Automated Total Hip Arthroplasty Templating: Development and Validation of a Deep Learning Neural Network Model

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INTRODUCTION:
Prior to surgical intervention in patients with osteoarthritis of the hip, surgeons must accurately template to restore leg length and offset to adequately restore function and maximize patient outcomes. Prior studies have utilized demographic variables in predicting total hip arthroplasty (THA) cup and stem sizes, however to date no studies have utilized the growing field of deep learning to better facilitate preoperative radiographic templating. The purpose of this study is to create a deep learning model to accurately predict THA cup and stem sizes.
METHODS:
We trained, validated, and tested a deep learning system to predict THA cup and stem sizes for a common cementless THA system utilized at our institution. Two models were created: one using anterior-posterior (AP) radiographs only and one combined model also incorporating patient sex and height. A total of 180 patients were included in the study. Images were augmented for training and a prior model trained on AP radiographs of the hip was utilized in a transfer-learning fashion (previously trained on 1,972 THA images) to increase model reliability. Model outcome metrics included accuracy within one predicted size and mean average difference between actual and predicted size. Models were compared with the Kolmogorov-Smirnov test with an alpha value of 0.05.
RESULTS:
The models accurately predicted the cup and stem in THA with 93% and 92% accuracy in the radiograph-only model and 94% and 95% in the combined model, respectively. Mean average difference in the combined model for predicting cup size was 0.8 (standard deviation 0.1) and 0.6 (standard deviation 0.2) for predicting stem size. The combined model was superior when compared to the AP radiograph-only model ($p < 0.001$).
DISCUSSION AND CONCLUSION:
A deep learning model accurately predicts THA cup and stem size for one of the industry's leading cementless total hip arthroplasty systems.