Multimodal CT Imaging of Ischemic Stroke Thrombi Identifies Scale-Invariant Radiomic Features: A preliminary study towards predicting clot biology from pre-treatment imaging

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Abstract

Purpose: While paired analysis of ischemic stroke (IS) clot histology and pre-treatment radiomics has identified digital indicators of outcome, differences in scale limit our ability to understand clot biology from pre-treatment imaging. Radiomic analysis of resected clot microCTs has the potential to bridge this gap by identifying clot radiomics highly correlated among pre-treatment imaging modalities (CTA, nCCT) and post-treatment histopathology.

Methods: We performed multimodal CT imaging of 10 stroke clots retrieved by mechanical thrombectomy. Clots were manually segmented from co-registered, pre-treatment CTA and nCCT images. For the same cases, portions of resected clots were iodine stained, imaged with a ScanCo microCT 100 (4.9 μm resolution), and segmented using adaptive intensity thresholding. Clot radiomic texture features (RFs) (n=93 per modality, 279 total) were extracted using PyRadiomics. Correlation analysis was used to test associations between microCT and CTA (or nCCT) RFs. Statistical significance was considered $R \geq 0.65$ and $q < 0.05$.

Results: From paired RF correlation analysis, we identified 18 and 5 scale-invariant RFs significantly correlated between microCT—CTA and microCT—nCCT, respectively. Moreover, correlation of unpaired RFs between microCT and CTA (or nCCT) identified 377 positively and 36 negatively correlated RFs between microCT—CTA, and 168 positively and 41 negatively correlated RFs between microCT—nCCT. These findings suggest that specific clot RF pairs among CT imaging modalities can be used in correlation studies to relate etiology-specific histological phenomena with pre-treatment image features.

Conclusion: Multimodal CT and radiomic analysis of IS clots can help bridge the gap between pre-treatment imaging and IS pathobiology.