Electrical forces determine glomerular permeability

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The functioning of the glomerular filter is an intriguing and still only partially resolved question in the field of Nephrology. Per day, about 144 l of plasma are filtered across the glomerular filtration barrier. During this process, more than 99% of the plasma proteins are retained, yet the filter never clogs. We tested the hypothesis that extracellular electrical potential differences are generated by the flow of the filtrate across the charged glomerular filter. For this purpose, glomerular capillaries were micropunctured in Necturus maculosus, a model organism with an unusually large capillary diameter. With this setup, a potential difference was directly measured across the glomerular filtration barrier, which depended directly on glomerular filtration pressures. The potential difference was generated without temporal delay. It was negative in Bowman’s space and it was completely reversible when decreasing the perfusion pressures to baseline levels.

An independent mathematical model was created using published experimental data. The model predicted that the measured potential differences might be sufficient to significantly influence the glomerular sieving coefficient of albumin.

In summary, the new model provides a mechanistic theory on the filtration characteristics of the glomerular filtration barrier. It provides a novel (patho-) physiological explanation for the microanatomy of the glomerulus, renal autoregulation, why the filter does not clog.

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