CONVEGNO ACAR 2019

Tirrenia (PI) 5-7 aprile 2019

Marcello Bartolo
Diagnostic and Therapeutic Neuroradiology
IRCCS Neuromed

OVERVIEW

- Introduction to EOS System
- EOS indications and limits
- Post-processing and clinical applications
- Conclusions

40% of the population will undergo a hip, knee or spine surgery

Osteo-articular pathologies & orthopedics

Lifestyle changes | **Aging population** | **Obesity**

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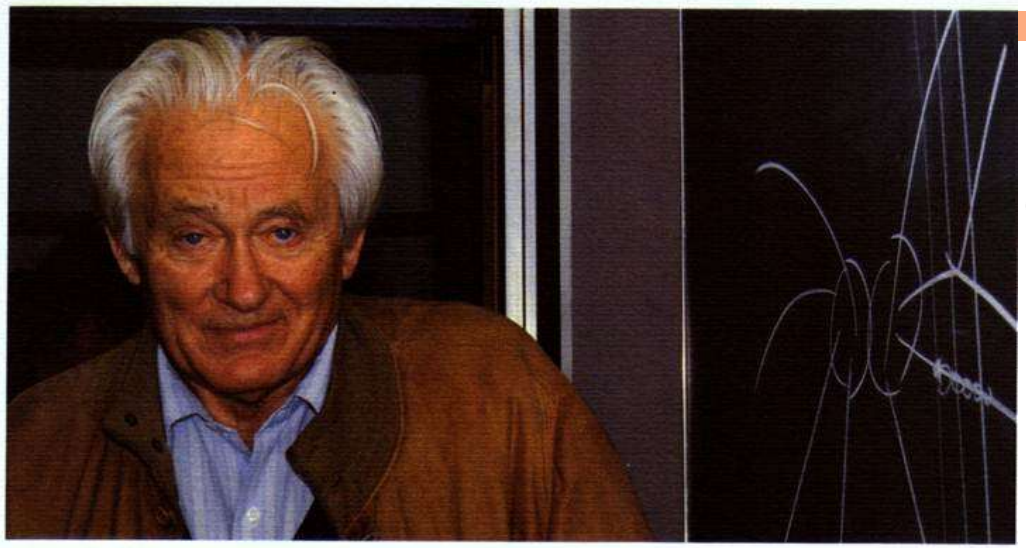
WHAT IS EOS SYSTEM?



Georges Charpak, 1992 Physics Nobel Prize
Founder of EOS imaging

- Is a sophisticated radiological French aerospace agency product created after the discovery of **Georges Charpak**, awarted the Nobel Prize for physics in 1992

- Main feature is to perform an X-ray of the skeleton in the **upright** position, in few seconds with very low radiation dose

Current solutions for osteo-articular imaging are

Bone orthopedic imaging

2D radiographs

- X-ray (2D radiographs) are **local and in two dimensions (projected)**

CT Scanner

- CT Scanner has more limited use due to **dose and recumbent position**

Ligaments, disks and cartilages

Ultrasound

MRI

Techniques used to visualize soft tissues

2D and 3D MSK imaging in one single exam

Takes two simultaneous digital planar radiographs in the standing position with very low dose :

2D

DETECTION TECHNOLOGY ALLOWING FULL BODY LOW DOSE 2D

Creates a three dimensional bone envelope weight bearing image :

3D

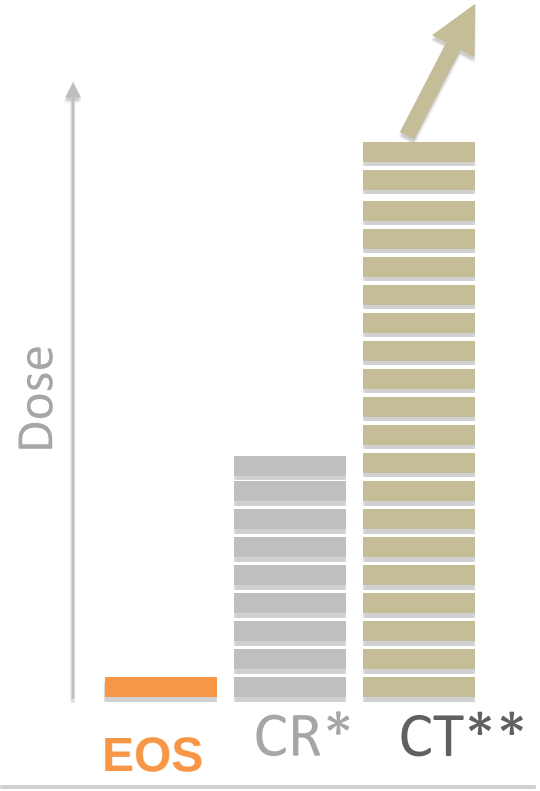
3D VISUALISATION AND AUTOMATIC CALCULATION OF CLINICAL PARAMETERS

Low dose

EOS vs CR: >85% dose reduction *
EOS vs CT: >95% dose reduction **

- Linear detector: no scatter detected, noise suppressed
  ➔ **Signal to noise improvement for same dose**

- Unique detector principle : Cascade reaction between photons and pressurised gaz
  ➔ **Signal amplified internally with a non-linear, self adjustable gain allowing extreme efficiency at very low dose**



* S. Parent et al., "Diagnostic imaging of spinal deformities: Reducing patients radiation dose with a new slot-scanning x-ray imager" – Spine April 2010, 35 (9): 989.
** D. Folinais et al., "Lower Limb Torsional assessment: comparison EOS/CT Scan" – JFR 2011

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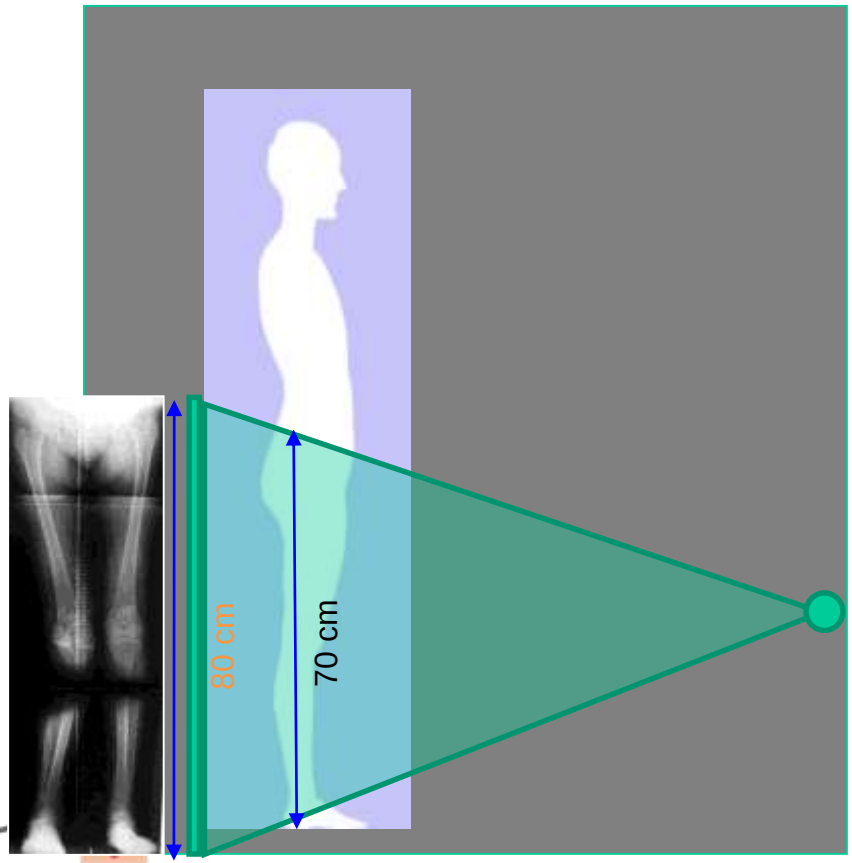
Full body

