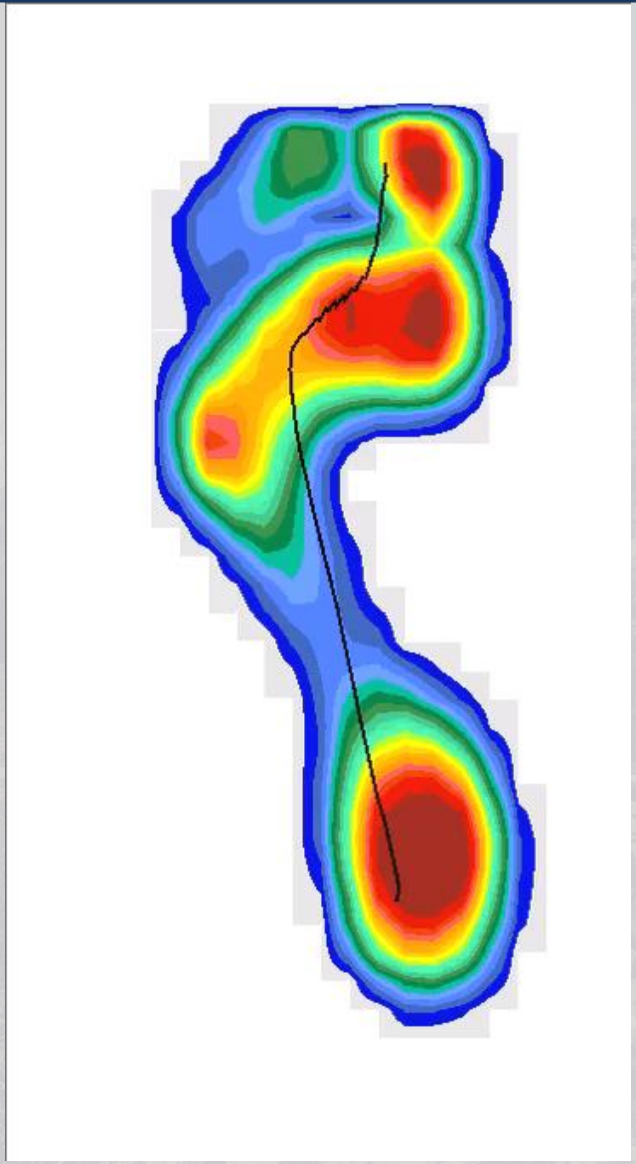
Spine Movement during the Gaitcycle



Pedographic Data during the Gaitcycle

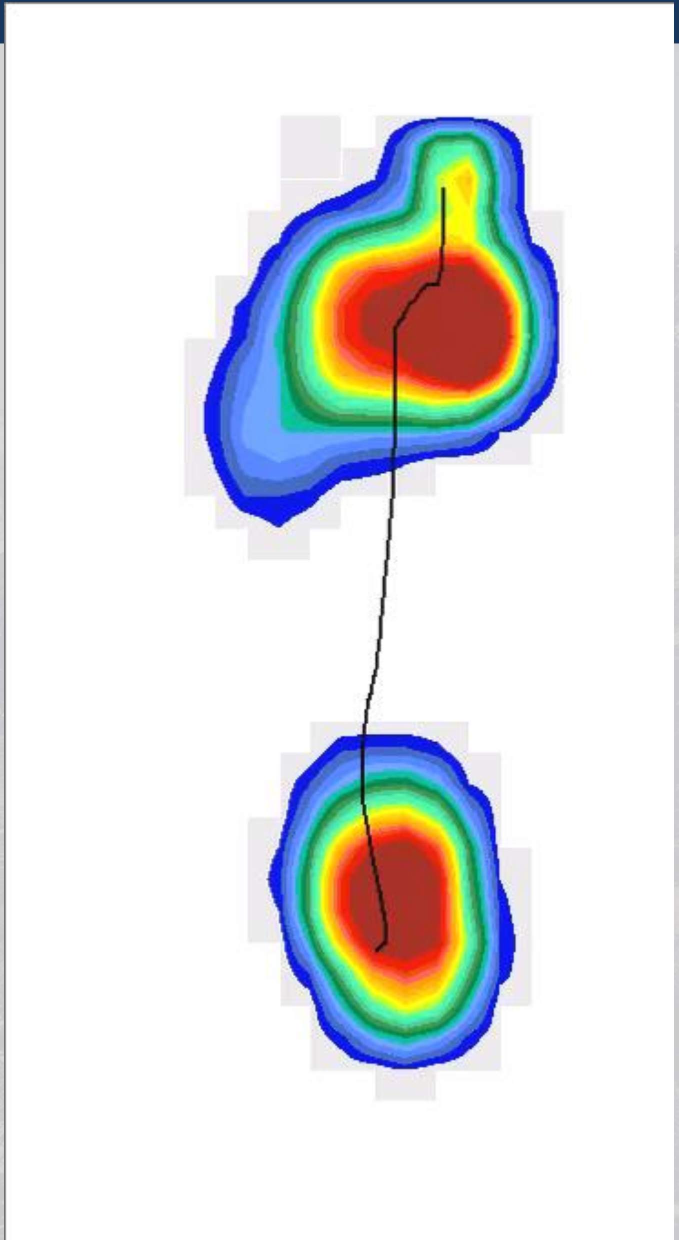
Regular rolling behaviour

- IC on lateral heel
- LR lets COP turn towards heel center, pointing towards M III
- MSt: Max. pressure on M V, COP closing on M II/III
- TSt: Pressure transmission via transverse arch
- PSw: Hallux as last contact



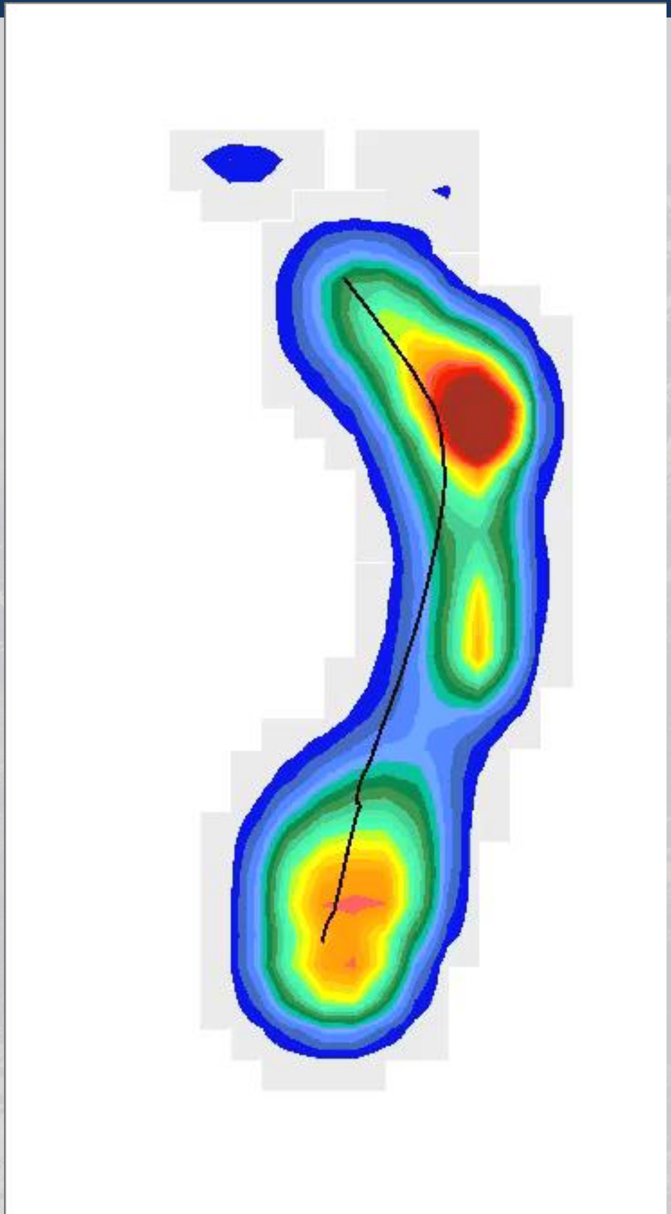
Skewfoot

- IC on lateral heel
- LR lets COP turn to the heel center
- **MSt: medial bending of the COP line, Pmax on M III, M II or M I**
- TSt: Maximum pressure on M I and Hallux
- PSw: Hallux as last contact



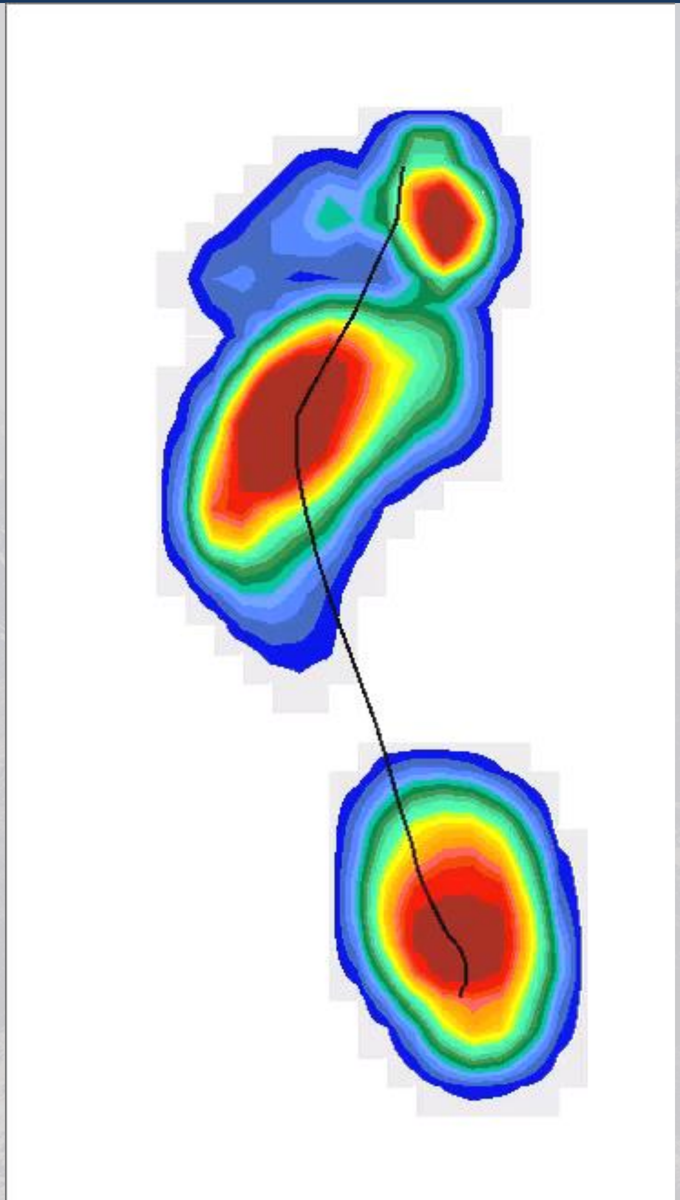
Low arch

- IC on lateral heel
- LR guides COP regularly in the direction of MIII
- **MSt: maximum pressure in the middle foot, growing size**
- TSt: The maximum pressure is regularly guided over the transverse arch
- PSw: Hallux as last contact



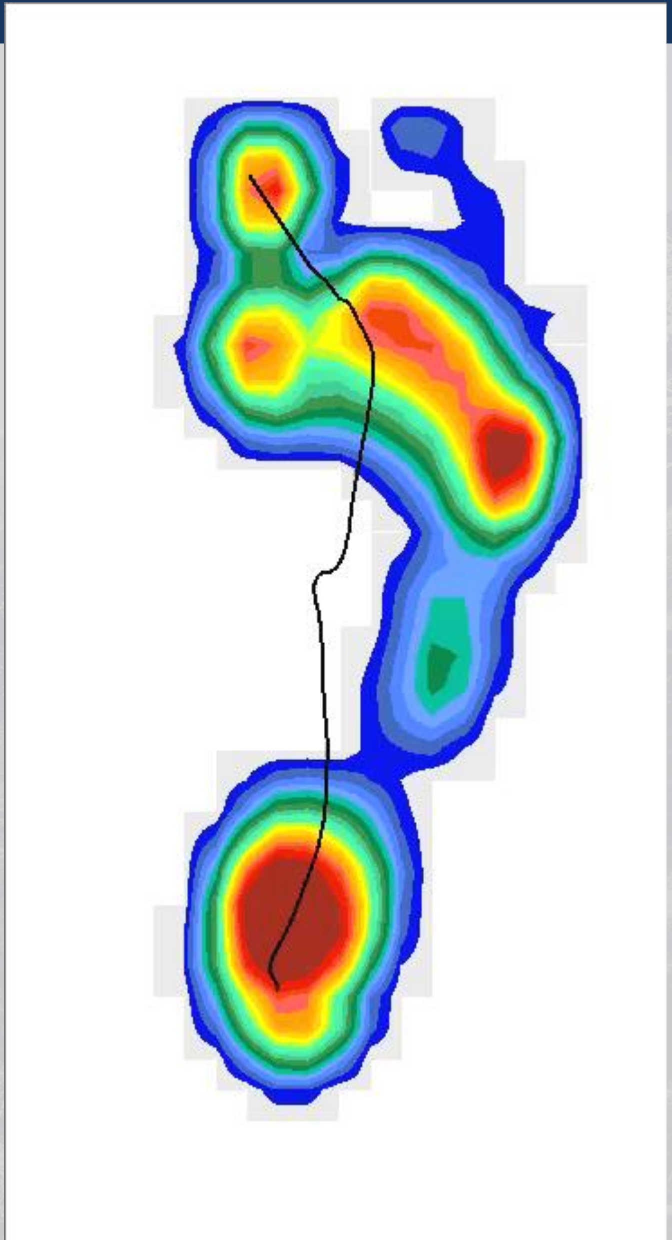
High arch

- IC on lateral heel
- LR guides COP regularly in the direction of M III
- **MSt: No pressure signals in mid foot area with regular Pmax at M IV/V**
- TSt: Pressure maximum is transmitted over the entire length of the transverse arch
- PSw: Hallux as last contact



