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TUMOR-INDUCED STROKE: DIAGNOSTIC INSIGHTS FROM NEUROIMAGING

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Abstract
Despite the widespread use of advanced radiologic imaging techniques in neurosurgical practice, the diagnosis and management of various brain tumors (BT) remain significant challenges for clinicians and healthcare systems. This is largely due to the high incidence of both primary and metastatic brain tumors, the considerable rate of unfavorable outcomes, and the substantial financial burden associated with their treatment. In addition, brain tumors may lead to serious cerebrovascular complications, including ischemic and hemorrhagic stroke, resulting from vascular compression, tumor invasion, hypercoagulability, or treatment-related effects. Early and accurate radiologic assessment plays a crucial role in detecting tumor-related stroke and guiding appropriate therapeutic strategies.
Keywords: benign tumor, malignant tumor, premalignant lesion, brain tumor, ischemic stroke, hemorrhagic stroke, neuroimaging, cranial pathology.

Relevance of the study. Brain and central nervous system (CNS) malignancies remain a major global public health challenge due to their high mortality rates, significant socioeconomic burden, limited survival outcomes, and substantial impact on patients' quality of life. In 2020, approximately 308,102 new cases of brain and CNS tumors were reported worldwide, accounting for nearly 1.6% of all newly diagnosed cancers. During the same period, these tumors were responsible for about 251,329 deaths, placing them among the leading causes of cancer-related mortality. Prognosis varies depending on geographic region and access to specialized medical care; however, survival rates remain relatively low because of the aggressive biological behavior of many tumors and the difficulties associated with early detection. In addition to direct tumor-related morbidity, brain neoplasms may lead to severe cerebrovascular complications, including ischemic and hemorrhagic stroke. Stroke associated with brain tumors may result from vascular compression, arterial or venous invasion, tumor-induced hypercoagulability, embolic phenomena, radiation-induced vasculopathy, or postoperative complications. These conditions significantly worsen neurological outcomes and increase mortality risk. Therefore, timely radiological differentiation between tumor progression and tumor-related stroke is critically important. Neuroimaging has become indispensable in the diagnosis, treatment planning, and follow-up of patients with brain tumors. This review focuses on modern computed tomography (CT) techniques widely applied in neuro-oncology, particularly non-contrast and contrast-enhanced CT, which provide valuable noninvasive information for tumor characterization and preoperative evaluation. The study also

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emphasizes diagnostic challenges, as radiologic findings such as calcifications, cystic formations, sclerosis, edema, hematomas, and infarction zones may mimic or coexist with neoplastic processes. Since the early years of Uzbekistan's independence, consistent efforts have been made to modernize the national healthcare system. The introduction of advanced radiological technologies, including multispiral computed tomography (MSCT), has significantly improved the diagnostic accuracy of intracranial pathologies. MSCT enables high-resolution assessment of brain structures and detection of tumors, hemorrhage, ischemic lesions, and postoperative complications. Nevertheless, challenges remain, particularly in the field of radiation diagnostics, where early identification of life-threatening brain tumors and tumor-related vascular complications continues to be a critical issue.

Purpose of the Study. To comprehensively evaluate the diagnostic capabilities of modern computed tomography techniques in identifying brain tumors and their associated complications, including tumor-related stroke.

Materials and Methods. The study included patients diagnosed with brain tumors who received treatment at the Oncology Dispensary of the Andijan region. Radiological evaluation was performed using CT and MRI before and after surgical intervention, as well as during follow-up examinations.

Results. Postoperative assessment of patients with glial brain tumors using CT and MRI enabled detailed visualization of cerebral structures following tumor resection and identification of reactive postoperative changes. Imaging findings after total tumor removal typically included the absence of residual tumor mass within the surgical cavity, surrounding edematous brain tissue with indistinct margins, absence of significant structural displacement, and gradual reduction of reactive changes following dehydration therapy. CT scans demonstrated postoperative scar tissue as areas of mildly increased density with clearly defined borders within cerebrospinal fluid–filled cavities. These regions did not show contrast enhancement and produced no mass effect, as evidenced by the absence of midline shift, ventricular compression, or cerebral herniation. A major objective of early postoperative imaging was the detection of residual tumor tissue to guide prognosis and further management. Residual tumor was identified in 48 patients after partial or subtotal resection and in 9 of 34 patients who underwent total tumor removal. No residual tumor was detected in 20 patients, while evaluation was limited in 5 cases due to postoperative hematoma. Contrast-enhanced CT performed within 24 hours after surgery improved visualization of residual tumor tissue. However, early postoperative MRI demonstrated increased signal intensity related to hemoglobin degradation products, complicating interpretation when contrast agents were used. Within the first three postoperative days, CT was preferred for detecting acute complications such as hemorrhage, cerebral edema, brain displacement, ischemia, hydrocephalus, and pneumocephalus, as it is less sensitive to motion artifacts and allows rapid assessment. Special attention was given to identifying acute ischemic stroke and hemorrhagic transformation, which may occur due to vascular injury, tumor compression, or postoperative thrombosis. Stereotactic cryodestruction was applied as part of combined therapy for glial tumors located in deep or functionally significant brain areas under MRI guidance in six patients. Tumor volume reduction ranged from partial (one-sixth) to complete removal. In deeply located gliomas, stereotactic biopsy ensured histological verification, while cryodestruction provided

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palliative benefit, including in glioblastoma cases. Follow-up CT and MRI examinations (3–6 months post-intervention) revealed cerebrospinal fluid cyst formation at treatment sites. Imaging also facilitated detection of necrotic areas and hemorrhagic complications. Radiation therapy was administered to 101 out of 118 operated patients as adjuvant treatment for tumor recurrence prevention or residual disease control. Dose-dependent effects were observed: no significant structural damage at 45–50 Gy; mild density reduction in isolated cases at 65–70 Gy; and varying degrees of necrosis and edema in poorly differentiated tumors. Additionally, radiation-induced vasculopathy and delayed ischemic stroke were identified in several cases during long-term follow-up. Tumor regression was more pronounced in well-differentiated neoplasms, whereas recurrence was noted within 3–12 months after therapy.

Conclusion. The integrated use of CT and MRI plays a pivotal role in the diagnosis, postoperative monitoring, and complication assessment of brain tumors. Modern neuroimaging techniques not only enable accurate tumor localization and evaluation of residual tissue but also facilitate early detection of life-threatening complications, including ischemic and hemorrhagic stroke. Early radiologic identification of tumor-related cerebrovascular events significantly improves clinical decision-making and patient outcomes.

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