

Importance of Calibration for the Radiographic Assessment of Fusionless Treatment of Pediatric Scoliosis

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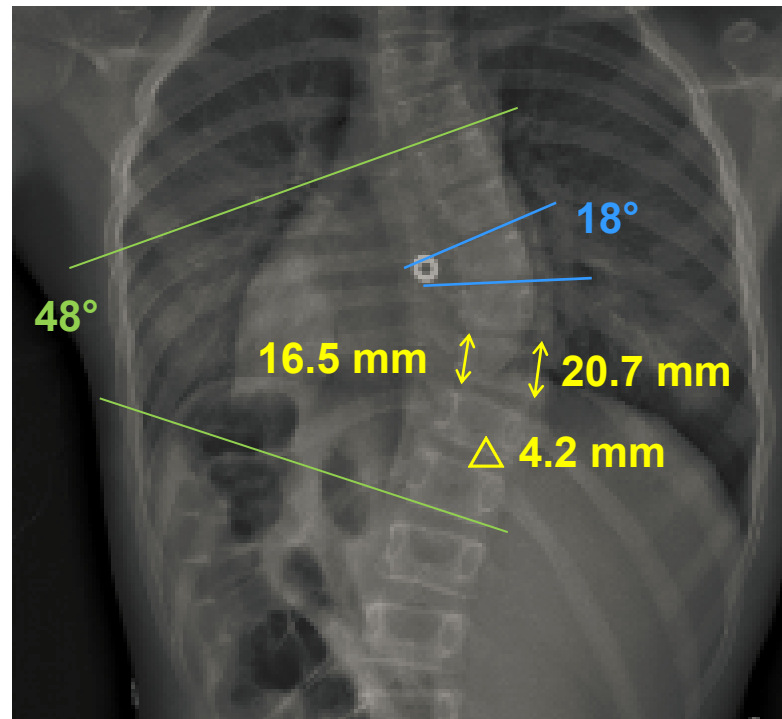
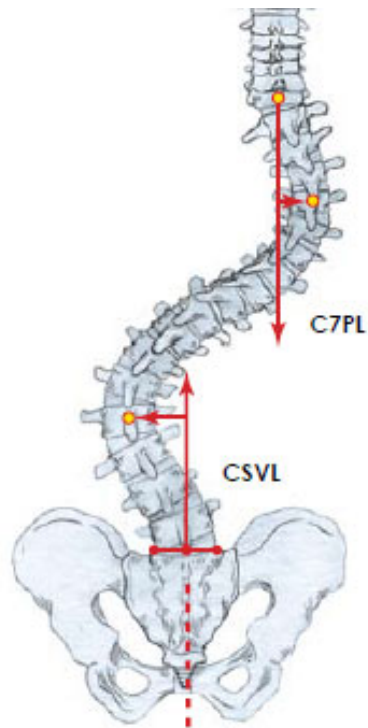
Disclosures

Carl-Eric Aubin	Natural Sciences and Engineering Research Council of Canada (a), Medtronic (a, b, c), Scoliosis Research Society (a)
Christian Bellefleur	Natural Sciences and Engineering Research Council of Canada (a), Medtronic (a), Scoliosis Research Society (a)
H. Labelle	Spinologics (f), DePuy Spine (a), Canadian Institutes of Health Research (a)
S. Parent	Spinologics (f), AOSpine (g), Depuy Synthes (a,c), EOS Imaging (a,c), K2M (a), Medtronic (a, c)

