SCOLIOSIS ASSOCIATION (UK)

EOS Imaging

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Introduction

X-ray radiographs of the whole spine are required to diagnose and manage the treatment of people with scoliosis. The frequency of imaging ranges between 3 and 12 months, depending on age, curve size, interventions, and the speed of growth. Most people with scoliosis will be monitored until skeletal maturity is reached, which ranges between 3 and 5 years, depending on the age at diagnosis. The average number of radiographs for women is 12 and for men 10. Surgical intervention for scoliosis also increases radiation exposure, with pre- and postoperative imaging and intraoperative fluoroscopy.

Many improvements have been made to reduce X-ray doses of spinal radiographs, these include high-speed X-ray films, paediatric dosing techniques, limiting the number of images taken (especially lateral views), and using posteroanterior (PA) X-ray. Posteroanterior view, ie, back to front, imaging reduces the X-ray doses to the breast and thyroid gland by around 95%, because the X-ray energy beam is weakened whilst passing through the body before reaching these organs. However, the X-ray radiography is counteracted by an increasing trend to use computer tomography (CT) scans for perioperative surgical planning, and intraoperative navigation.

EOS imaging (EOS imaging, Paris, France) is based on a Nobel prize-wining invention of a highly sensitive particle detector, hence reducing the amount of radiation dose needed to produce images with higher contrast and sharpness. The EOS device consists of two perpendicular (at right angles) pairs of radiation sources and particular detectors, hence is capable of capturing biplanar (frontal and lateral X-rays) simultaneously of a standing patient. Images are captured between 10 and 25 seconds.

Advantages of EOS

Reduced radiation dose

The use of EOS imaging clearly reduces radiation exposure when compared with standard X-ray. However, the amount of reduction is unclear. Studies that quote comparison figures use very different parameters: dual-sided versus single sided computer radiography, PA versus anteroposterior (AP) (front to back) views, different EOS settings (paediatric exposure, low

dose, micro dose), and different units mSv versus mGy. These differences make direct comparison extremely difficult.

X-ray dose of paediatric exposure EOS is quoted to be around half of standard modern X-ray, which is compatible with the calculations in my own institution. The newer micro dose protocol has been shown to be sufficiently accurate for follow-up studies to measure curvature progression, and the dose reduction is a further 6-7 folds. Furthermore, using PA EOS imaging (versus AP) reduces radiation to the breast and thyroid by 8 and 4 fold respectively.

Continued overleaf

The use of standard EOS imaging system reduces radiation exposure by 0.9 years of background radiation, throughout the treatment period. Therefore micro dose PA EOS imaging further reduces the radiation dose, and can almost be considered negligible.

3D reconstruction and surgical planning

The frontal (AP) and lateral (LAT) images that are captured are spatially calibrated and acquired simultaneously through coordinated movements of the two pairs of radiation sources and detectors. This design enables accurate 3D reconstruction of the spine and pelvis, with proprietary software SterEOS®, which uses a combination of co-registration of bony reference points and generic human skeleton models. The measurements are accurate to 1.5mm in human studies. The radiation dose of the EOS 3D reconstruction was shown to be 800-1000 times less than a typical CT scan 3D reconstruction.

This can provide 3D visualisation of complex scoliosis anatomy for pre-operative planning, and the bespoke software can simulate surgical techniques (such as osteotomies, cage position, and length of rods applied) before the operation, and predict the final results of the surgery.

Full body imaging including pelvis and leg length

EOS imaging also has the advantage of imaging the whole body, including the legs without stitching of individual radiographs. Because the images are acquired by linear radiation source, there are no issues of displacement and distortion. Furthermore, the images have higher contrast and resolution, with post processing creating optimal "windowing" of contrast in different areas of interest. Therefore, pelvic parameters are much easier to be measured with EOS than with conventional X-rays. These parameters have been shown to be useful in treating adult scoliosis, and possibly in paediatric cases as well. Leg length difference can also be simultaneously measured to adjust for postural element of scoliosis.

Faster workflow with no stitching

The average acquisition time of EOS imaging is 10 to 25 seconds, and no imaging stitching is required. Therefore, the workflow of EOS is much improved compared to conventional X-rays.

Disadvantage of EOS

Availability and costs

At the time of writing, there is still a limited number of EOS imaging centres in the United Kingdom; and, in some areas, it is only available in the private sectors. The cost of the "full package" imaging and 3D reconstruction report is still 2-3 times the price of conventional X-rays. However, some NHS trusts have managed to negotiate contracts to use EOS imaging

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without inflicting extra costs to the patients.

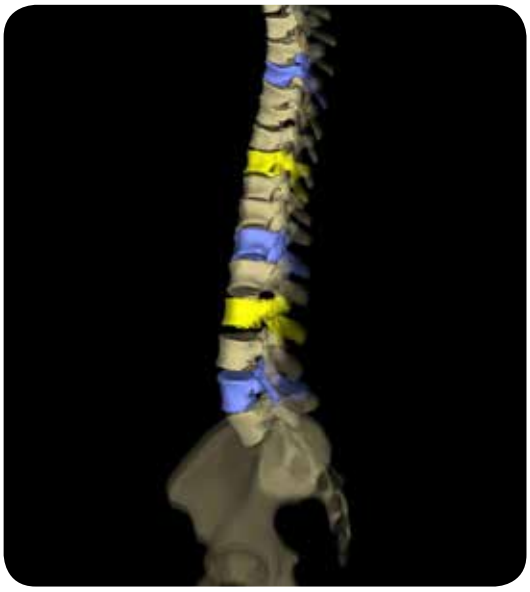
Because of the limited availability of the technology, patients often have to travel further, with many attendances to both the imaging centre and the clinic appointment. Logistical errors, in which failure of image transfer before the clinic appointment is also a source of frustration. Early teething problems, such as calibration error and positioning, also needed to be ironed out.

Metalwork imaging

Motion artefacts are often encountered in EOS imaging, as the acquisition process require patients to be motionless for 10 to 25 seconds. These artefacts have been mistaken for loss of fixation or bending of the instrumentations. However, familiarity of these appearances will decrease the incidence of misinterpretation. Subtle metalwork fracture is still difficult to identify in EOS, when compared with conventional radiography.

Conclusions

There is no doubt that patients would prefer low or negligible radiation dose for the management of scoliosis. The theoretical increased risk of cancer from radiation is well documented, but still difficult to quantify. EOS imaging produces an opportunity to reduce radiation dose, yet producing acceptable (and sometimes superior) quality images. Surgeons will need to know the limitation of the technology, and realise that in some conditions, such as metalwork fracture and non-ambulant patients, conventional X-rays are still best.



EOS have provided SAUK with permission to use the images above.

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