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Three-dimensional analysis of reconstructed skulls using three different open-source software versus commercial software

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Abstract

This study aimed to compare the 3D skull models reconstructed from computed tomography (CT) images using three different open-source software with a commercial software as a reference. The commercial Mimics v17.0 software was used to reconstruct the 3D skull models from 58 subjects. Next, two open-source software, MITK Workbench 2016.11, 3D Slicer 4.8.1 and InVesalius 3.1 were used to

reconstruct the 3D skull models from the same subjects. All four software went through similar steps in 3D reconstruction process. The 3D skull models from the commercial and open-source software were exported in standard tessellation language (STL) format into CloudCompare v2.8 software and superimposed for geometric analyses. Hausdorff distance (HD) analysis demonstrated the average points distance of Mimics versus MITK was 0.25 mm. Meanwhile, for Mimics versus 3D Slicer and Mimics versus InVesalius, there was almost no differences between the two superimposed 3D skull models with average points distance of 0.01 mm. Based on Dice similarity coefficient (DSC) analysis, the similarity between Mimics versus MITK, Mimics versus 3D Slicer and Mimics versus InVesalius were 94.1, 98.8 and 98.3%, respectively. In conclusion, this study confirmed that the alternative open-source software, MITK, 3D Slicer and InVesalius gave comparable results in 3D reconstruction of skull models compared to the commercial gold standard Mimics software. This open-source software could possibly be used for pre-operative planning in cranio-maxillofacial cases and for patient management in the hospitals or institutions with limited budget. © IMechE 2023.

Author keywords

3D reconstruction; computed tomography; craniofacial reconstruction; open-source software; standard tessellation language; superimposition; surgical planning

Indexed keywords

MeSH

Head; Humans; Imaging, Three-Dimensional; Skull; Software; Tomography, X-Ray Computed

Engineering controlled terms

Budget control; Computerized tomography; Image reconstruction; Open systems; Three dimensional computer graphics

Engineering uncontrolled terms

3-D slicer; 3D reconstruction; Commercial software; Computed tomography; Craniofacial reconstruction; Open-source softwares; Skull models; Standard tessellation language; Superimposition; Surgical planning

EMTREE medical terms

diagnostic imaging; head; human; skull; software; three-dimensional imaging; x-ray computed tomography

Engineering main heading

Open source software