- | | |
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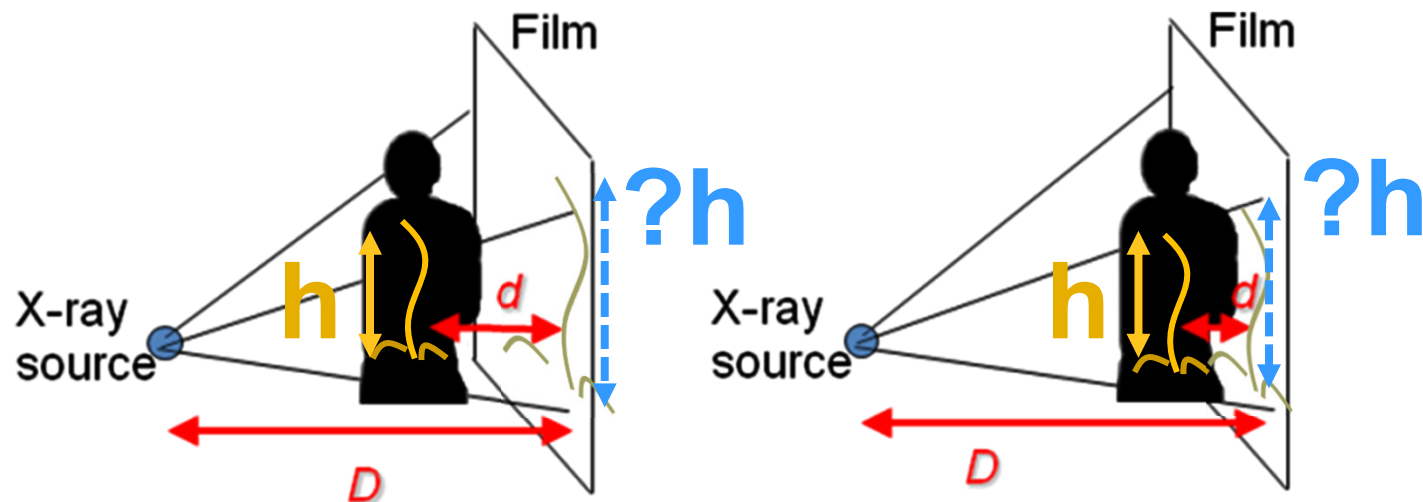
Introduction

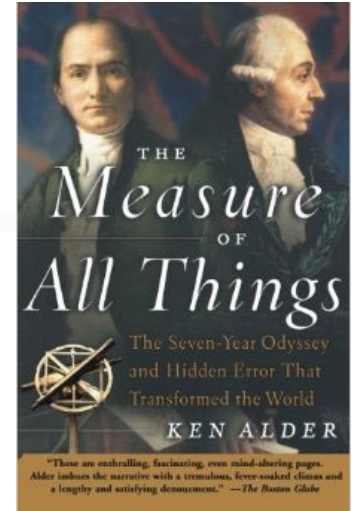
- Radiographic measurements are commonly used for the immediate assessment and follow-up of fusionless treatments of pediatric scoliosis



[Problems]

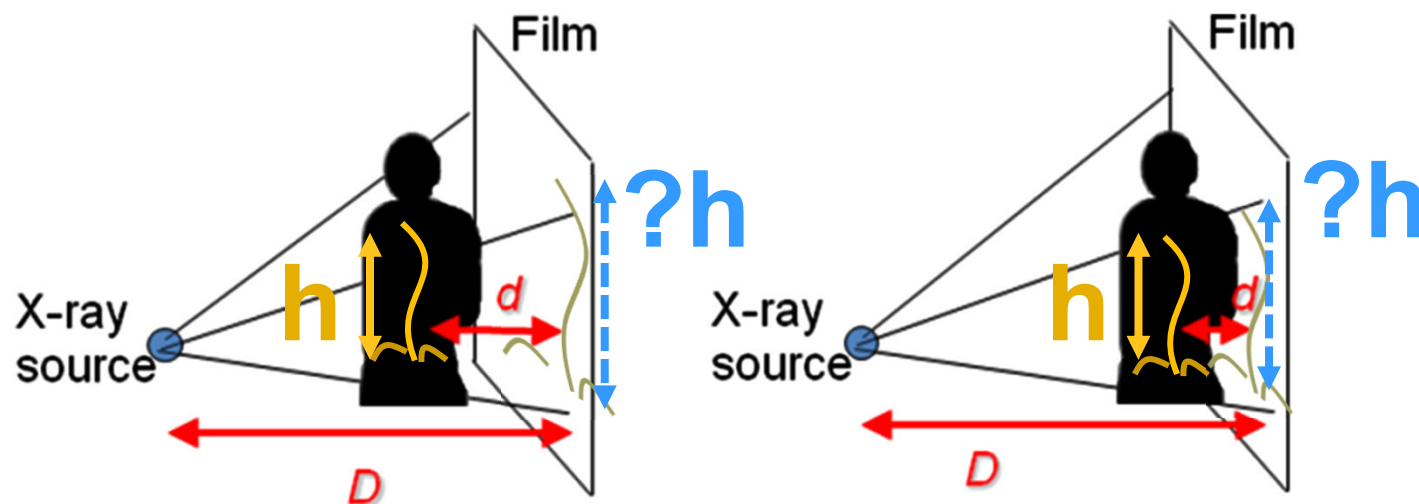
- Variety of radiographic systems, acquisition techniques and size ratio for image storing (PACS)
- Variability of image scaling due to the perspective projection:
 - Spine to X-ray film distance (d)
 - X-ray source to film distance (D)
- Use of a **ruler** on radiographic cassette or pixel size:
 - Calibration of the film vs. *patient*





