EOS - ultra low dose 2D|3D imaging system

Clinical Case: Correction of a major grade secondary scoliosis in cerebral palsy

Pr. Tamas Illes, MD, DSc, University of Pecs, Clinical Center, Department of Orthopedic Surgery, Hungary*

Clinical Study

1.1 Patient History

The patient is a 13 years 4 months old girl born with cerebral palsy (CP) showing signs of spastic diplegia and gait with a limp, flexed hip and knees and bilateral lower limb rotation. Patient history showed multiple corrective surgeries on lower limb deformities between 1997 and 2004. Her spine deformity was detected 3 years ago and a conservative treatment (bracing) was started. In spite of bracing however, the scoliotic deformity progressed and she was referred to the Scoliosis Center at our Department for examination and consideration for a surgical correction.

1.2 Therapy Planning and Outcome

The first examination was done in February 2008 when physical status showed a severe right convex thoracic/thoracolumbar curve with a 3 cm rib hump and 4 cm upper body decompensation to the right side. A global lordosis of the lumbar and thoracic spinal segment, typical to CP, was also observed. EOS X-rays examination (Fig. 1) showed a 73° right convex thoracolumbar curve (Th7-Th11-LII) with 18° axial rotation of the apical Th11 vertebra. Dorsal kyphosis was only 2°, lumbar lordosis was 47°. The patient was pre-pubertal with Risser grade 0.

At this time continued conservative treatment was advised (Cheneau bracing) until the patient reached a higher level of maturity, i.e., pubertal phase is started.

7 months later this has occured and 11 months after the first examination, a second pre-operative EOS X-rays and sterEOS 3D examination revealed a significant progression (Fig. 2). The right convex thoracolumbar curve (Th7-Th11-LII) increased to 93° with axial rotation of apical vertebra to 21°, dorsal kyphosis to 1°, lumbar lordosis to 57°. Risser grade was 3.

Surgical correction was done according to Cotrel-Dubousset (C-D) technique using multi-anchors and rods system with a posterolateral long segmental fusion between Th4-LIV. Postoperative EOS X-rays were obtained, and since vertebral anatomic landmarks were detectable, a postoperative sterEOS 3D modeling was performed as well (Fig. 3). This showed a good correction with a thoracolumbar curve decreased to 17°, dorsal kyphosis increased to 28° and lumbar lordosis decreased to normal (48°). Apical rotation of vertebra Th11 was lowered to 17°, and the upper body got compensated. Gait of the patient remained spastic due to her CP status but overall balance was improved significantly.

1.3 Conclusion

EOS and sterEOS software created a special ability to capture full-body, low-dose bilateral planar X-ray images in normal standing position and to make precise 3D modeling of the spine of the patient. We were able to monitor the progression of the severe spinal deformity preoperatively and control the results of the corrective surgery, as well, with 3 simple and fast, low-dose radiographic examinations. We were able to visualize and quantify the degree of deformity in all 3 planes and obtain spinal and pelvic clinical parameters in their 3-dimensional, true-to-reality values. Thanks to this, our assessment of actual circumstances became more accurate, hence, more valid.

With sterEOS unique Overhead view of the 3D reconstructed spine and pelvis we had an especially valuable, exclusive insight into the positional and orientational changes of the spinal column and vertebrae, relative to the pelvis, in the Horizontal plane. This proved to be a significantly new contribution in the preop and postop evaluation of the spinal deformity besides the usual Coronal and Sagittal views, by providing a direct imaging method to visualize and measure relative position, layout and axial rotation of vertebrae, without using extra radiography and radiation dose. SterEOS 3D Overhead view also allowed to directly visualize sagittal imbalance and upper body decompensation and their changes in case progression or after C-D operation. SterEOS 3D model in Overhead view could, by itself, reveal new and very characteristic patterns in vertebral layout and position that could serve as a basis for evaluation of curve progression and results of surgical correction.

With EOS and sterEOS, all the above possibilities became routine clinical procedures available in each and every scoliosis case.

* Pr. Tamas Illes is a Professor and Head of Department of Orthopedic Surgery at University of Pécs, Clinical Center in Pécs, Hungary. He is a specialist in scoliosis and degenerative spine therapy, having learned the technique of Cotrel-Dubousset instrumentation directly from Prof. Dubousset during his tenure at St. Vincent de Paul Hospital in Paris in 1989-1990. He has 19 years of experience in C-D correction with over 1500 spine deformity cases operated. Based on his recommendation, University of Pécs Clinical Center obtained in May 2007 the first commercial EOS ultra low dose 2D|3D system worldwide. During the first 24 months of clinical use more than 1150 EOS examinations and about 360 sterEOS 3D modeling have been made at his Department.