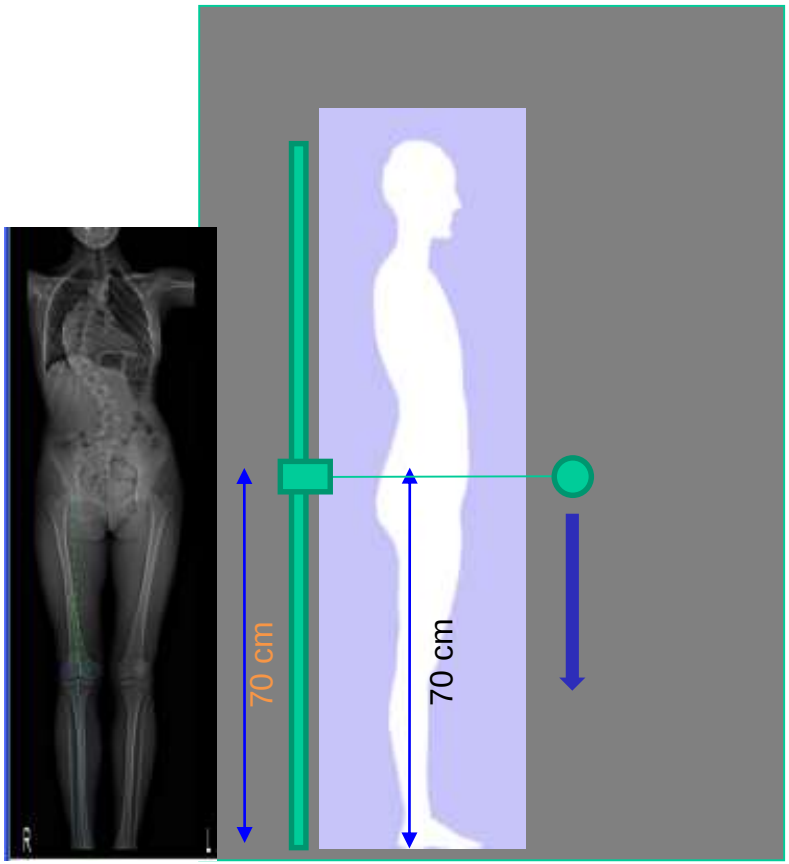
Scanning suppresses projection zoom errors

Full body in one take of 20s or less

CR/DR

EOS





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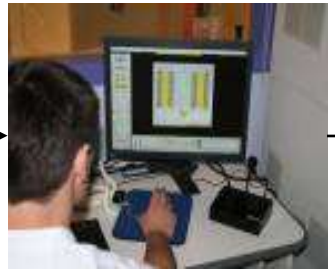
High throughput

- 3min 40sec average for complex spine exams

Patient welcome

Patient measurement

Changing room



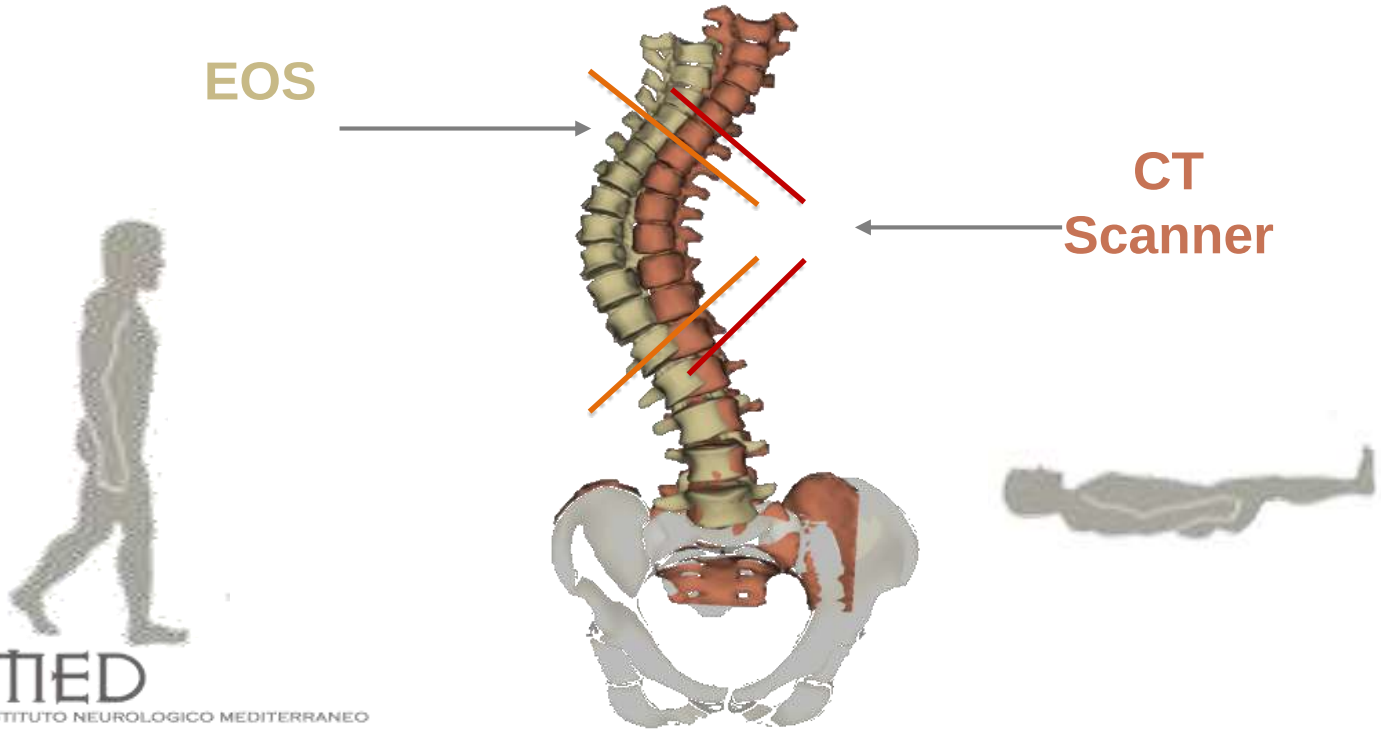
Acquisition

Images sent to PACS

Weight bearing 3D: until now unavailable

- Diagnosis and surgery planning must be carried in the **functional, weight bearing position**

EOS vs. CT Scanner



EOS limits

- ✓ Limited applicability to patients with underlying neurologic or neuromuscolar disorders
- ✓ The 2D images on X-ray films presents less contrast compared to coventional digital radiography
- ✓ 3D reconstructions is semi-automatic (increase risck of error without adeguate operator shaping adjusts)
- ✓ Available software packages do not allow 3D reconstruction for children below the age of 5-6 years, because they were originally conceived for adult bones
- ✓ 3D reconstruction involves just the outer bone surface (“envelope”); the inner structure or achitecture of the bone is not considered because the reconstruction is based on only two radiographies, unlike the CT scan.

EOS examination

- *Correct positioning of the patient is very important.*
- Examination lasts few seconds.
- Post-processing almost an **hour**.
- 2D and 3D images are obtained (accurate measurement of the angles of the spine and pelvis)

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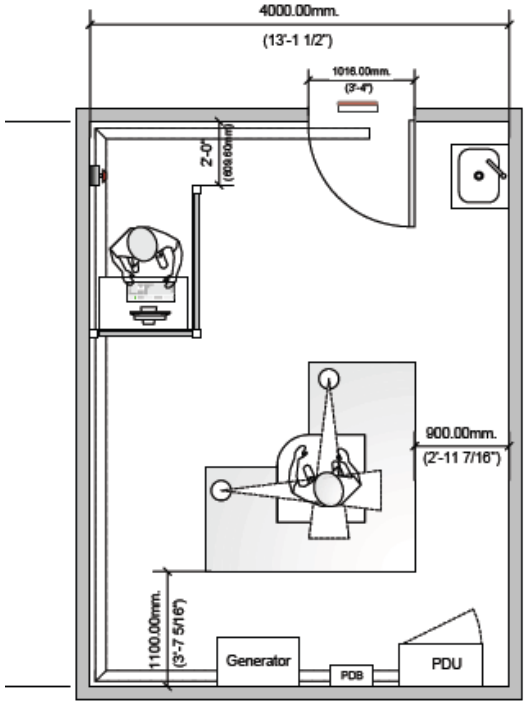
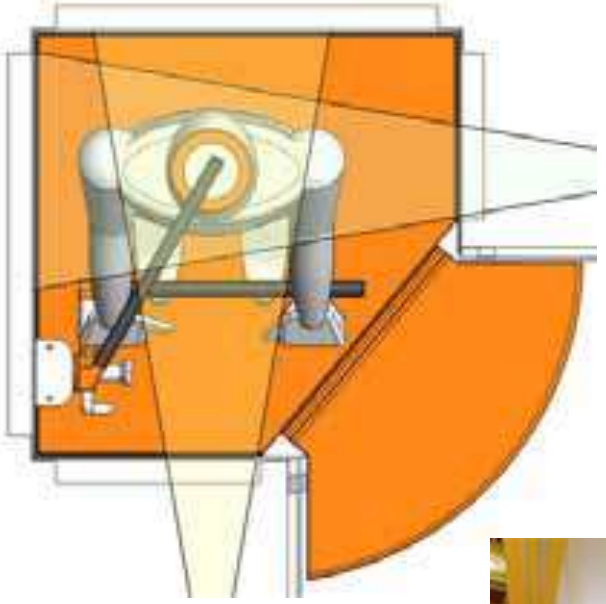


