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Role of vasa recta and chemical diversity in Randall's plaque pathogenesis

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Background
Alexander Randall identified calcium phosphate plaques in renal papillae as the origin of kidney stones. However, little is known about the early steps of Randall's plaque formation, preceding the onset of urolithiasis. Our objectives were to characterize the composition and the initial formation site of incipient Randall's plaque.

Material and Methods
Fifty-four healthy papillae from kidneys removed for cancer have been analyzed by immunohistochemistry and Von Kossa staining, Field Emission-Scanning Electron Microscopy with Energy Dispersive X-ray analysis, µ-Fourier Transform Infrared Spectroscopy, Cryo-Transmission Electron Microscopy coupled to Selected-Area Electron Diffraction and Electron Energy Loss Spectroscopy.

Results
Incipient Randall's plaque has been observed in 72.7% of kidneys. Carbonated apatite was the main component of microcalcifications altogether with amorphous calcium phosphate and whitlockite. Incipient plaques stood in the deepest part of the papillae, around the loop of Henle tip but also vasa recta (respectively 62.4 % and 37.2 % of microcalcifications). Microcalcifications were often made of several nanocrystals inside organic material looking like microvesicles.

Conclusion
Incipient Randall's plaque is frequent and appears at the tip of renal papillae, around the hairpin structure of the loop of Henle and vasa recta as well. Nanoscale analyses suggest a local nucleation process promoting nanocrystal growth in a supersaturated milieu.