Beyond Radiology

EOS edge

Introducing EOS to New Zealand

Beyond Radiology®, in its goal to bring state-of-the-art imaging to New Zealand, is proud to introduce the first scanner of its kind to New Zealand. This scanner also represents only the 3rd EOS installation in Australasia.

EOSedge imaging platform is a second-generation slot scanning general X-ray system introduced by EOS® imaging. It represents cutting edge imaging technology in the field. This latest iteration second generation scanner was recently introduced at the annual meeting of the Radiological Society of North America in December 2019.

The EOSedge imaging platform strives to provide functional orthopaedic imaging with a strong adherance to the 'ALARA' principle (a principle describing the aim to use "as low as reasonably achievable" radiation dose). EOSedge provides significant radiation dose savings to the patient while providing superior image quality and accuracy for the radiologist and orthopaedic surgeon.

Software integrations with EOSapps™ enables 3D modelling based on two plane 2D image acquisition enabling generation of accurate 3D representations of individual patient anatomy without the drawbacks of stitching artefacts created by conventional planar imaging. The derived 3D data enables surgeons to optimise selection and placement of implants for spine, hip and knee surgeries.

EOSedge @ RSNA 2019 – adapted from @EOSimaging.

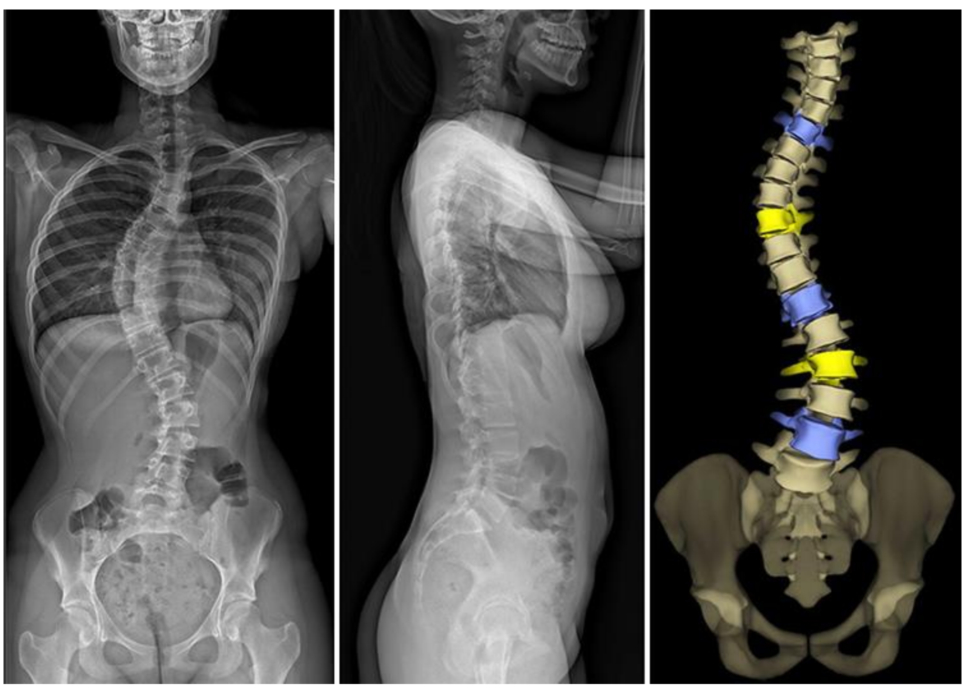
Key features and benefits

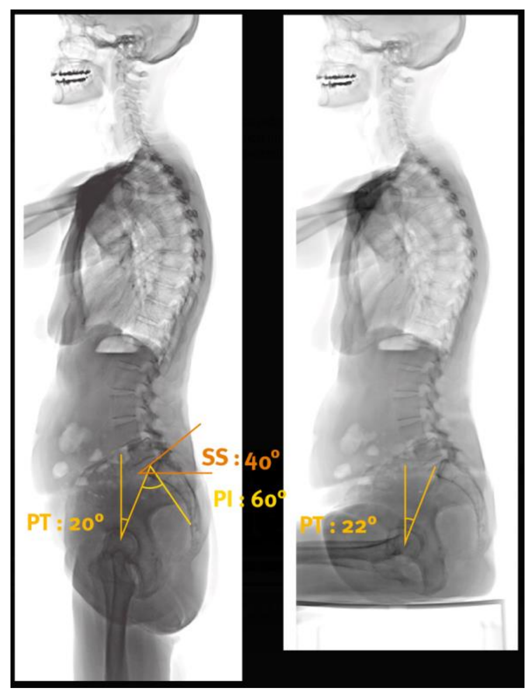
1. Capture true 1:1 scale functional 2D images

- Improves accuracy by eliminating stitching artefacts
- Slot scan acquisition reduces errors introduced by image magnification
- Functional accquisions in natural weightbearing postures (sitting and standing)

2. Generate precise 2D and 3D measurements with simultaneous stereoradiographic acquisition

- Accurate simultaneous two plane (AP/PA and lateral) 2D acquisition for 2D measurements
- Software integrations to allow semi-automated generation of patient specific 3D models





Images:
Lateral radiographs in standing and seated positions enabling functional assessments [right]
Frontal and lateral skull spine and pelvis 2D radiographs with 3D modelling of spinal column and pelvis [left]

3. Open design with a large functional image acquisition zone

- 175 x 45cm imaging zone
- Mobile patient base platform allows for greater patient acompatibility and easy access

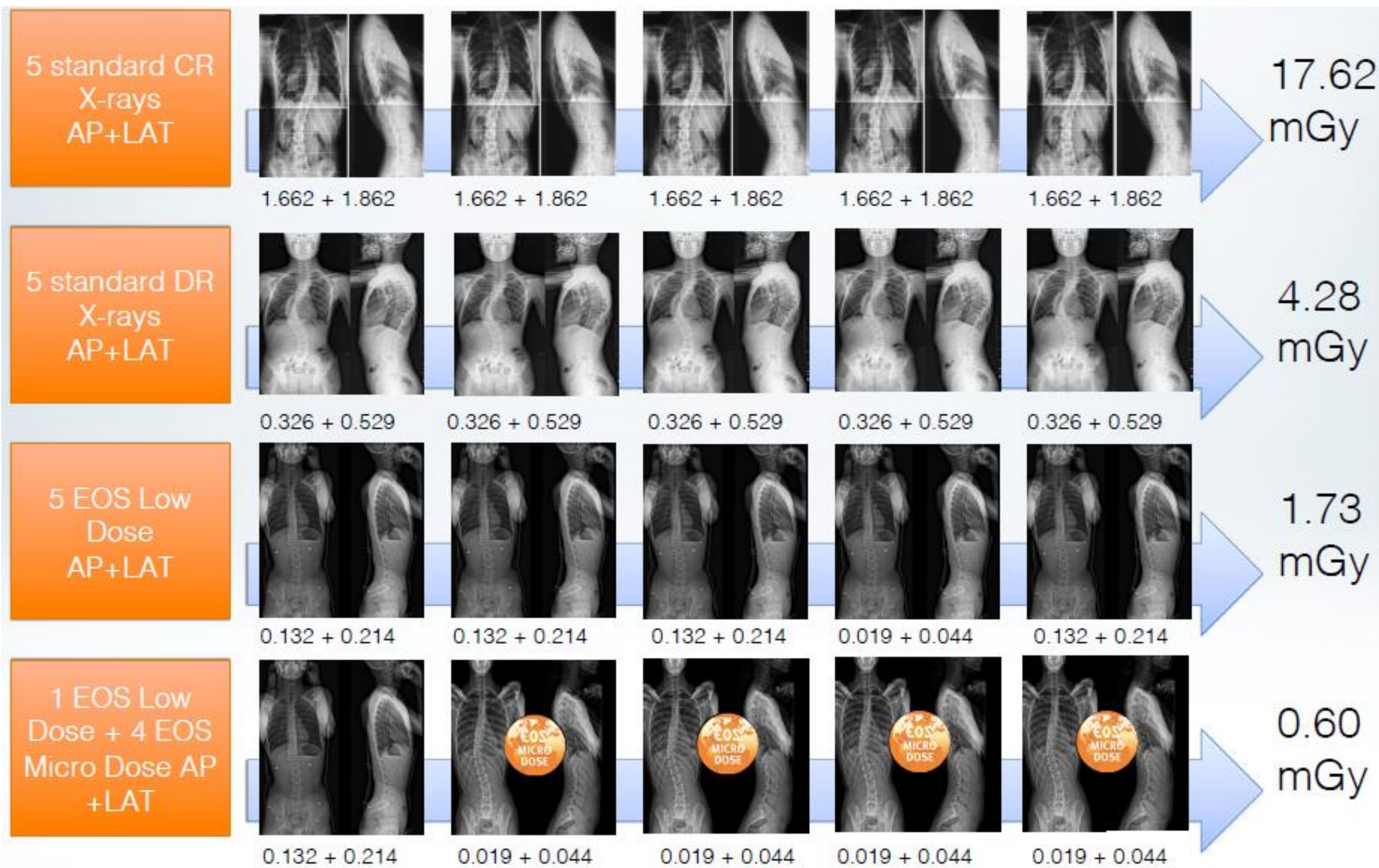
4. Fast image acquisition

- Image acquisition time in scanner is under 20 seconds for average-sized adults and 15 seconds for children