Minimum ceiling height = 275 cm (9 feet)



X-ray

X-ray

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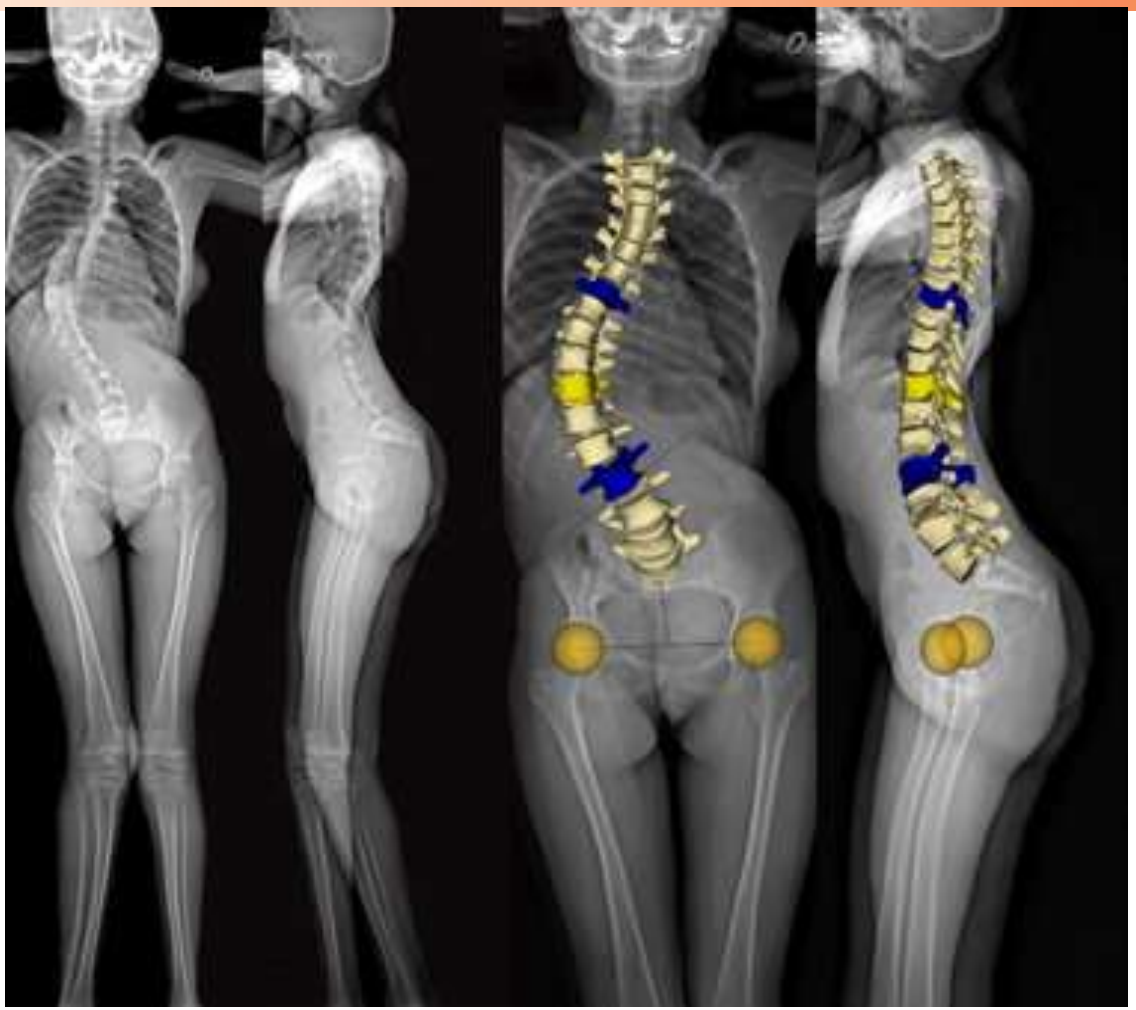
Past……FUTURE

NOW!!!