Objective

To demonstrate the importance of appropriate radiographic calibration to appropriately measure and monitor scoliotic deformities and correction over time



Methods

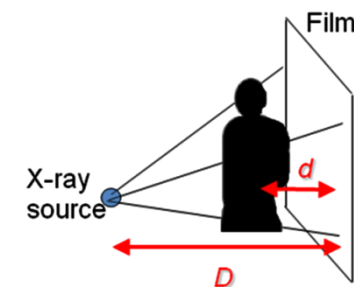
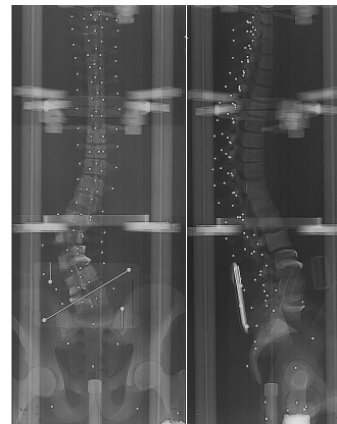
- 10 synthetic spines in different acquisition settings:

RX Setting	Model	Coronal Image	Lateral Image	Spine to cassette distance d (mm)	Source to film distance D (mm)
#1	Right Thoracic – Hyper Lordosis	PA	Left	429	1843
#2	Left Lumbar	PA	Left	432	1873
#3	Right Thoracic – Left Lumbar	PA	Left	462	1857
#4	Left Lumbar – Hypo Lordosis	PA	Left	464	1844
#5	Right Thoracic – Left Lumbar	PA	Left	430	1850
#6	Right Thoracic – Left Lumbar	PA	Left	420	1820
#7	Normal #1	PA	Left	459	1849
#8	Normal #2	PA	Left	357	1847
#9	Normal #3	AP	Right	175	1830
#10	Normal #4	PA	Right	200	1830

d : 175-464 mm

D : 1830-1873 mm

Ex:
Case #3:

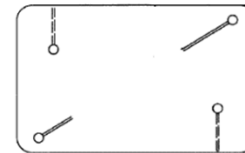


Measurements

•Angular: Cobb, sagittal angles

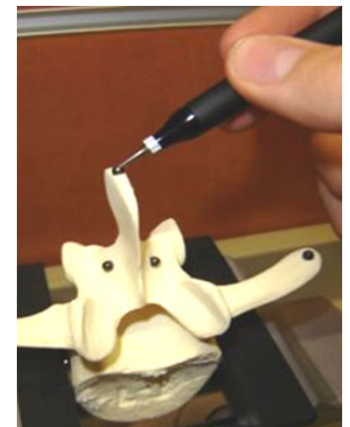
•Linear: SVA, C7PL, AVT, spine height, VB height

- 1) Directly on the X-rays and scaling the measurements w/ a radiographic ruler (or DPI)
- 2) Scaling the measurements using a calibration device (4 radiopaque markers, with known dimensions) put on the back of the spine



Comparison to:

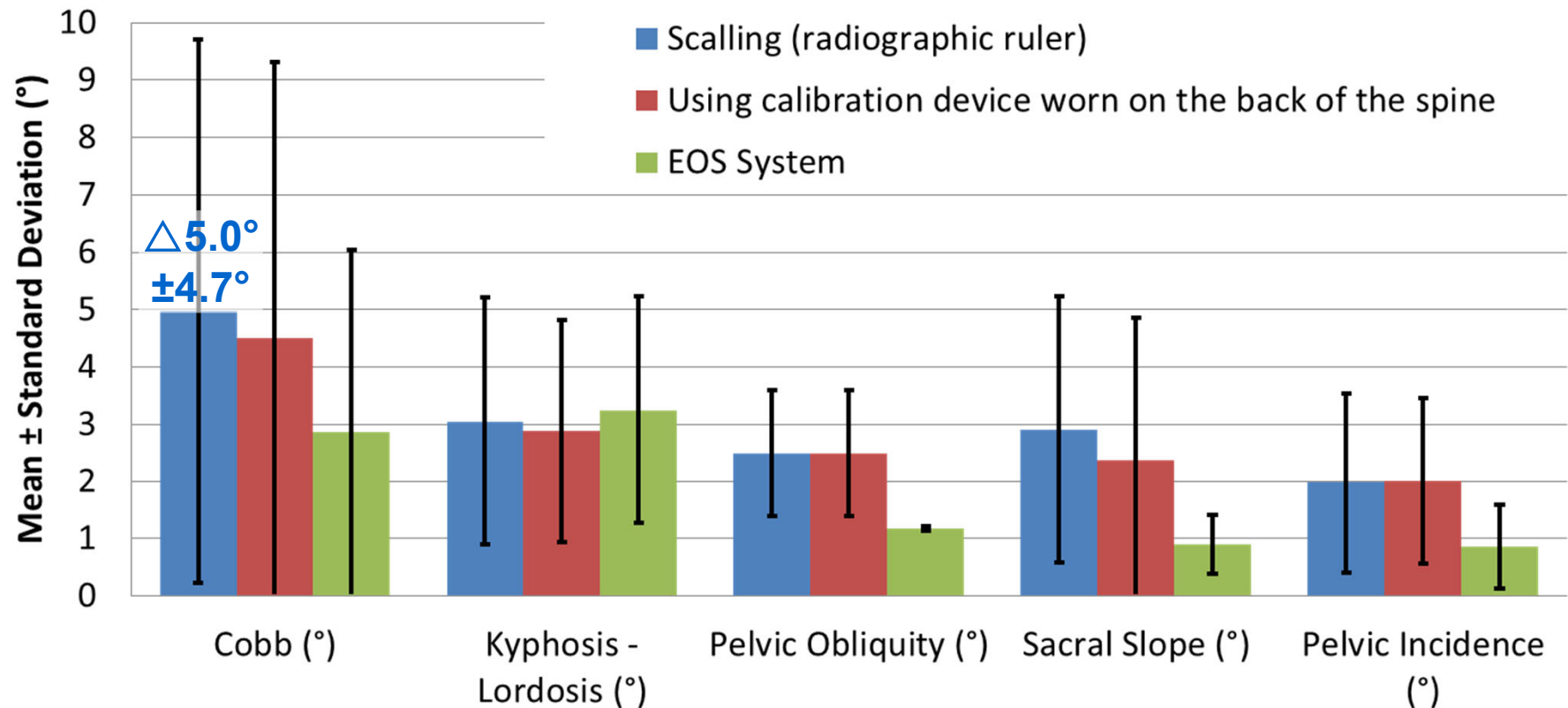
- 3) Precise measurements made with a 3D digitizer (reference; 0.1 mm accuracy)
- 4) Complementary measurements (n=3) with the *EOS imaging* biplanar X-ray system (factory calibrated)



