Editorial

Will a low-dose biplanar radiograph become "gold standard" for three-dimensional assessment of spinal deformity in patients with adolescent idiopathic scoliosis?

Yu Yamato, Yukihiro Matsuyama

Department of Orthopaedic Surgery, Hamamatsu University School of Medicine, Hamamatsu-city, Shizuoka, Japan

Correspondence to: Yu Yamato. Department of Orthopaedic Surgery, Hamamatsu University School of Medicine, 1-20-1, Handayama, Higashi-ku, Hamamatsu-city, Shizuoka 431-3192, Japan. Email: yamato@hama-med.ac.jp.

Provenance: This is an invited Editorial commissioned by the Section Editor Dr. Xu Wang (Department of Health Science and Technology, Aalborg University, Aalborg, Denmark).

Comment on: Sullivan TB, Reighard FG, Osborn EJ, *et al.* Thoracic Idiopathic Scoliosis Severity Is Highly Correlated with 3D Measures of Thoracic Kyphosis. J Bone Joint Surg Am 2017;99:e54.

Submitted Jan 11, 2018. Accepted for publication Mar 12, 2018.

doi: 10.21037/jss.2018.06.05

View this article at: http://dx.doi.org/10.21037/jss.2018.06.05

The spinal deformity of patients with adolescent idiopathic scoliosis (AIS) is definitely complicated. Scoliotic spine constructs consist of three-dimensional (3D) reconstructions, including coronal, sagittal, axial rotation, and their combinations. Presently, two-dimensional (2D) radiograph in coronal and sagittal planes is the gold standard for the assessment of curvature and is clinically available in the diagnosis and follow-up of patients with AIS (1,2). However, the 2D image of whole spine on planar radiograph represents a projection and simplification of the true 3D spine deformity arising from the scoliotic spine. Conventional 3D reconstructions of computerized tomography (CT) scans are accurate techniques to assess the 3D structure of the spine. Routine CT scan is not an available option in AIS because CT scan is obtained only in the recumbent position, and radiation exposure is high. High-dose radiation exposure is a serious problem for CT scan. The use of CT scans in children to deliver cumulative doses of approximately 50 and 60 mGy might almost triple the risk of leukemia and brain cancer, respectively, based on large samples in a retrospective study (3). CT scan should only be performed when clinically justified. With regard to radiation exposure in patients with AIS, many authors addressed the risks for malignancy. Simony *et al.* (4) recently reported the incidence of cancer in a cohort of patients with AIS treated 25 years previously. They showed that the overall cancer rate in the AIS cohort was 4.3% which was five times higher than that in an age-matched Danish population, with endometrial and breast cancer as the most frequent. More careful attention is necessary to reduce the radiation dose distributed to patients with AIS during treatments.

Some authors (5-9) recently reported the utility of low-dose biplanar radiography and its reconstructed 3D images with regard to the assessment of the scoliotic spine and its less invasiveness. Nault *et al.* (5) has evaluated 3D morphological spine parameters at the first visit using a low-dose biplanar radiograph. They revealed that progressive AIS is hypokyphotic at the initial visit compared with an equivalent normal group. Glaser *et al.* (6) examined the accuracy of 3D reconstruction image of low-dose biplanar radiographs compared with 3D computed tomography (CT) image using polyurethane spine phantoms. This study showed that biplanar radiograph provided accurate 3D representations of the scoliotic spine. It also allowed upright weight-bearing imaging, which was critical in the evaluation of patients with scoliosis. Low-dose biplanar radiographs provided accurate 3D representations of relative vertebral body position, orientation, and shape in scoliosis compared with 3D CT scans. Yvert *et al.* (7) compared the radiation dose and image quality between a slot-scanning system and a dynamic flat-panel detector in assessing scoliosis in children. Currently, a slot-scanning system should be the best settlement regarding the dose and image quality for

spine and lower limb examinations. Luo *et al.* (8) reported that standard low-dose biplanar slot-scanning radiographs without a filter resulted in a 50% decrease in total effective radiation exposure compared with standard CR imaging. The posteroanterior films significantly reduced the exposure dose in the breast and thyroid. Law *et al.* (9) also reported that the cumulative effective dose and cancer risk at any age of exposure in the adolescent patient population undergoing repetitive full spine imaging were observed with the use of computer simulation and analytic formulation. Female patients with scoliosis would have a statistically significantly higher effective dose and cumulative cancer risk than the male patients undergoing the same low-dose biplanar radiographs with full spine imaging protocol.