CR/DR

EOS



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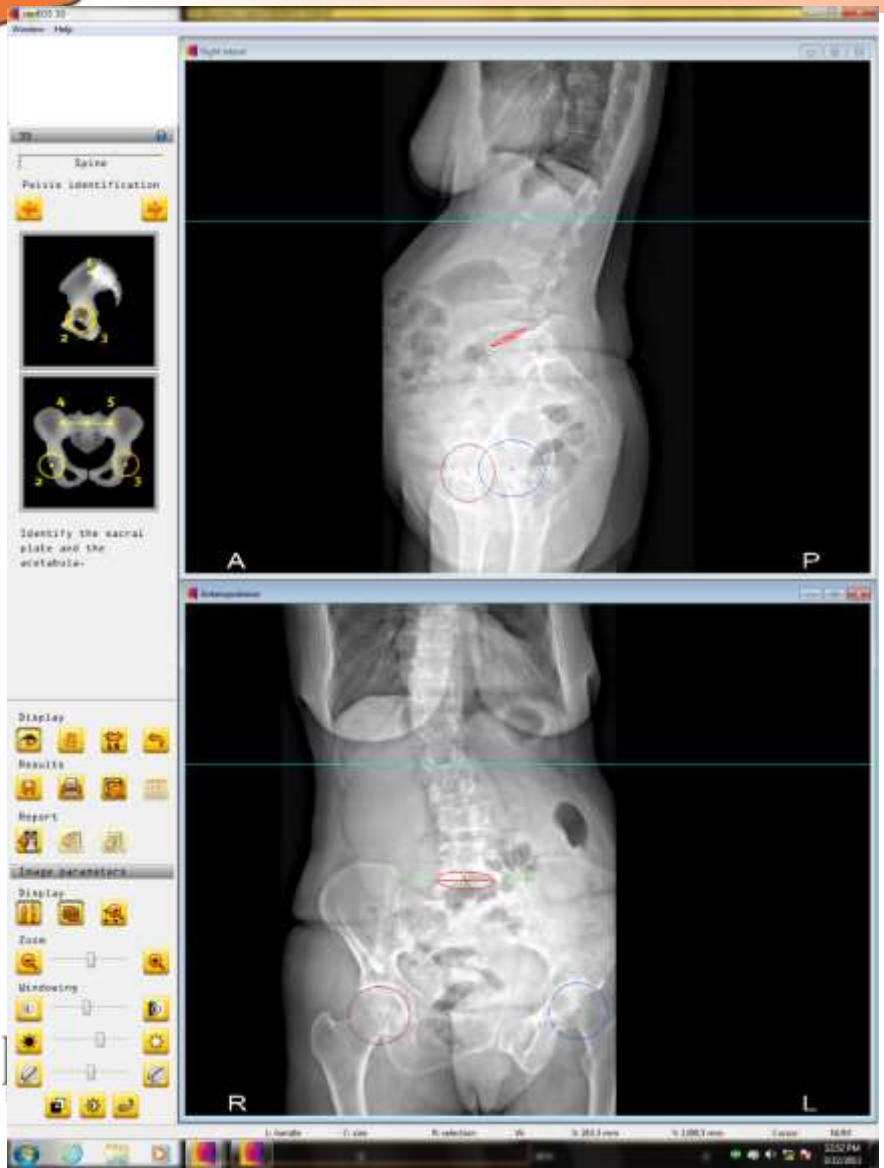
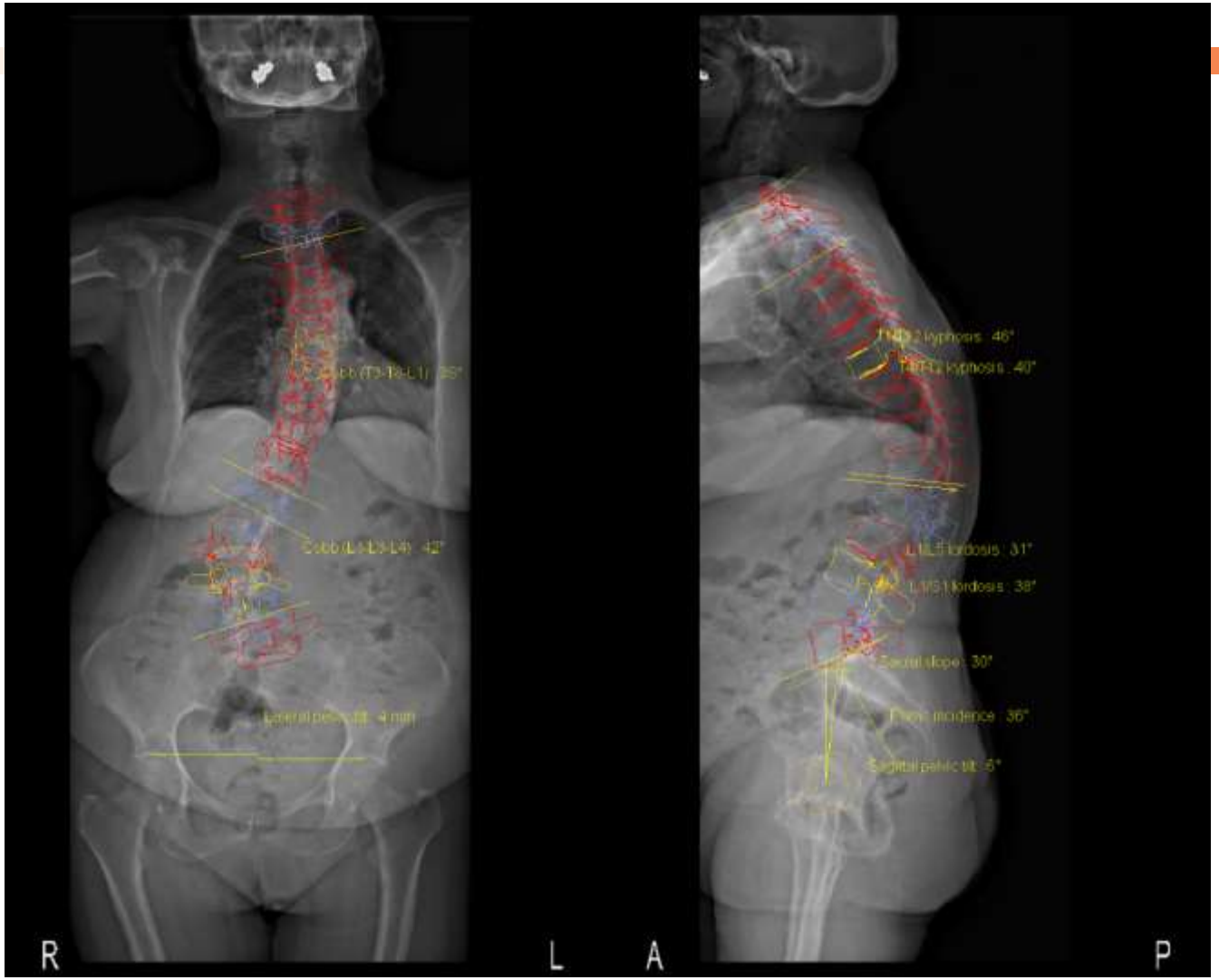
EOS SPINE post-processing





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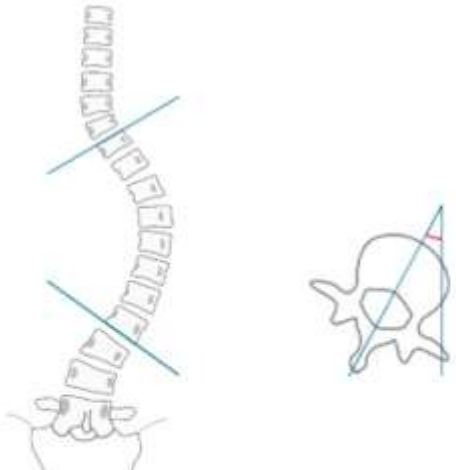
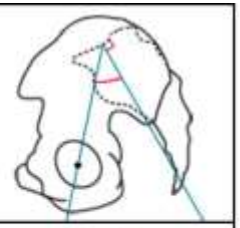
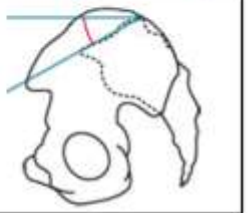
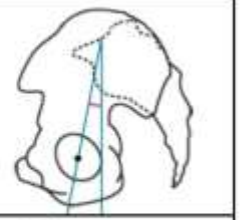
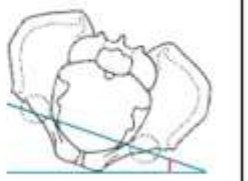
Radiological Report

T1/T12 kyphosis	46°
T4/T12 kyphosis	40°
L1/L5 lordosis	31°
L1/S1 lordosis	38°

Curve (L1-L3-L4)	Cobb (L1-L3-L4)	42°
	Axial rotation of apical vertebra L3	6°
Curve (T3-T8-L1)	Cobb (T3-T8-L1)	38°
	Axial rotation of apical vertebra T8	0°



Pelvic incidence (1)	36°	
Sacral slope (1)	30°	
Sagittal pelvic tilt (1)	6°	
Lateral pelvic tilt (1)	4 mm	
Pelvis axial rotation (2)	-1°	

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Radiological Report

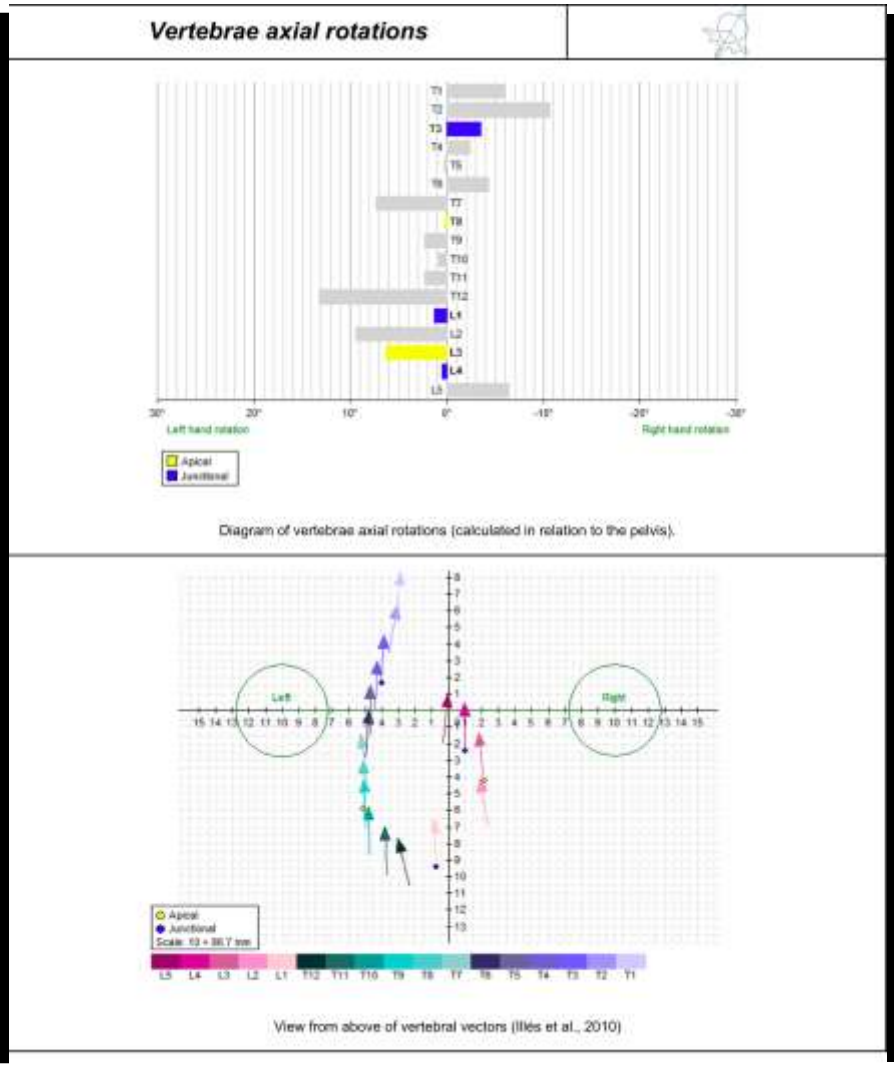


Diagram of vertebrae axial rotations (calculated in relation to the pelvis).

