SIMULATION OF VERTEBRAL DEFORMITY: DEVELOPMENT OF A NOVEL APPLICATION FOR PEDIATRIC SPINE SURGERY

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INTRODUCTION

Idiopathic Scoliosis (IS) is a sub-class of pediatric spinal deformities that is characterised by a complex three dimensional (3D) spatial disorientation of the spine.[1]

Surgery is one of the treatment options for IS and is effective in achieving and preserving a correction and stabilization of the spine [2].

An essential component of this surgery is the insertion of transpedicular screws which serve to fixate the longitudinal elements to the spine, transmit forces, and minimize intervertebral motion.[3]

The appropriate position and angulation of the transpedicular screws are fundamental to achieving optimal strength and minimize the risk of compromising sensitive neurological and vascular structures [3-5].

The presence of vertebral deformity and limited access to 3D imaging techniques poses a significant challenge for Orthopaedic Residents and Trainees.

EDUCATIONAL RELEVANCE

A program of simulation would allow surgical trainees the opportunity to plan, rehearse and practice their surgical approaches prior to performing surgery on real patients. Our simulations will allow for increased amounts of planning and practice, leading to better surgical performance in the OR.

OBJECTIVE

The long term goal of the present work is to develop a surgical skills training platform for paediatric orthopaedic spine surgery. The specific objective of the present work is to develop a technique to permit the visualization of 3 D vertebral deformities.

METHODS

Participants:

- 1 cadaveric spine, C7- L1 vertebral elements

Instrumentation:

1) Faro 3D Scanner Arm: 3D laser scanner, scanned C7-L1

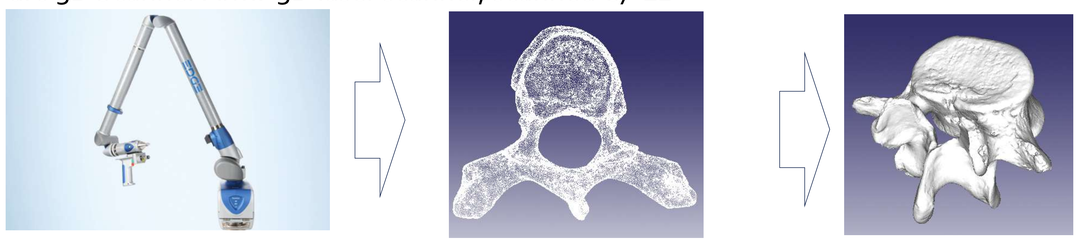


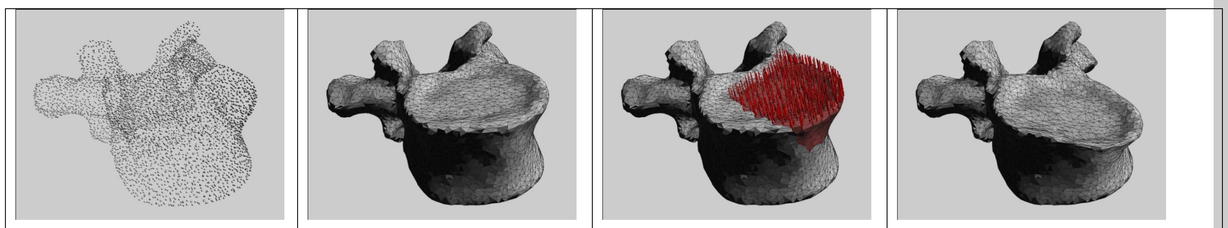
Figure 1: 3D laser scanner, and scanned vertebral model.

METHODS (cont'd)

Modeling of vertebral deformity:

Deformed vertebral surface (X_D) = undeformed vertebral surface (X_U) + displacement field (D) (See Figure 2)

Displacement field (D) is geometrically represented by weighted composition of translational component (D_T) and rotational (torsional) component (D_R).

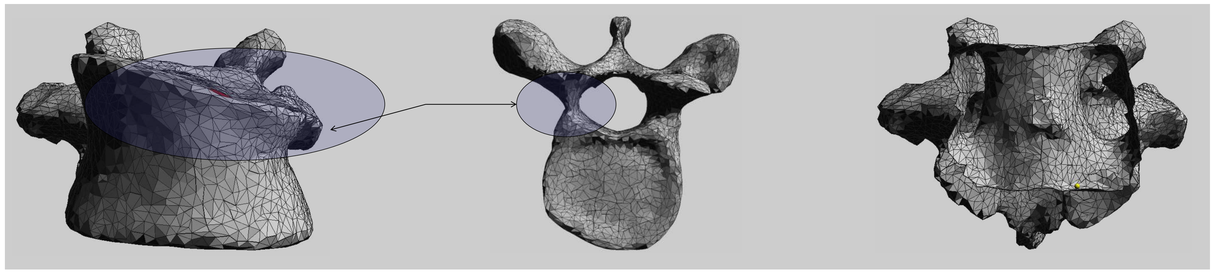


Step 1: Point set obtained by using 3D scanner.	**Step 2:** Undeformed surface (X_U) that is reconstructed by polygonization.	**Step 3:** Segmented region (S) and displacement field (D) that are manually edited.	**Step 4:** Deformed surface (X_D) resulted from geometric deformation applied onto S.

Figure 2: Modellng of vertebral deformity

RESULTS

Deformable vertebrae with 3D visualization of internal and external geometry



CONCLUSION

This emerging work has demonstrated the feasibility of user defined rendering of localised 3D vertebral deformity. This represents the first step towards the development of a library of deformed vertebrae that may serve to train orthopaedic surgeons. To develop this library further work will focus on recruiting a cohort of experienced orthopaedic surgeons to generate deformed vertebrae that are typical to those found in the general IS population.

Acknowledgments

CIHR IRSC
Canadian Institutes of Health Research
Instituts de recherche en santé du Canada

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