Angular Measurement Difference

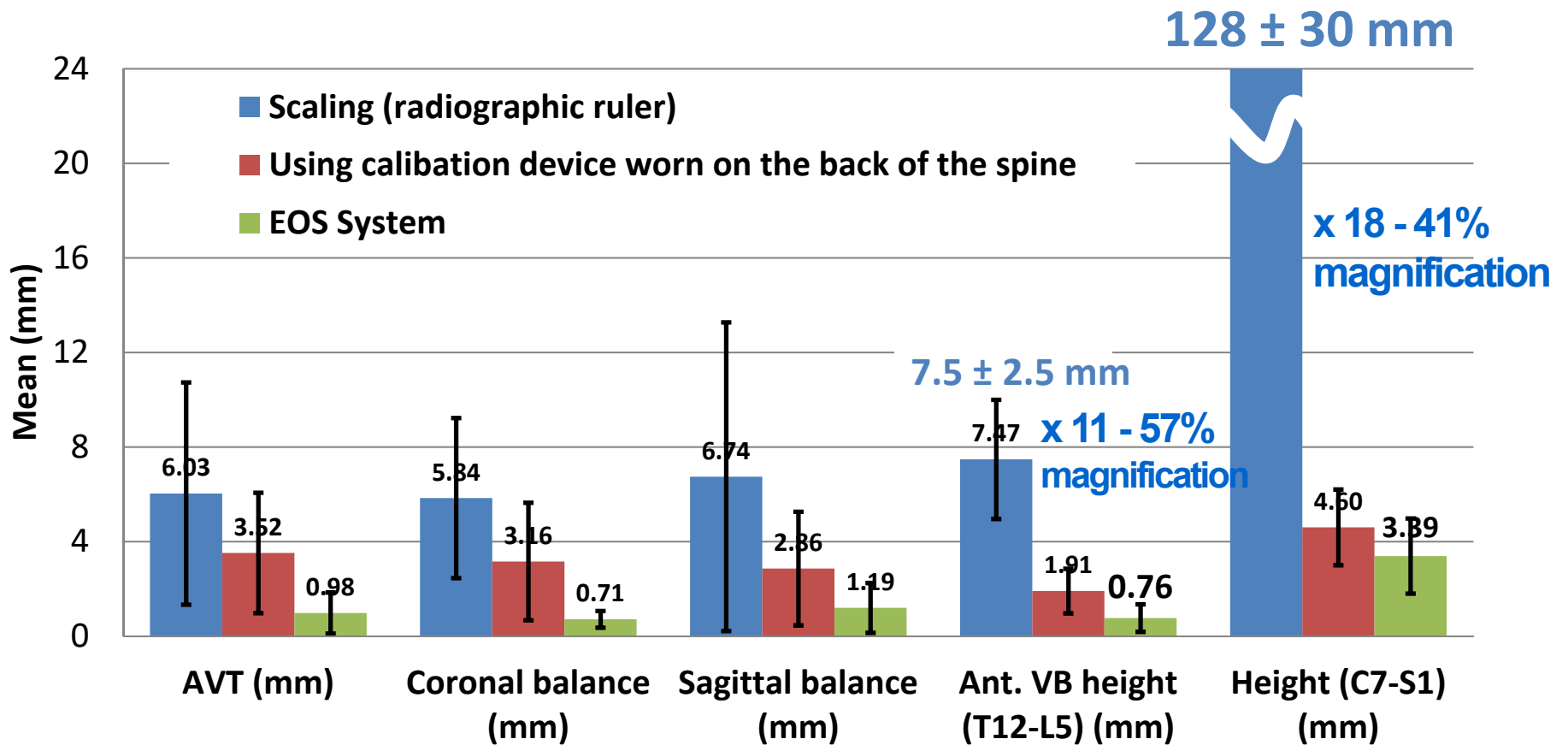


w/r to reference



- Angular measurements not influenced by the calibration technique for STD radiographs
- Accuracy improvement of 1-2° using EOS imag radiographs