Combined malfunction

- IC on lateral heel
- LR guides COP regularly in direction of MIII
- **MSt: Medial bending of COP line, Pmax on M III, M II or M I, maximum pressure in the mid foot, growing size**
- **TSt: Pressure maximum on several sections, mostly M V, M III and M I**
- PSw: Hallux as last contact



GAIT DEVIATIONS

- ANKLE
- KNEE
- HIP
- PELVIS
- SPINE

- Low heel
- Forefoot contact
- Foot–flat contact
- Foot slap
- Excess plantarflexion
- Excess dorsiflexion
- Excess supination
- Excess pronation
- Heel–off/ Premature heel–off
- No heel–off
- Toe drag
- Contralateral vaulting

GAIT DEVIATIONS

- ANKLE
- KNEE
- HIP
- PELVIS
- SPINE

- Limited flexion
- Excess flexion
- Wobbles
- Hyperextends
- Extension thrust
- Varus/ Valgus
- Excess contralateral flexion

GAIT DEVIATIONS

- ANKLE
- KNEE
- HIP
- PELVIS
- SPINE

- Limited flexion
- Excess flexion
- Past retract
- Internal rotation
- External rotation
- Adduction
- Abduction

GAIT DEVIATIONS

- ANKLE
- KNEE
- HIP
- PELVIS
- SPINE

- Hikes
- Posterior tilt
- Anterior tilt
- Lacks forward rotation
- Lacks backward rotation
- Excess forward rotation
- Excess backward rotation
- Ipsilateral drop
- Contralateral drop

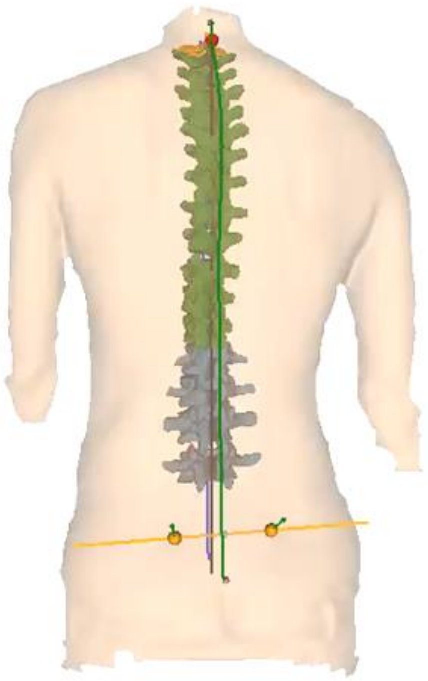
GAIT DEVIATIONS

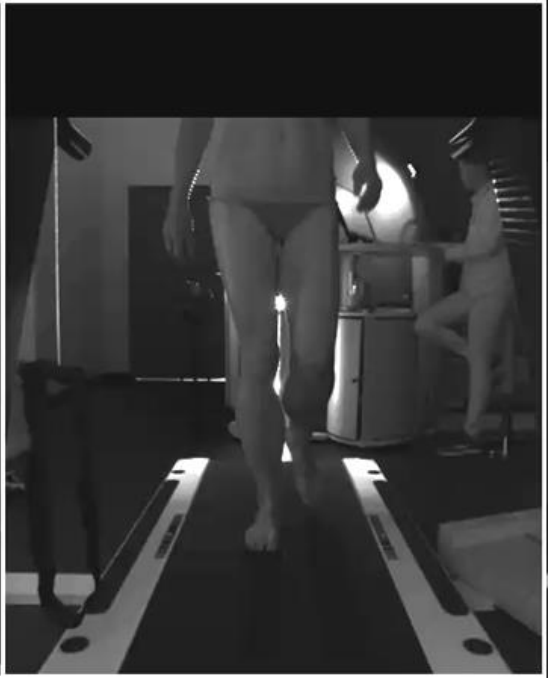
- ANKLE
- KNEE
- HIP
- PELVIS
- SPINE

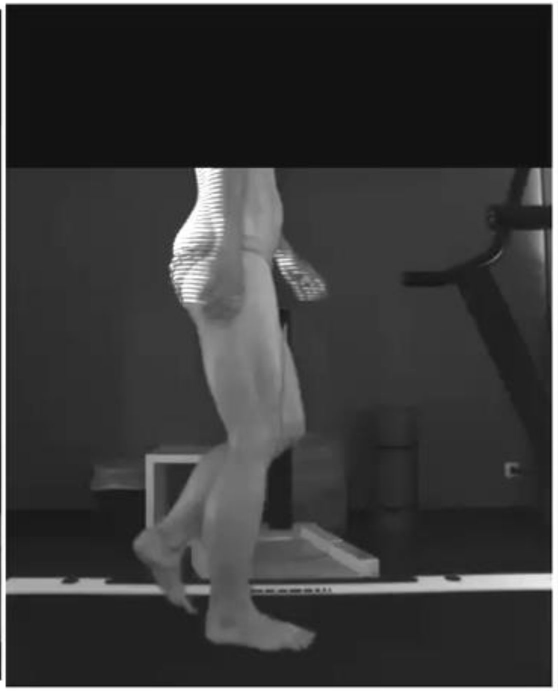
- Forward lean
- Backward lean
- Lateral lean (duchenne)
- Excess forward/ backward rotation
- Lateral Deviat
- Unilateral / Excessive Rotation
- Timing / Coordination

Case, Hip Arthritis

Pat. fem., *1973, Hip Arthritis (R>L)







Name	Wert	Einheit
Rumpflänge VP-DM	502	mm
Rumpfneigung VP-DM	4	°
Oberflächenrotation (+max)	6	°R (~T...
Oberflächenrotation (-max)	1	°R (~...
Seitabweichung VP-DM (-max)	4	mm L (...
Seitabweichung VP-DM (Amplitude)	13	mm

Case, Hip Arthritis

Pat. fem., *1973, Hip Arthritis (R>L)

DIERS leg axis post

Deviation:

Visible excessive pelvis rotation to both directions

Gait phase:

Terminal Stance

Case, Hip Arthritis

Pat. fem., *1973, Hip Arthritis (R>L)

DIERS leg axis post

Deviation:

Visible excessive pelvis rotation to both directions

Gait phase:

Terminal Stance

Case, Hip Arthritis

Pat. fem., *1973, Hip Arthritis (R>L)

DIERS leg axis post

Deviation:

Visible excessive pelvis rotation to both directions

Gait phase:

Terminal Stance

Conclusion:

Reduced hip extension (pain, gluteal weakness?), compensated by increased pelvis rotation. This keeps a sufficient step length.

Case, Hip Arthritis

Pat. fem., *1973, Hip Arthritis (R>L)

DIERS leg axis lateral

Deviation:

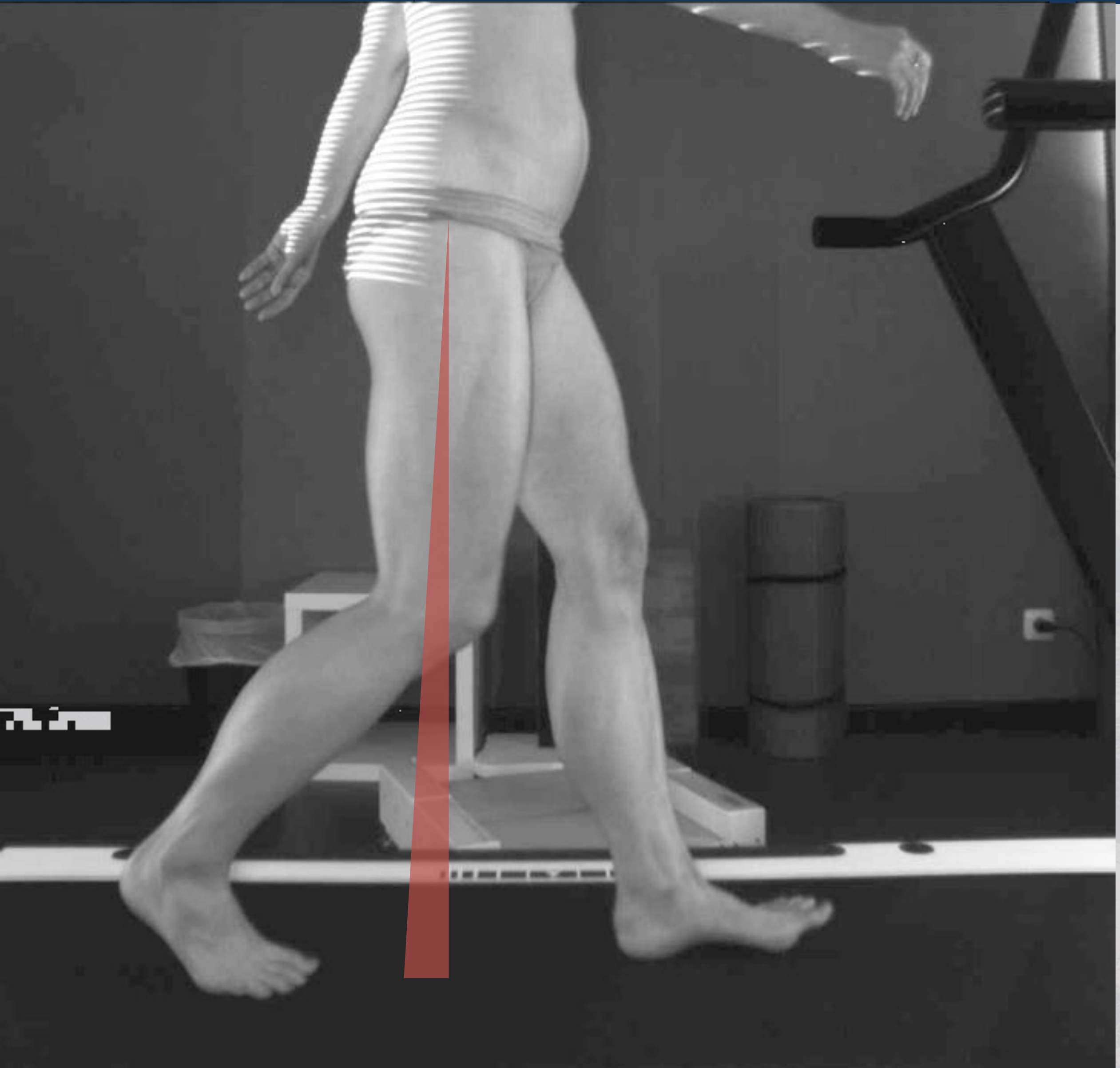
excessive knee flexion along reduced hip extension R

Gait phase:

Terminal Stance R

Case, Hip Arthritis

Pat. fem., *1973, Hip Arthritis (R>L)



DIERS leg axis lateral

Deviation:

excessive knee flexion along reduced hip extension R

Gait phase:

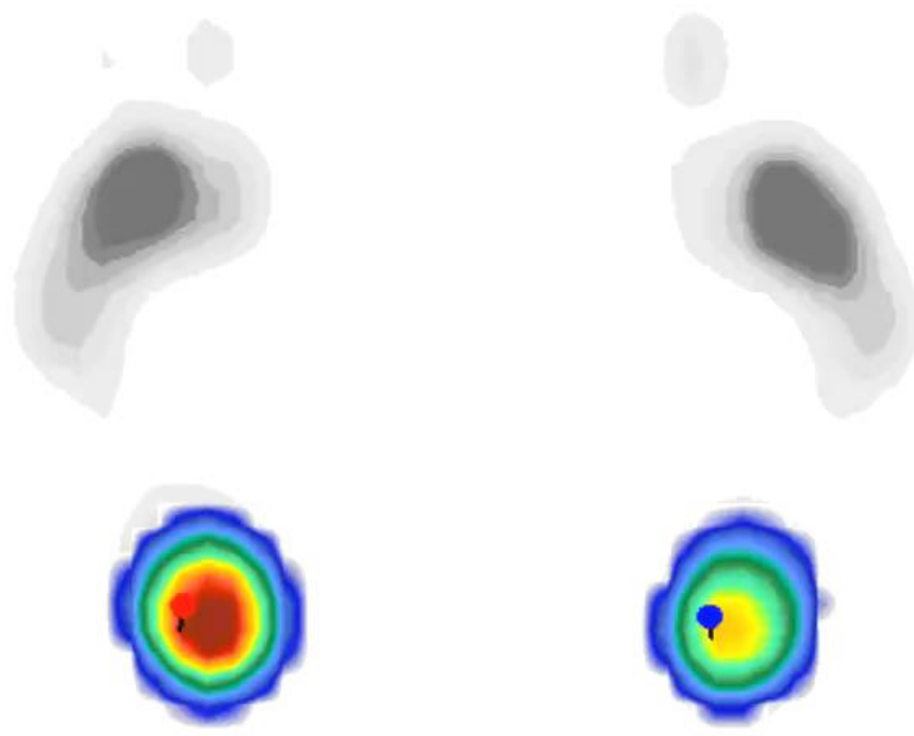
Terminal Stance R

Conclusion:

Knee flexion is a possibility to move step length towards a sufficient length. Also this is lowering the COM.

Case, Hip Arthritis

Pat. fem., *1973, Hip Arthritis (R>L)



DIERS pedogait

Deviation:

Medializationof the gait line R

Gait phase:

End Loading Response R

Conclusion:

Insufficient excentric stability (glut. max & med., mm. vastii). Leads to inward-turning of base of support, eventually coming with inner rotation of tibia and femur.

