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Development of a rapid semi-automated tool to measure total kidney volume in autosomal dominant polycystic kidney disease

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Abstract

Background

Total kidney volume (TKV) is an approved early prognostic marker of progression in autosomal dominant polycystic kidney disease. The approval of tolvaptan for patients with rapid disease progression in Europe requires accurate patient stratification. Current methods of TKV measurement rely on manual segmentation which is time consuming, restricting its clinical use. To address this important clinical challenge we report the development and performance of a semi-automated method (Sheffield TKV tool) to measure TKV in patients with this disease.

Methods

1.5T MRI scans were acquired (Siemens Avanto) in 61 adult patients with autosomal dominant polycystic kidney disease. Manual segmentation of the kidneys was performed on T2 true fast imaging with steady state precession MRI. Computational semi-automated segmentation methods were tested in a subgroup of ten patients and the optimum method used in all 61 cases to measure TKV (mL). Manual and semi-automated results were compared by Bland–Altman analyses. Processing time for manual and semi-automated methods were recorded.

Findings

Our cohort consisted of 29 men and 32 women (mean age 45 years, SD 14). Estimated GFR (eGFR) in patients within 1 month of the MRI ranged between 32 and 138 mL/min. TKV measured by manual segmentation ranged between 258 and 3680 mL. The Sheffield TKV tool performed optimally for calculating TKV, reporting accurate results in 80% of cases compared with manual TKV. Inaccuracies were associated with erroneous inclusion of blood vessels, the renal hilum, or leakage into neighbouring tissues, and overall were more frequent in smaller kidneys. Processing time for TKV with the Sheffield TKV tool was 2–5 min compared with 20–30 min for manual segmentation.

Interpretation

We describe a new rapid, semi-automated method for measuring TKV on MRI which should be a useful tool for evaluating patients with autosomal dominant polycystic kidney disease. We plan to optimise MRI acquisition sequences and extract the renal hilar volume to improve performance of the Sheffield TKV tool and validate it in another population with autosomal dominant polycystic kidney disease, with the ultimate aim of using it in clinical practice.

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