Linear Measurement Difference



- **w/ calibration : ↓50%**
- **EOS imaging: 0.7 to 3.4 mm**

Ex: VB Height measurement

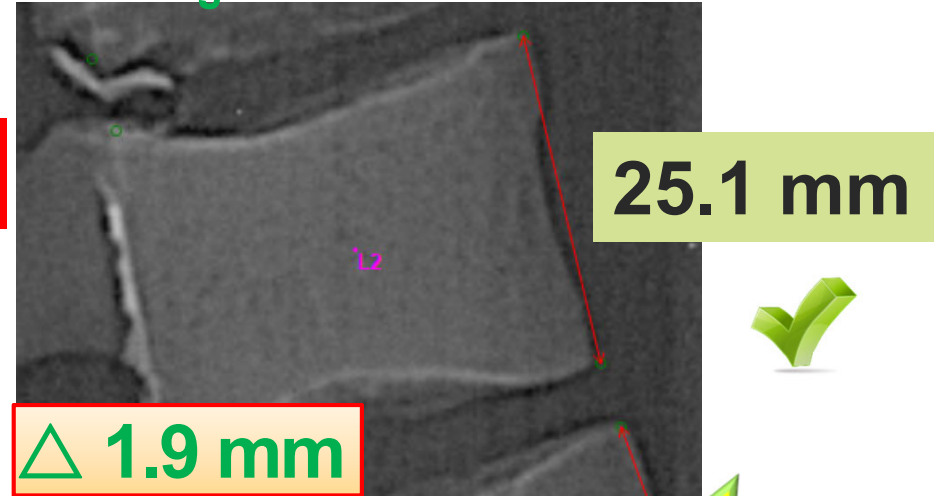
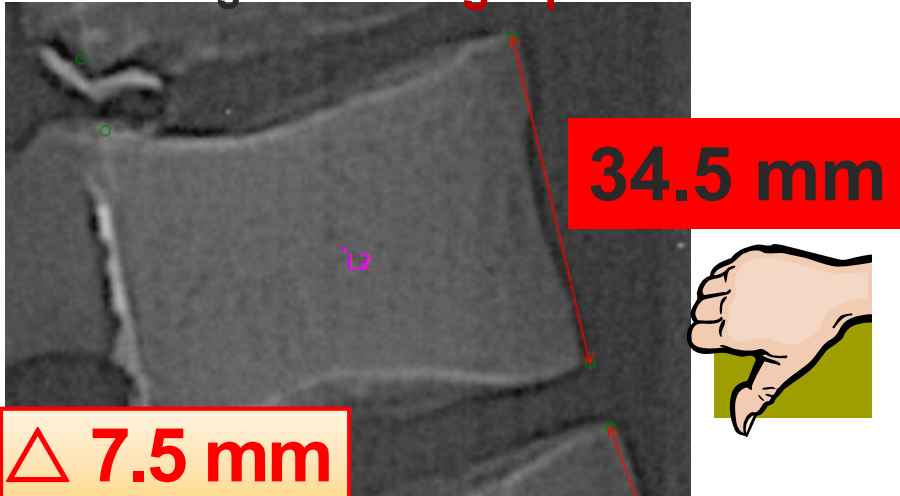
SAME spine, SAME vertebra

