Introduction

- Scoliosis is a complex three-dimensional (3D) deformity of the spine associated with axial vertebral rotation.
- Adolescent idiopathic scoliosis (AIS) is the most common type of scoliosis which accounts for 80% of cases, and affects 1.5 - 3% of the population [1].
- Axial vertebral rotation (AVR) is one of the important parameters to assess the severity of scoliosis (Fig. 1).
- In the literature, methods have been developed to measure AVR from radiographs [2-7]. However, these approaches have two major drawbacks:
  - The 2D AVR measurement may underestimate its true value.
  - Radiation exposure may increase the risk of cancer.

A 3D non-ionizing method is needed.

Objective

To investigate if the AVR measurements from the 3D ultrasound images are correlated to the radiographic measurements.

Materials and Methods

- A medical ultrasound system and a probe with a built-in positioning system were used in this study (Fig. 2).
- Five AIS subjects with curves less than 40 degrees were recruited and scanned from C7 to L5 in a standing position.
- After the 3D ultrasound data was acquired, an in-house developed program was used to process, reconstruct, and display the 3D spinal images (Fig. 3).
- Axial rotations were measured on three vertebrae from each spinal curve (at the apex and its two adjacent vertebral levels).
- The center-of-lamina method was used on the ultrasound images (Fig. 4), while the Stokes method was used on radiographs (Fig. 5). The measurements on sonographs and radiographs were compared.

Materials and Methods (cont’d)

- The center-of-lamina method was used on the ultrasound images (Fig. 4).
- The semi-automatic center-of-lamina AVR measurement illustrated on a 3D reconstructed image of a cadaveric vertebra (Fig. 4).
- The reference plane (xz).
- The 3D spinal image was used to process, reconstruct, and display the 3D spinal images (Fig. 3).
- Transducer with the GPS receiver.
- GPS transmitter.
- 3D Guidance.
- Use the mouse pointer to manually locate the 2 centres of laminae.

Results

- Axial rotations were measured on twenty vertebra levels.
- The range of the AVR measurements from the sonographs and radiographs were 0 – 11° and 1 – 21°, respectively.
- The linear correlation (r²) of the two measurements was 0.46.
- The mean absolute difference between the two measurements was 3.8° ± 0.8°.
- The absolute differences ranged from 0 to 14°.
- However, if a correction factor is applied, the correlation is increased to 0.73 (r²).

Conclusions

- The 3D ultrasound measurements are not linearly correlated to the 2D radiographic measurements.
- Applying a correction factor may improve their correlation.
- To truly evaluate the vertebral rotation measurements from the sonographs, 3D spinal images from other imaging modalities may be required.

References