View from above of vertebral vectors (Illés et al., 2010)

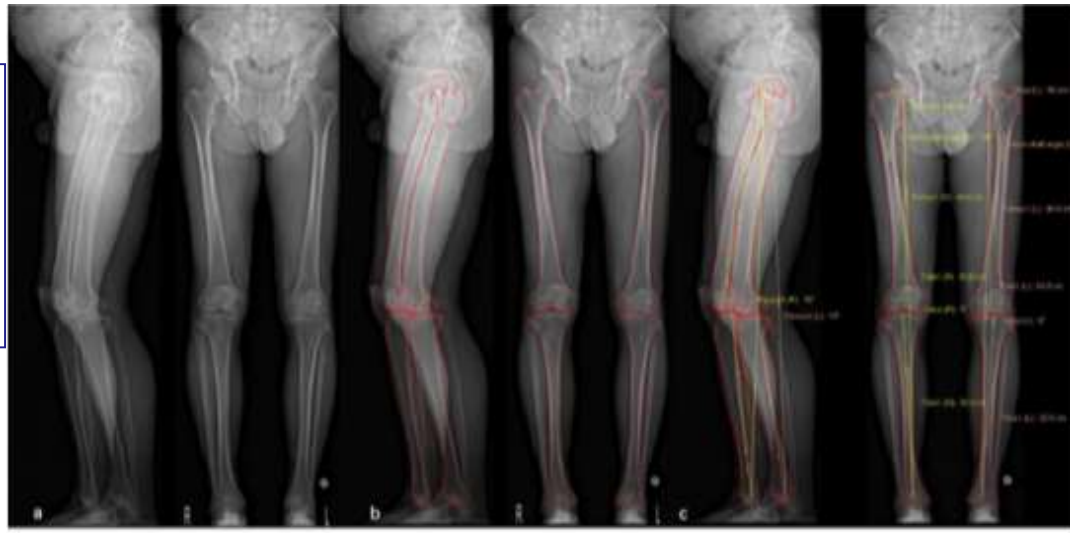
EOS Lower Limb post-processing

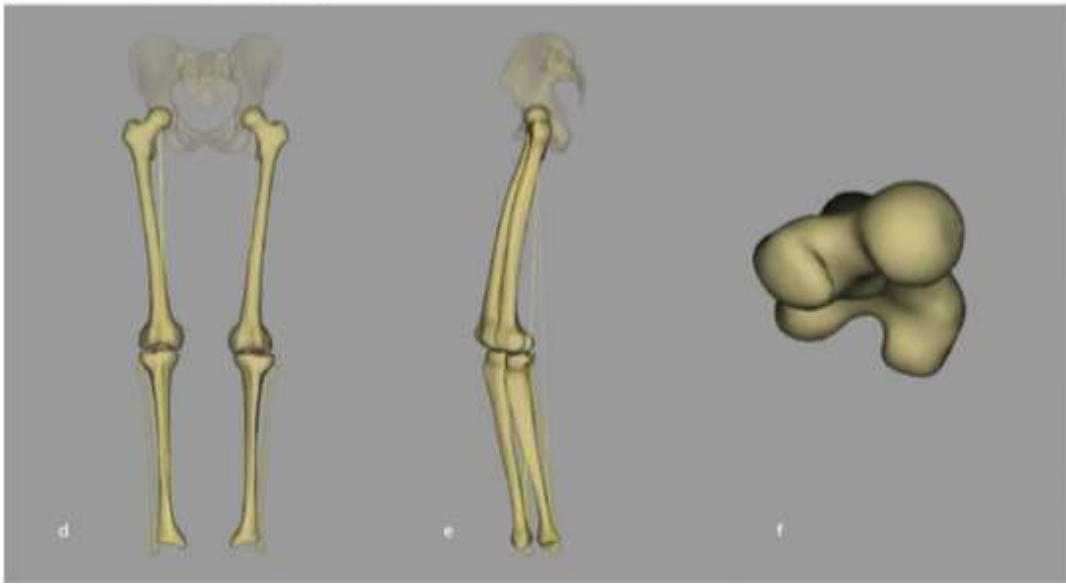
J Child Orthop (2016) 10:1–14
DOI 10.1007/s11832-016-0713-0

CURRENT CONCEPT REVIEW

EOS® biplanar X-ray imaging: concept, developments, benefits, and limitations

Elias Melhem[1] · Ayman Assi[2] · Rami El Rachkidi[1] · Ismat Ghanem[1,2]





Clinical applications

Axial skeleton pathologies:

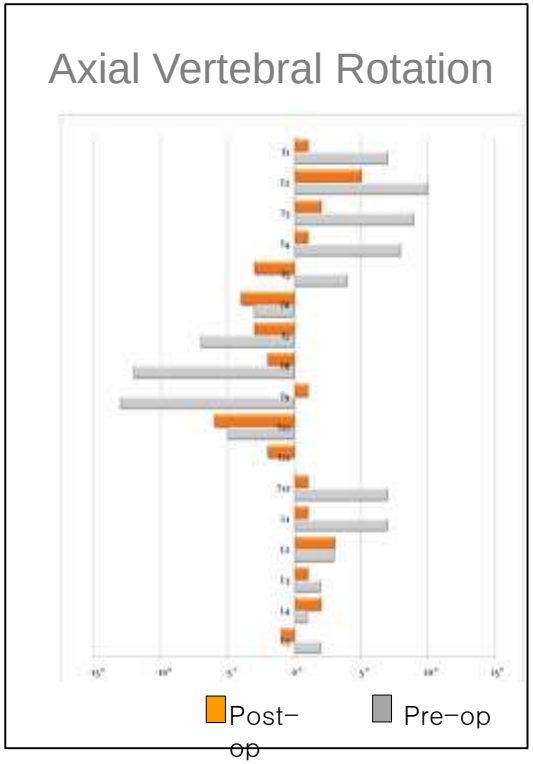
- Deformative and degenerative spine
- Hip and knee pathologies & arthoplasty
- Lower limb deformity
- Global posture assessment
- Rheumatology