d = 43 cm

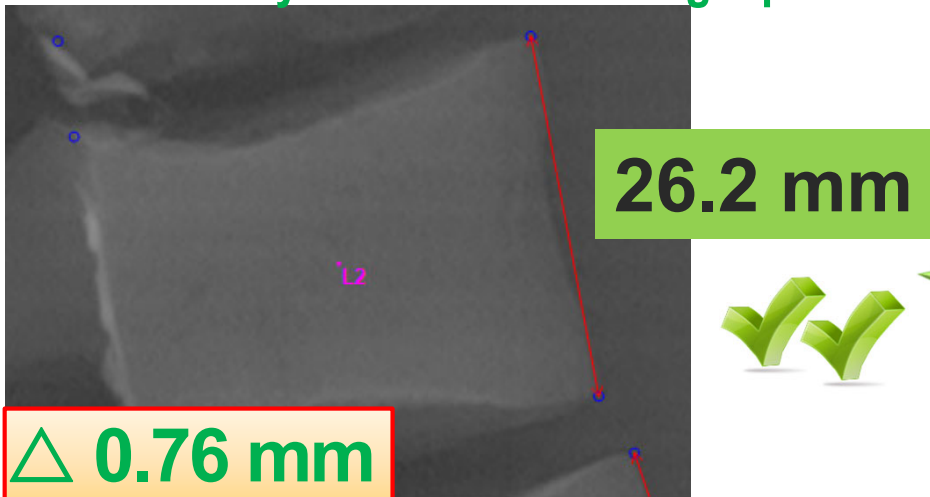
d = 43 cm

+Scaling w/ radiographic ruler

Scaling w/ Calibration device



EOS factory calibrated radiographs



True measurement:
27 mm

Ex: Spine height

SAME spine, SAME D, SAME d

True measurement:
404 mm

d = 20 cm

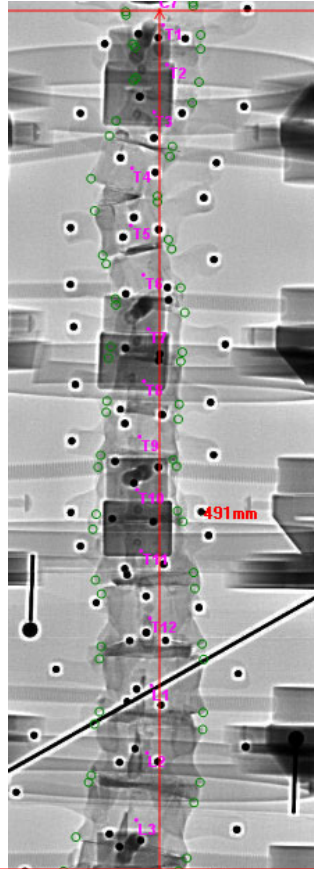
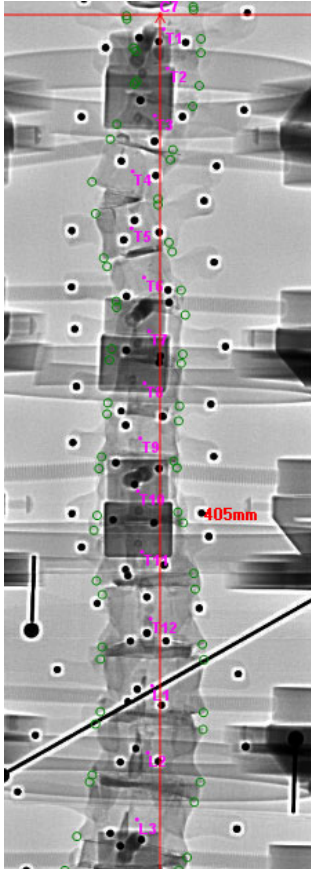


d = 20 cm



Scaling w/ Calibration device

+Scaling w/ radiographic ruler



△ 1 mm

△ 86 mm

405 mm

491 mm

d = 43 cm

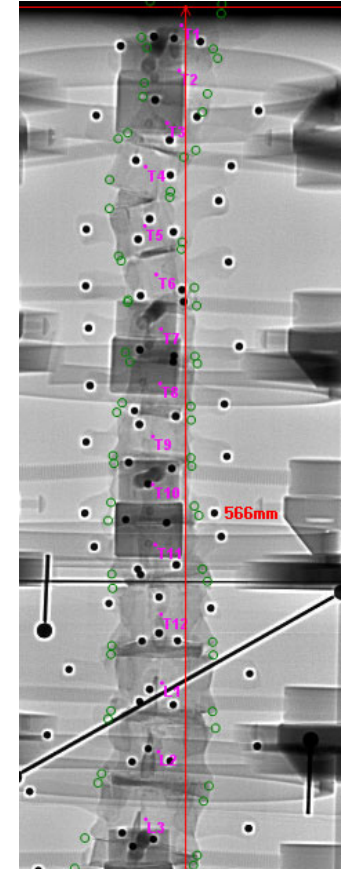
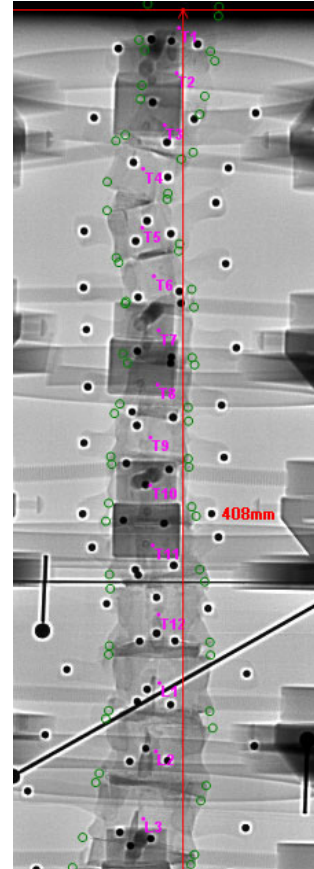


