
Introduction of a standardized multimodality image protocol for navigation-guided surgery of suspected low-grade gliomas.


Abstract

OBJECT Surgery of suspected low-grade gliomas (LGGs) poses a special challenge for neurosurgeons due to their diffusely infiltrative growth and histopathological heterogeneity. Consequently, neuronavigation with multimodality imaging data, such as structural and metabolic data, fiber tracking, and 3D brain visualization, has been proposed to optimize surgery. However, currently no standardized protocol has been established for multimodality imaging data in modern glioma surgery. The aim of this study was therefore to define a specific protocol for multimodality imaging and navigation for suspected LGG.

METHODS Fifty-one patients who underwent surgery for a diffusely infiltrating glioma with nonsignificant contrast enhancement on MRI and available multimodality imaging data were included. In the first 40 patients with glioma, the authors retrospectively reviewed the imaging data, including structural MRI (contrast-enhanced T1-weighted, T2-weighted, and FLAIR sequences), metabolic images derived from PET, or MR spectroscopy chemical shift imaging, fiber tracking, and 3D brain surface/vessel visualization, to define standardized image settings and specific indications for each imaging modality. The feasibility and surgical relevance of this new protocol was subsequently prospectively investigated during surgery with the assistance of an advanced electromagnetic navigation system in the remaining 11 patients. Furthermore, specific surgical outcome parameters, including the extent of resection, histological analysis of the metabolic hotspot, presence of a new postoperative neurological deficit, and intraoperative accuracy of 3D brain visualization models, were assessed in each of these patients.

RESULTS After reviewing these first 40 cases of glioma, the authors defined a specific protocol with standardized image settings and specific indications that allows for optimal and simultaneous visualization of structural and metabolic data, fiber tracking, and 3D brain visualization. This new protocol was feasible and was estimated to be surgically relevant during navigation-guided surgery in all 11 patients. According to the authors' predefined surgical outcome parameters, they observed a complete resection in all resectable gliomas (n = 5) by using contour visualization with T2-weighted or FLAIR images. Additionally, tumor tissue derived from the metabolic hotspot showed the presence of malignant tissue in all WHO Grade III or IV gliomas (n = 5). Moreover, no permanent postoperative neurological deficits occurred in any of these patients, and fiber tracking and/or intraoperative monitoring were applied during surgery in the vast majority of cases (n = 10). Furthermore, the authors found a significant intraoperative topographical correlation of 3D brain surface and vessel models with gyral anatomy and superficial vessels. Finally, real-time navigation with multimodality imaging data using the advanced electromagnetic navigation system was found to be useful for precise guidance to surgical targets, such as the tumor margin or the metabolic hotspot.

CONCLUSIONS In this study, the authors defined a specific protocol for multimodality imaging data in suspected LGGs, and they propose the application of this new protocol for advanced navigation-guided procedures optimally in conjunction with continuous electromagnetic instrument tracking to optimize glioma surgery.
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