EOSedge scanner illustration demonstrating mobile platform and imaging of adult and child

5. Prioritising the ALARA principle

- Radiation dose As Low As Reasonably Achievable
- EOS 3 vs EOS 4 (EOS edge) with the introduction of a photon counting detector dose has been further reduced with the new platform while maintaining comparable image quality.
- Particle detector linear slot scanning technology eliminates need for a traditional grid to eliminate scatter radiation and allows for automated flexible dose modulation
- EOS microdose protocol for paediatric spine follow-ups further reduces radiation dose.
- Significant benefits in paediatric populations, especially in for girls with reduction in breast and ovarian dose exposure.



EOS microdose protocol for the radiological follow-up of adolescent idiopathic scoliosis.

Ilharreborde B. et al. Eur Spine J. 2015 Apr 24.

Dose comparison - EOS vs DR vs CT

	Air KERMA (mGy) at reference point	Multiplication factor Compared to EOS	Dose-Area Product (cGy.cm^2)	Multiplication factor Compared to EOS
Full Spine AP+LAT **EOS**	0.346 [1]	x1	158.4 [2]	x1
Full Spine AP+LAT DR x-ray	0.856 [2*]	x2.47	392.2 [2]	x2.47
Full Spine Low Dose CT	5 [1]	x14.45		
Lower limbs (AP+Lat) **EOS**			202.0 [3]	x1
Lower limbs (AP only) DR x-ray			170.9 [2]	X1.86
Full body (AP+Lat) **EOS**			360.4 [2,3]	

1. EOS microdose protocol for the radiological follow-up of adolescent idiopathic scoliosis. Ilharreborde B. et al. Eur Spine J. 2014
2. 2. Comparison of radiation dose, workflow, patient comfort and financial break-even of standard digital radiography and a novel biplanar low-dose X-ray system for upright full-length lower limb and whole spine radiography. Dietrich TJ et al. Skeletal Radiol. 2013.
3. 3. Ionizing radiation doses during lower limb torsion and anteversion measurements by EOS stereoradiography and computed tomography . Delin C. et al. Eur J Radiol. 2014

6. Software integration

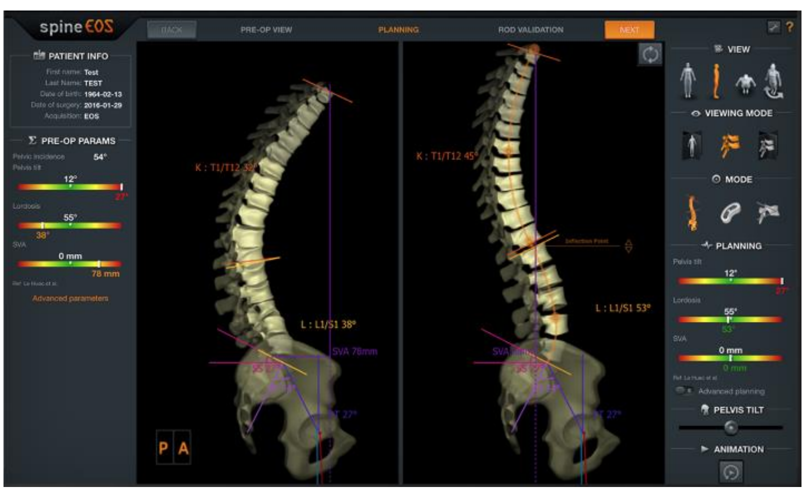
EOS apps allows for two plane 2D imaging to be translated in software into 3D models allowing for more accurate assessment of anatomy, pathology and treatment planning.

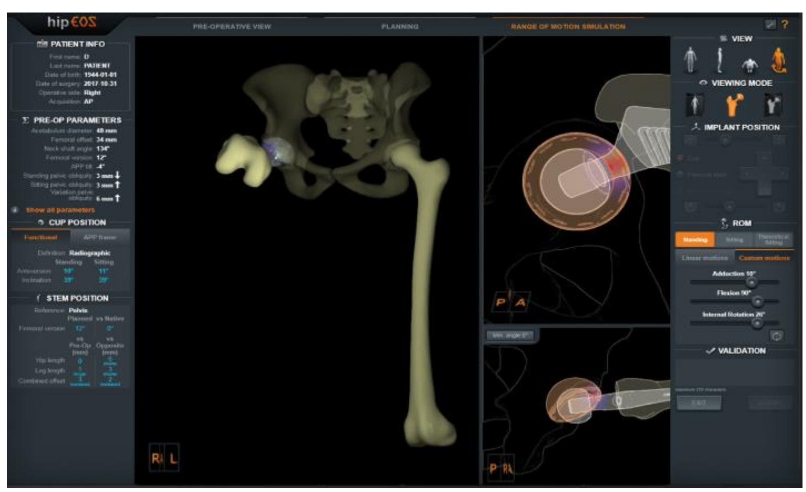
spineEOS 3D surgical planning software dedicated to paediatric and adult spine cases. spineEOS provides a 3D pre-operative assessment of each patient including a full body sagittal balance analysis. Surgical planning can be undertaken with a better understanding of patient's frontal and sagittal alignment, including compensatory mechanisms in pelvis and lower limbs.

spineEOS provides tools to accurately simulate and plan procedures in 3D - including osteotomies, selecting and positioning of interbody cages, and the design of spinal rods.

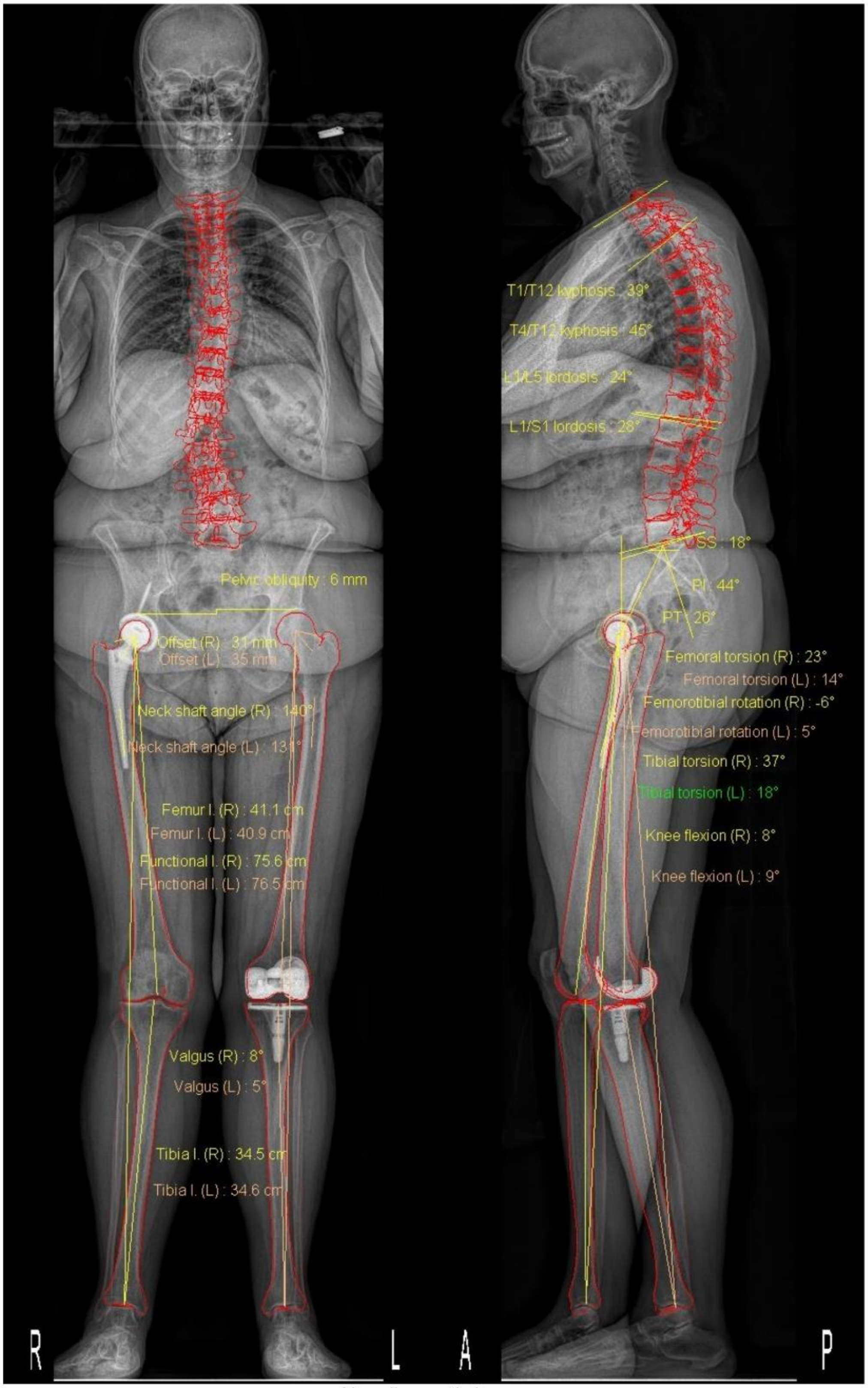
hipEOS 3D surgical planning software for primary total hip arthroplasties. Combination of standing and sitting EOS images, 3D models, and measurements allows identification of abnormal spino-pelvic relationship.

