Fully Automated Analysis of the Anatomical and Mechanical Axes from Pediatric Standing Lower Limb Radiographs using Convolutional Neural Networks

Yousif Murad, MD; Anthony Cooper, MD; Harpreet Chhina

externalfixators@cw.bc.ca

What was the question?
Can convolutional neural networks (CNNs) perform lower limb alignment and axes analysis with performance comparable to trained orthopaedic surgeons?

How did you answer the question?
We used a set of CNNs based on the ResNet 18 and ResNet 50 architectures in combination with custom Matlab code to develop an automated workflow for the analysis of lower limb radiographs. CNNs were trained and validated on a set of pediatric standing lower limb radiographs. Results were then compared to manual measurements performed by orthopaedic surgery fellows.

What are the results?
CNNs combined with algorithms to find anatomical landmarks were used to extract mechanical axis parameters (mLFDA and mMPTA). Initial results compared favourably with those measured by orthopaedic surgery fellows. mLFDA measurements of 44 limbs showed a mean difference of –0.28 degrees with a standard deviation of 1.27 degrees. mMPTA measurements of 36 limbs showed a mean difference of 2.33 degrees and a standard deviation of 3.14 degrees. Full axis measurements were recorded to take approximately 2 seconds per radiograph to run on a consumer–grade laptop computer.

What are your conclusions?
CNNs are a promising approach to automating commonly performed, repetitive tasks, especially those pertaining to image processing. The time savings are particularly important in clinical research applications where large sets of radiographs are routinely available and require analysis. With further development of these algorithms, we anticipate significantly improved agreement with expert–measured results as well as the calculation speed. In the future, there is the potential to integrate these algorithms into routine clinical practice.