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Kidney Ultrastructure by Atomic Force Microscopy Imaging Directly From Formalin Fixed-Paraffin Embedded Biopsy: Is This a Dream Come True?

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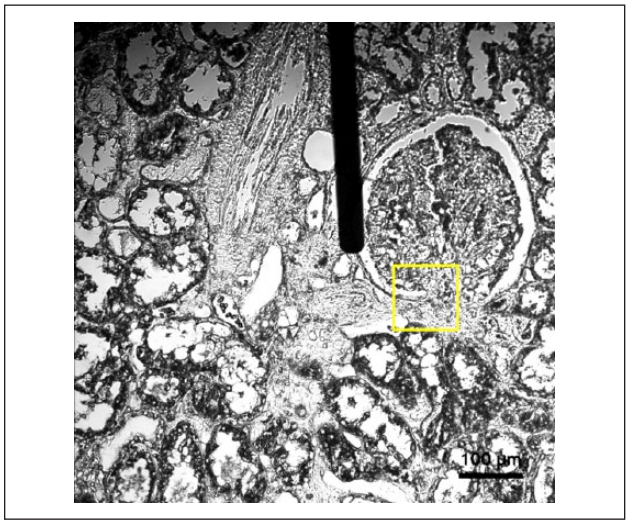

Figure 1. 20× capture of a normal renal corpuscle. The vertical black bar on the left of the renal corpuscle is the cantilever probe. Yellow square is the selected area (10 000 µm^2) for AFM scanning. Inverted optical microscope (Olympus IX70).

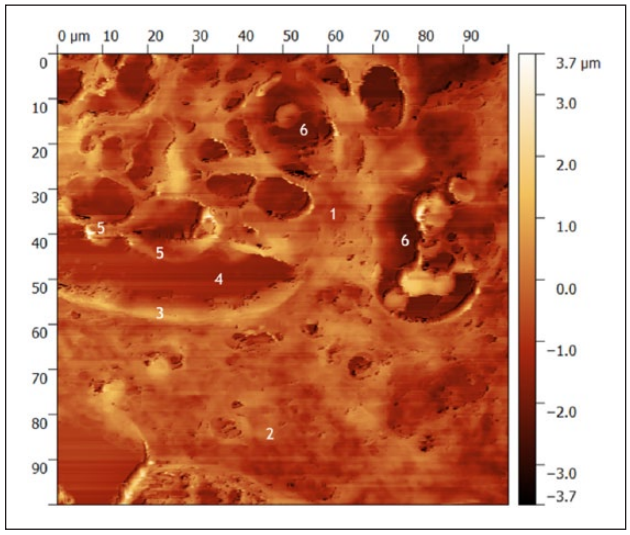

Figure 2. Topography high-resolution AFM imaging of the scanning area. It is possible to identify amazingly the renal corpuscle structures, that is, (1) intraglomerular mesangium zone, (2) juxtaglomerular apparatus zone, (3) Bowman's capsule–parietal layer, (4) Bowman's space, (5) podocytes and pedicels, (6) glomerulus with red cells on the inside. *X*- and *Y*-axes scale corresponds to the scanning area. Colored bar corresponds to depth (*Z*-axis). Technical details: high-resolution CONTACT "GOLDEN" Silicon Cantilever (NT-MDT model CSG11). AFM (Keysight Technologies model 5500 ILM).

The golden years of transmission electron microscopy in basic sciences and daily diagnostics were from 1950 to 1980. A plethora of new information about the structure of cells was coupled to and followed by biochemical, clinical, and functional studies. Immunohistochemistry, immunofluorescence, and other modern techniques in diagnostic pathology are growing; however, electron microscopy and ultrastructural studies remain pivotal in kidney pathology. Atomic force microscopy (AFM) is a powerful tool able to evaluate the structural and the mechanical properties of biological samples from the microscale to the nanoscale.[1] We consider this technique as a real possibility for fast, easy, and low-cost complementary histological diagnosis on normal or pathological renal biopsies, and it can be applied directly to uncovered/unstained small formalin fixed-paraffin embedded samples.[2] Additionally, topography AFM imaging measurements can be used for 2D/3D structural analysis or to characterize physical parameters such as roughness, linearity, depth, and so on. Figure 1 shows one normal renal corpuscle on an uncovered/unstained fixed sample. Figure 2 shows the topography AFM imaging (512 points per line, scanning rate = 0.10

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lines/s in air environment and in contact mode) of the scanning area selected in Figure 1.

Further studies are required to elucidate the diagnostic capabilities and advantages of the AFM in a clinical setting, but this technique may represent a promising and useful chapter in kidney pathology.

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