Case, Hip Arthritis

Pat. fem., *1973, Hip Arthritis (R>L)

Orthopädie Aukammklinik

Case, Hip Arthritis

Pat. fem., *1973, Hip Arthritis (R>L)

Case, Hip Arthritis

Pat. fem., *1973, Hip Arthritis (R>L)

Deviation:

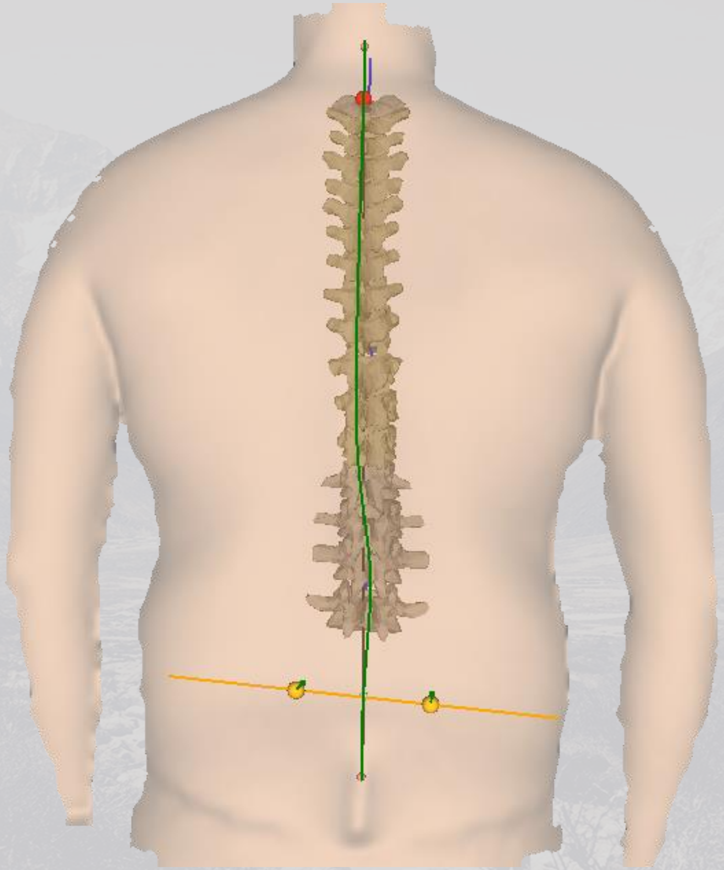
High Pelvis Rotation values

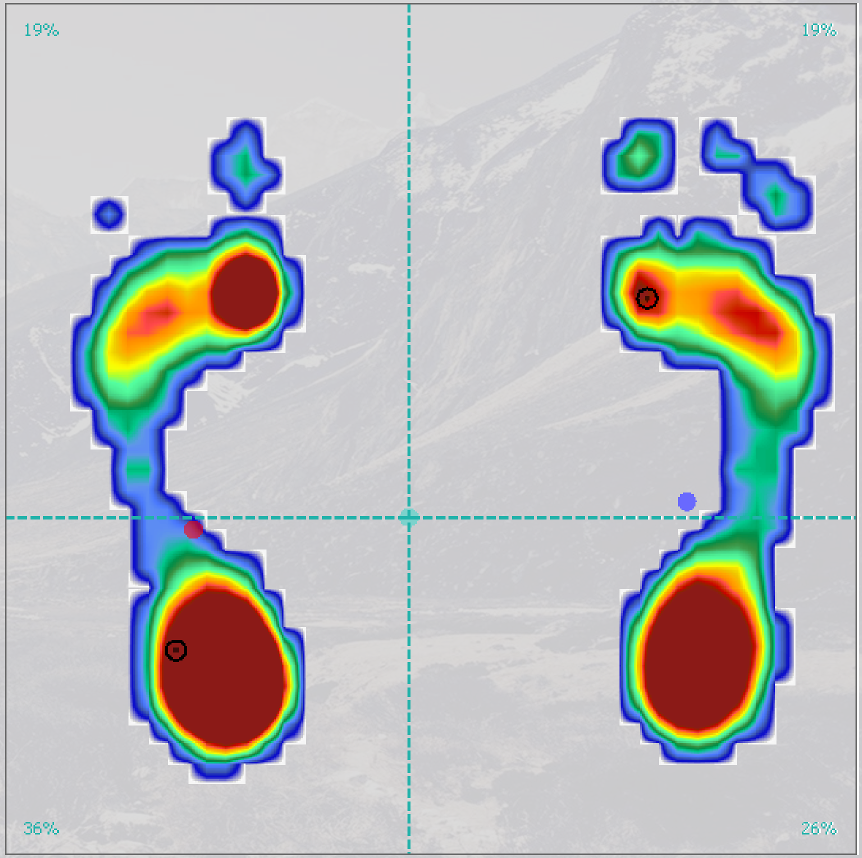
Gait phase:

End of Terminal Stance

Case Gonalgie, knee valgus

Pat. male, *1994, knee valgus L, duchenne, hip adduction, rear foot eversion





Case Gonalgie, knee valgus

Pat. male, *1994, knee valgus L, duchenne, hip adduction, rear foot eversion

DIERS leg axis post

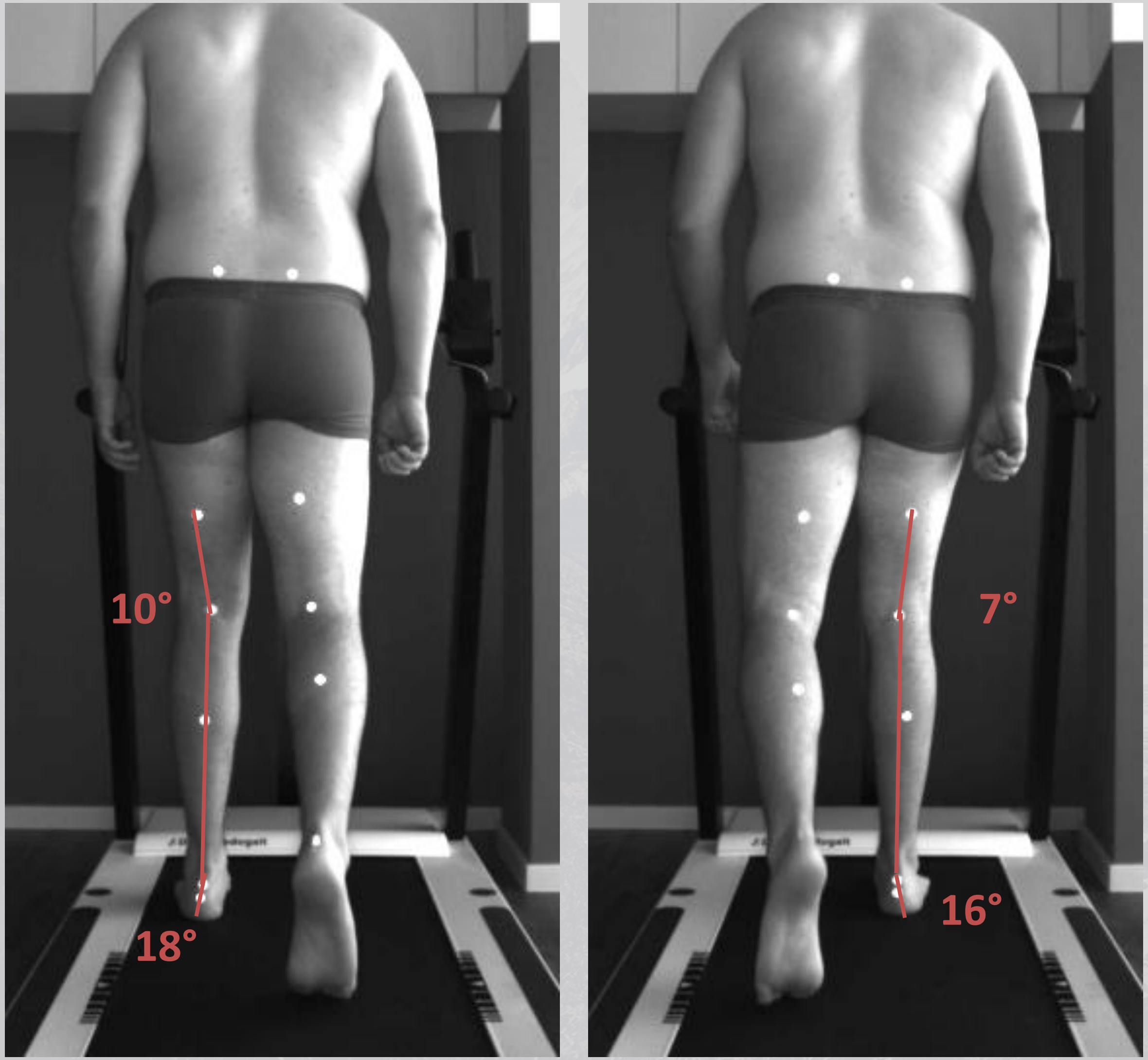
Deviations:

High track width

Thighs close

Case Gonalgie, knee valgus

Pat. male, *1994, knee valgus L, duchenne, hip adduction, rear foot eversion



DIERS leg axis post

Deviations:

knee valgus, -inner rotation

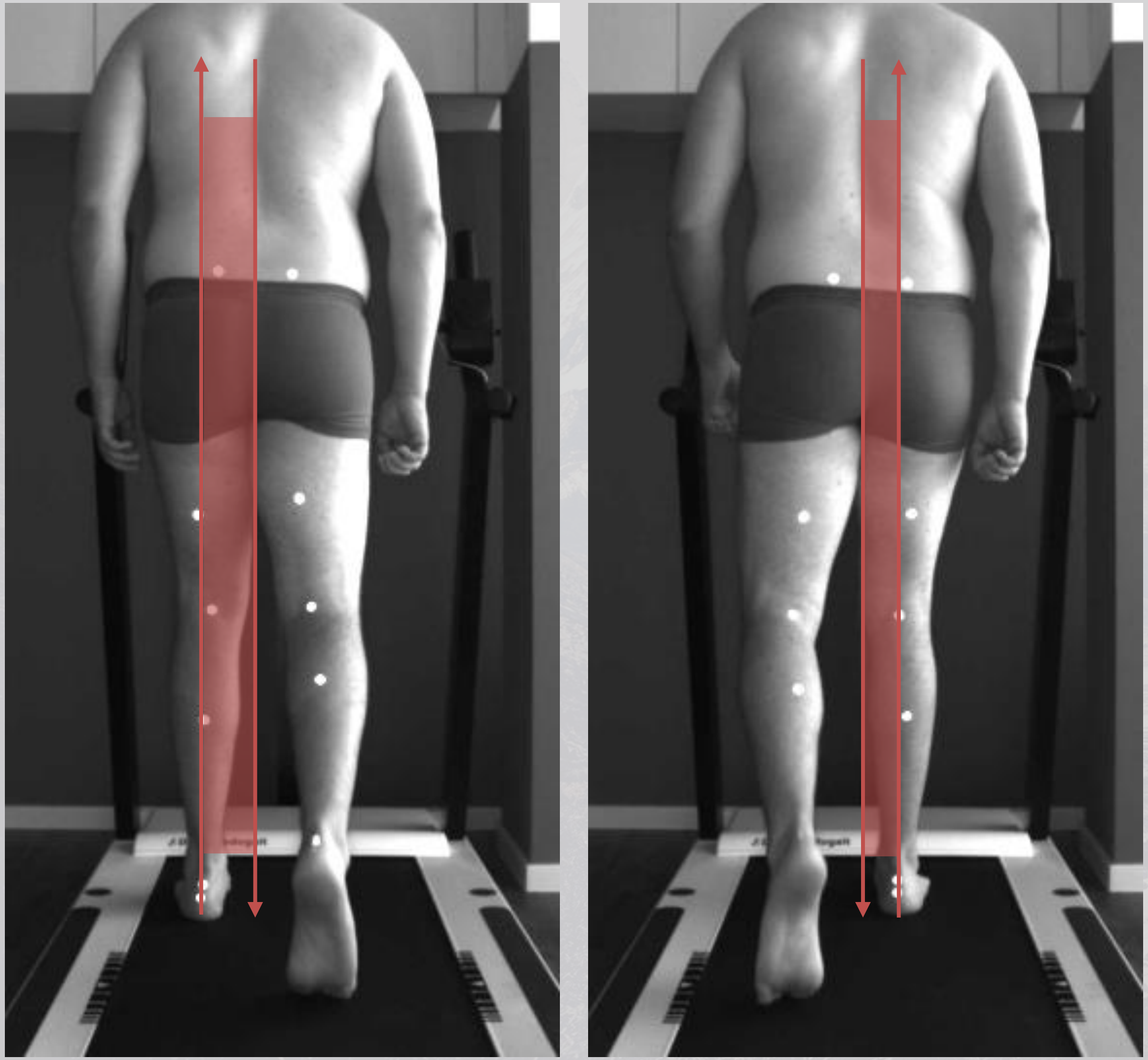
Rear foot eversion

Gait phase:

End of Loading Response

Case Gonalgie, knee valgus

Pat. male, *1994, knee valgus L, duchenne, hip adduction, rear foot eversion



DIERS leg axis post

Deviations:

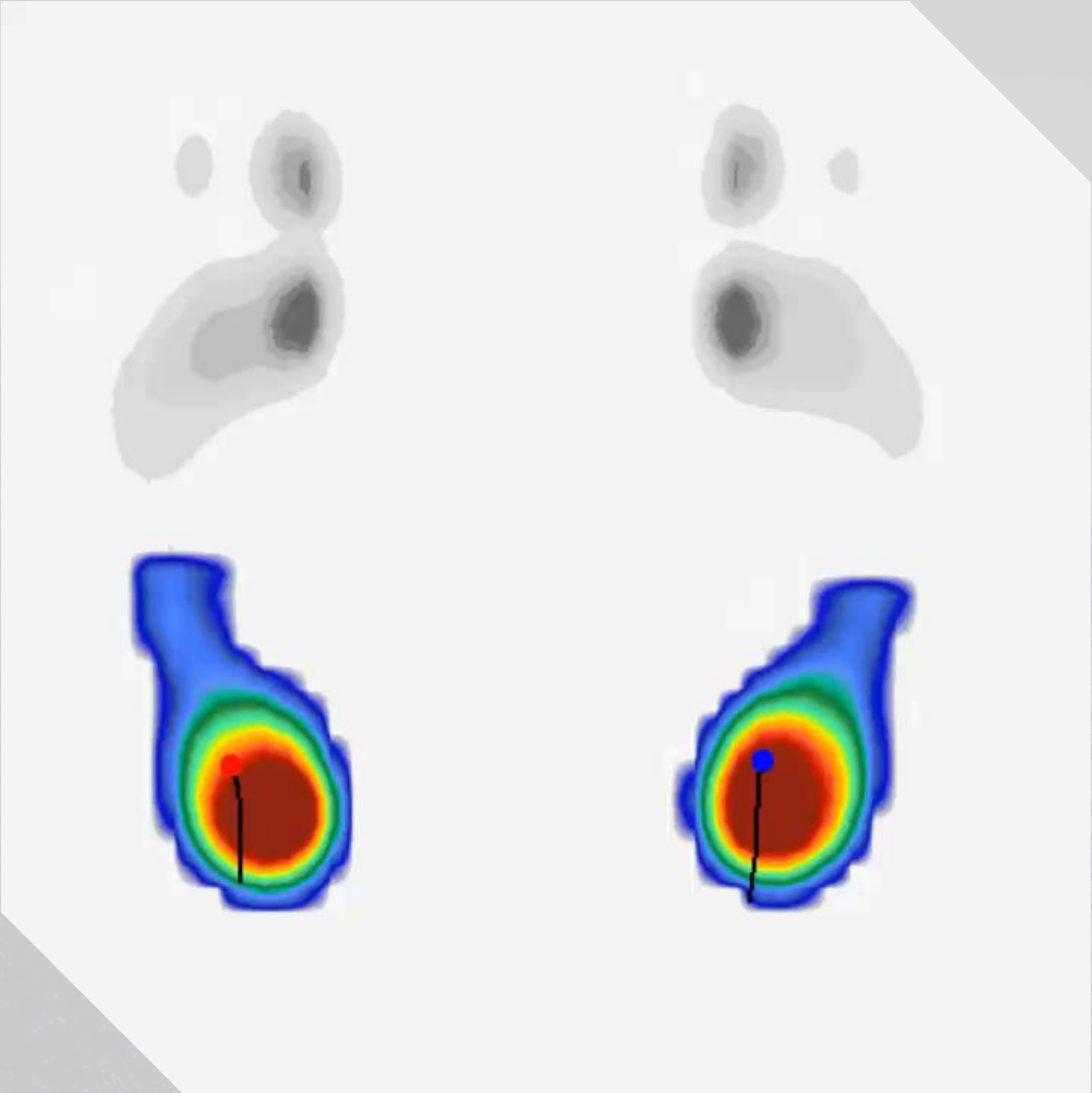
Lateral Trunk Lean

Gait phase:

