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Intraoperative variations in intra-axial brain tumor size after craniotomy: a prospective study with histopathological and tumor tissue composition correlation, introducing concepts of tumor expansion and tumor surfacing

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Abstract

Intraoperative assessment of tumor margins can be challenging; as neoplastic cells may extend beyond the margins seen on preoperative imaging. Real-time intraoperative ultrasonography (IOUS) has emerged as a valuable tool for delineating tumor boundaries during surgery. However, concerns remain regarding its ability to accurately distinguish between tumor margins, peritumoral edema, and normal brain tissue. Preoperative contrast-enhanced MRI (CEMRI) and contrast-enhanced CT (CECT) were performed to assess tumor dimensions, and IOUS was used intraoperatively to further evaluate tumor characteristics. Tumor volume was estimated using the prolate ellipsoid formula. Statistical analysis was conducted to compare tumor dimensions between imaging modalities and assess tumor expansion post-craniotomy. Our study included 51 patients with intracranial tumors. IOUS revealed larger tumor dimensions compared to preoperative CEMRI and CECT, with significant differences observed in surface area and volume. Tumors exhibited varied echogenicity on IOUS, with most showing mixed echogenicity. Histopathological analysis revealed a range of tumor grades, with gliomas being the most common. Statistical analysis indicated significant differences in tumor dimensions between imaging modalities, with tumor expansion observed post-craniotomy. Tumor type and grade were predictive factors for tumor volume expansion. Tumors exhibit expansion after craniotomy, with both tumor volume and surface area increasing. This expansion phenomenon, not solely attributed to tumor edema, underscores the importance of considering tumor mass expansion during surgical planning and intraoperative decision-making. These findings highlight the utility of IOUS in accurately delineating tumor boundaries and optimizing surgical outcomes in the management of intracranial tumors.

Keywords: Brain tumor surgery; Craniotomy; Intraoperative ultrasonography; Surgical planning optimization; Tumor expansion.

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