Spine 2D

Pediatric

Degenerative

Spine 3D pre-, post op



Post-op 3D reconstruction allows 3D control of scoliosis reduction*

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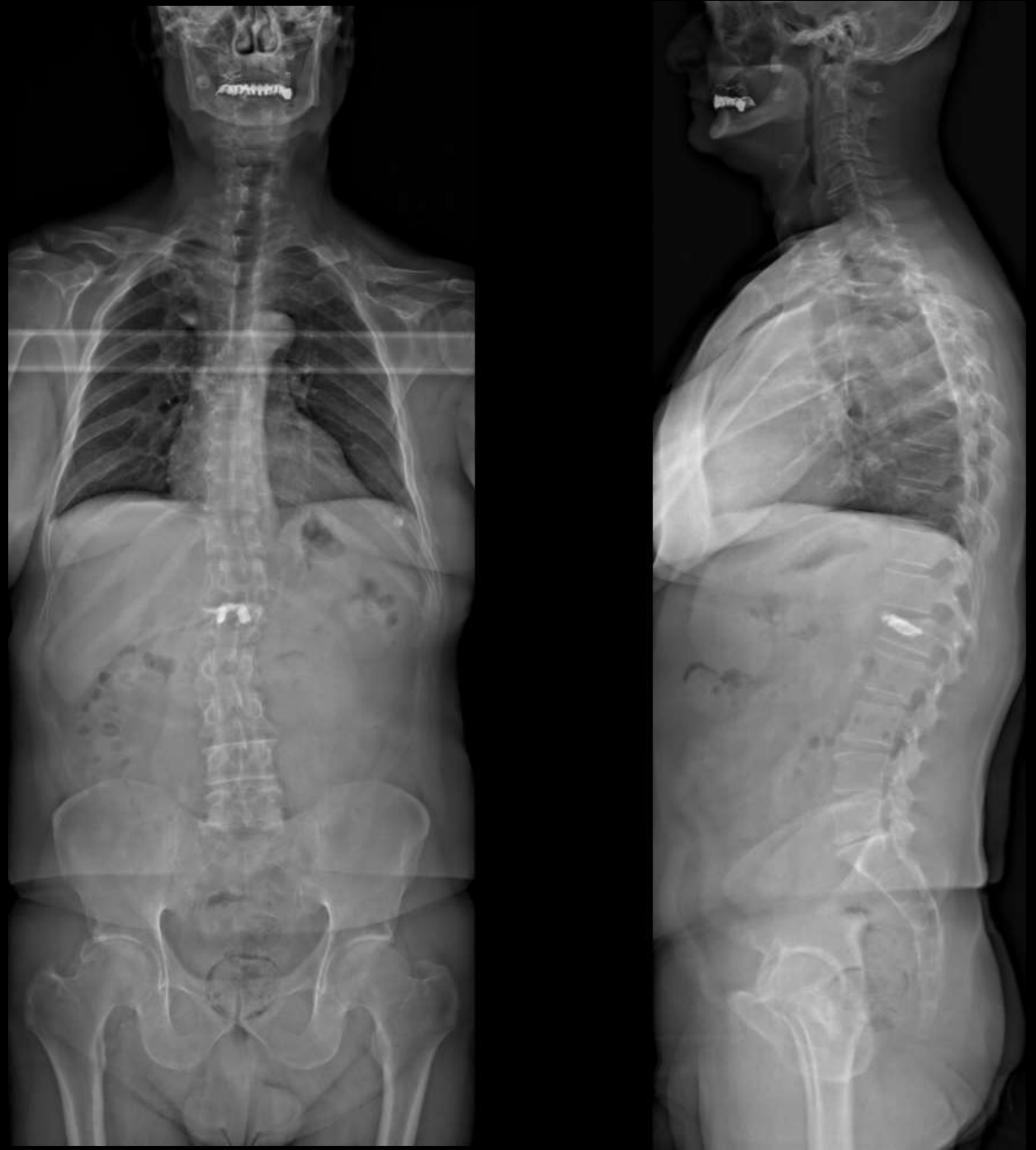
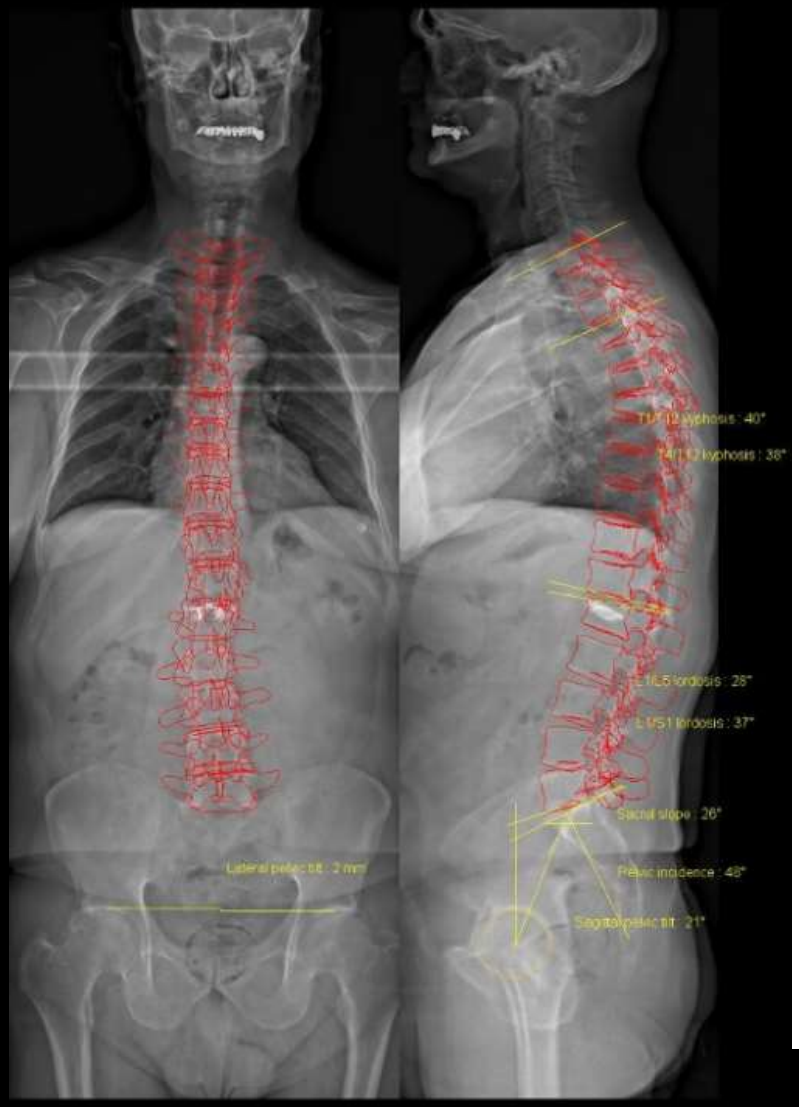
* Illhareborde et al, Spine 2011

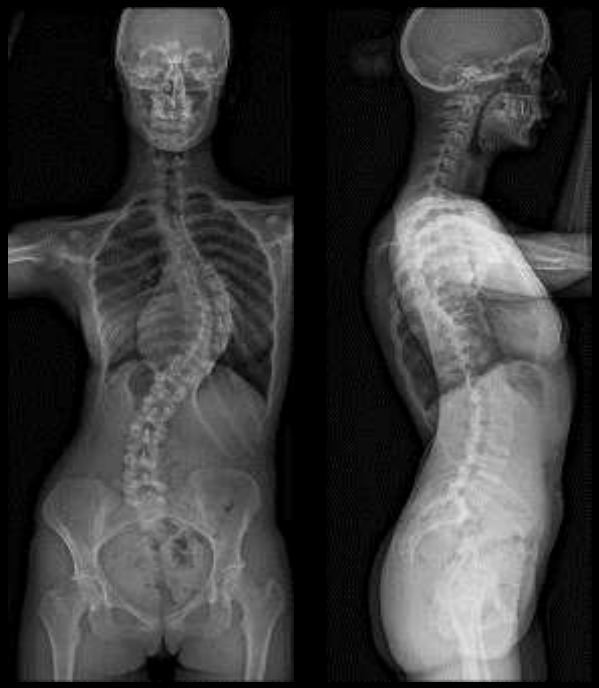
Vertebral Fracture

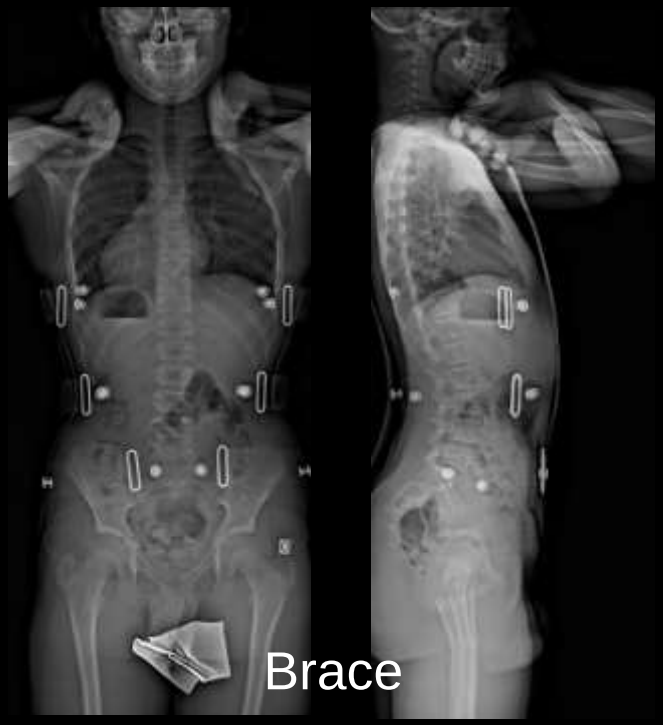

T1/T5 kyphosis : 43°
T5/T12 kyphosis : 38°
L1/L5 lordosis : 25°
L1/S1 lordosis : 27°
Sacral slope : 24°
Pelvic incidence : 44°
Sagittal pelvic tilt : 19°
Lateral pelvic tilt : 0 mm