End of Loading Response R

Case Gonalgie, knee valgus

Pat. male, *1994, knee valgus L, duchenne, hip adduction, rear foot eversion



DIERS pedogait

Deviations:

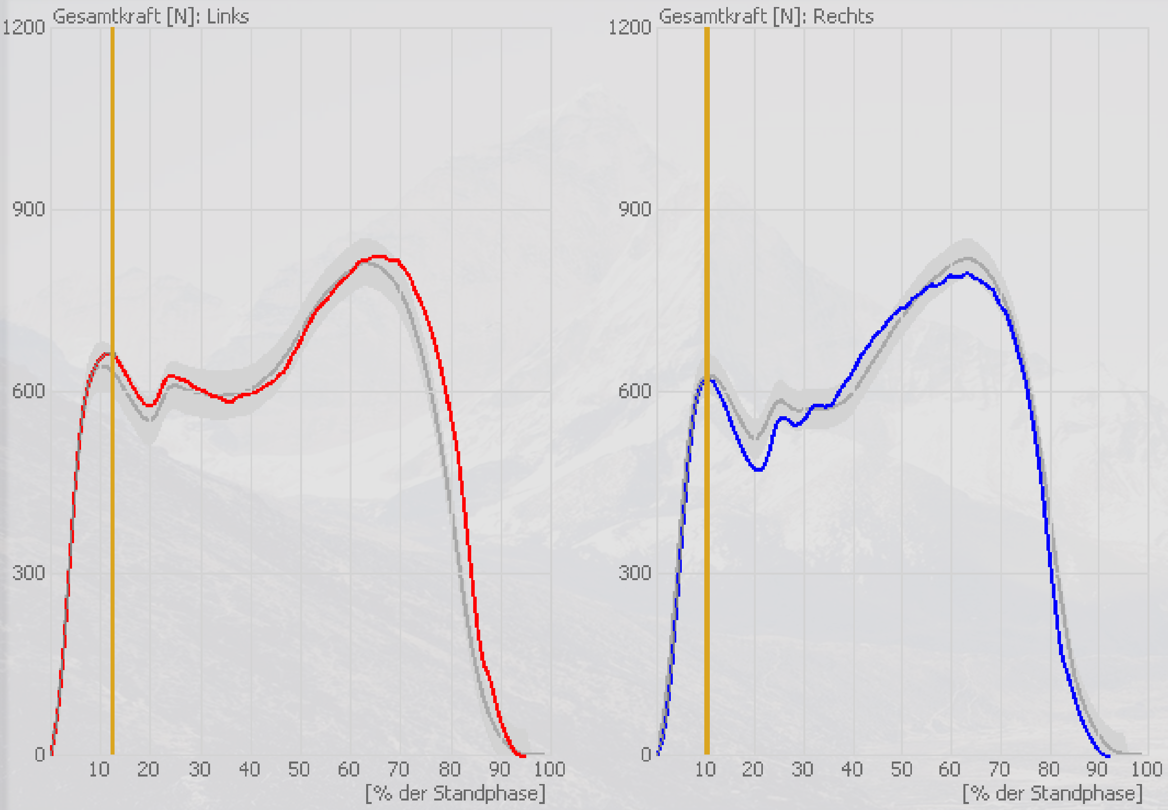
Medialization of gait line

Gait phase:

End of Loading Response R

Case Gonalgie, knee valgus

Pat. male, *1994, knee valgus L, duchenne, hip adduction, rear foot eversion



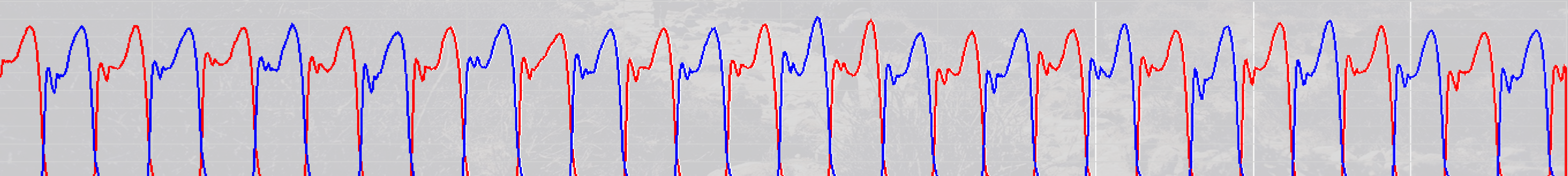
DIERS pedogait

Deviations:

Reduced ground reaction force = reduced excentric capacity, medial collapse

Gait phase:

End of Loading Response R



Case Gonalgie, knee valgus

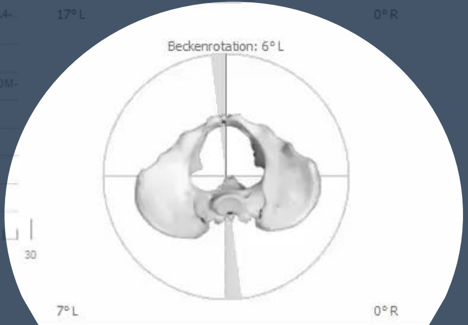
Pat. male, *1994, knee valgus L, duchenne, hip adduction, rear foot eversion

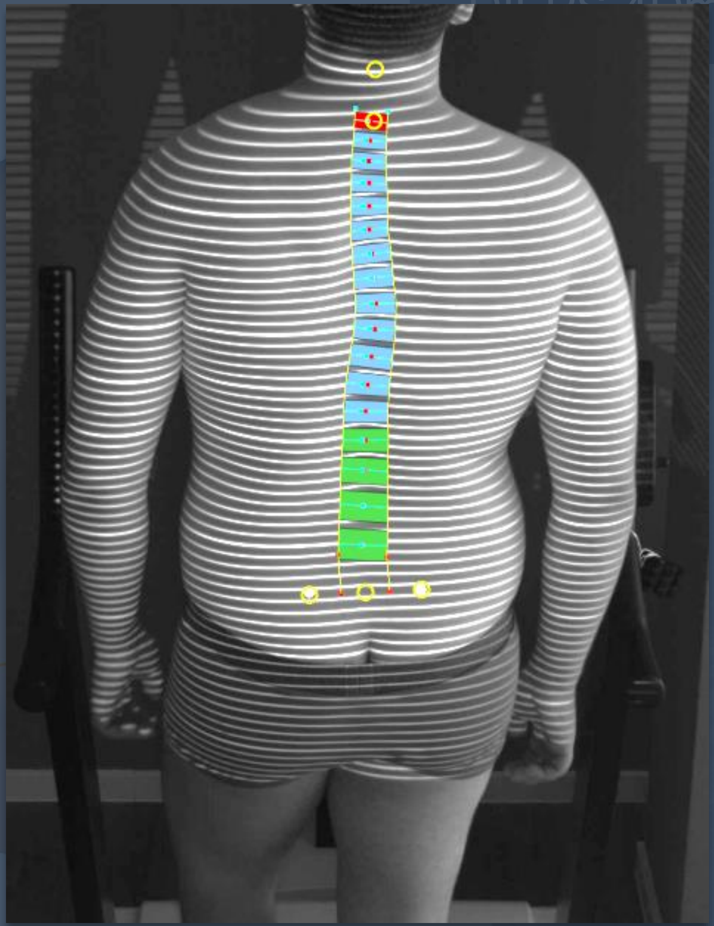
Deviation:

Unilateral Pelvis Rotation

Gait phase:

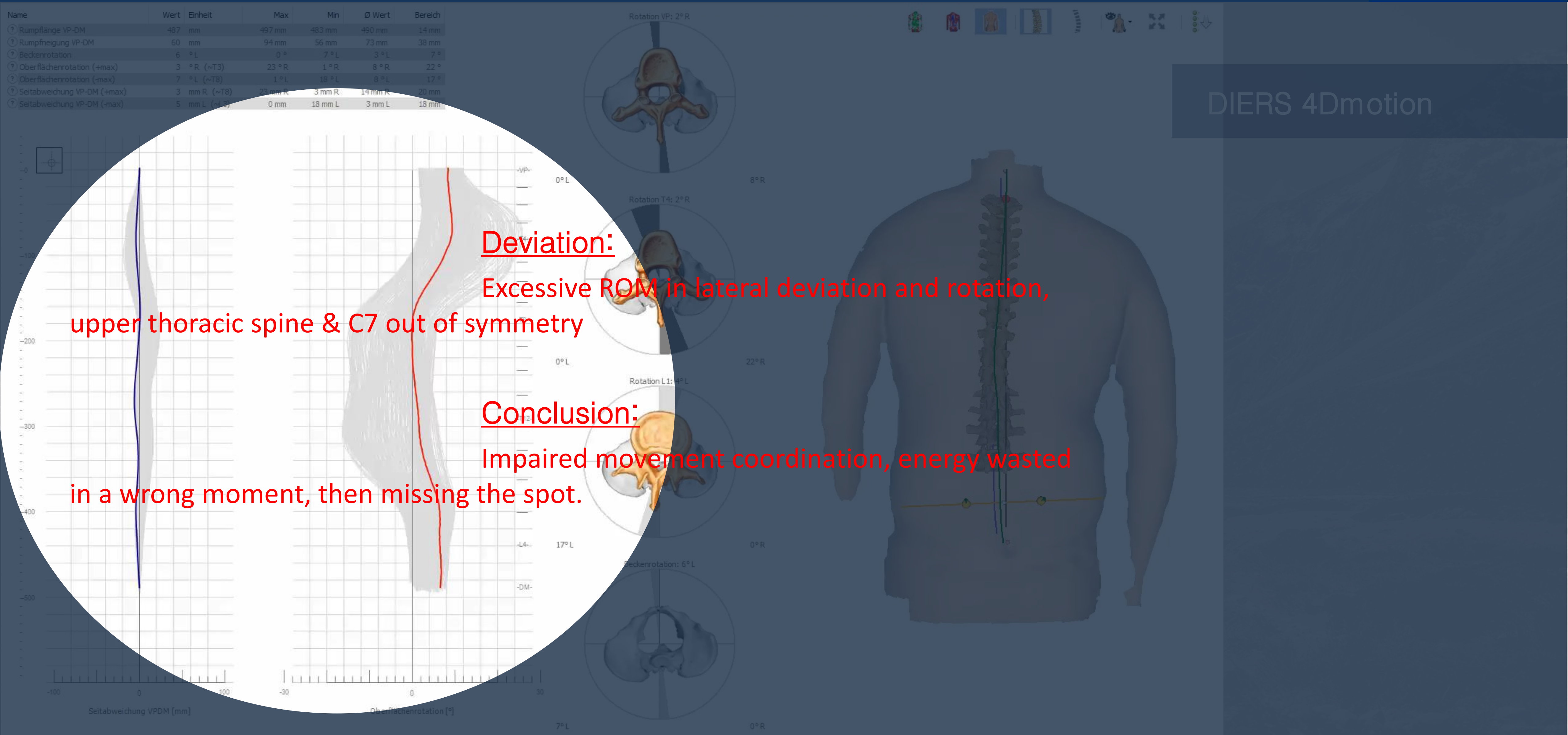
Mid Mid Stance!