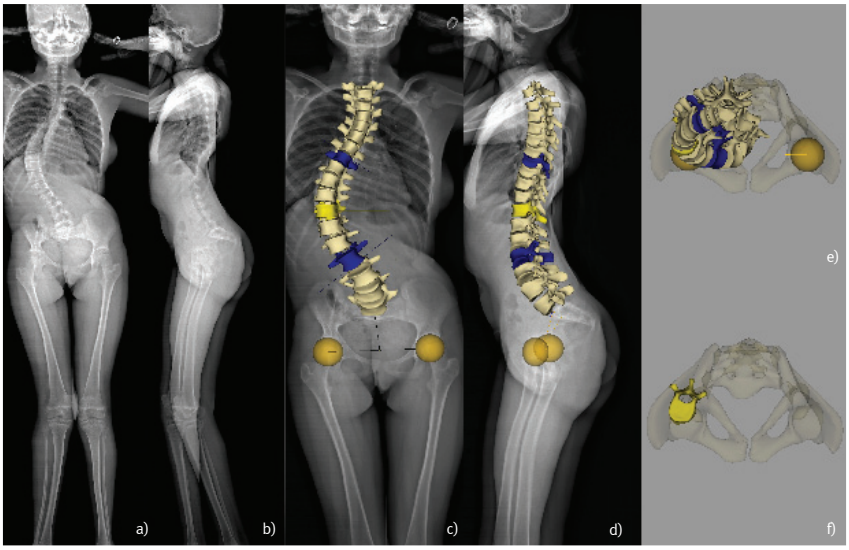

Figure 1. Preoperative EOS examination No. 1 (February 2008)

Figure 1.

a-b. Anteroposterior (AP) and lateral (LAT) EOS 2D X-ray images show high contrast, high dynamic-ratio full-body images in standing position documenting a severe right convex thoracolumbar scoliosis, a bilateral coxa valga with bilateral genu valgum, characteristic in cerebral palsy (CP). A global lordotic sagittal curve present in the lumbar and thoracic segment and a spastic flexion in the hip and knee, also typical in CP, are demonstrated by the LAT image.

c-d. SterEOS 3D modeling of the spinal column projected onto 2D X-rays demonstrates a severe 73° Cobb angle right thoracolumbar curve in Th7-Th11-LII segment. Th11 apical vertebra (yellow), end-vertebrae (blue) of the curve and the acetabulums (yellow spheres) are marked in color.

e. SterEOS 3D reconstructed spine model in Horizontal plane view allows to visualize the 3D layout, position of spinal column relative to the pelvis and the interacetabular axis (yellow line), and the axial rotations of individual vertebrae.

f. Single-vertebra view of the 3D spine model in Horizontal plane view demonstrates a large lateral ejection of the apical vertebra (yellow) relative to the sagittal median axis (a perpendicular line through the center of sacrum base and the middle of the interacetabular axis). Note that the apical vertebra reached the level of the right acetabulum.

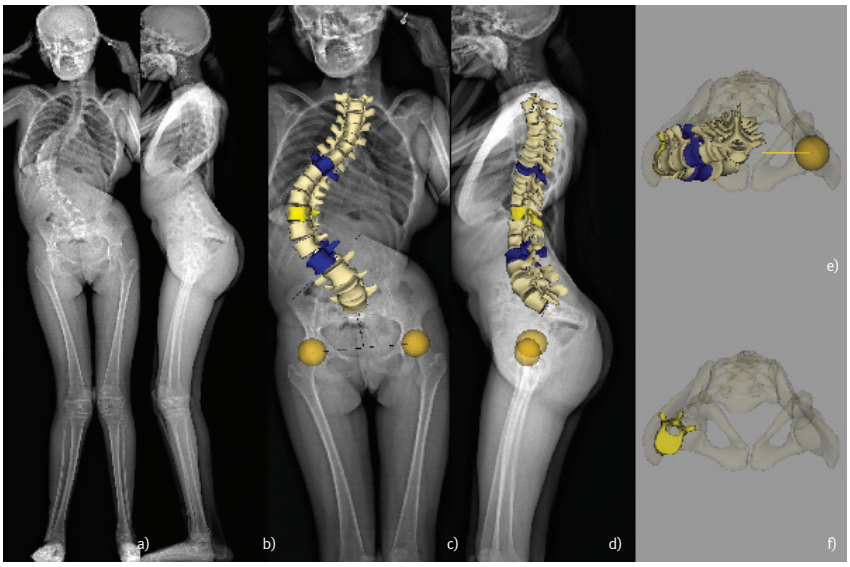

Figure 2. Preoperative EOS examination No. 2 (January 2009)

