Artificial Intelligence Segmentation in Orthopaedics: How Accurate are the 3D Models?

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INTRODUCTION:

Accurate and rapid segmentation of the patient anatomy is critical for 3D preoperative planning of total hip arthroplasty (THA) surgery. In this study, we evaluated the accuracy of a proprietary artificial intelligence (AI) algorithm in segmenting a dataset of CT images of the hip of a US population as a function of sex, age, and ethnicity.

METHODS:

Sixty cadaveric CT scans of the pelvis from a multi-ethnic data set aged 40-70 years were studied. There were 26 females and 34 males. The pelvis and femurs were automatically segmented by proprietary AI (Figure 1). Segmentation accuracy was compared across sex, age, and ethnicities between the automatically segmented geometries and the manually segmented comparator subset generated in popular software by a panel of US-board registered radiologists experienced in 3D image segmentation. The metrics used to evaluate the accuracy of the segmentations were the surface-to-surface mean absolute distance (MAD) and Dice score (an overlap index between 0 and 1). Additionally, time efficiency was evaluated.

RESULTS:

The automated segmentations of the hemipelvis had an average Dice score of 0.949 and average MAD of 1.15 mm, and the femurs had an average Dice score of 0.967 and average MAD of 1.353 mm. Segmentation accuracy was comparable across males and females, ethnicities, under-55, and 55-and-over groups. The proprietary AI returned a complete segmentation in 10 mins, compared to manual segmentation, which took an average of 60 mins.

DISCUSSION AND CONCLUSION:

All segmentations exceeded the acceptance criteria for Dice and MAD. These results demonstrate the high accuracy and robustness of the AI segmentation in automatically obtaining patient-specific morphologies of the pelvis and femur, regardless of sex, age, and ethnicity. The AI generated segmentation was non-inferior to expertly acquired manual segmentation and was 600% more time efficient.