IN-VIVO MEASUREMENTS OF AXIAL VERTEBRAL ROTATION USING A 3D SPINAL IMAGE: A PILOT STUDY

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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.

Materials and Methods (cont’d)

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 vertebrae 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.

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 ($r^2$) 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 ($r^2$).

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