Figure 2.

a-b. Anteroposterior (AP) and lateral (LAT) EOS 2D X-ray images show high contrast, high dynamic-ratio full-body images in standing position documenting a visible progression in the right convex thoracolumbar curve. Global lordotic sagittal curve present in the lumbar and thoracic segment became more dominant as demonstrated by the LAT image.

c-d. SterEOS 3D modeling of the spinal column projected onto 2D X-rays demonstrates the progression of the right thoracolumbar curve in Th7-Th11-LII segment to 93°.

e. SterEOS 3D reconstructed spine model in Horizontal plane view shows a significant change in the 3D layout and position of spinal column relative to the pelvis and the interacetabular axis (yellow line) – most of the vertebrae are lined up around or ventral to the interacetabular line.

f. Single-vertebra view of the 3D spine model in Horizontal plane view demonstrates an increase in the lateral ejection of the apical vertebra (yellow) relative to the sagittal median axis. The apical vertebra is beyond the lateral rim of the right acetabulum.

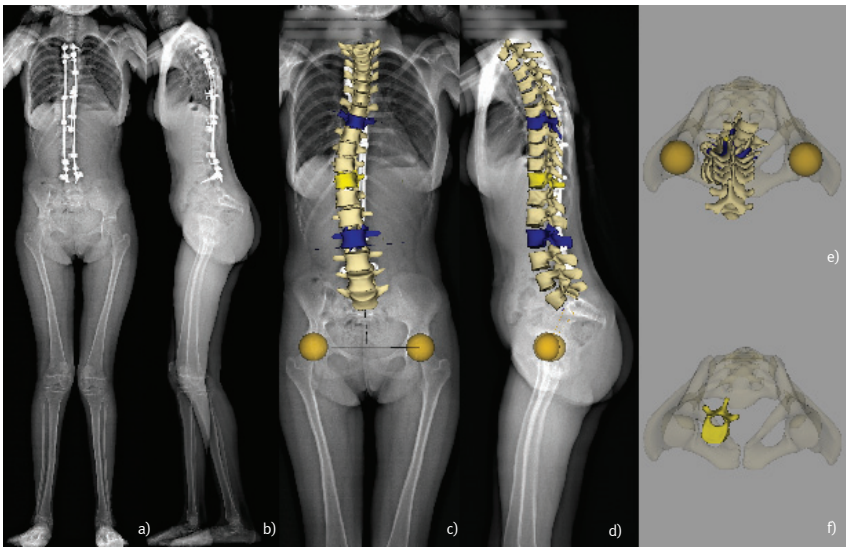

Figure 3. Postoperative EOS examination (February 2009)

Figure 3.

a-b. Anteroposterior (AP) and lateral (LAT) EOS 2D X-ray images show results of the surgical correction. Two long and one short metallic rods and multiple anchors fix the spine in good position, significantly reducing the right convex thoracolumbar curve to a moderate level. Bilateral coxa valga and genu varum are still present. Sagittal curves in the lumbar and thoracic segment changed close to a physiological range as demonstrated by the LAT image. Spastic flexion in the hip and knee remained unchanged.

c-d. SterEOS 3D modeling of the spinal column projected onto 2D X-rays demonstrates the correction of the right thoracolumbar curve in Th7-Th11-LII segment to 17° in the AP image and the close-to-normal sagittal curvature in the LAT image.

e. SterEOS 3D reconstructed spine model in Horizontal plane view shows a significant change in the 3D layout and position of spinal column relative to the pelvis and the interacetabular axis (yellow line) – as a result of the correction, most of the vertebrae are lined up perpendicular to the interacetabular line close to the sagittal median axis.

f. Single-vertebra view of the 3D spine model in Horizontal plane view demonstrates a significantly smaller lateral ejection of the apical vertebra (yellow) relative to the sagittal median line.

Note: 3D modeling shown here present a pseudopelvis only, i.e., not an actual 3D modeling of the individual pelvis of the patient. Visualization of pseudopelvis is based on a built-in pelvis 3D model modified automatically based on user-defined pelvical anatomical reference objects, such as acetabulum and sacrum positions.

EOS imaging SA.
10 rue Mercoeur | 75011 Paris France | +33 (0) 155 25 60 60

EOS imaging Inc.
185 Alewife Brook Parkway #410 | Cambridge, MA 02138 USA | 678.564.5400

www.eos-imaging.com