Kidney filtration pressure as a “single effect” for osmotic gradient

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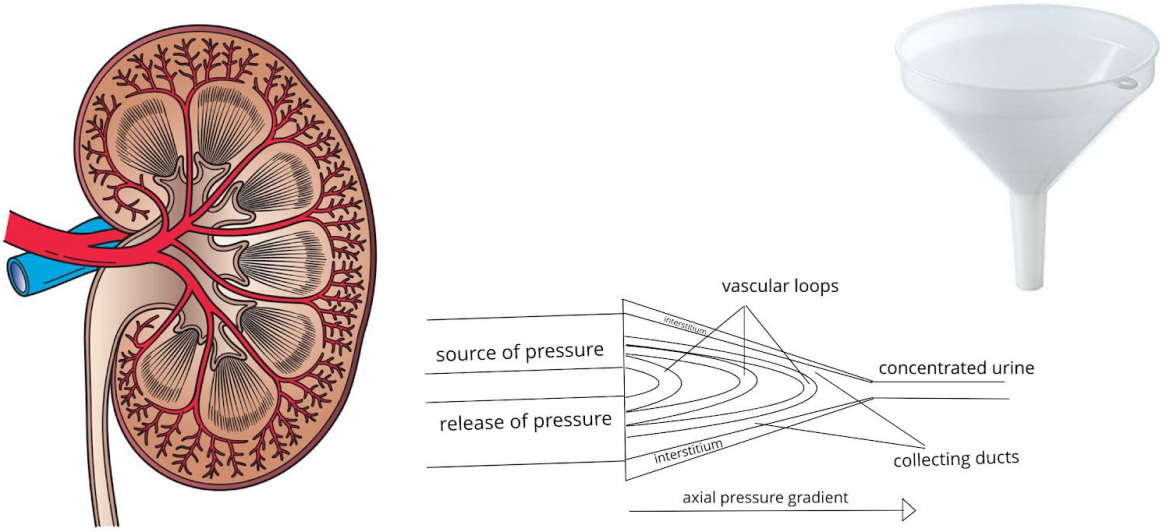
Consider the name of the renal pyramids, and that it points to them being pyramidal. This anatomy suggests the “urine compartment”, the nephrons and collecting ducts, narrows from the base of the renal pyramid (cortex) to the top (papilla), in the same way as a funnel. This anatomical arrangement likely has a role in the reabsorption of 99% of all filtrate produced per day, simply by providing resistance.

If this architecture is able to contribute to reabsorption of water, and, by that, concentration of urine, and if this concentrated urine to some extent equilibrates with the surrounding medullary interstitium, then it would provide a “single effect” for an osmotic multiplier. This multiplication effect could be called “sequential multiplication”, since each “bolus” of urine filtered contributes a “single effect” to the axial osmolarity gradient for the next “bolus”, and so forth.

This osmotic multiplier would conveniently rely only on pressure provided by the heart, an organ that invests 1/5th of its stroke volume in the kidney, and, on fascial tension within the kidney parenchyma and capsule.



In the case that the collecting duct system within the renal funnels contains smooth muscle lining the walls of the ducts, then the strength of this sequential multiplier can be regulated using vasoconstrictors and vasodilators. This could then be how the vasoconstrictor anti-diuretic hormone conserves water, by upregulating the funnel resistance and with it the osmotic gradient, and how the vasodilator furosemide has the opposite effect.