T1/T12 kyphosis : 40°
T4/T12 kyphosis : 38°
L1/L5 lordosis : 28°
L1/S1 lordosis : 37°
Sacral slope : 26°
Pelvic incidence : 48°
Sagittal pelvic tilt : 21°
Lateral pelvic tilt : 2 mm

Paediatric- Spine





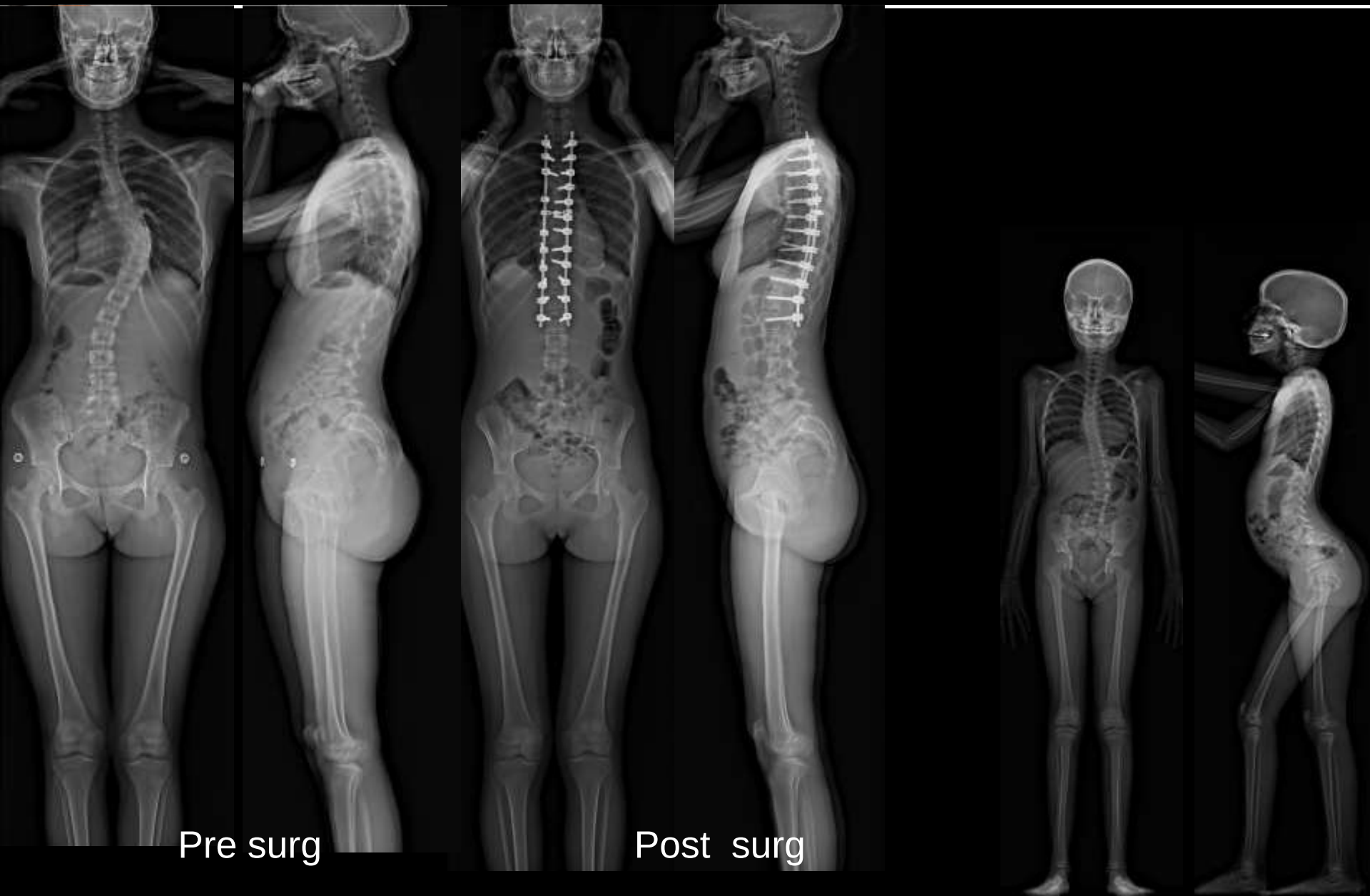
Brace

Bending

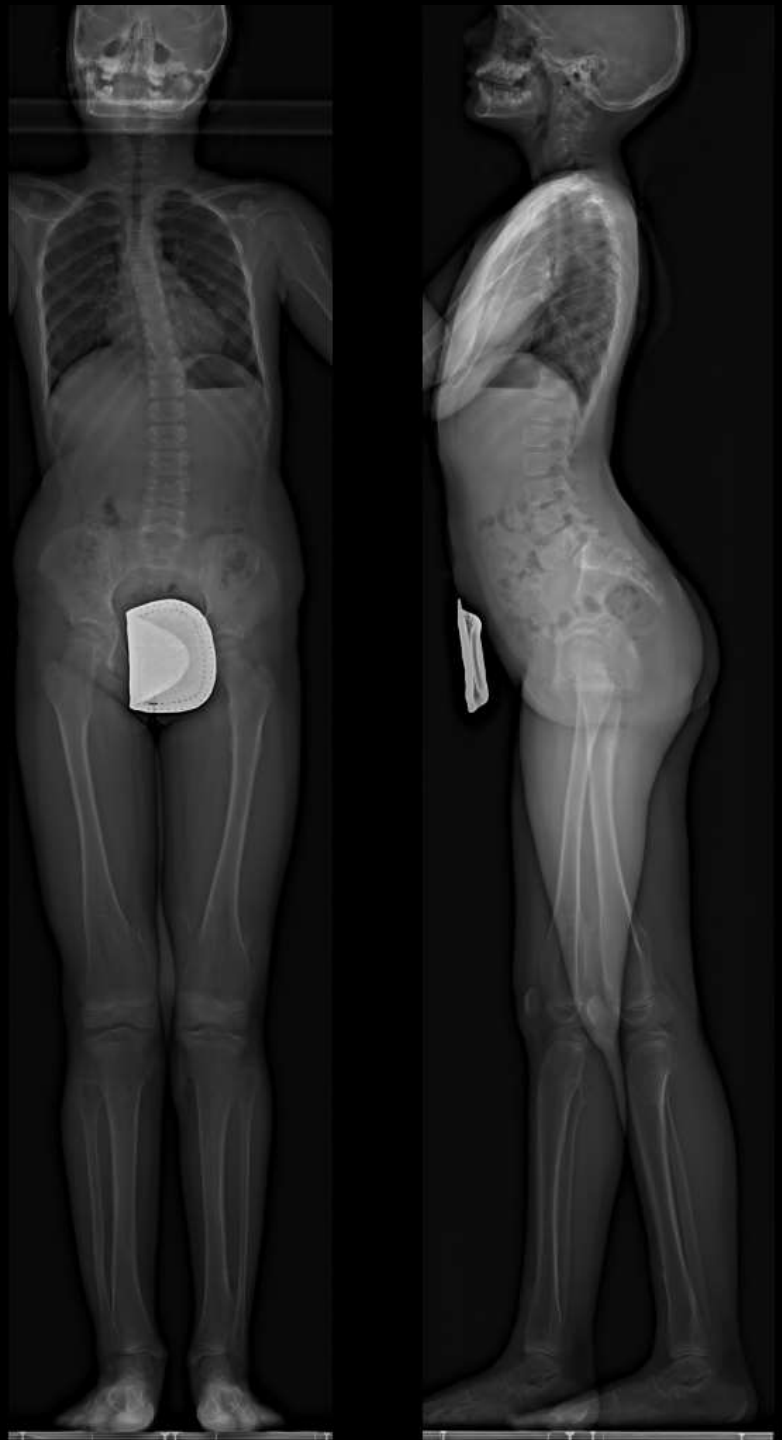
Adult Cervicals

Bending & No bending

Full Body



M. di Ollier




U
Jan 10 2019 11:52:26
antero-posterior
400mA 7173ms
61.0kV
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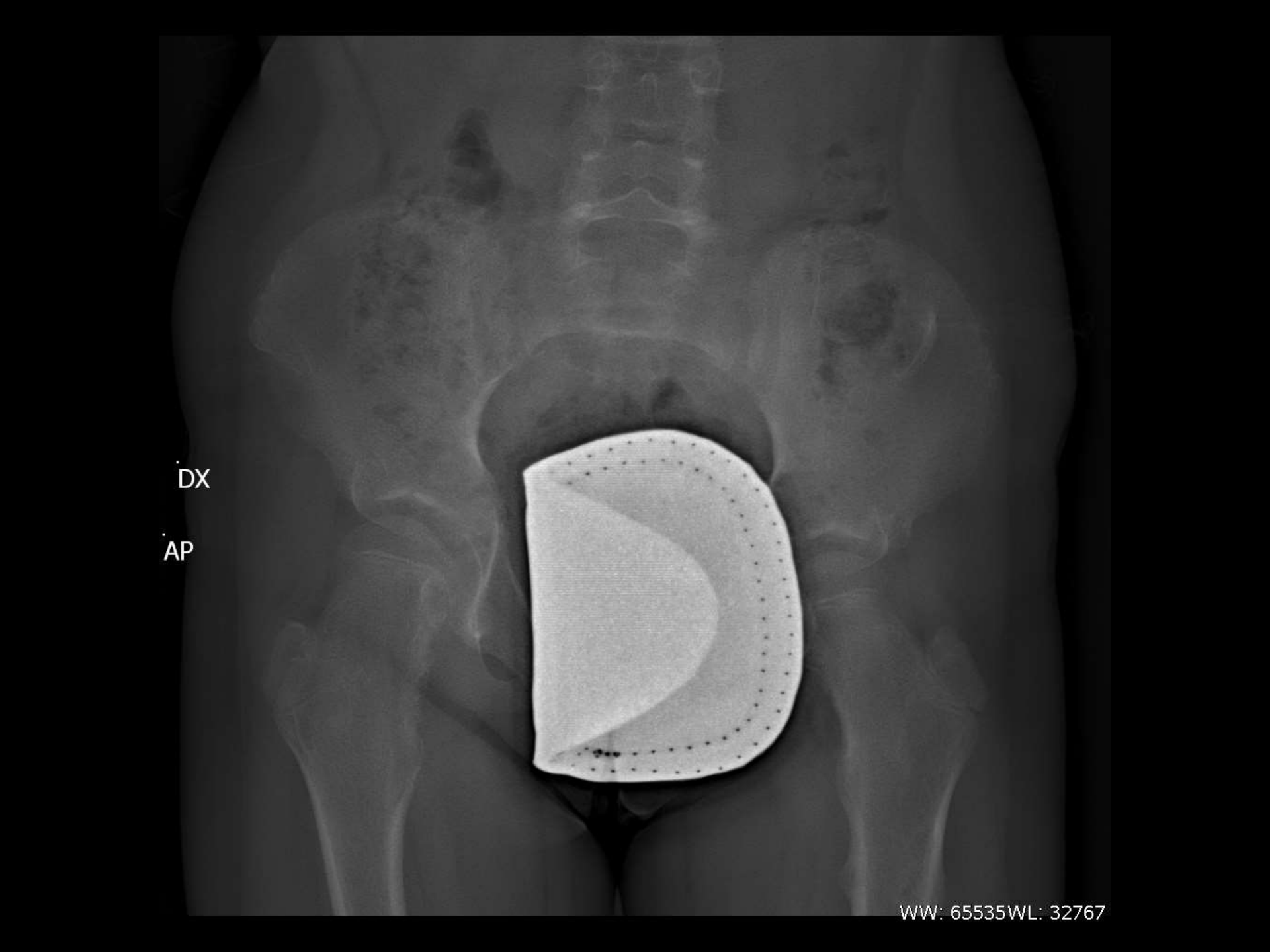
Processed
WW:


DX
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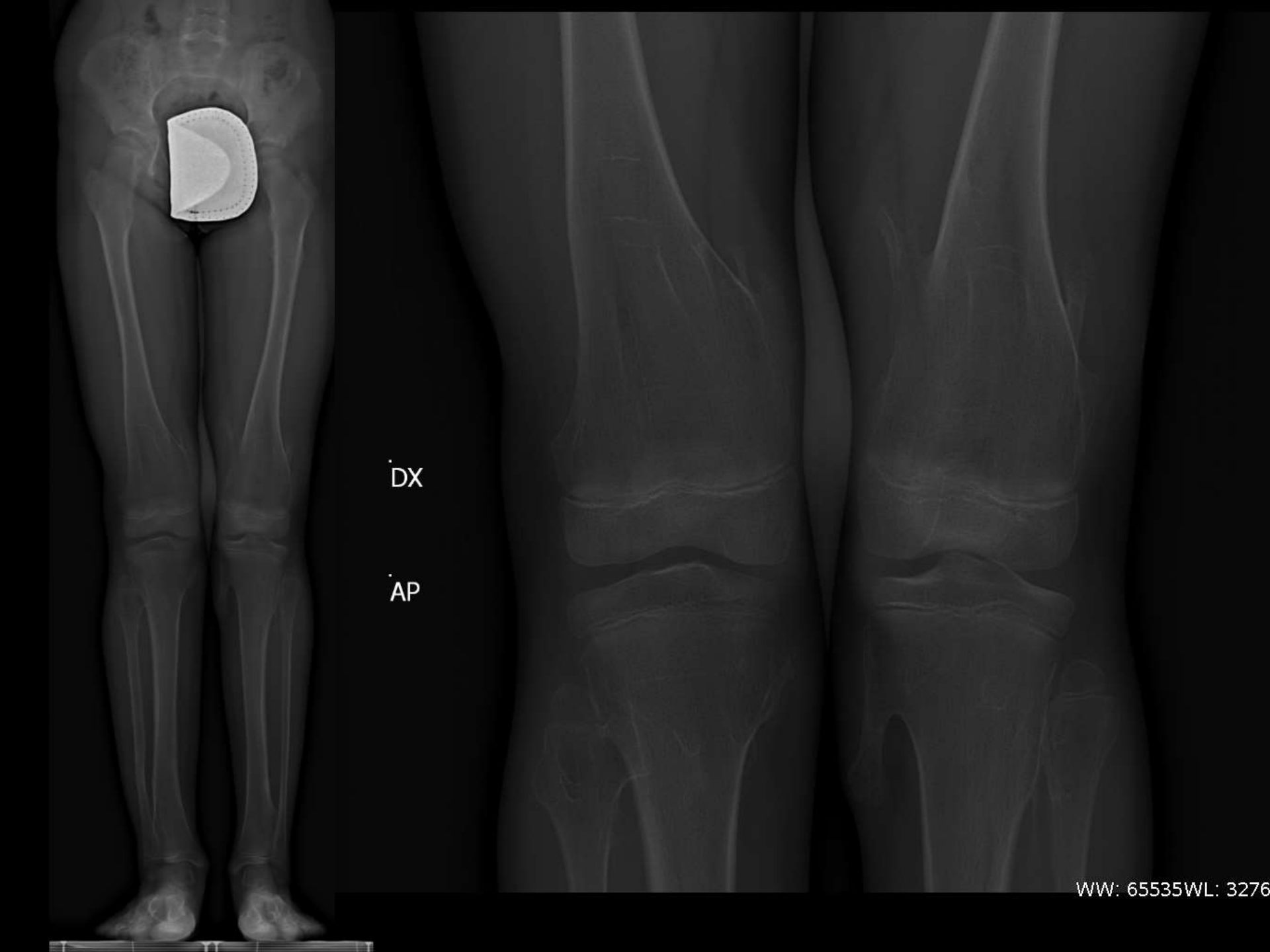
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CONCLUSIONS

- EOS is an innovative study of the skeleton in the upright, particularly the spine and pelvis
- The radiation dose administered to the patient is very low
- Are obtained 2D and 3D images
- The measurement of the bending angles of kiphosis and lordosis, as well as all parameters relating to the sagittal balance are performed automatically.

Num. Tel riservato ACAR:

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Grazie per l’attenzione

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