This information combined with 3D planning and simulation tools assists surgeons with surgical planning and optimum implants selection, with the aim to improve surgical outcomes.

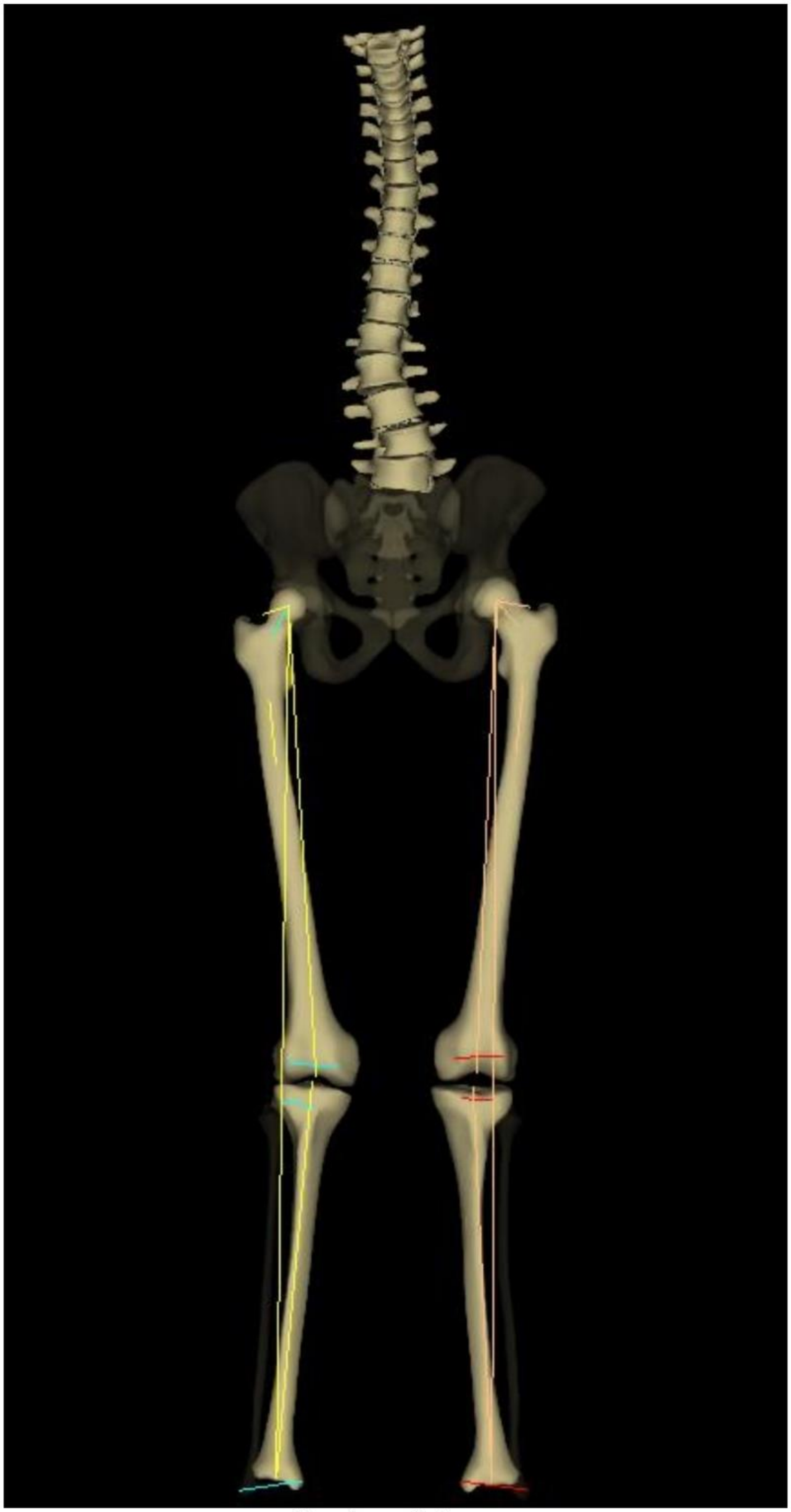




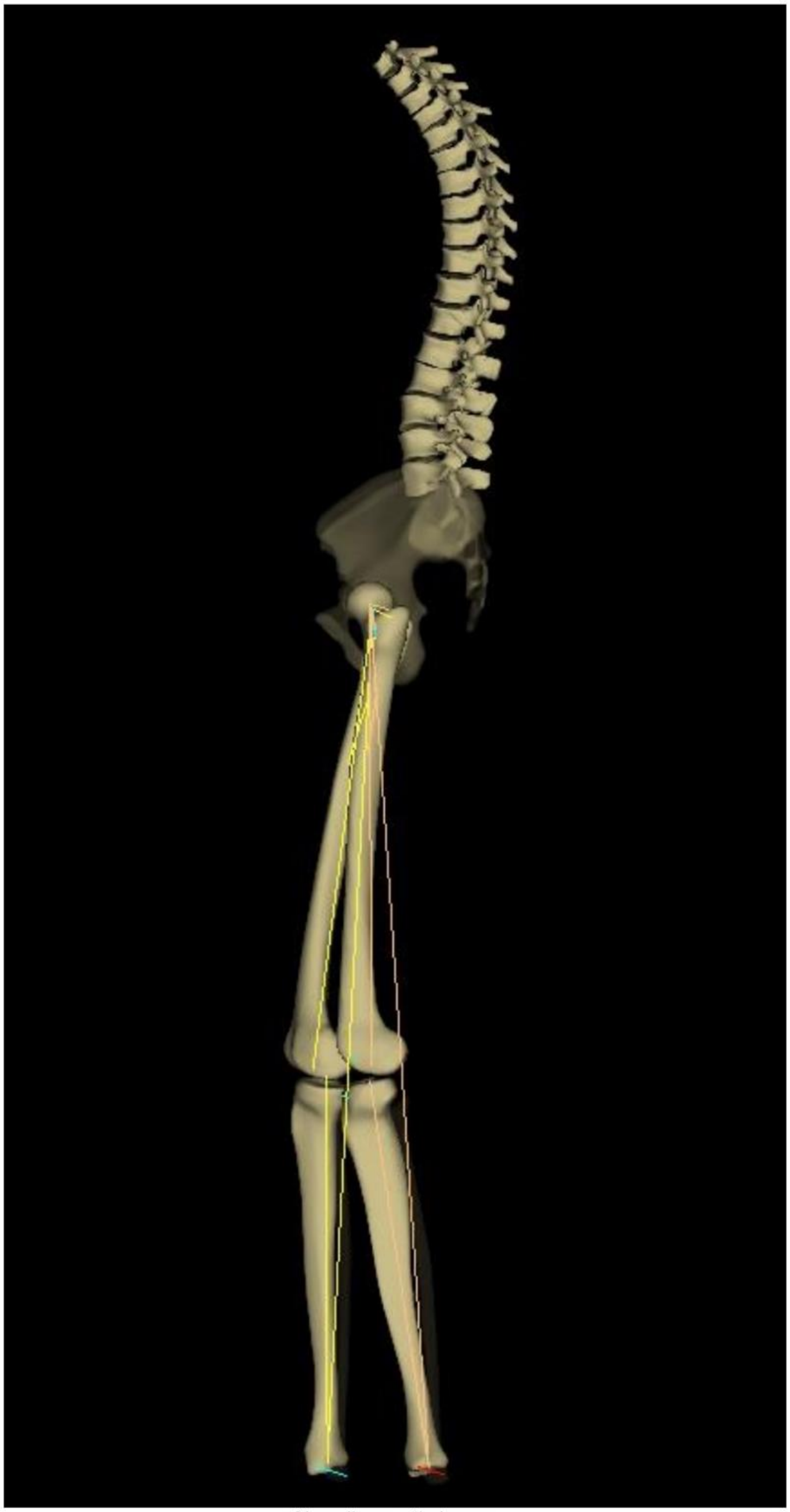
spineEOS (left) and **hipEOS** (right) software demonstrating wide range of planning and assessment tools available.



