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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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INTRODUCTION AND AIMS: Total kidney volume (TKV) is an approved prognostic biomarker of disease progression in autosomal dominant polycystic kidney disease (ADPKD), especially in the early stages when traditional measures of kidney function (glomerular filtration rate, GFR) are stable. The recent approval of Tolvaptan therapy in Europe and the UK for use in ADPKD patients with 'evidence of rapid disease progression' has stressed the urgent need for accurate patient stratification. Current methods of measuring TKV rely on manual segmentation which is time consuming, restricting its usefulness in clinical practice. Automated techniques are however prone to error because of image complexity and estimation formulas (based on ellipsoid) have been proposed as an alternative. We sought to address this important clinical challenge by creating a rapid and reliable method for measuring TKV. Here, we report the development of a semi-automated method (*Sheffield TKV tool*) to measure TKV in patients with ADPKD and its initial evaluation in comparison to manual techniques and estimating equations.

METHODS: Magnetic resonance imaging (MRI) scans were undertaken in 61 adult patients with ADPKD attending our institution. MRI sequences were acquired on a Siemens Avanto 1.5T scanner using a standard protocol to obtain 4mm coronal slices of the kidneys. Manual segmentation of the kidneys was performed on T_2 trueFISP MR images to determine TKV (ml). Three computational methods of semi-automated kidney segmentation were developed and tested in a representative subgroup of 10 MRI scans. TKV results were compared using Bland-Altman analyses and the most accurate segmentation technique was developed in Matlab. This semi-automated *Sheffield TKV tool* was then tested on the remaining MRI scans (51) to measure TKV and compared with manual TKV results. Standard deviation (SD) and bias (+x) of results are reported as percentages of TKV. Processing time for manual and semi-automated methods were recorded.

RESULTS: There were 29M and 32F patients, with an age range of 20-77years. Estimated GFR (eGFR) in patients within 1 month of the MRI ranged between 30-154ml/min. The TKV measured by manual segmentation in this patient cohort ranged between 258-3680ml. The Deformable model (*Sheffield TKV tool*) performed optimally for calculating TKV, reporting accurate results in 80% of cases compared to manual TKV. Inaccuracies were associated with the erroneous inclusion of blood vessels or leakage into neighbouring tissues and overall were more frequent in smaller kidneys. The *Sheffield TKV tool* reported left TKV with a SD and bias of 11.8 (+0.8)% and right TKV with 10.2 (+7.2)% compared to manual TKV. These figures are superior to previously reported methods of estimating TKV. Processing time for TKV using the *Sheffield TKV tool* was 3-5 minutes compared to 20-30 minutes for manual segmentation.

CONCLUSIONS: We describe a new rapid, semi-automated method for measuring TKV on MRI which could be a useful tool for evaluating patients with ADPKD. We plan to optimise MRI sequence techniques to improve its performance and validate the *Sheffield TKV tool* in another ADPKD population with the ultimate aim of using it in clinical practice.