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An Overview of AI Applications in Renal Pathology

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Description

Renal pathology is a branch of anatomic pathology that focuses on the diagnosis and characterisation of medical diseases of the kidneys that aren't tumours. Kidney pathologists collaborate closely with nephrologists and transplant surgeons in academic settings, who often collect diagnostic specimens by percutaneous renal biopsy. To make a definite diagnosis, the renal pathologist must synthesize data from light microscopy, electron microscopy, and immunofluorescence. The glomerulus, tubules and interstitium, vasculature, or a merger of these compartments may be affected by medical renal disorders.

Renal pathology is a branch of general pathology that defines medical and transplant kidney diseaes using light microscopy, immunofluorescence microscopy, and electron microscopy as diagnostic tools. New AI applications for renal pathology have recently become accessible, owing to successful AI implementations in digital pathology and the increased use of digital diagnostic imaging, particularly recent improvements in Whole Slide Imaging (WSI)

Kidney diseases may be related to other organ ailments since the kidneys play such a crucial part in homeostasis. When systemic dysfunctions affects renal problems, for example, the converse can happen. The clinical characteristics of most renal disorders are complex and overlapping. This might result in errors and missed diagnosis, which could lead to late diagnoses and illness progression. Furthermore, the high frequency and poor knowledge of renal diseases might make early diagnosis and intervention difficult, especially if the resources are insufficient. Artificial intelligence (AI) can assist physicians in reducing these flaws and reinforcing medication to help kidneys last longer.

An AI-assisted renal pathology research generally follows a four-stage workflow: (1) issue formulation, (2) data collection and annotation, (3) AI construction and training, and (4) data fusion and analysis. The fine-grained categorization of these globally sclerotic glomeruli as obsolescent, cemented, or vanishing may be done using AI to count the fraction of glomeruli with global glomerulosclerosis (GS). Obsolescent GS is related with normal aging, but solidified/disappearing GS is connected with hypertension-associated disease.

Specific difficulties from scientific study or clinical practise often inspire AI studies in renal pathology. Artificial intelligence (AI) is used in renal pathology investigations for two reasons. The primary goal is to assist pathologists in doing certain activities with reduced manual effort, increased efficiency, and improved results. Calculating the proportion of sclerotic glomeruli in a biopsy is a simple example. The second goal is to provide new tools for pathologists to explore situations that are unscalable or unfeasible. For example, AI can "visualize" all voxels inside a 3D volume simultaneously, using advanced 3D microscopy imaging, while the human vision is limited by understanding serial 2D sections or projections.

Artificial intelligence is becoming increasingly relevant in the field of renal pathology. These methods have the ability to change current clinical paradigms by speeding up workflow, assisting in clinical decision-making, and creating individualised treatment regimens. However, there are still significant obstacles to AI's wider use in renal pathology, such as a shortage of annotated data, difficult multi-modal data, and clinical validation. Therefore, more seamless collaboration between pathologists and engineers will leverage further advances in developing next generation AI algorithms in renal pathology, with potential for major impacts in diagnosis and understanding of kidney diseases.