Non-diagnostic image



Non-diagnostic image
Warning: the displayed object is a 3D model and is not intended to be an accurate representation of bone morphology.



Non-diagnostic image

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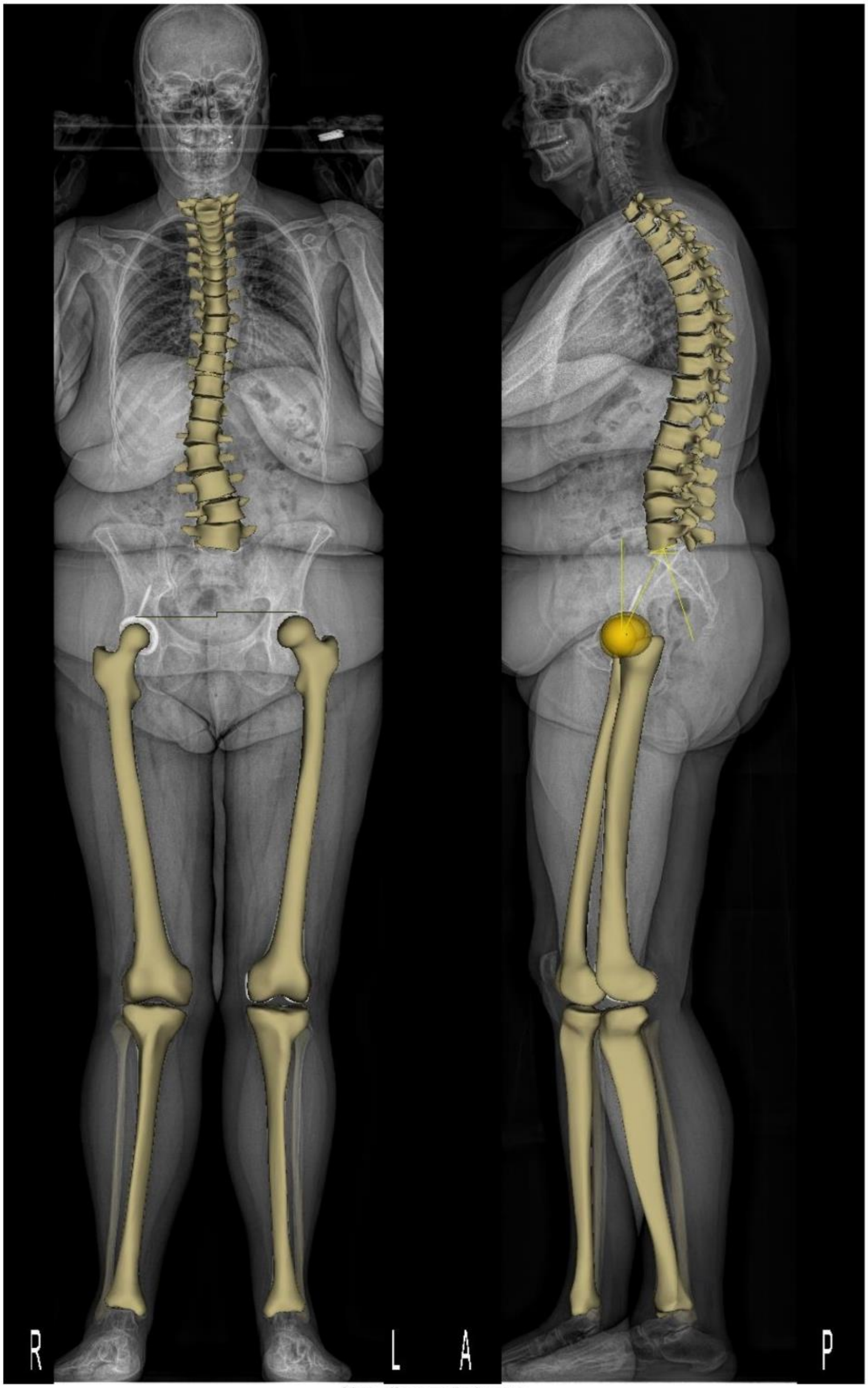
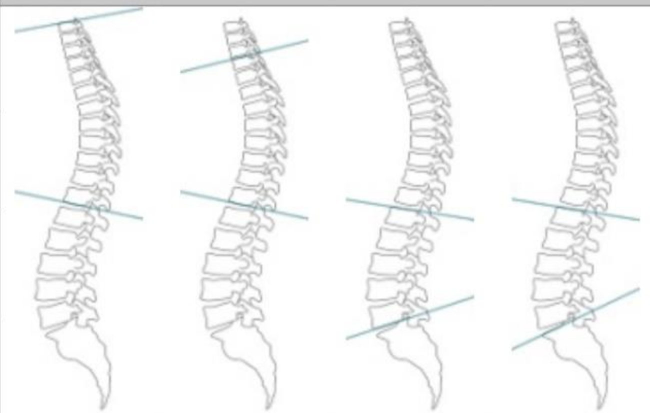


Non-diagnostic image

Spine

Sagittal balance (1)	*Value*	
T1/T12 kyphosis	**39°**	
T4/T12 kyphosis	**45°**	
L1/L5 lordosis	**24°**	
L1/S1 lordosis	**28°**	

(1) Parameters calculated in the patient frame (based on a vertical plane passing through the center of the acetabula), which corrects the effect of a potential axial rotation of the pelvis during acquisition.
An axial vertebra rotation is positive when the vertebra is rotated towards the patient left side.