Case Gonalgie, knee valgus

Pat. male, *1994, knee valgus L, duchenne, hip adduction, rear foot eversion



Deviation:

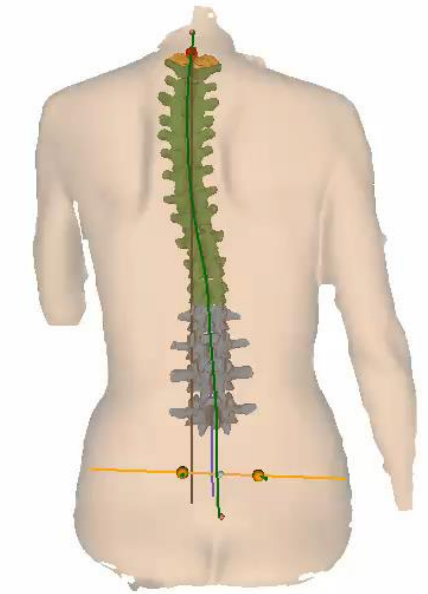
Excessive ROM in lateral deviation and rotation, upper thoracic spine & C7 out of symmetry

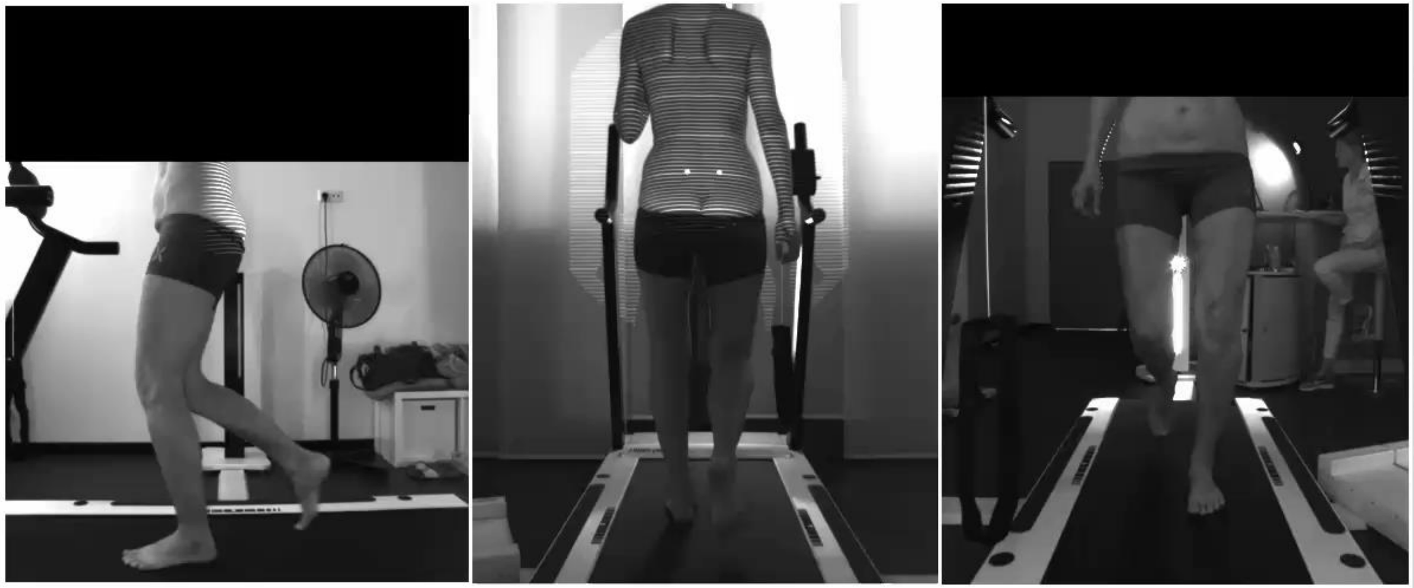
Conclusion:

Impaired movement coordination, energy wasted in a wrong moment, then missing the spot.

Case Forefoot runner

Pat. fem., *1969, half marathon runner, high arched foot, gastroc contraction



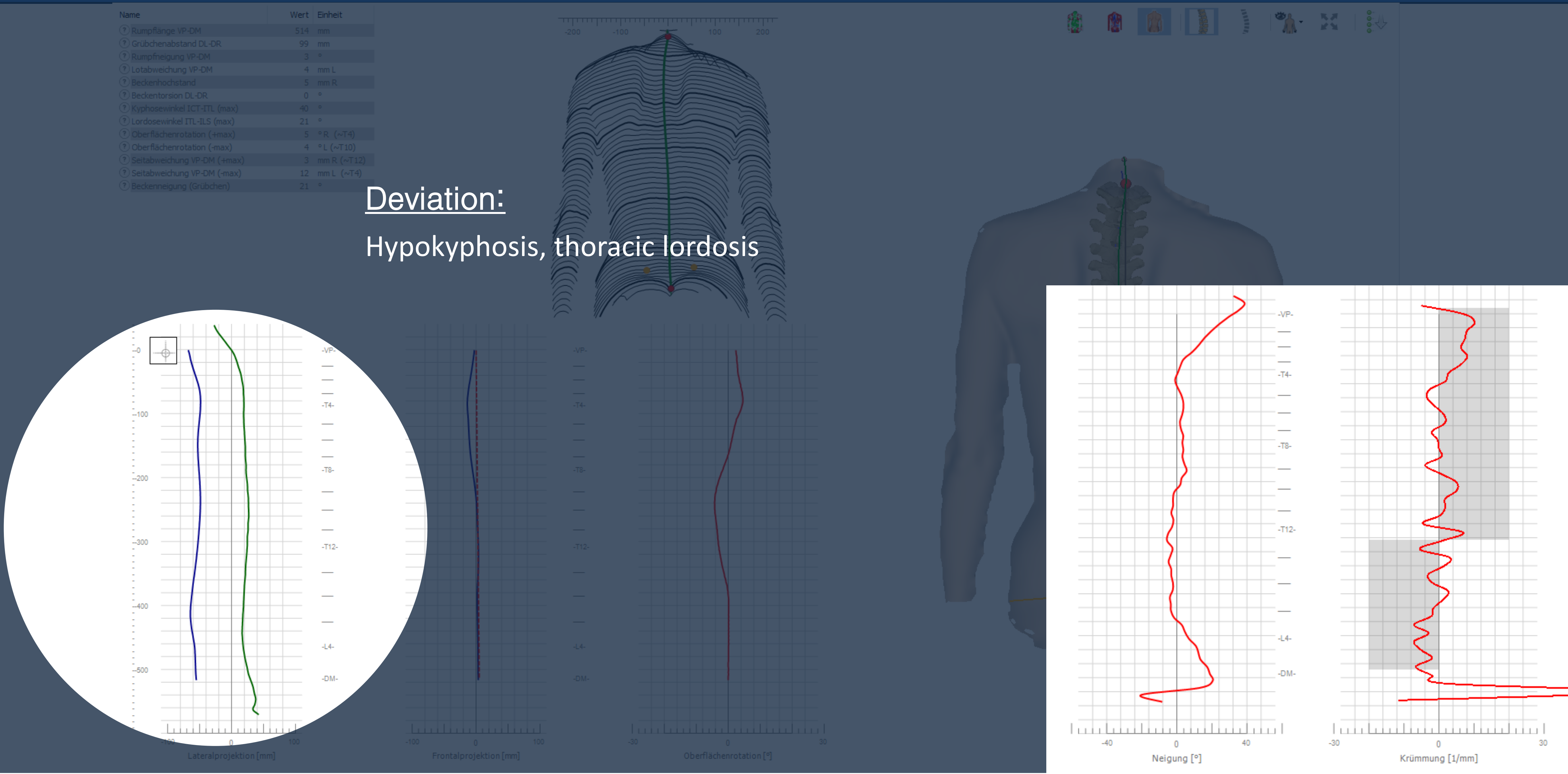


Name	Wert	Einheit
Rumpflänge VP-DM	493	mm
Rumpfneigung VP-DM	7	°
Oberflächenrotation (+max)	1	°R (~L3)
Oberflächenrotation (-max)	6	°L (~T...
Seitabweichung VP-DM (-max)	13	mm L (...
Seitabweichung VP-DM (Amplitude)	18	mm

NORMWERTE FÜR DEN GESCHWINDIGKEITSBEREICH VON 2 BIS 5 KM/ H. NACH PERRY, J.(2003): GANGANALYSE - NORM UND PATHOLOGIE DES GEHENS (1.AUFL.). MÜNCHEN, JENA. URBAN FISCHER VERLAG

Case Forefoot runner

Pat. fem., *1969, half marathon runner, high arched foot, gastroc contraction



Deviation:

Hypokyphosis, thoracic lordosis

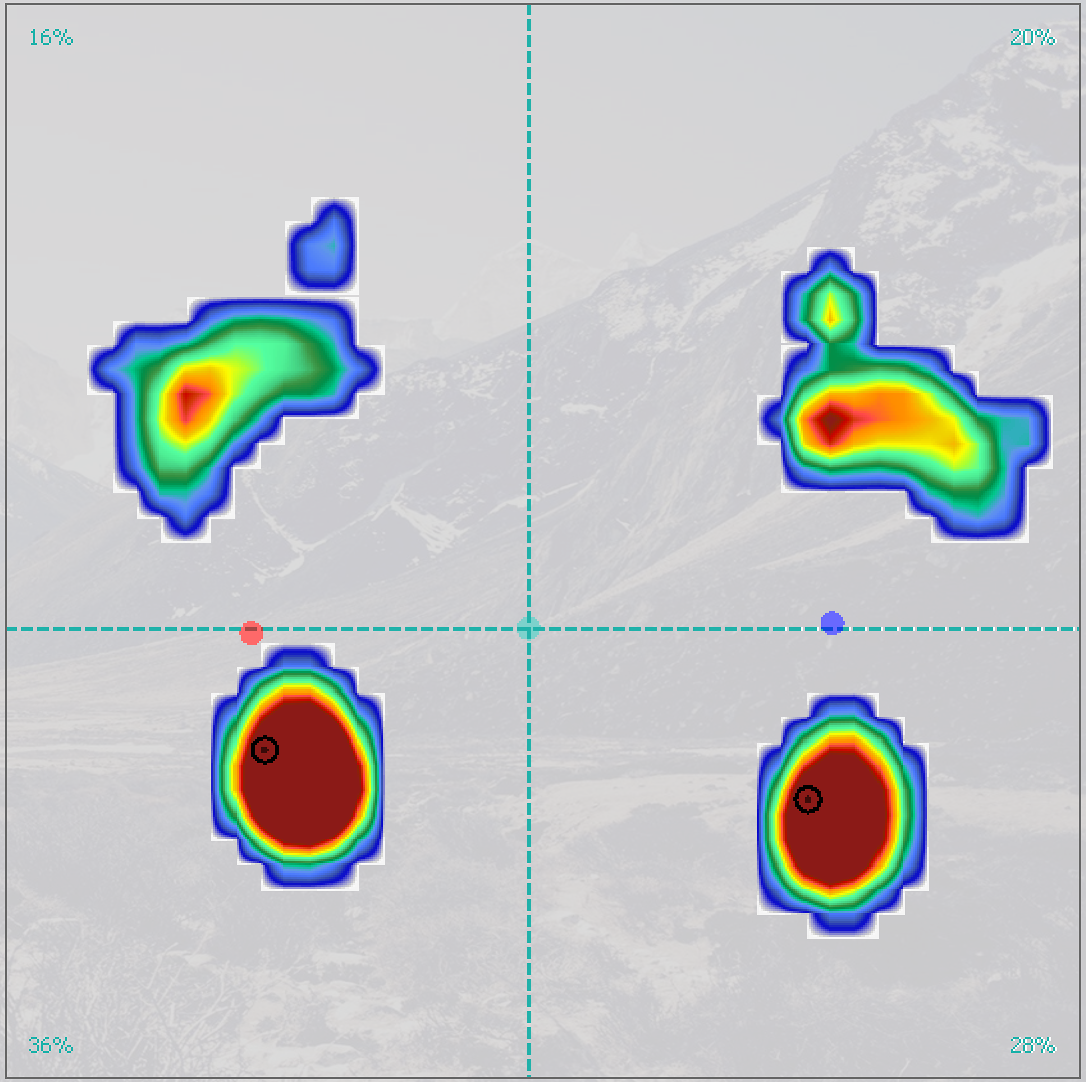
Case Forefoot runner

Pat. fem., *1969, half marathon runner, high arched foot, gastroc contraction

Deviation:

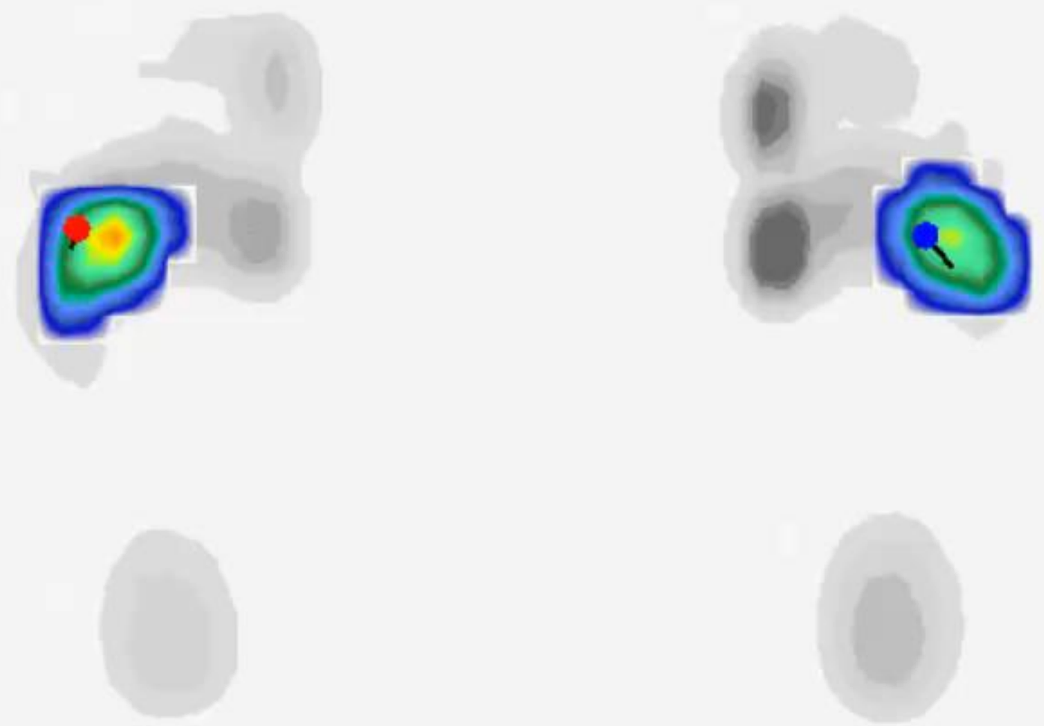
Hip ventrally of ankle

high arched foot L



Case Forefoot runner

Pat. fem., *1969, half marathon runner, high arched foot, gastroc contraction



DIERS pedogait

Deviation:

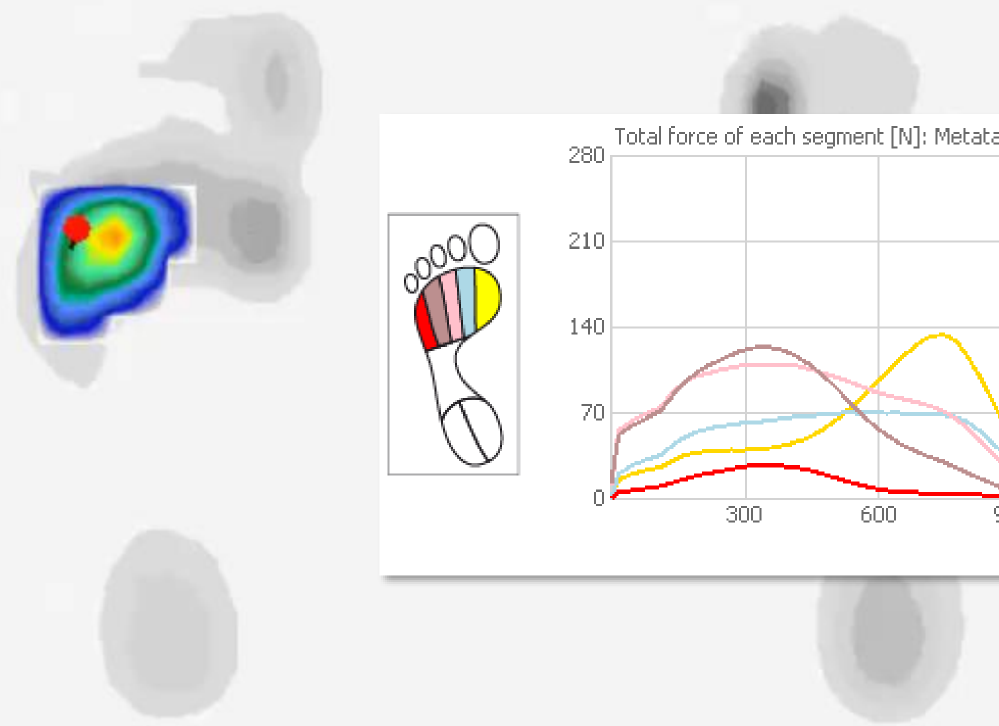
Initial contact with forefoot

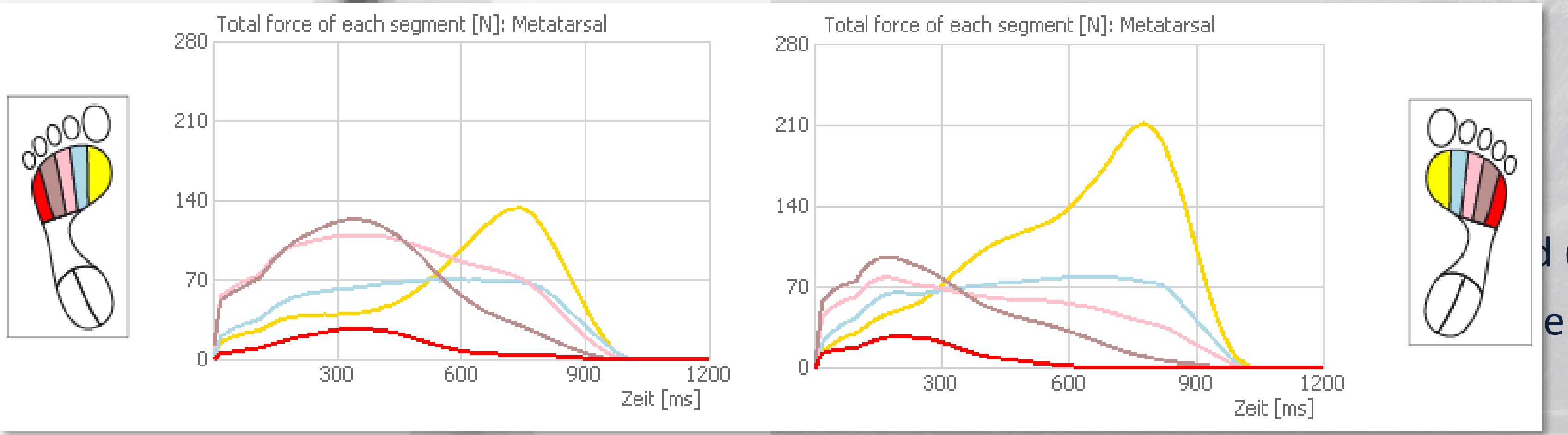
Mid foot is hardly contacting the ground (R > L)

IC on both feet laterally under transverse arch

Case Forefoot runner

Pat. fem., *1969, half marathon runner, high arched foot, gastroc contraction





DIERS pedogait

d (R > L)

e arch

Case Forefoot runner

Pat. fem., *1969, half marathon runner, high arched foot, gastroc contraction

DIERS leg axis lateral

Deviation:

Initial Contact on forefoot

IC in plantarflexion

Early heel-off

Case Forefoot runner

Pat. fem., *1969, half marathon runner, high arched foot, gastroc contraction

Orthopädie Aukammklinik

IC

DIERS leg axis lateral

Deviation:

Initial Contact on forefoot

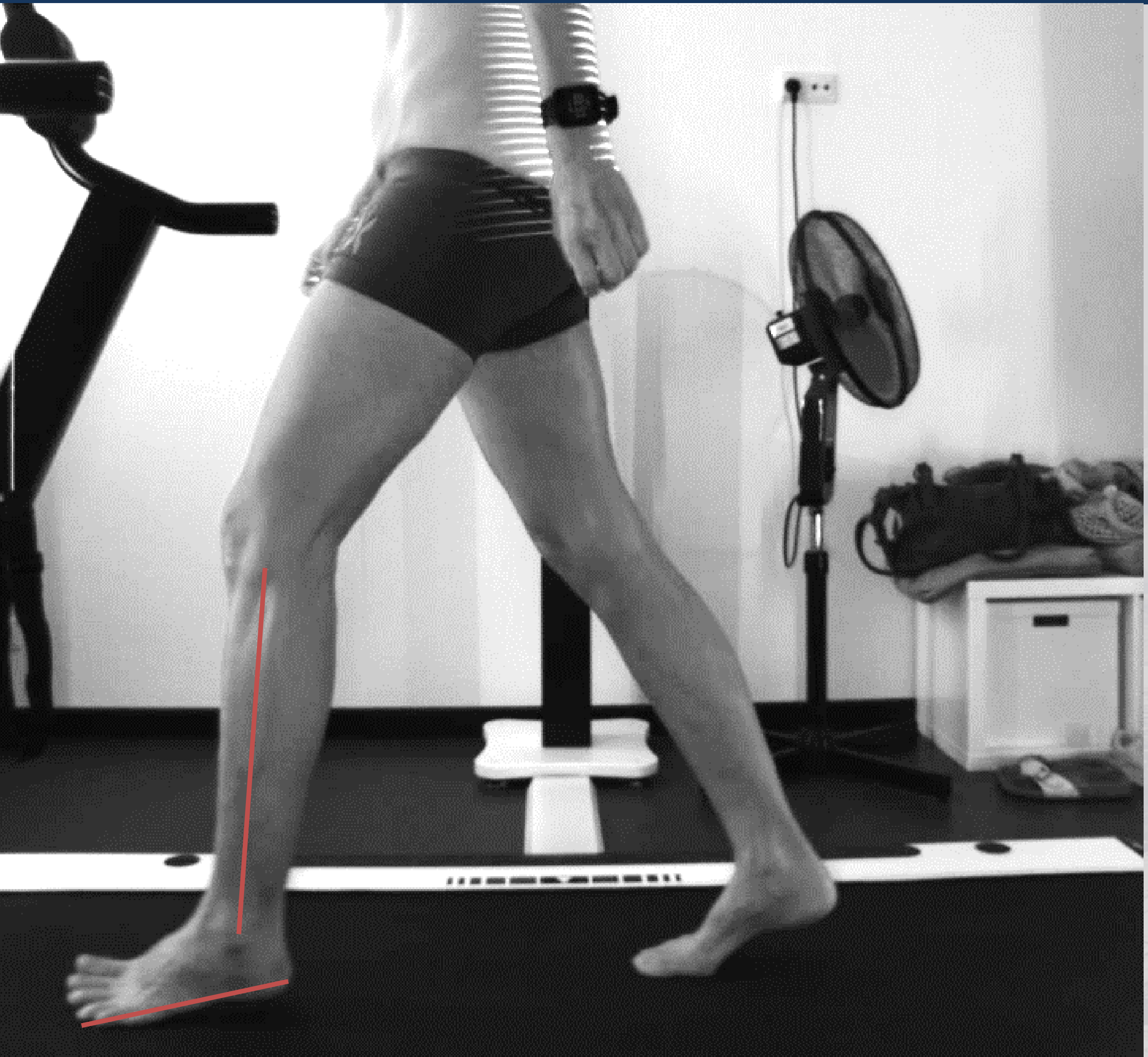
IC in plantarflexion

Early heel-off

Orthopädie Aukammklinik

Case Forefoot runner

Pat. fem., *1969, half marathon runner, high arched foot, gastroc contraction



DIERS leg axis lateral

Deviation:

Initial Contact on forefoot

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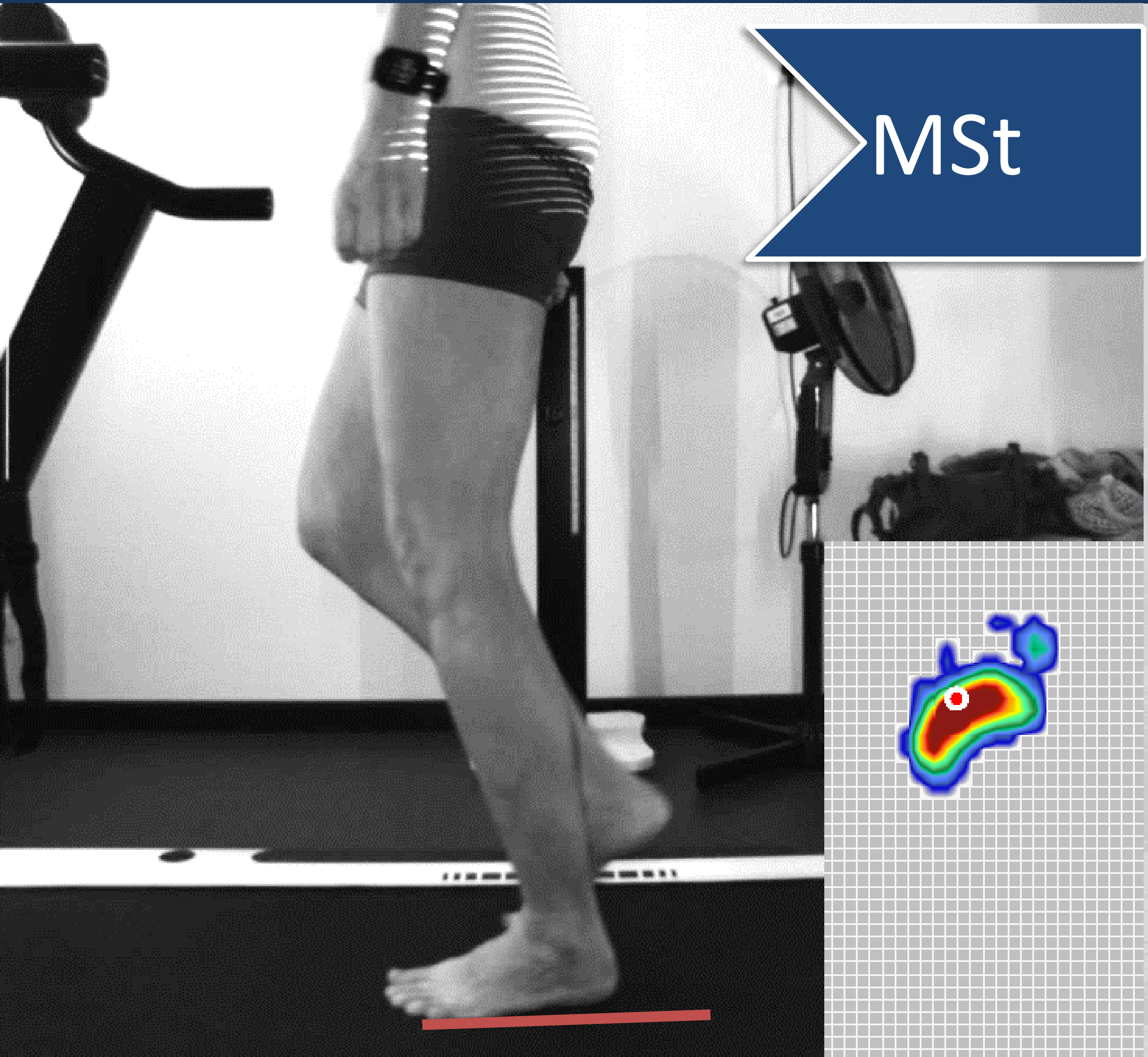
Early heel-off

