COMPUTATIONAL IDENTIFICATION & 3D MORPHOLOGICAL CHARACTERIZATION OF RENAL GLOMERULI IN OPTICALLY CLEARED MURINE KIDNEYS

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Background

Characterization of glomerulus structure is of critical importance to understand the pathophysiological involvements of the kidney in renal and systemic diseases such as cardiovascular dysfunction.

The aim of our study was to establish an accessible methodology for the objective identification and three-dimensional morphological characterization of renal glomeruli in mice.

Methodology

Animal model

C57BL6/J (n = 7)
8-week-old females

Studied parameters

Global parameters
→ volume density & numeric density
→ Shape : mean surface area, volume & compacity*

Topological parameters
→ Surfaces distribution
→ Volumes distribution

*normalized volume/surface ratio whose maximal value is 1 for a sphere

Renal glomeruli imaging

Injection of a capillary fluorescent marker (DyLight649- coupled Tomato lectin)

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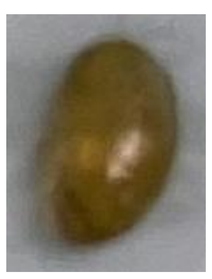
Optical clearing (iDISCO+)



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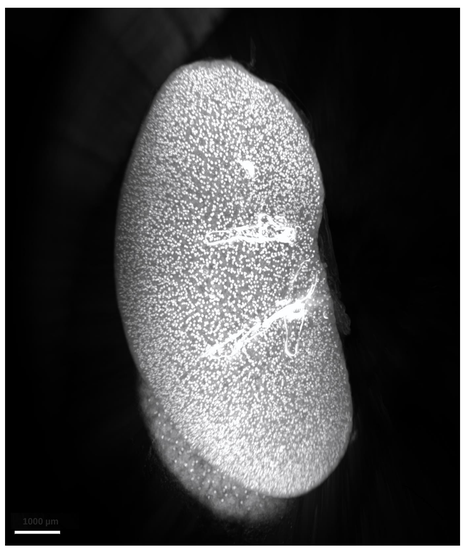
Light Sheet Microscopy



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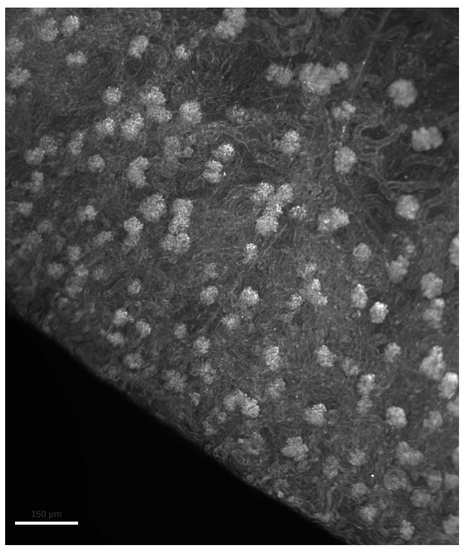

1080x1280x300 µm
Voxel size : 0.5x0.5x2 µm

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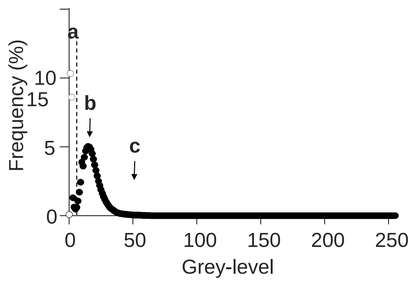
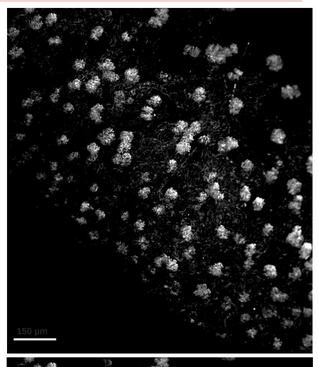
3D reconstruction (256 gray levels)

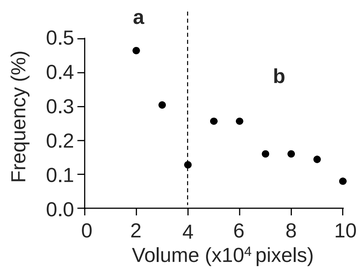
Image segmentation based on …

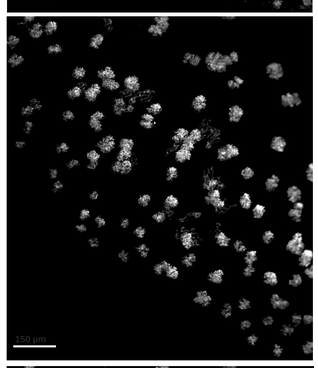
1 Grey-level distribution
(a) background
(b) renal tissue
(c) lectin-labeled objects



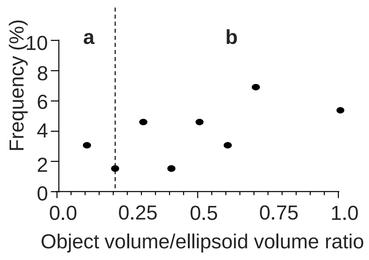


2 Volume distribution
(a) small non-glomerular objects
(b) big non-glomerular objects & renal glomeruli



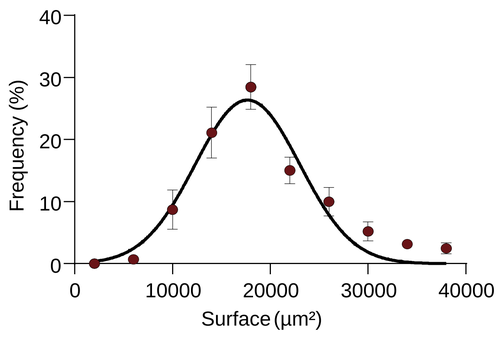


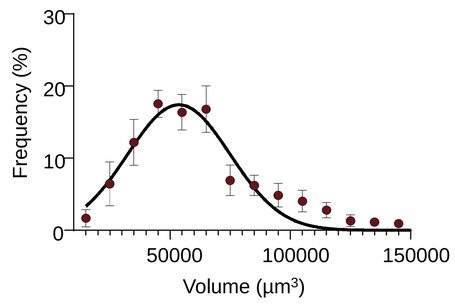
3 Shape
(a) non-glomerular objects
(b) renal glomeruli



Results

Parameter	
Volume density	1.73 ± 0.47 %
Number/mm³ of renal tissue	273 ± 41
Surface area	21,430 ± 5800 µm²
Volume	63,000 ± 13000 µm³
Compactness	0.064 ± 0.026





Conclusion

The proposed standardized methodology is easily accessible for biologists. It provides the identification of the renal glomeruli and their 3D morphological characterization and allows statistical comparison between samples. It is hence useful for the study of renal functions and dysfunctions.