Advances in Defining the Ultrastructure of the Glomerulus

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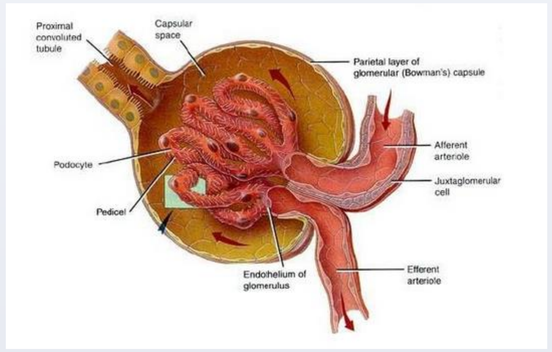
Introduction

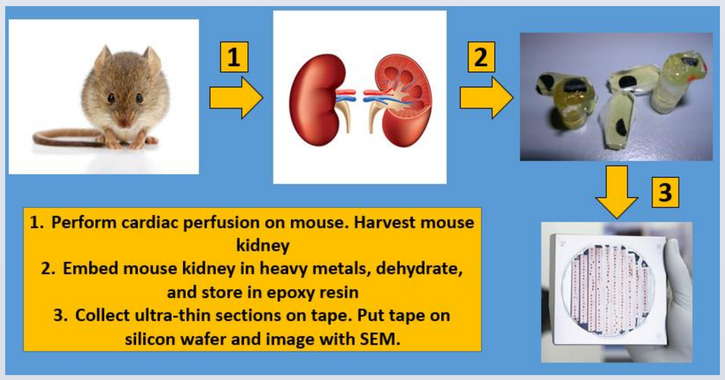
Each human kidney is composed of approximately 1 million nephrons. The initial filtration of blood occurs in the glomerulus of the nephron, and the nearby juxtaglomerular apparatus (JGA) has a central role in regulating blood pressure. Here, we use serial section electron microscopy to examine the glomerulus and JGA



The capillary network is thought to begin as a single bent loop. The glomerulus could be a single long capillary, or several parallel long loops, but rather, it is a branches network. We thought that our higher resolution data could resolve whether the network arises by intusseption, rather than sprouting and fusion. This method would avoid the creation of “short cuts”

One unexpected feature is the presence of dead ends in the glomerular capillary network. There were 5 in this glomerulus. They extend for about 3-5 microns. Thus, they are not quite large enough to accommodate an erythrocyte.

Methods



Sectioning to determine the glomerular capillary network and dead ends consisted of 160 sections each 500 nm thick

Sectioning to determine the structure of the JGA consisted of 200 sections each 500 nm thick

Sectioning to determine the ultrastructure of the glomerular capillary consisted of 160 sections each 60 nm thick

Results

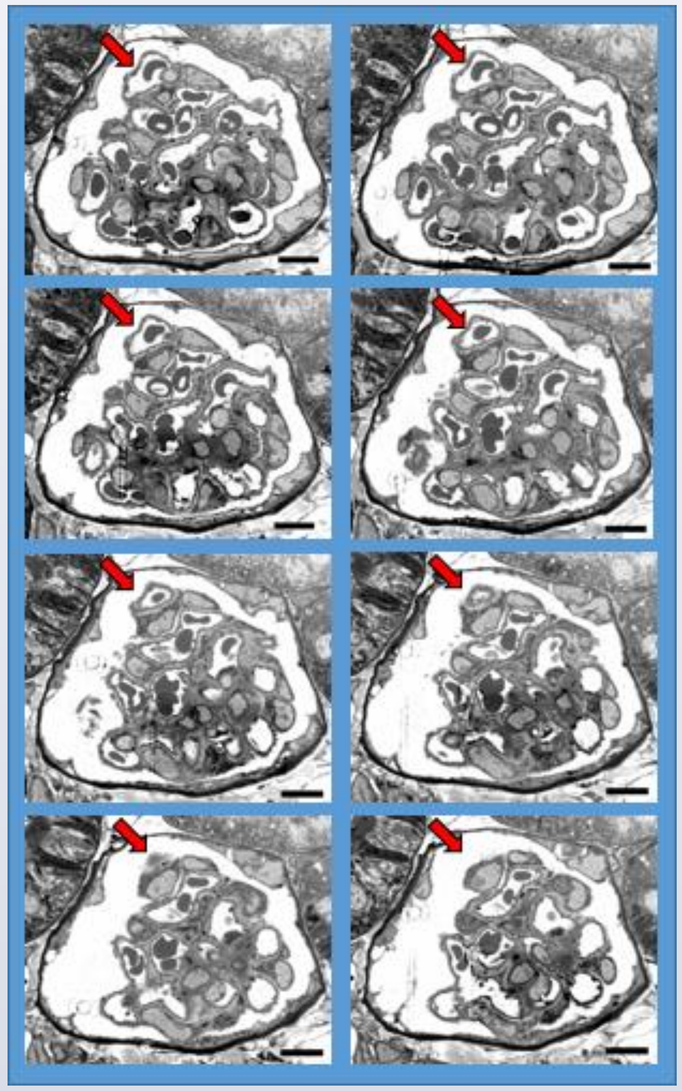
Diagram of the Glomerular Capillary Network

Diagrammatic representation of the network of glomerular capillaries. The arterioles are labeled on each end of the network. The connections are represented by dots and are numbered.