Vertebrae axial rotations

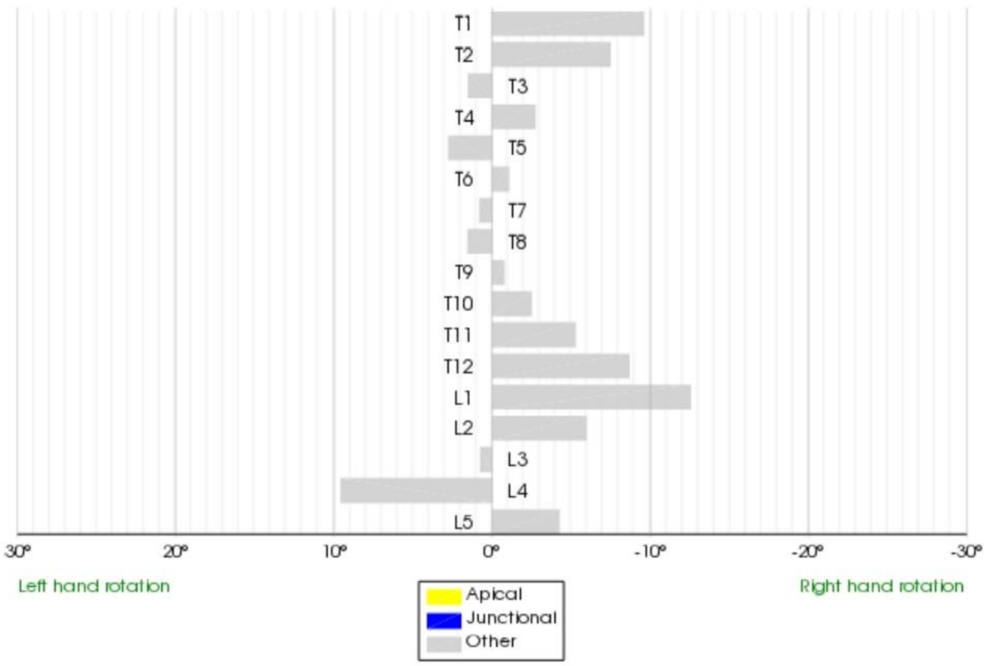
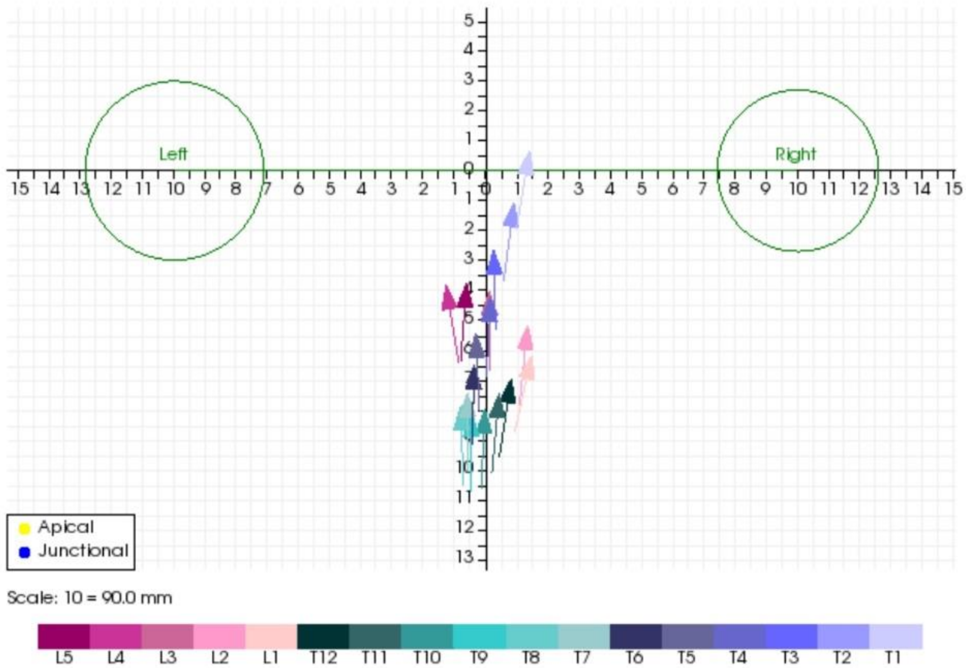
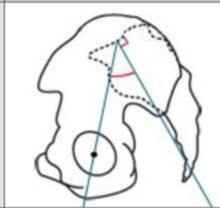
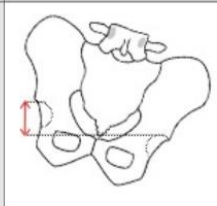
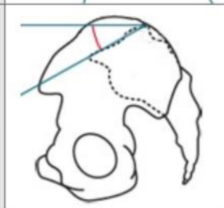
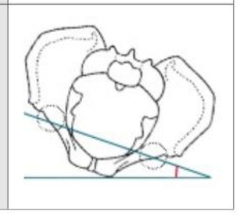
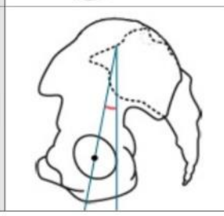


Diagram of vertebrae axial rotations (calculated in relation to the pelvis).



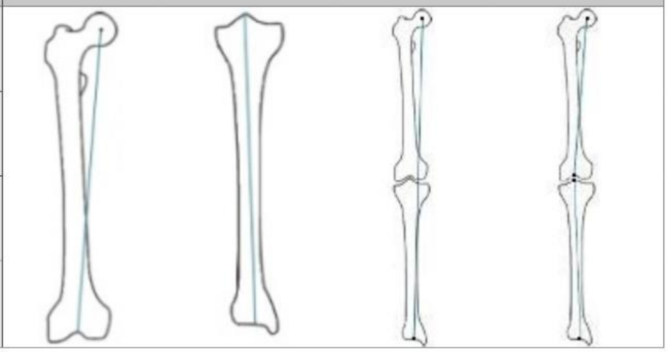
View from above of vertebral vectors (Illés et al., 2010)

Pelvis					
Pelvic parameters	***Value***		***Pelvic parameters***	***Value***	
Pelvic incidence (1)	**44°**		Pelvic obliquity (1)	**6 mm**	
Sacral slope (1)	**18°**		Pelvis axial rotation (2)	**5°**	
Pelvic tilt (1)	**26°**				

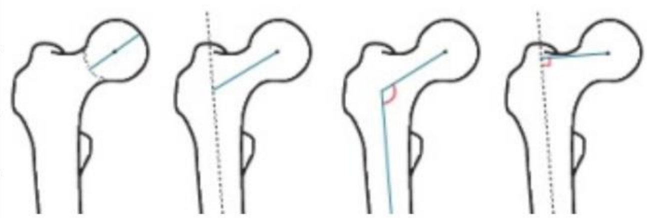
(1) Parameters calculated in the patient frame (based on a vertical plane passing through the center of the acetabula), which corrects the effect of a potential axial rotation of the pelvis during acquisition.
(2) A pelvis axial rotation is positive when the pelvis is rotated towards the patient left side.

Hip and knee

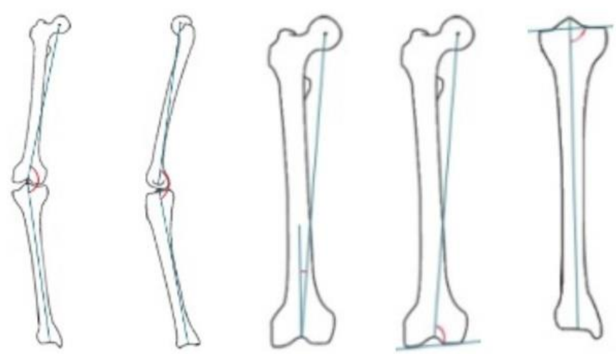
Lengths (3)	*Right*	*Left*
Femur length	**41.1 cm**	**40.9 cm**
Tibia length	**34.5 cm**	**34.6 cm**
Functional length	**75.6 cm**	**76.5 cm**
Anatomical length	**75.5 cm**	**75.4 cm**



Femur (3)	*Right*	*Left*
Femoral head diameter	**33 mm**	**42 mm**
Neck length	**47 mm**	**45 mm**
Neck shaft angle	**140°**	**131°**
Femoral offset	**31 mm**	**35 mm**

