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3D RECONSTRUCTION OF ADOLESCENT SCOLIOTIC TRUNK SHAPE FROM BIPLANAR X-RAYS: A FEASIBILITY STUDY

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Summary: Adolescent idiopathic scoliosis (AIS) is a 3D deformity of the spine detectable by trunk asymmetry. As a decision-aid tool, a body scanner can help assessing non-invasively the external shape of the trunk. However if AIS is diagnosed, additional personalized 3D reconstructions of the spine, rib cage and pelvis are useful to have a complete understanding of the pathology and plan a treatment. For instance, both internal and external geometry are required for computer-aided brace design.

Since a body scanner cannot currently guarantee reliable bones reconstruction, low-dose biplanar X-rays (BXR) is a relevant alternative. Indeed, it enables to compute reliable reconstructions of bony structures using validated methods daily used in clinical routine. More recently, 3D body shape reconstruction of asymptomatic subjects from BXR was also proved to be feasible with good accuracy.

In order to prevent young scoliotic subjects from multiple examinations, we investigated the feasibility of trunk shape reconstruction from BXR. The proposed method relies on the 3D reconstructions of the spine, rib cage and pelvis priory performed and 10 radio-opaque markers placed on the subject on which we fit a statistical shape model (SSM). This model was built on a training set of 50 asymptomatic and 15 scoliotic female subjects for whom spine, rib cage, pelvis and trunk shape were reconstructed. The trunk shape reconstructions were assessed using the above mentioned method of body shape reconstruction. For the training on scoliotic subjects, this solution was corrected by 100 radio-opaque markers placed on the subjects and detected on the X-rays. During testing, after regression using the SSM, the trunk shape is registered automatically on apparent radiographic contours. Finally, few manual adjustments can be performed.

This method has been evaluated on the 15 scoliotic subjects (13.7 ± 1.3 years, Cobb = 23.3° ± 8.5°) using a leave-one-out procedure. Signed marker-to-surface errors were computed on several trunk regions. The bias was everywhere lower than 0.7mm in absolute value and the standard deviation lower than 6mm. These results are promising and could be improved with a larger database. Thus, this study is a first step toward computer-aided brace design with a single examination.