Clinical Case: Image Quality
Emory University Orthopedic and Spine Center, Atlanta, Georgia*

Introduction
EOS has the unique advantage of offering a significantly reduced radiation dose while maintaining the high image quality and information content required for diagnostic radiology. The technological characteristics behind EOS’s low dose capabilities are the scanning method and the unique detector. The thin fan-beam geometry and the slot scanning technique results in X-ray scatter suppression. The unique EOS detector technology provides a very high signal-to-noise ratio and optimal dynamic range management [3]. Clinical studies have been performed to compare radiation dose and resulting image quality between EOS and other X-ray modalities.

The objective of this paper is to outline a study comparing the conventional radiography system (film) with EOS in terms of image quality (Emory University) and dose (Entrance Surface Air Kerma, ESAK).

Clinical study
1.1 Materials and method
A comparative study, performed at Erasmus Hospital, Brussels and St. Vincent de Paul, Paris, on 64 scoliosis patients, compared radiation dose between EOS and conventional screen-film systems for both AP and lateral spine images. An individual informed consent was obtained from all patients enrolled. 64 patients, 41 females and 23 males (mean age=14.7±4.8 y – BMI= 19.8±4.6 kg/m²) admitted for scoliosis detection or follow-up, underwent full spine radiographs. For all patients, a Postero-Anterior (PA) and a lateral projection (LAT) were prescribed, except for 7 patients who had a single PA radiograph and for 2 patients who had a single LAT radiograph. Regardless of the medical prescription, each patient underwent examination with the EOS system under similar technical conditions of those used with a conventional screen-film device.

Acquisition parameters, X-ray tube output dose rates, and patient morphologic data were registered during acquisition on both modalities. This data allowed for the calculation of Entrance Surface Air Kerma (ESAK), which corresponds to the dose at the entrance of the patient without backscatter radiation.

1.2 Results
1.2.1 Dosimetry
The following are the dose results obtained during this study.

<table>
<thead>
<tr>
<th>Modality</th>
<th>PA View</th>
<th>EOS (ESAK)</th>
<th>Film (ESAK)</th>
<th>EOS – Film</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Spine PA</td>
<td>0.12 mGy</td>
<td>0.19 mGy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Screen-Film</td>
<td>0.81 mGy</td>
<td>1.67 mGy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modality (ESAK)</td>
<td>85%</td>
<td>89%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

EOS dose measurements for both PA and LAT spine images were 85% to 89% below those obtained using conventional screen-film modality.

1.2.2 Image Quality
In addition, the images were evaluated based on the European guideline quality criteria for diagnostic radiographic images [1]. These guidelines consist of 8 criteria for both PA and LAT images including both reproduction and inclusion criteria. Scores yielded a significantly higher score for EOS than for screen-film images for 4 quality criteria in the PA view and 5 in LAT view. More importantly, the observers reported a global image quality score significantly higher for PA and LAT radiographs obtained with EOS than with screen-film.

For additional image quality testing, a random sampling of these images was read by U.S. Board Certified Radiologists from the Emory University Orthopedic and Spine Center. For each reading, images were randomized, in a non-paired manner, and scored by three independent radiologists who were blinded as to the origin of the modality. To evaluate the image quality, the criteria were based on the European Guidelines on Quality Criteria for Diagnostic Radiographic Images[1] and were finalized by the Chief of Musculoskeletal Imaging at Emory University. The quality of the images was scored on a 1-4 scale for feature conspicuity. Understanding that conspicuity is a subjective assessment of several features which include spatial and contrast resolution, these measures were not quantified for this study. The following scale was used:

1: Not seen.
2: Poor but usable, characteristic features are detectable but details are not fully reproduced; features just visible.
3: Good: allows an adequate assessment, details of anatomical structures are visible but not necessarily clearly defined; details emerging.
4: Very good: allows an excellent assessment, anatomical details are clearly defined; details clear.

The following tables show the image quality comparison results from the Emory University Radiologist for both PA and LAT exams.
1.3 Discussion and conclusion

Scoliosis patients often require repeated X-ray exposure, which is why this population deserves particular attention and became the focus of this initial dose reduction study. Obtaining good quality diagnostic images with a significantly lower dose of radiation is an important public health goal, especially for these patients. This study shows that with EOS, dose reduction by more than 85% is possible without compromising image quality, and in fact providing an improvement in most of the quality criteria evaluated. In addition, other systems (CR) make it possible to deliver a smaller dose, but often by compromising image quality for certain criteria [2]. Through this study, EOS has proven itself as a great diagnostic imaging tool for addressing dose reduction issues in pediatric scoliosis patients. A study of greater depth, currently being finalized at several sites in Montreal, Canada (phantom and in vivo, 30 to 40 patients), will be published soon. These studies target the lung, pelvis and the spine by comparing EOS with both DR and CR systems. All initial findings of these Montreal trials seem to confirm the result of the above study.

1.4 References


* Three American Board of Radiology Certified physician radiologists from the Emory Orthopedic and Spine Center in Atlanta, GA served as independent observers for image evaluation. They included Michael Terk, MD, Chief of Musculoskeletal Radiology, Walt Carpenter, MD, and Terry Hudson, MD.