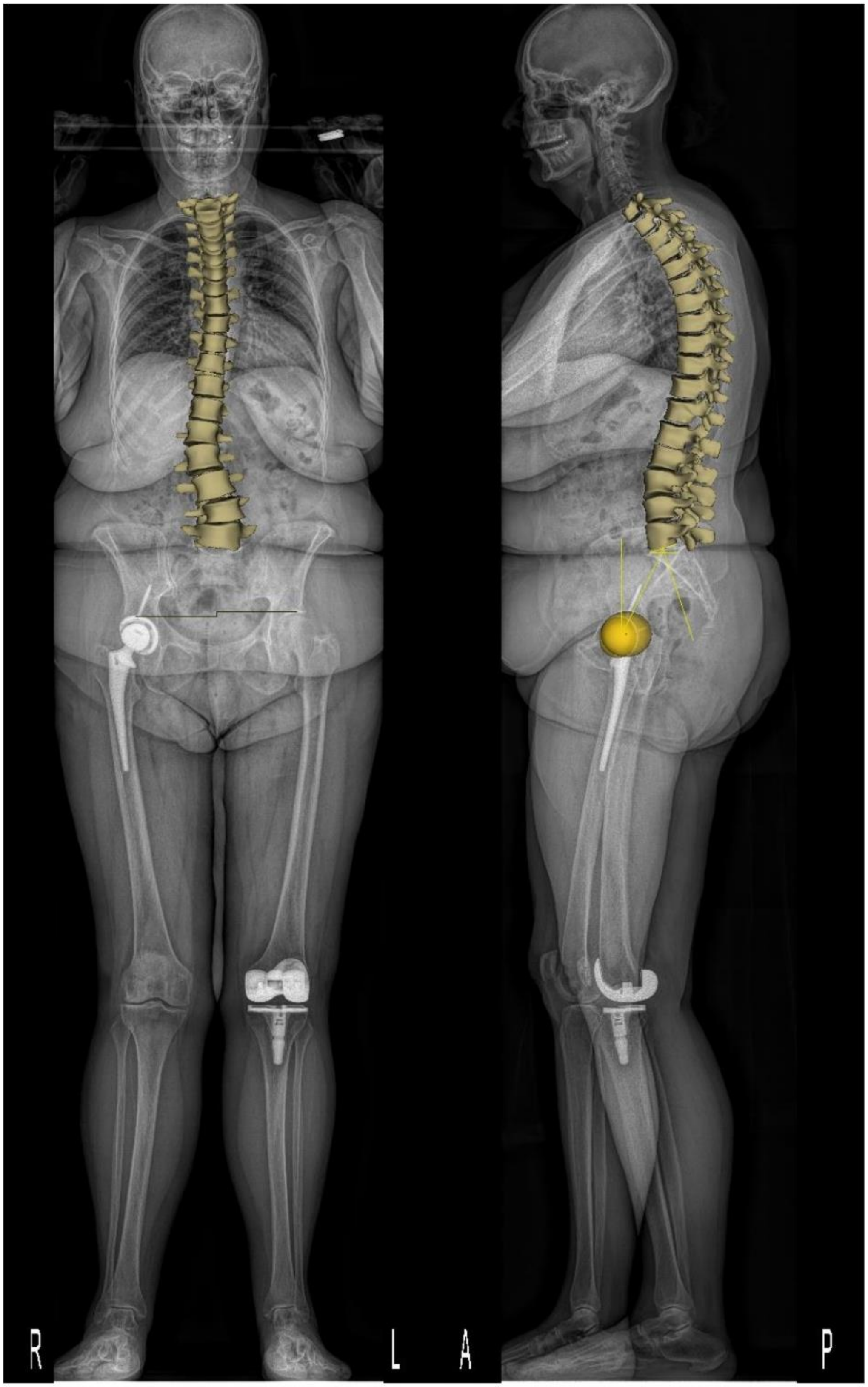


Knee (4)	*Right*	*Left*
Valgus/Varus	**Valgus 8°**	**Valgus 5°**
Knee flexion/Knee extension	**Flexion 8°**	**Flexion 9°**
HKS	**3°**	**4°**
Femoral mechanical angle	**96°**	**91°**
Tibial mechanical angle	**87°**	**94°**



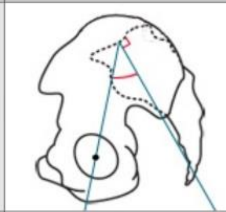
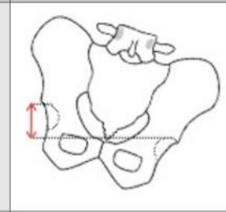
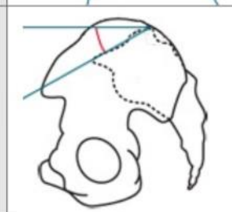
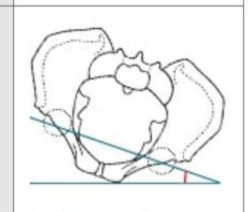
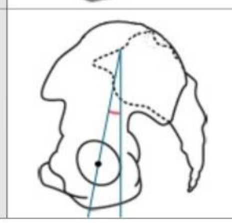
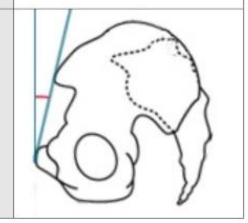
Torsions (4)	*Right*	*Left*
Femoral torsion	**23°**	**14°**
Tibial torsion	**37°**	**18°**
Femorotibial rotation	**-6°**	**5°**

(3) Parameters calculated in 3D.
(4) Parameters calculated relative to bi-condylar plane.

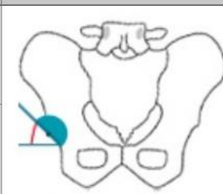
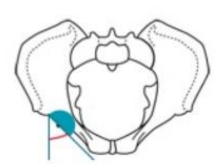


Non-diagnostic image

Pelvis

Pelvic parameters	*Value*		*Pelvic parameters*	*Value*	
Pelvic incidence (1)	**44°**		Pelvic obliquity (1)	**6 mm**	
Sacral slope (1)	**18°**		Pelvis axial rotation (2)	**5°**	
Pelvic tilt (1)	**26°**		Anterior pelvic plane inclination	**-8°**	

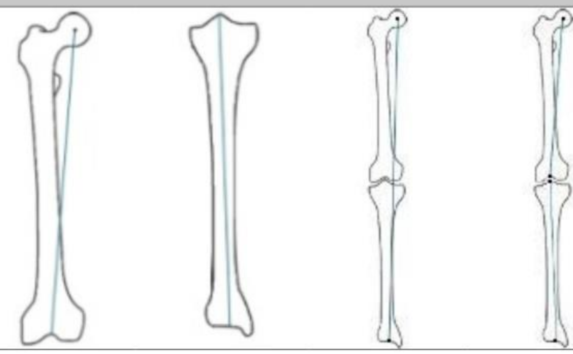
(1) Parameters calculated in the patient frame (based on a vertical plane passing through the center of the acetabula), which corrects the effect of a potential axial rotation of the pelvis during acquisition.
(2) A pelvis axial rotation is positive when the pelvis is rotated towards the patient left side.

	Right		*Left*		
Acetabular cup	*Patient*	*APP*	*Patient*	*APP*	
Acetabular cup inclination	**49°**	**44°**	**58°**	**60°**	 
Acetabular cup anteversion	**40°**	**35°**	**-25°**	**-29°**	

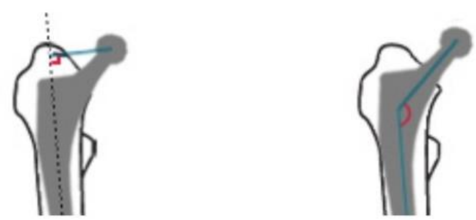
Patient: Parameters calculated in the patient frame (based on a vertical plane passing through the center of the acetabula), which corrects the effect of a potential axial rotation of the pelvis during acquisition.
APP: Parameters calculated relative to Anterior Pelvic Plane (Lewinnek et al.,1978)

Hip and knee

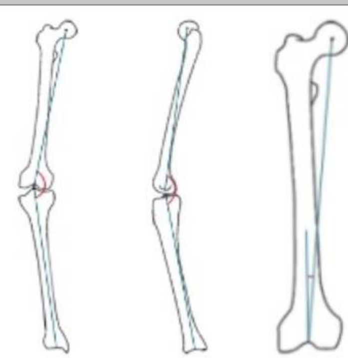
Lengths (3)	*Right*	*Left*
Femur length	**41.0 cm**	**40.6 cm**
Tibia length	**34.5 cm**	**34.4 cm**
Functional length	**75.7 cm**	**76.0 cm**
Anatomical length	**75.5 cm**	**75.0 cm**



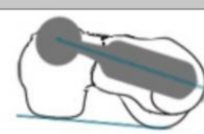
Femur (3)	*Right (Implant)*	*Left (Implant)*
Femoral offset	**32 mm**	**111 mm**
Neck shaft angle	**135°**	**94°**