d = 43 cm



Scaling w/ Calibration device

+Scaling w/ radiographic ruler



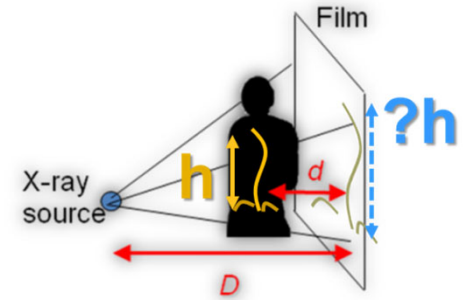
△ 4 mm

△ 158 mm

408 mm

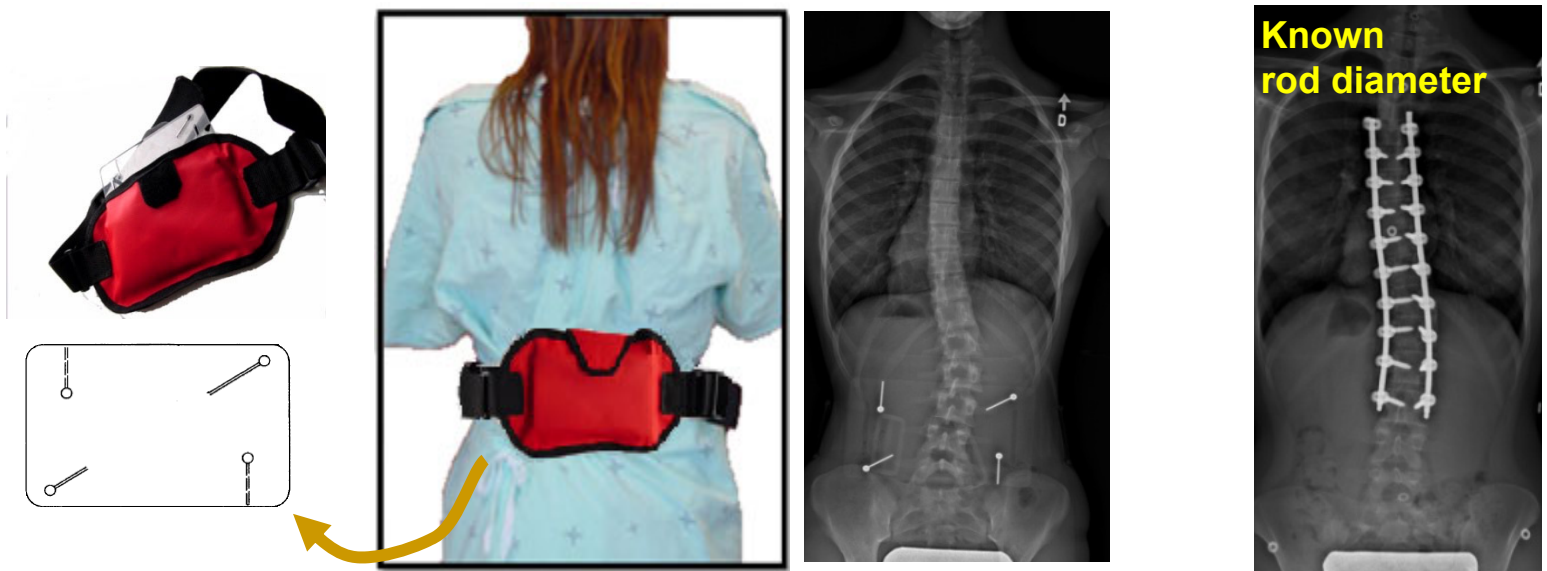
566 mm

Conclusions



- Due to the difference b/w the radiographic settings and **perspective projection magnification**, scoliosis linear measurements could **NOT** accurately be made and compared, except when using calibrated radiographs (factory calibrated EOS imaging system or a calibration device of known dimensions worn on the patient; **not** DPI or a ruler on the radiographic cassette).

Example of an appropriate calibration device:



[Acknowledgments]

