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Implementation of U-Net Deep Learning Model in SPECT Myocardial Perfusion Image Segmentation

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Introduction/Background

Background: Myocardial perfusion imaging (MPI) is a type of single photon emission computed tomography (SPECT) imaging that is performed to evaluate patients with suspected or docu-mented coronary artery disease (CAD) that detection and diagnosis is among the complex prog-nosis that requires accurate and precise image processing (2). Processing and segmentation should be done accurately to provide an accurate diagnosis. Many problems may arise from segmentation issues, leading to difficulties in diagnosis (5). Machine learning (ML) algorithms have been de-veloped with superior performance to overcome segmentation problems (7). To solve segmenta-tion problems and provide accurate segmentation, this study used a deep learning (DL) algorithm called U-Net for image segmentation in MPI.

Methods/Intervention

Method: one thousand one hundred patients who had an MPI study were collected from the PACS system at Al Jahra Hospital between the period of 2015 and 2024. To train the U-net model, 100 studies have been segmented by different nuclear medicine (NM) experts to provide ground truth (i.e., gold-standard coordinates). To assess the performance of the model, multiple cross-validation tests (i.e., accuracy, precision, intersection over union (IOU), recall, and F1 score) were utilized after breaking down the main dataset into a training set (n= 100 images) and valida-tion subsets (n= 900 images).

Results/Outcome

Result: A dataset of 4560 images and 4560 masks was obtained, and a holdout and k-fold (k-5) were utilized. Both cross entropy and dice score were also utilized. The findings indicate that the best case was corresponding to the holdout split scenario with a cross-entropy loss function with a test accuracy stands at 98.9%, test IOU at 89.5%, and the test Dice coefficient at 94%. The K-fold sce-nario was more balance between true positive rate and false positive rate. The results of U-Net segmentation were not significantly different from that produced from an expert nuclear medicine technologist ($p=0.1$).

Conclusion

The results show that the U-Net model provide a solution for segmentation problems, allowing better diagnosis and subsequent accurate reporting.

Statement of Impact

This research demonstrates that the U-Net deep learning algorithm significantly enhances MPI segmentation accuracy, aligning closely with expert evaluations and promising improved diagnostic precision for CAD.

Keywords

Artificial intelligence; Deep Learning; SPECT; Myocardial Perfusion