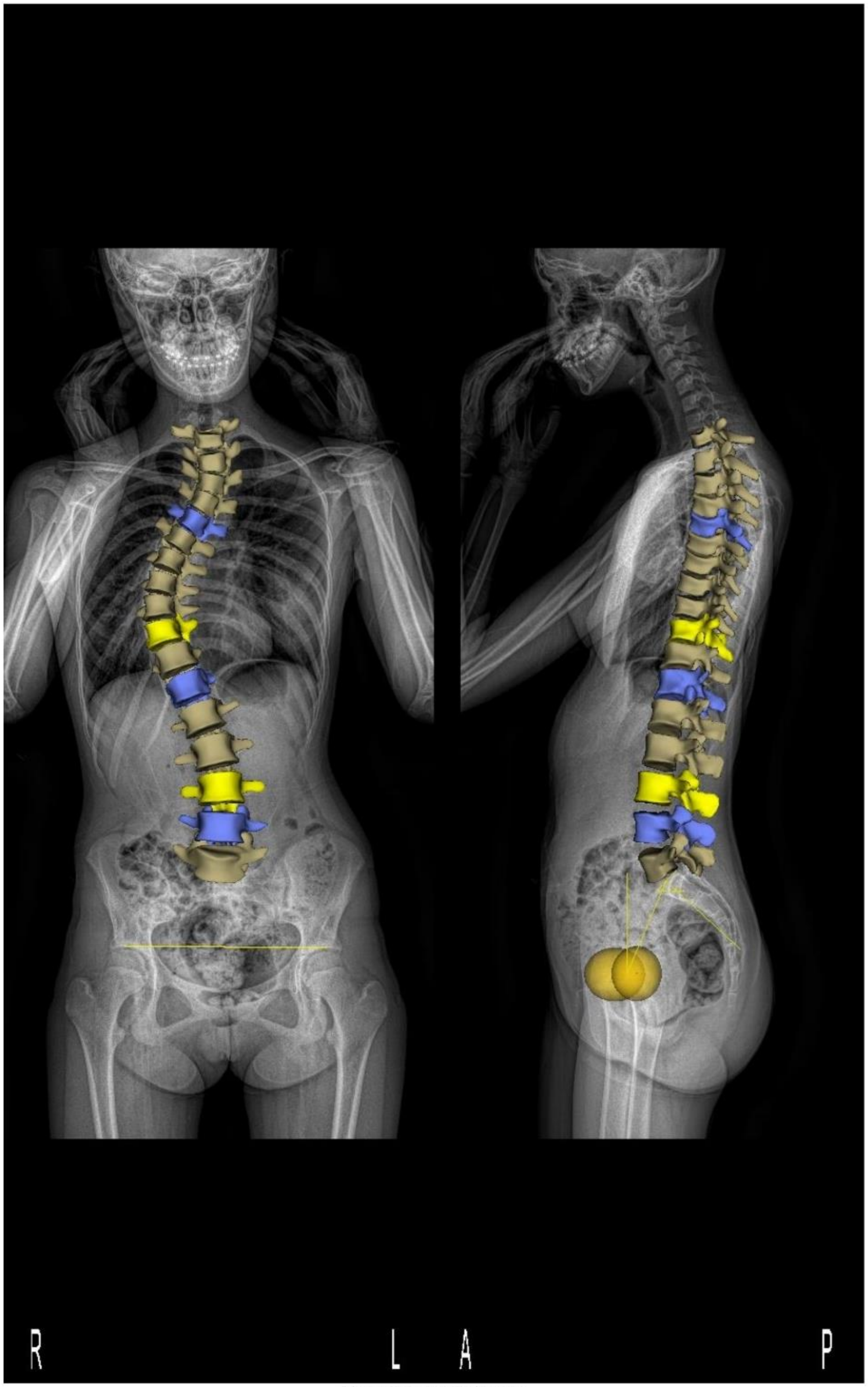
Knee (4)	*Right*	*Left*
Valgus/Varus	**Valgus 8°**	**Valgus 6°**
Knee flexion/Knee extension	**Flexion 7°**	**Flexion 9°**
HKS	**4°**	**4°**



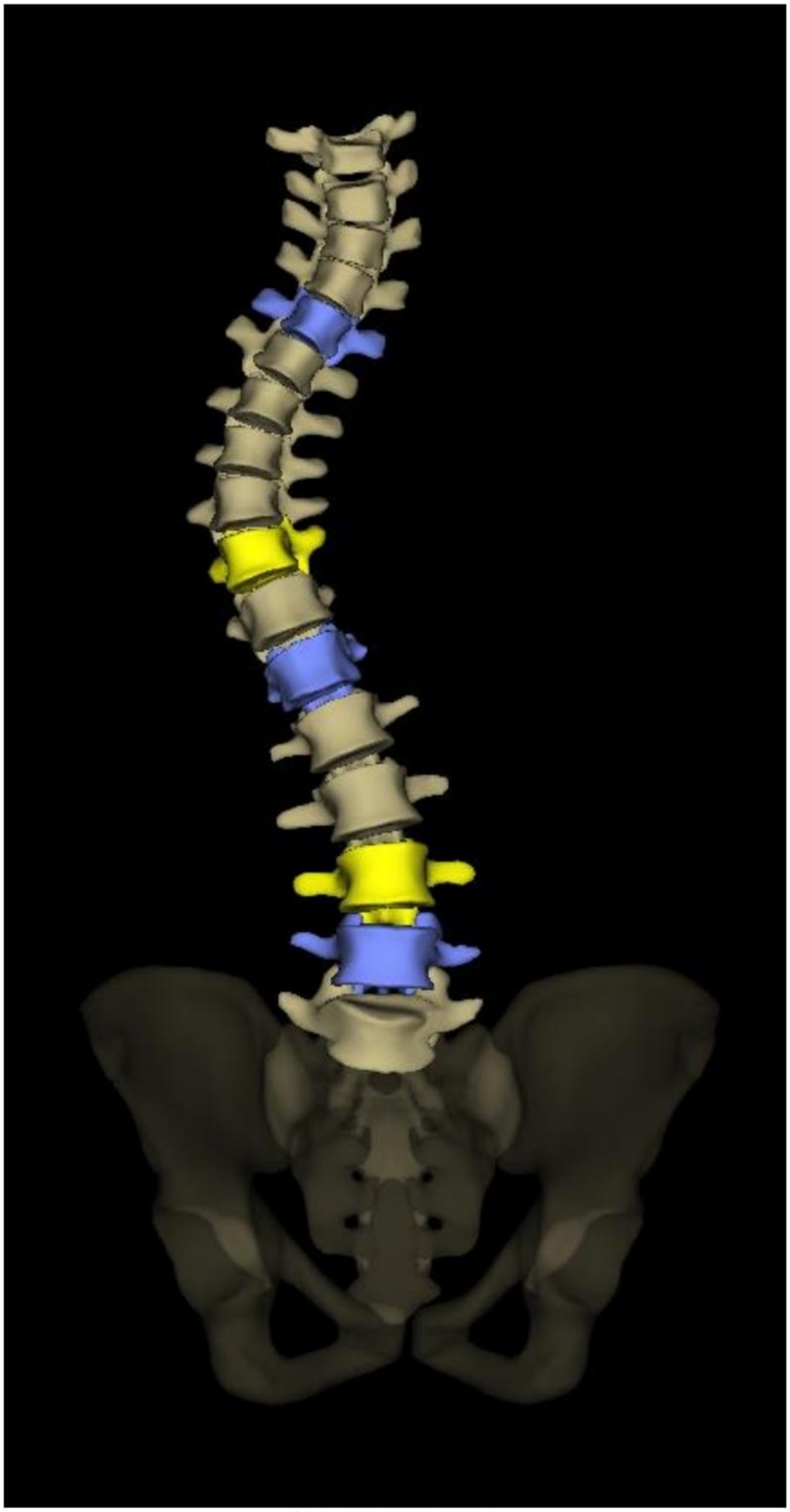
Torsions (4)	*Right*	*Left*
Stem antetorsion	**37°**	**19°**



(3) Parameters calculated in 3D.
(4) Parameters calculated relative to bi-condylar plane.



Non-diagnostic image



Non-diagnostic image
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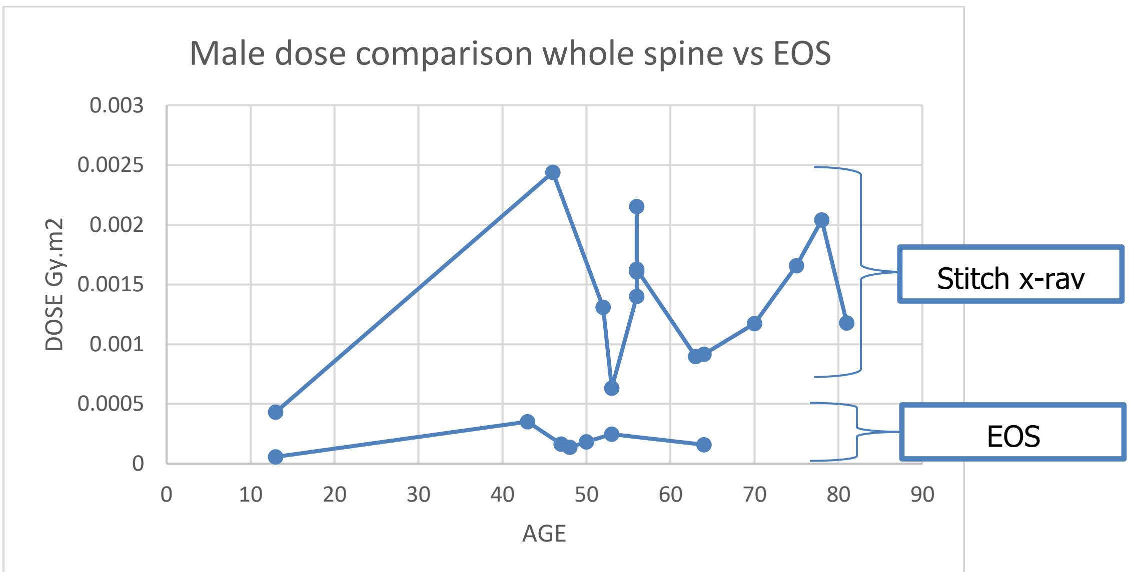
Radiation dose and time compare between whole spine stitching x-ray compare to EOS scan.

