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Fast and Accurate Automatic Measurements of the Hip from X-Rays using AI

James McCouat, Irina Voiculescu, Sion Glyn-Jones

Background: Taking routine hip measurements from anterior posterior radiographs of the pelvis is a time consuming process for clinicians. Additionally, measurements often depend on subtle anatomical features, such as a small bump on the femoral head, and these subtleties are difficult to spot. An Artificial Intelligence (AI) assisted tool has the potential to increase the speed and accuracy of the measurement process leading to better patient outcomes.

Methods: We utilise 375 x-ray images taken as part of Femoroacetabular Impingement (FAI) Trial. These images contain patients between the ages of 18 and 60 each with clinical and radiographic evidence of FAI. A clinician manually provided 8 anatomical landmark annotations on each hip. We then train a convolutional neural network architecture (modified U-Net, 200:75:100 training:validation:testing data split) to automatically detect these landmarks. From these landmarks the following measurements are calculated automatically: Alpha, Lateral Center Edge (LCE) and Neck Shaft angles, Acetabulum Indices and Pelvic Tilt.

Results: The AI detected the 8 landmarks for each hip in all images in the test dataset (n=100), with a mean error of 2.34mm. The mean average difference (in degrees) and correlation (ICC) between the human expert and the AI method were calculated for all the measurements as follows: alpha angle 7.53 degrees mean difference (ICC: 0.76), LCE angle 1.29 degrees (ICC: 0.96), Neck Shaft angle 1.93 degrees (ICC: 0.63), Acetabulum Index 0.88 degrees (ICC: 0.89) and pelvic tilt 0.30 degrees (ICC: 0.97). Alpha Angle was the hardest angle for the AI to calculate but the ICC achieved is still higher than a 0.73 ICC recorded between 2 clinicians. In addition to these impressive accuracy scores our AI calculates all these measurements in 5 seconds compared to approximately 10 minutes for a clinician with current tools. Implementing this software into clinical practice would therefore provide a large cost saving to the NHS.

Conclusions: This method will improve the speed and accuracy of hip measurements which will lead to better patient outcomes and a reduced time burden on clinicians who can be reallocated to different tasks.