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Clinical Validation of Stimulated Raman Histology for Rapid Intraoperative Diagnosis of CNS Tumors

Misha Movahed-Ezazi¹, Mustafa Nasir-Moin², Camila Fang¹, Isabella Pizzillo¹, Kristyn Galbraith¹, Steven Drexler³, Olga A Krasnozhen-Ratush⁴, Seema Shroff⁵, David Zagzag⁶, Christopher William¹, Daniel Orringer², Matija Snuderl⁷

Affiliations

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Abstract

Stimulated Raman histology (SRH) is an ex-vivo optical imaging method that enables microscopic examination of fresh tissue intraoperatively. The conventional intraoperative method uses frozen section analysis, which is labor and time intensive, introduces artifacts that limit diagnostic accuracy, and consumes tissue. SRH-imaging allows rapid microscopic imaging of fresh tissue, avoids tissue loss, and enables remote telepathology review. This improves access to expert neuropathology consultation in both low- and high-resource practices. We clinically validated SRH by performing a blinded, retrospective two-arm telepathology study to clinically validate SRH for telepathology at our institution. Using surgical specimens from 47 subjects, we generated a dataset composed of 47 SRHimages and 47 matched whole slide images (WSIs) of FFPE tissue stained with H&E, with associated intraoperative clinicoradiological information and structured diagnostic questions. We compared diagnostic concordance between WSI and SRH-rendered diagnoses. Also, we compared the 1-year median turn-around-time (TAT) of intraoperative conventional neuropathology frozen sections with prospectively rendered SRH-telepathology TAT. All SRH-images were of sufficient quality for diagnostic review. A review of SRH-images showed high accuracy in distinguishing glial from non-glial tumors (96.5% SRH vs 98% WSIs) and predicting final diagnosis (85.9% SRH vs 93.1% WSIs). SRHbased diagnosis and WSI-permanent section diagnosis had high concordance (κ=0.76). The median TAT for prospectively SRH-rendered diagnosis was 3.7 minutes, approximately 10-fold shorter than median frozen section TAT (31 minutes). The SRH-imaging procedure did not affect ancillary studies. SRH generates diagnostic virtual histologic images with accuracy comparable to conventional H&Ebased methods in a rapid manner. Our study represents the largest and most rigorous clinical validation of SRH to date. It supports the feasibility of implementing SRH as a rapid method for intraoperative diagnosis complementary to conventional pathology laboratory methods.

Keywords: Stimulated Raman histology; artificial intelligence; brain tumors; frozen section; glioma; intraoperative diagnosis.

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