Results (cont’d)

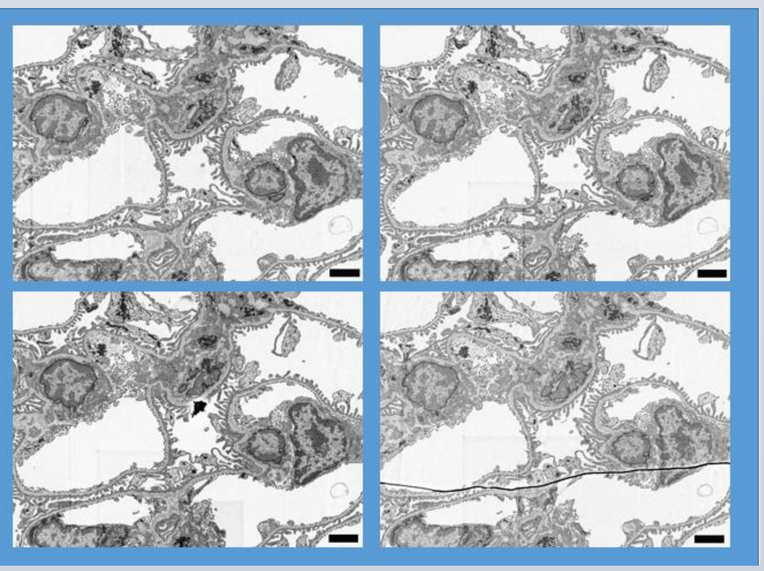
Dead Ends in the Glomerular Capillary Network

An example of a “dead end” in the glomerular capillary network The “dead end” is highlighted by the red arrow. Here, the “dead end” has disappeared within 4 microns of the original, top right photograph. The panels are read from left to right and then top to bottom. Scale bar is 12.5 microns. Sections are 500 nanometers thick.



Ultra-Thin Serial Section of the Glomerulus

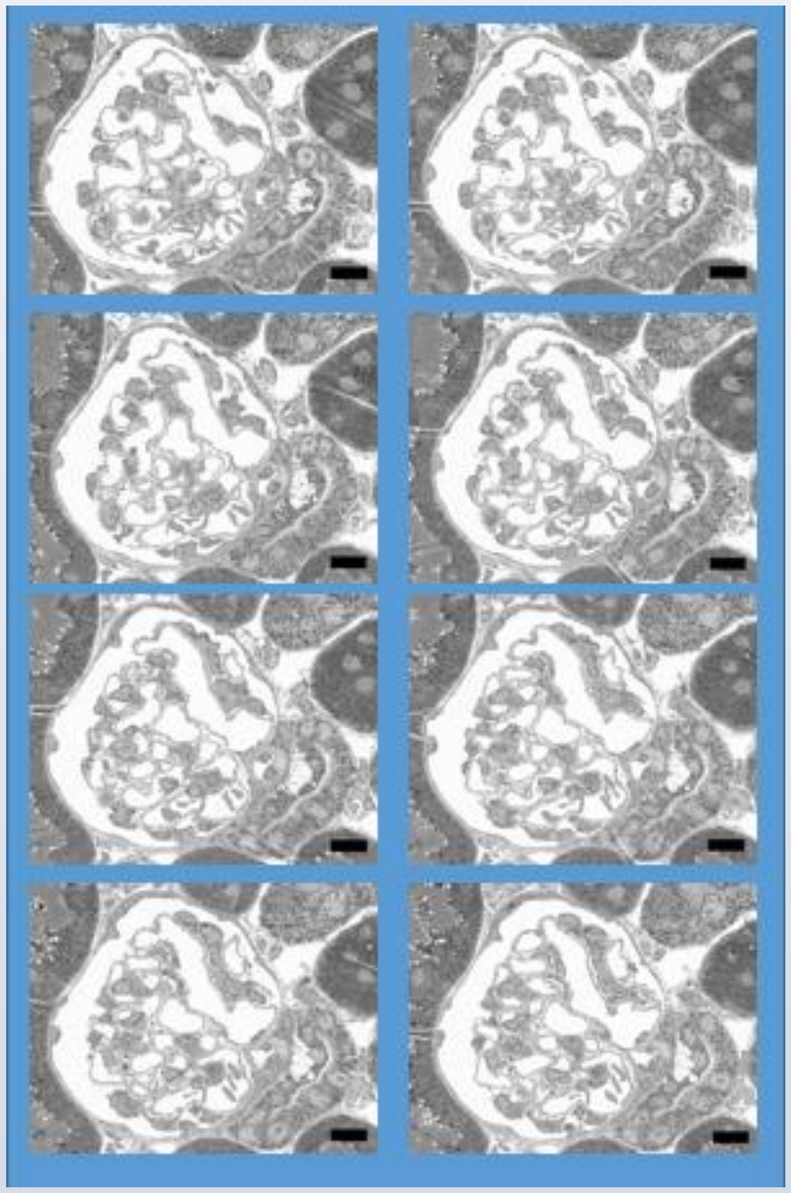
An example of an ultra-high resolution serial section through the glomerulus. The panels are read from left to right and from top down. The scale bar is 2 microns. Sections are 60 nanometers thick.



Results (cont’d)

Serial Section of the Juxtaglomerular Apparatus

A serial section of the juxtaglomerular apparatus. The afferent arteriole, distal convoluted tubule, and glomerulus can all be seen. The panels are read from left to right and then top to bottom. The scale bar is 10 microns. Sections are 500 nanometers thick.



Conclusions

It is now feasible to collect 500 nanometer sections through an entire kidney glomerulus and to reconstruct its capillary network. The capillary network contains some free ends

Future Directions

Reconstruct the juxtaglomerular apparatus

Analyze capillary flow by network theory