Case Forefoot runner

Pat. fem., *1969, half marathon runner, high arched foot, gastroc contraction



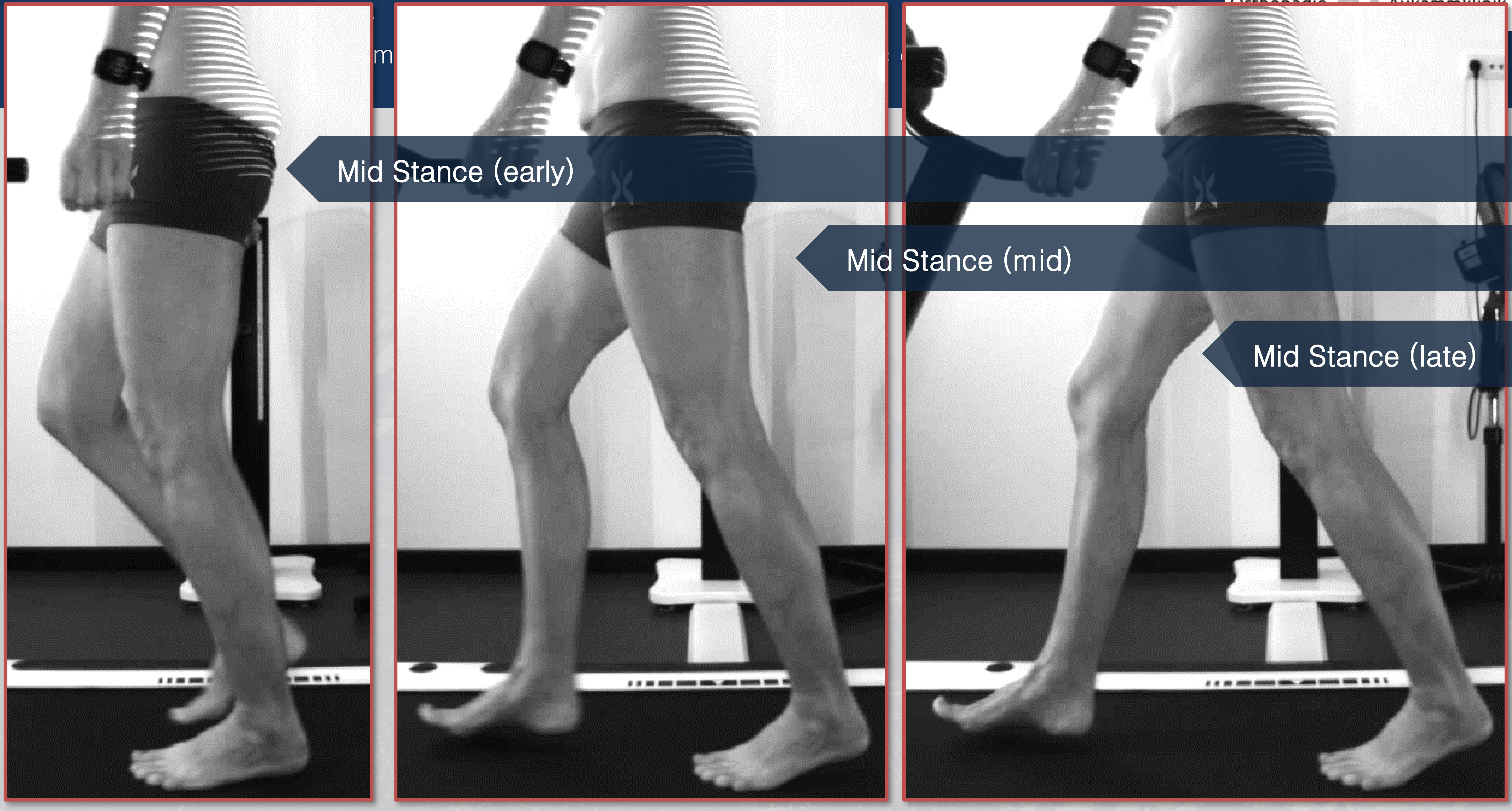
DIERS leg axis lateral

Deviation:

Initial Contact on forefoot

IC in Plantarflexion

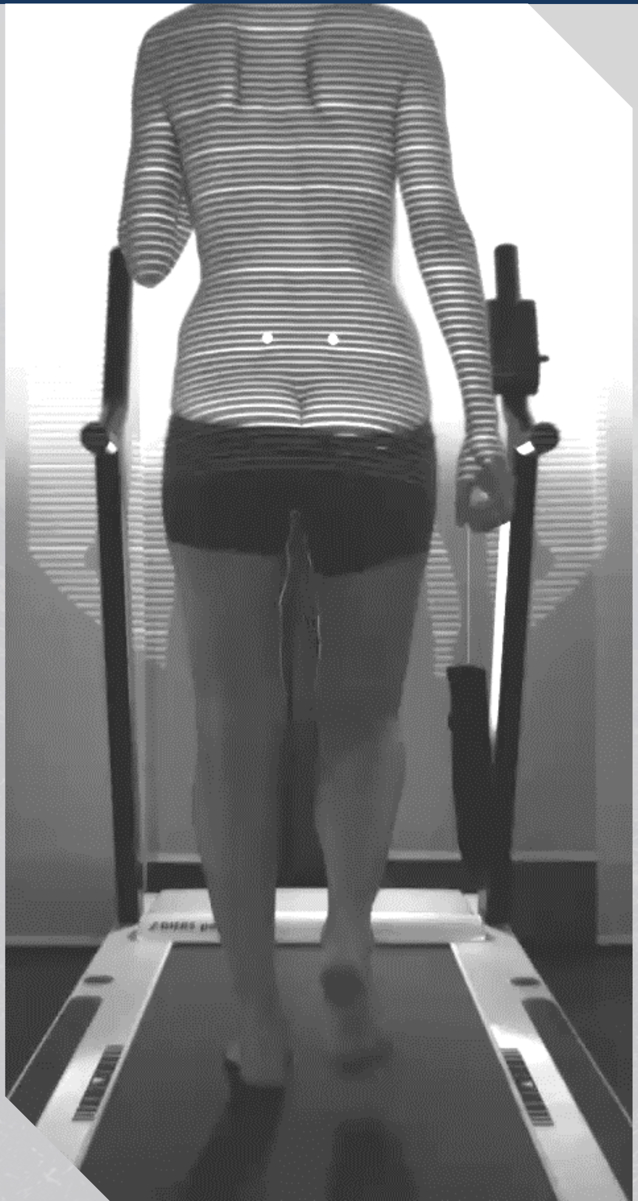
Early heel-off


Mid Stance (early)
Mid Stance (mid)
Mid Stance (late)

Stance (late)

Case Forefoot runner

Pat. fem., *1969, half marathon runner, high arched foot, gastroc contraction



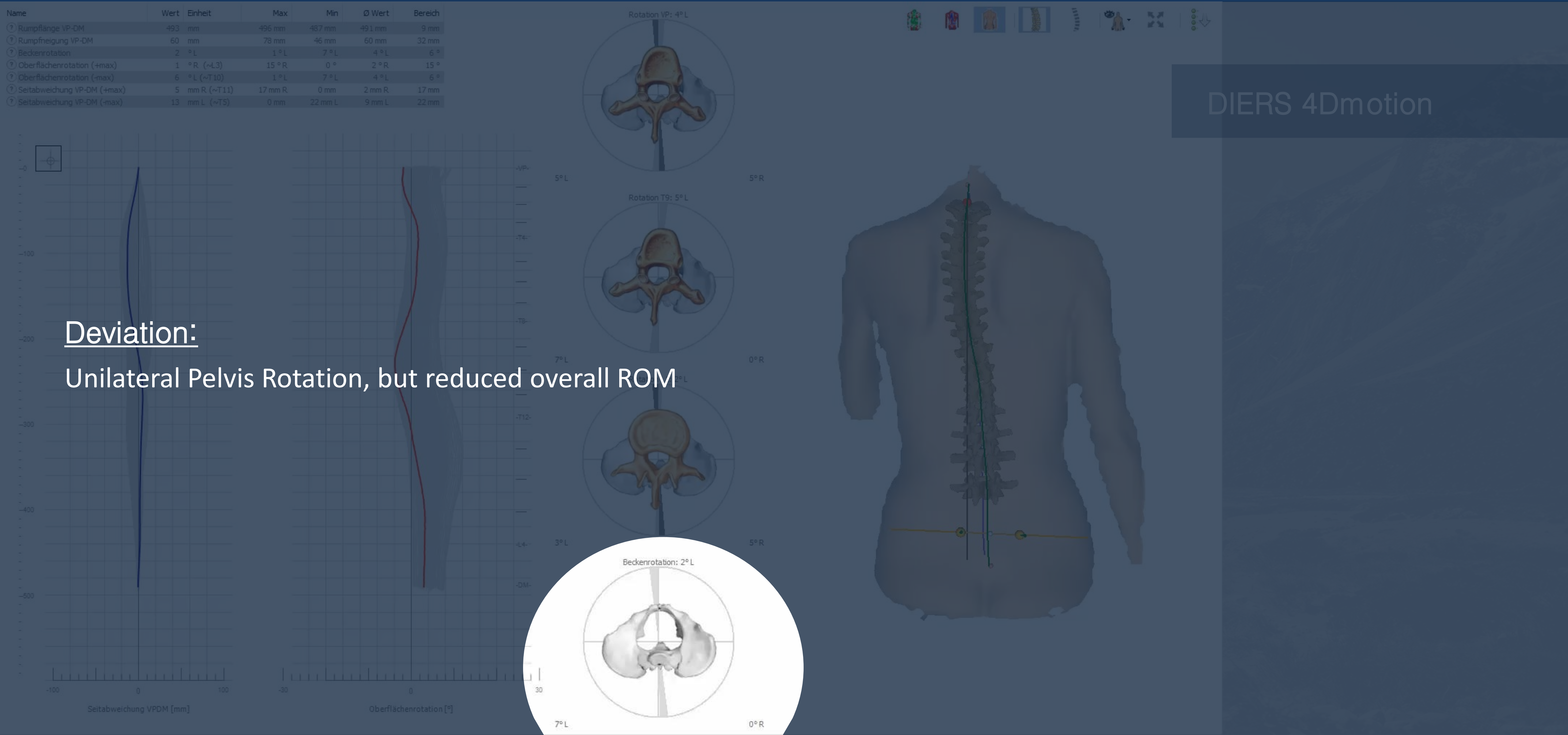
DIERS leg axis posterior

Deviation:

Visible up- and down-movement of entire body, initialized in TSt.

Case Forefoot runner

Pat. fem., *1969, half marathon runner, high arched foot, gastroc contraction



Deviation:

Unilateral Pelvis Rotation, but reduced overall ROM

Case Forefoot runner

Pat. fem., *1969, half marathon runner, high arched foot, gastroc contraction

Deviation:

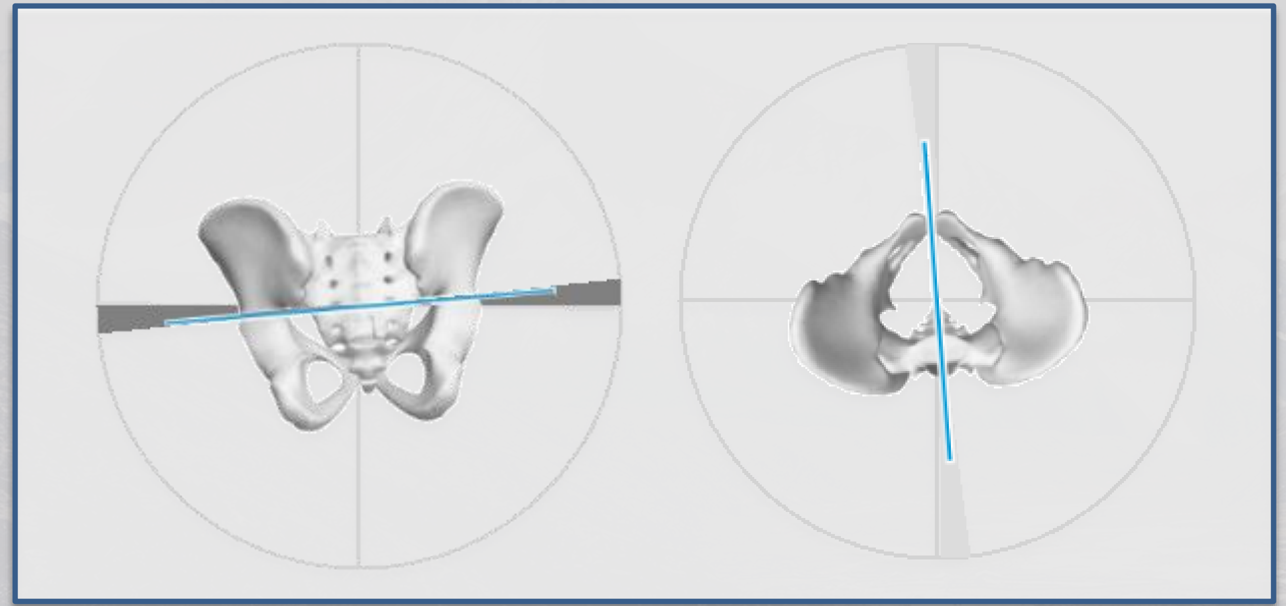
Increased ROM in Lateral Deviation

Case Forefoot runner

Pat. fem., *1969, half marathon runner, high arched foot, gastroc contraction

Orthopädie Aukammklinik

DIERS 4Dmotion



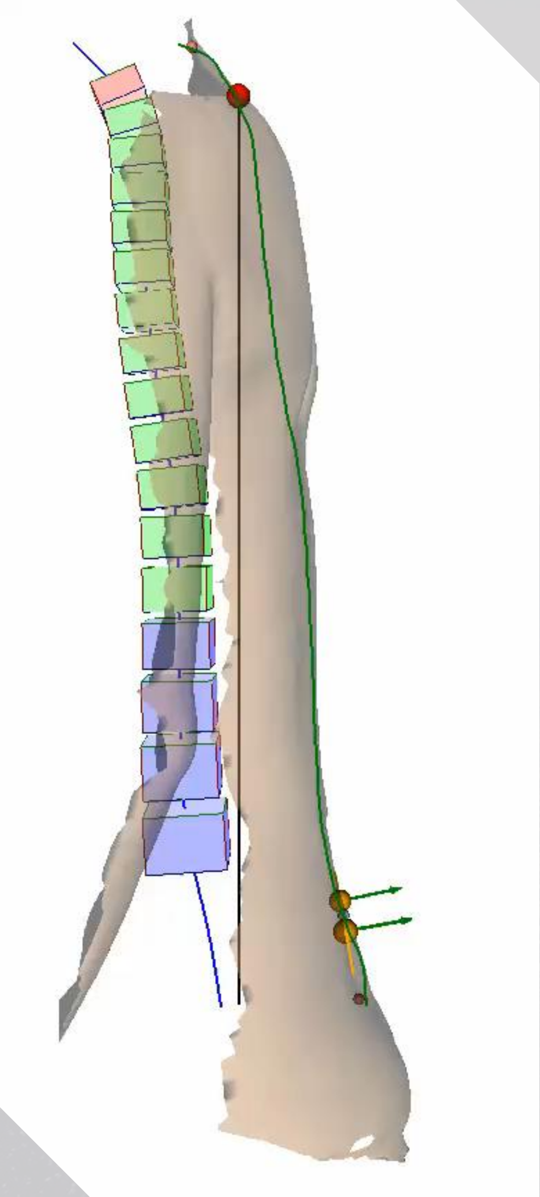
Deviation:

