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Expert-level segmentation using deep learning for the volumetry of polycystic kidney and liver

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Objectives: Autosomal dominant polycystic kidney disease (ADPKD) is the most common hereditary kidney disease, with serious impacts on patients. In polycystic kidney and liver diseases (PKLD), including ADPKD, volumetry is used to assess disease progression and drug efficiency. However, since no rapid and accurate method has been developed, volumetry has not been established in clinical practice, hindering the development of therapies for this disease. This study presents an AI-based PKLD volumetry method that showed powerful performance.

Methods: As a first experiment, the performance of AI was evaluated compared to ground-truth (GT). We trained a V-net based convolutional neural network on 175 ADPKD computed tomography (CT) segmentations (GT) produced by 3 experts using images from 214 patients. The dice similarity coefficient (DSC), inter-observer correlation coefficient (ICC), and Bland-Altman plots of 39 GT and AI segmentations in the validation set were compared. Next, the performance of AI on the segmentation of 50 random CT images was compared to that of 11 PKLD specialists based on the resulting DSC and ICC.

Results: The DSC and ICC of the AI were 0.961 and 0.999729, respectively. The error rate was within 3% for approximately 95% of CT scans (error <1%, 46.2%, 1% ≤ error <3%, 48.9%). Compared to the specialists, AI showed moderate performance. Furthermore, an outlier in our results confirmed that even PKLD specialists can make mistakes in volumetry.

Conclusions: PKLD volumetry using AI was fast and accurate. AI showed comparable performance to that of human specialists, suggesting its practical use in clinical settings.

Our sequential experiments to evaluate the performance of our framework for automatic segmentation and volumetry