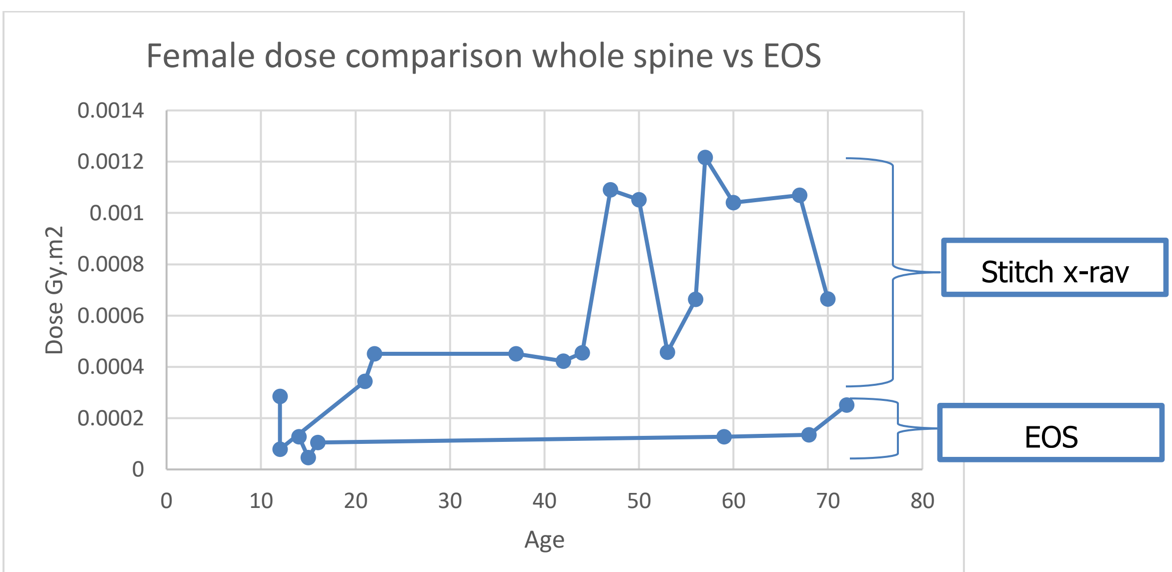
Part 1 radiation comparison

All the data in the report is extracted from Siemens YISO digital radiography system and EOS scanner, which both installed and operated since June 2021.

The following charts include radiation dose between male and female patients.

The whole spine stitching x-ray data extracted since June 2021 till now; the EOS data extracted since 1st Jan 2022, and radiation dose unit in Gy.m2.

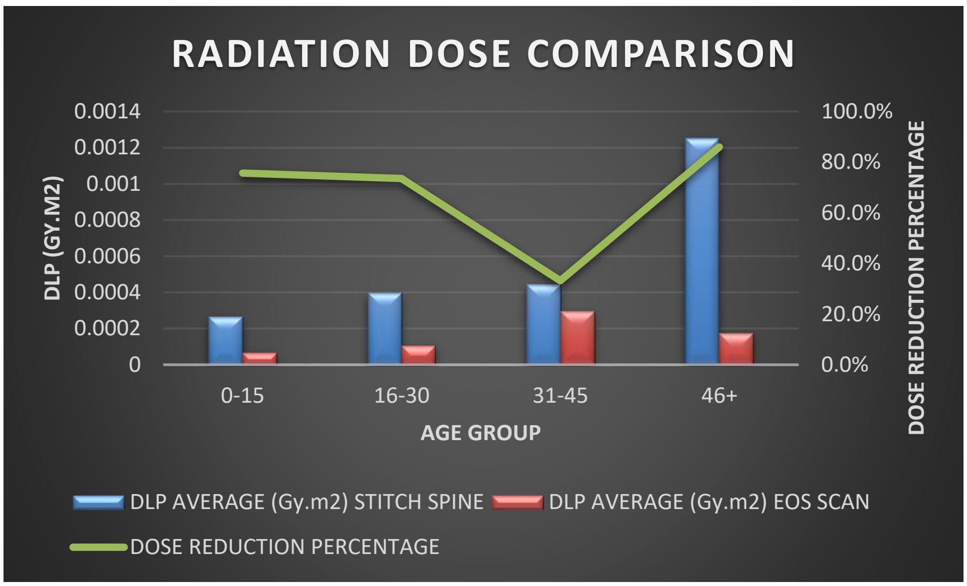




Part 2 Radiation dose reduction

All the data in the report is extracted from Siemens YISO digital radiography system and EOS scanner. The data has been classified the patient into four age group 0-15, 16-30, 31-45, 46+ with no gender specification.

Age group	DLP AVERAGE (Gy.m2) STITCH SPINE	DLP AVERAGE (Gy.m2) EOS SCAN	DOSE REDUCTION PERCENTAGE
0-15	0.00026539	0.000064392	75.7%
16-30	0.00039706	0.00010517	73.5%
31-45	0.00044271	0.000295803	33.2%
46+	0.00125178	0.000175409	86.0%



The radiation dose reduction on EOS scan compared to stitching whole spine x-ray shows, in paediatric and young adult, EOS give over 70% less dose; in the age group 46+, EOS scan dose reduction is 86%!

For the age group of 31-45, the reduction is only 33%, which due to lack of data for the sampling.

The following data is present from EOS, and which is almost aligned with our test results.

EOS vs DR: **50% less**
Comparison of radiation dose, workflow, patient comfort and financial break-even of standard digital radiography and a novel biplanar low-dose X-ray system for upright full-length lower limb and whole spine radiography. Dietrich TJ et al. Skeletal Radiol. 2013

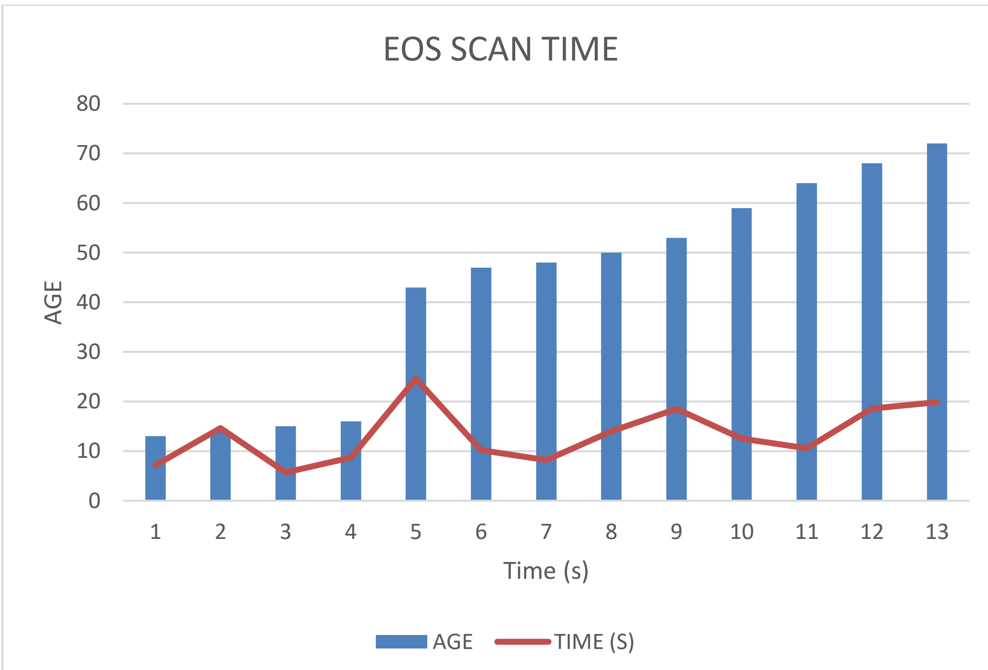
EOS vs CR: **85% less**
Diagnostic imaging of spinal deformities: reducing patient's radiation dose with a new slot-scanning X-ray imager. Deschenes S et al. Spine (Phila Pa 1976)2010 Apr 20;35(9):989-9

Part 3 Scanning time

In this part of the analysis, the time we present extracted from EOS radiation dose report.

The following chart only specified via age, not gender. The chart shows, the scanning time proportional to the patient size, not age or gender.

The software for imaging post-process can compromising the movement blurring, without repeating.



The stitching whole spine x-ray procedure include:

- placing the patient on a platform.
- x-ray tube taking 2-4 x-rays time could up to 60s.
- computer stitching the images.

Common problem for stitching whole spine and long leg x-ray:

- Movement blurring lead to repeat
- Long breathing hold time
- Image distortion.
- Image magnification.