In this study, Sullivan *et al.* investigated 2D and 3D images using low-dose upright biplanar radiography in 442 patients with magnitudes of the main thoracic coronal curves ranging from 1° to 118°. The magnitude of the main thoracic coronal curve and the thoracic kyphosis (T5–T12) were measured for each patient on 2D posteroanterior and lateral radiographs. 3D thoracic kyphosis had a strong negative correlation with the magnitude of the main thoracic curve (R^2=0.56, R=–0.75), whereas no statistically significant correlation was observed in 2D thoracic kyphosis. 3D thoracic kyphosis progressively decreased as the scoliosis magnitude increased. 3D assessment is critical for adequate characterization of multi-planar deformity of idiopathic scoliosis.

Recent development of modern technology and low-dose radiation biplanar imaging system made the assessment of the scoliotic spine with routine 3D clinical imaging possible. Low-dose biplanar radiograph and its 3D reconstruction might possibly become the "gold standard" for routine assessment of spinal deformity in patients with AIS. This study has some limitations, including its retrospective design, single-center setting, and a single time-point evaluation based on their index radiographic image. The specific sequence of deformity development and progression was not delineated. Determination of whether thoracic hypokyphosis or pathologic loading secondary to axial rotation is the primary event, which could prove to be valuable to further characterize the disease process via a longitudinal prospective study using this low-invasive 3D examination technique.

Acknowledgements

None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

References

1. King HA, Moe JH, Bradford DS, et al. The selection of fusion levels in thoracic idiopathic scoliosis. J Bone Joint Surg Am 1983;65:1302-13.
2. Lenke LG, Betz RR, Harms J, et al. Adolescent idiopathic scoliosis. A new classification to determine extent of spinal arthrodesis. J Bone Joint Surg Am 2001;83:1169-81.
3. Pearce MS, Salotti JA, Little MP, et al. Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: A retrospective cohort study. Lancet 2012;380:499-505.
4. Simony A, Hansen EJ, Christensen SB, et al. Incidence of cancer in adolescent idiopathic scoliosis patients treated 25 years previously. Eur Spine J 2016;25:3366-70.
5. Nault ML, Mac-Thiong JM, Roy-Beaudry M, et al. Three-dimensional spinal morphology can differentiate between progressive and nonprogressive patients with adolescent idiopathic scoliosis at the initial presentation: A prospective study. Spine (Phila Pa 1976) 2014;39:E601-6.
6. Glaser DA, Doan J, Newton PO. Comparison of 3-dimensional spinal reconstruction accuracy: Biplanar radiographs with EOS versus computed tomography. Spine (Phila Pa 1976) 2012;37:1391-7.
7. Yvert M, Diallo A, Bessou P, et al. Radiography of scoliosis: Comparative dose levels and image quality between a dynamic flat-panel detector and a slot-scanning device (EOS system). Diagn Interv Imaging 2015;96:1177-88.
8. Luo TD, Stans AA, Schueler BA, et al. Cumulative radiation exposure with EOS imaging compared with standard spine radiographs. Spine Deform 2015;3:144-50.
9. Law M, Ma WK, Chan E, et al. Evaluation of cumulative effective dose and cancer risk from repetitive full spine imaging using EOS system: Impact to adolescent patients of different populations. Eur J Radiol 2017;96:1-5.

Cite this article as: Yamato Y, Matsuyama Y. Will a low-dose biplanar radiograph become "gold standard" for three-dimensional assessment of spinal deformity in patients with adolescent idiopathic scoliosis? J Spine Surg 2018;4(2):465-466. doi: 10.21037/jss.2018.06.05