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Quantification of glomerular number and size using MRI at 9.4 and 3 Tesla as a viable alternative to stereology

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The analysis of glomerular numbers (N_{glom}) and sizes is essential for the accurate study of kidney diseases. The gold-standard for this analysis is stereology which is based on the physical segmentation of the kidney. Stereology is incompatible by design with longitudinal studies whereas MRI-based methods could potentially be employed for longitudinal studies. However, long scanning times reduce the efficiency and throughput of the method and restrict the applicability to *ex vivo* studies. In this work, an efficient method to quantify glomeruli and assess their sizes in *ex vivo* mouse kidneys at 9.4 T was developed. The method used a scan time of 33 minutes. Thus, it achieved a ca. 8.7-fold time reduction in comparison to the quickest previously reported method (based on rat kidneys and scan times of 4:46 hours). Validation was performed by comparison to the gold-standard with the same kidneys (N = 9). N_{glom} found were: MRI = 15 606 ± 1 178 and stereology = 16 273 ± 1 523 (mean ± SD). The difference accounted for less than 4 %. A variation of the method was used to study hyperfiltration in a disease model with 33 kidneys. Out of this total, 24 kidneys were validated with stereology and a difference of less than 400 glomeruli was found (N = 24, N_{glom}: 13 480 ± 1 841 MRI and 13 090 ± 1 863 stereology). The quickest scan achieved that allowed the quantification was 15 minutes (~19-fold reduction compared to the rat kidneys study). At 3 T, the feasibility to image glomeruli was proven using rat kidneys but quantification was not achieved. However, qualitative imaging showing accumulation of CF in the glomeruli was achieved in ~5 minutes. In conclusion, an efficient pre-clinical tool to study glomeruli was developed. Moreover, the methods presented here are a step forward to quantify glomeruli *in vivo* which could be used for longitudinal studies. These tools are expected to aid the early diagnosis of kidney injury and possibly prevent chronic kidney disease.