Constant Pelvic Drop L, Pelvis Rotation L

Case Forefoot runner

Pat. fem., *1969, half marathon runner, high arched foot, gastroc contraction

Orthopädie Aukammklinik



DIERS 4Dmotion

Deviation:

Flatback with reduced shock absorption capacity

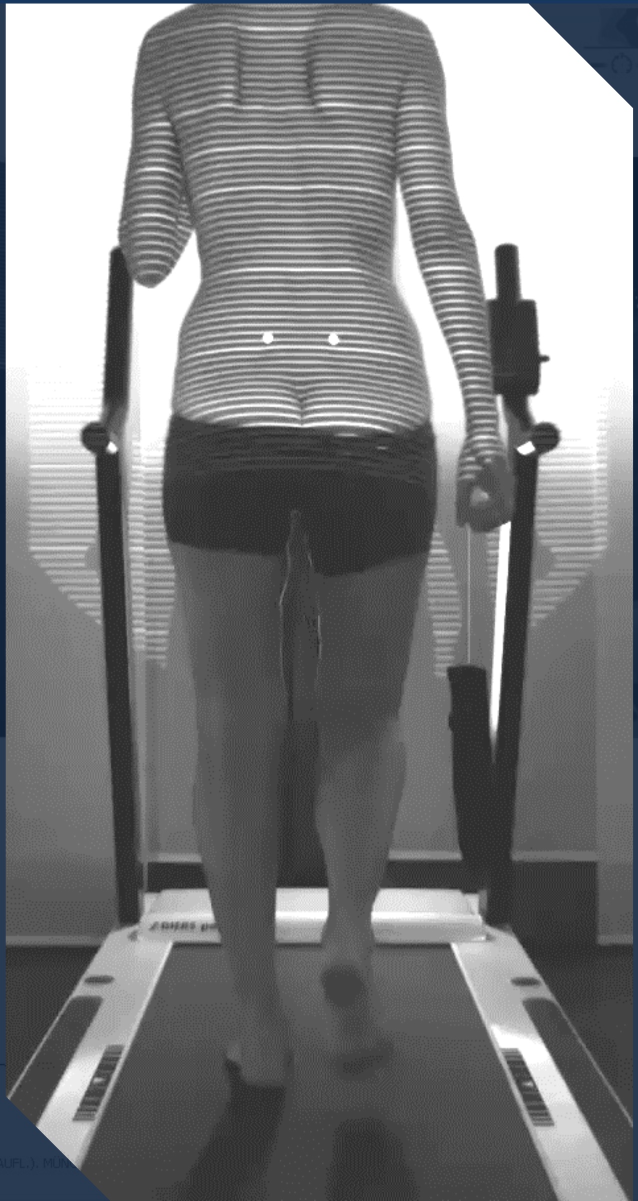
Pelvis Inclination also reduced

Case Forefoot runner

Pat. fem., *1969, half marathon runner, high arched foot, gastroc contraction

Summarizing findings:

- Pat. shows increased pf activity



Orthopädie Aukammklinik

Case Forefoot runner

Pat. fem., *1969, half marathon runner, high arched foot, gastroc contraction

Summarizing findings:

- Pat. shows increased pf activity
- Knee L remains in flexion in TSt (Pelvis Rotation L - increases step length)

Case Forefoot runner

Pat. fem., *1969, half marathon runner, high arched foot, gastroc contraction

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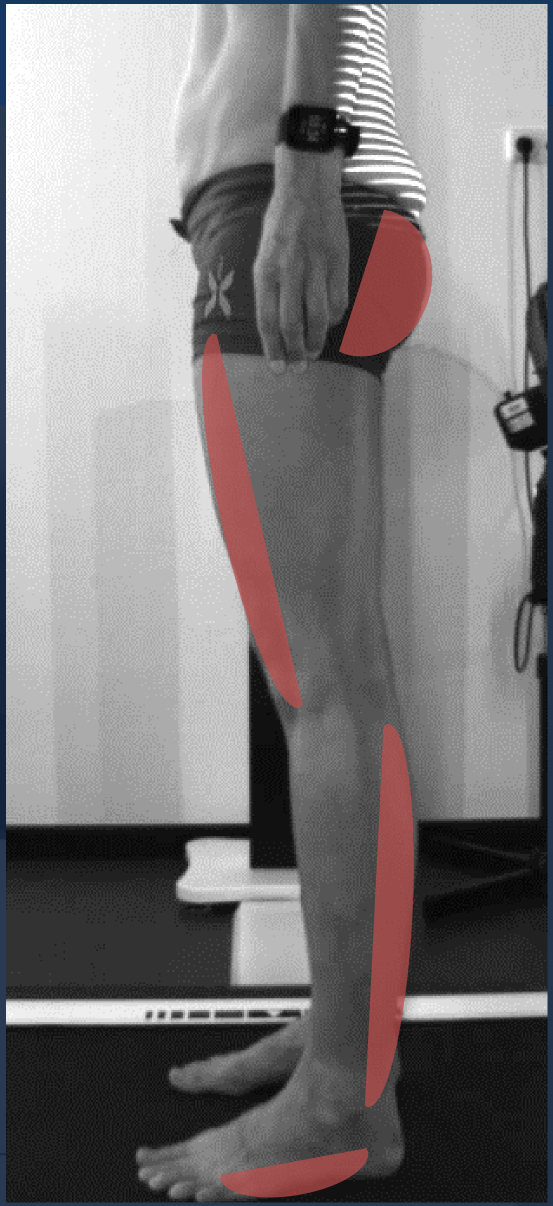
- Assumption: gastroc contraction L >R

Orthopädie Aukammklinik

Case Forefoot runner

Pat. fem., *1969, half marathon runner, high arched foot, gastroc contraction



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- Knee L remains in flexion in TSt (Pelvis Rotation L - increases step length)
- Assumption: gastroc contraction L >R
- Functional chain would increase energy demand and counter activity in knee and hip extensors. Hip flexors relaxed
- Gluteal muscle fibres in approximation

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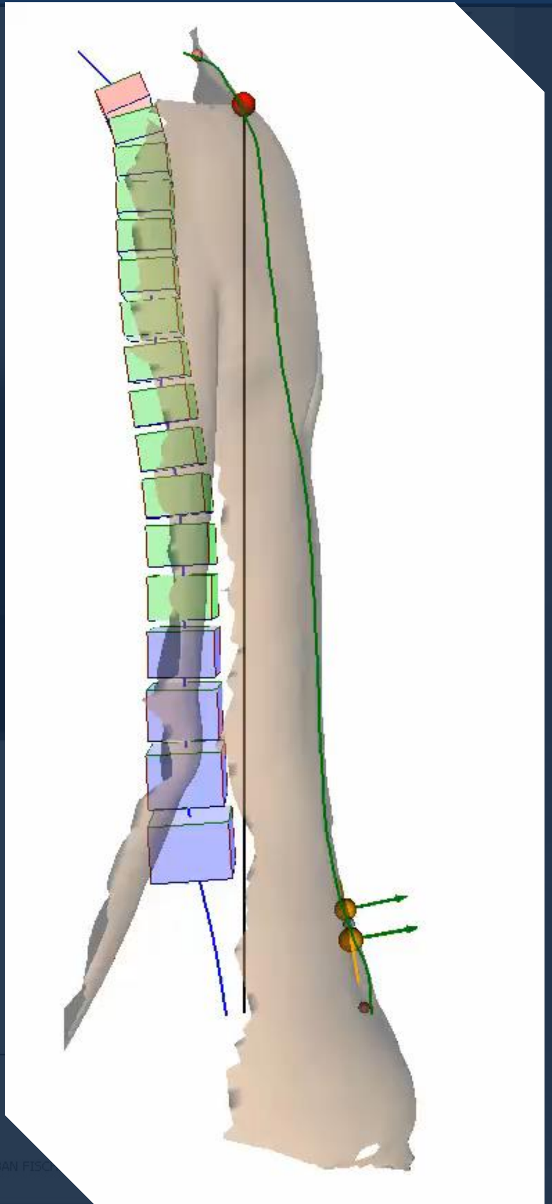
- Leads to altered demands on shock absorption (flatback)



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Pat. fem., *1969, half marathon runner, high arched foot, gastroc contraction

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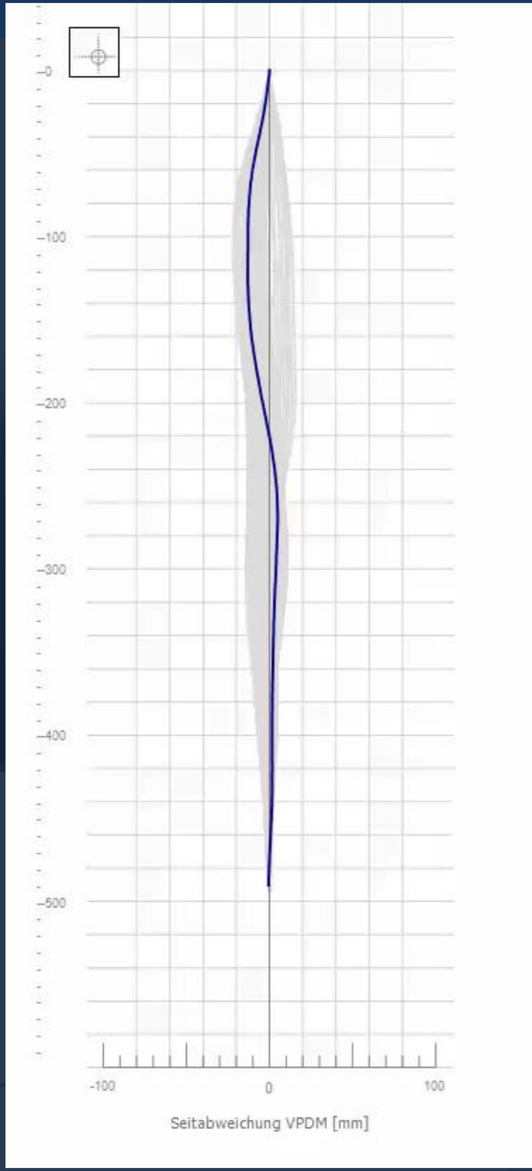
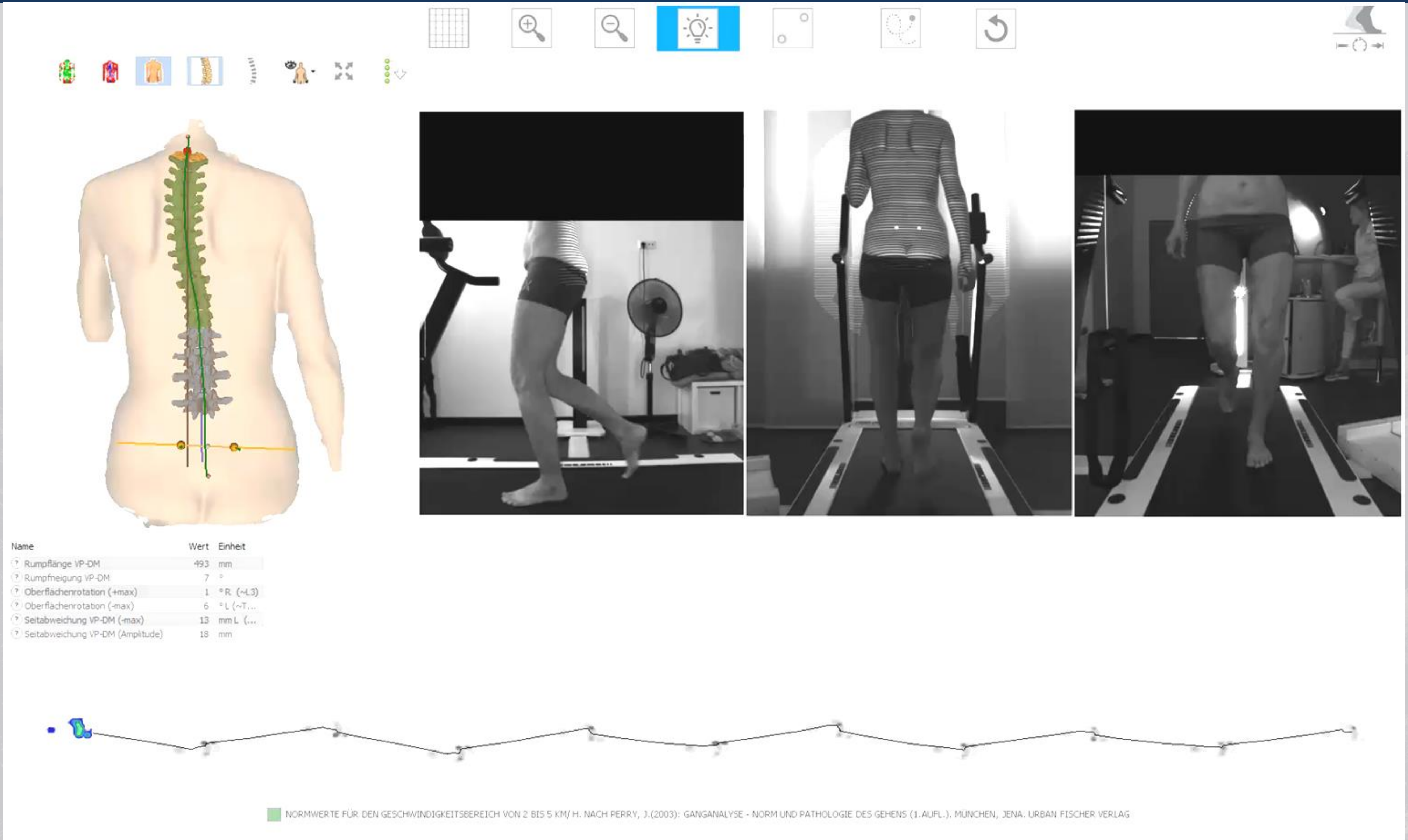
- Functional chain would increase energy demand and counter activity in knee and hip extensors. Hip flexors relaxed
- Gluteal muscle fibres in approximation
- Leads to altered demands on shock absorption (flatback)
- Increased energy demand coming from high ROM in Lateral Deviation



Orthopädie Aukammklinik

Case Forefoot runner

Pat. fem., *1969, half marathon runner, high arched foot, gastroc contraction



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