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A Deep Learning Approach to Calculate Cardiothoracic Ratio From Chest Radiographs

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Abstract : The cardiothoracic ratio (CTR) is the ratio of the diameter of the heart to the diameter of the thorax. An abnormal CTR, that is, a value greater than 0.55, is often an indicator of an underlying pathological condition. The accurate prediction of an abnormal CTR from chest X-rays (CXRs) aids in the early diagnosis of clinical conditions. We propose a deep learning-based model for automatic CTR calculation that can assist the radiologist with the diagnosis of cardiomegaly and optimize the radiology flow. The study population included 1012 posteroanterior (PA) CXRs from a single institution. The Attention U-Net deep learning (DL) architecture was used for the automatic calculation of CTR. A CTR of 0.55 was used as a cut-off to categorize the condition as cardiomegaly present or absent. An observer performance test was conducted to assess the radiologist's performance in diagnosing cardiomegaly with and without artificial intelligence (AI) assistance. The Attention U-Net model was highly specific in calculating the CTR. The model exhibited a sensitivity of 0.80 [95% CI: 0.75, 0.85], precision of 0.99 [95% CI: 0.98, 1], and a F1 score of 0.88 [95% CI: 0.85, 0.91]. During the analysis, we observed that 51 out of 1012 samples were misclassified by the model when compared to annotations made by the expert radiologist. We further observed that the sensitivity of the reviewing radiologist in identifying cardiomegaly increased from 40.50% to 88.4% when aided by the AI-generated CTR. Our segmentation-based AI model demonstrated high specificity and sensitivity for CTR calculation. The performance of the radiologist on the observer performance test improved significantly with AI assistance. A DL-based segmentation model for rapid quantification of CTR can therefore have significant potential to be used in clinical workflows.

Keywords : cardiomegaly, deep learning, chest radiograph, artificial intelligence, cardiothoracic ratio
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