OPEN ACCESS Freely available online

Anatomy & Physiology: Current Research

Opinion Article

Aquaporins and Water Balance in Renal Physiology

Sirio Kim*

Department of Pulmonology, University of Sydney, Sydney, Australia

DESCRIPTION

Aquaporins (AQPs) are integral membrane proteins that play a pivotal role in the regulation of water transport across cellular membranes. First discovered in 1992, aquaporins have since been recognized as essential components in maintaining water homeostasis in the body. In renal physiology, aquaporins are importantly involved in water reabsorption processes, particularly within the nephron, ensuring efficient regulation of water balance. Aquaporins are small proteins that form water-selective channels in the cell membrane. Each aquaporin monomer consists of six transmembrane alpha-helices, with cytoplasmic and extracellular loops that form the water channel's selective pore. The central region of the pore contains a narrow constriction site lined with hydrophobic residues, which facilitates the selective passage of water molecules while preventing the transport of ions or other solutes. In the kidneys, aquaporins enable water reabsorption by allowing passive movement of water along osmotic gradients. This selective permeability is important for concentrating urine and maintaining the body's fluid balance. The kidney contains several types of aquaporins, each localized to specific regions of the nephron. Found in the proximal tubules and descending limb of the loop of Henle. Responsible for the bulk of water reabsorption in these segments. Aquaporin-1 (*AQP1*) channels are constitutively active, facilitating continuous water transport. Primarily located in the collecting ducts and is the only aquaporin directly regulated by Antidiuretic Hormone (ADH). Under the influence of ADH, *Aquaporin-2* (*AQP2*) is translocated to the apical membrane, increasing water permeability and enhancing reabsorption in response to dehydration. Present on the basolateral membrane of the collecting duct cells. Facilitate the movement of water from the intracellular space into the interstitial fluid and eventually into the bloodstream. ADH, triggered by increased plasma osmolality or reduced blood volume, acts primarily on *AQP2*. The osmotic gradient in the renal medulla, maintained by the countercurrent multiplication mechanism, drives water reabsorption through aquaporins. This gradient is essential for the kidneys ability to concentrate urine. Phosphorylation, ubiquitination, and other modifications of aquaporin proteins influence their activity, trafficking, and degradation.

Aquaporins are central to maintaining fluid homeostasis in the body by enabling the kidneys to reabsorb water efficiently. Approximately 180 liters of plasma is filtered daily by the kidneys, and over 99% of this water is reabsorbed, primarily due to aquaporin-mediated transport. This reabsorption ensures that the body retains sufficient water to sustain physiological processes while excreting waste products in a concentrated urine. Mutations in the *AQP2* gene or defects in ADH signaling can result in Nephrogenic Diabetes Insipidus (NDI), characterized by impaired water reabsorption and excessive water loss. Overexpression or misregulation of *AQP2* can lead to Syndrome of Inappropriate Antidiuretic Hormone Secretion (SIADH), where excessive water reabsorption causes hyponatremia and fluid overload. Altered expression of aquaporins in cystic epithelia may contribute to fluid accumulation in Polycystic Kidney Disease (PKD). In acute kidney injury or chronic kidney disease, changes in aquaporin expression may impair the kidneys' ability to regulate water balance effectively. Given their essential role in renal water handling, aquaporins are emerging as potential therapeutic targets. Drugs that enhance or inhibit *AQP2* activity could be used to treat conditions such as NDI or SIADH. Small molecules targeting specific aquaporins could help manage water retention disorders or reduce intraocular pressure in glaucoma.

CONCLUSION

Aquaporins are indispensable for maintaining water balance in the body, playing a vital role in renal physiology. Their selective permeability to water enables efficient reabsorption and urine concentration, ensuring the kidneys adapt to changing hydration needs. Aquaporins, particularly *AQP1*, *AQP2*, Aquaporin-3 (*AQP3*), and Aquaporin-4 (*AQP4*), demonstrate region-specific roles in the nephron, with *AQP2* being directly regulated by antidiuretic hormone. Dysfunction or misregulation of *aquaporins* is implicated in various kidney disorders, including nephrogenic diabetes insipidus and SIADH. Advances in molecular and pharmacological research offer potential avenues for targeting aquaporins in therapeutic interventions.

Correspondence to: Sirio Kim, Department of Pulmonology, University of Sydney, Sydney, Australia, E-mail: siriokim@gmail.com

Received: 31-Oct-2024, Manuscript No. APCR-24-35375; **Editor assigned:** 02-Nov-2024, PreQC No. APCR-24-35375 (PQ); **Reviewed:** 16-Nov-2024, QC No. APCR-24-35375; **Revised:** 23-Nov-2024, Manuscript No. APCR-24-35375 (R); **Published:** 30-Nov-2024, DOI: 10.35248/2161-0940.24.14.512

Citation: Kim S (2024). Aquaporins and Water Balance in Renal Physiology. Anat Physiol. 14:512.