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Multi-stain Transformation using Generative

Adversarial Networks Highlights Glomerular Crescents

Masataka Kawai¹, Toru Odate¹, Kazunari Kasai¹, Tomohiro Inoue¹, Kunio Mochizuki¹, Naoki Ohishi¹, Tetsuo Kondo¹

¹Department of Pathology, University of Yamanashi

= Abstract =

Sections stained in periodic acid-Schiff (PAS), periodic acid-methenamine silver (PAM), hematoxylin and eosin (H&E), and Masson's trichrome (MT) stain with minimal morphological discordance are helpful for pathological diagnosis in renal biopsy. Here, we propose an artificial intelligence-based re-stainer called PPHM-GAN (PAS, PAM, H&E, and MT-generative adversarial networks) with multi-stain to multi-stain transformation capability. We trained three GAN models on 512×512-pixel patches from 26 training cases. The model with the best transformation quality was selected for each pair of stain transformations by human evaluation. Frechet inception distances and peak signal-to-noise ratio were calculated as auxiliary quality metrics. We validated the diagnostic utility using 5 120×5 120 patches of ten validation cases for major glomerular and interstitial abnormalities. 23 of 24 glomeruli (95.83%) from 9 additional validation cases transformed to PAM, PAS, or MT facilitated recognition of crescent formation. Stain transformations to PAM ($p=4.0E-11$) and transformations from H&E ($p=4.8E-9$) most improved crescent formation recognition. PPHM-GAN maximizes information from a given section by providing several stains in a virtual single-section view, and may change the staining and diagnostic strategy.

