Radiation Methods of Investigation (CT and MRI) In Evaluation of the Radicality of Surgical Treatment of Brain Tumors

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ABSTRACT

The detection in the last decade of an intensive growth in the development of oncological diseases of the central nervous system among the population of the Fergana Valley and Andijan region in particular cannot be considered a bad sign due to the fact that this fact rather indicates an increase in the level of early diagnosis of pathological conditions of the body, rather than any pathogenic factors, including the influence of lifestyle, ecology or heredity. The ubiquitous and financially affordable appearance of neuroimaging diagnostic rooms allows not only to detect pathology in its very inception, but also to observe its course and control its development at almost any stage, including after radical surgical treatment.

Keywords: Radiological examination, neuroimaging, tumor, radical surgery, brain tumors, osteoplastic trepanation, postoperative complications.

Detection of a primary brain tumor, its metastases, as well as the degree of response to subsequent chemoradiotherapy is impossible without the use of modern neuroimaging methods such as computed tomography (CT) and magnetic resonance imaging (MRI). Equally important is the diagnosis of complications of the early (in the first 2 days) postoperative period (hematoma, pneumocephalus, ischemic focus, edema, and dislocation) and assessment of the degree of radicalness of the performed surgical intervention [4–6]. However, the possibilities of CT and MRI in assessing the extent of the performed surgical intervention in the early postoperative period were considered only in a few works [2, 7–12].

As an example, we can cite data that in the Andijan region in 1999–2005. only one child operated on for a brain tumor underwent MRI on the third day after surgery [1]. At the same time, attempts to increase the life expectancy of patients in the postoperative period are associated with the use of new chemotherapeutic and immune drugs, as well as various types of radiation therapy. Their effective use requires objective information on the volume of tumor resection, which can currently only be obtained using CT and/or MRI in the early postoperative period [2]. Considering the above, the present work devoted to improving the effectiveness of CT and MRI in patients with brain tumors in the early postoperative period seems to be relevant. Using these modern methods of radiation diagnostics in the first 2 days after surgery on the brain, we tried to assess the amount of resection performed and, therefore, choose the most rational way to treat the patient in the postoperative period or decide on the need for repeated surgery to remove the remaining tumors. wt.

Material and methods.

Between 2010 and 2020 101 patients of the neurosurgical department of the Andijan branch of the RSCEM were examined. In 56

patients, CT and MRI were performed before and after intravenous contrast enhancement both before surgery (no more than 2 weeks) and in the first 2 days after surgery, the remaining 45 patients underwent only CT in the postoperative period. If necessary, repeated studies were carried out at a later date. CT was performed on a Somatom Smile tomograph manufactured by Siemens (Germany). The step of the tomograph table and the thickness of the selected section were 5 mm. All studies were performed in the native mode and after intravenous contrast enhancement using 50 ml of iodine-containing contrast agent Vizipak 320. At the same time, residual tumor masses were quite clearly visualized after intravenous contrast enhancement even against the background of postoperative hemorrhagic impregnation in the tumor bed and/or along the encephalotomy tract. MRI was performed on a Toshiba Opart device with a magnetic field strength of 0.5 T before and after the introduction of a paramagnetic contrast agent in the amount of 0.2 ml per 1 kg of the patient's body weight. The age of the patients ranged from 31 to 70 years.

26 tumors were localized in the left hemisphere, 30 in the right. The frontal region was affected in 12 patients, the temporal region in 20, the parietal region in 8, the occipital region in 4, the temporal parietal region in 4, the occipital-parietal region in 4, and the cerebellar hemisphere - at 4.

They underwent surgery for the removal of brain tumors - osteoplastic craniotomy in the projection of the tumor process, subtotal/total removal of the tumor.

According to the results of a histological examination of the macropreparation, 35 patients had malignant tumors (glioblastomas - in 16, anaplastic astrocytomas - in 10, metastases - in 9) and 21 patients had benign tumors (meningiomas - in 12, astrocytomas - in 5, oligodendrogliomas - in 2, teratoma - in 1, hemangioblastoma - in 1).

Results.

In this paper, we deliberately do not dwell on the possibilities and comparative assessment of CT and MRI in identifying such complications of the early postoperative period as hematoma, hygroma, hemorrhage, focusing on their ability to determine the presence and size of a residual tumor, depending on postoperative changes in the bed of the removed tumors. In all 56 patients, during the preoperative examination of the tumor, a contrast agent was accumulated to one degree or another. According to surgical intervention, total tumor resection was performed in 32 patients, subtotal resection in 18, partial resection in 6, and according to neuroimaging methods, in 30, 16, and 10 patients, respectively. On CT, in 26 (87%) of 30 patients, the absence of tumor masses was clearly noted, and in 4, the results of the study were questionable due to the presence of severe postoperative edema. MRI in all cases clearly proved the radical nature of the surgical intervention performed. As a result of a comprehensive assessment (data of surgery, CT and MRI), residual tumor masses were determined in 26 (46%) of 56 patients. When performing CT in 4 (15%) patients against the background of postoperative edema, they were not visualized, in 4 (15%) the results of the study were doubtful (in one case - against the background of postoperative edema, in the other - against the background of hemorrhage) and in 18 (70%) %) were determined quite clearly. On MRI, in 6 (23%) patients against the background of hemorrhage, the residual tumor was not visible, and in 20 (77%) patients it was visualized. Only in 2 (8%) of 26 patients with subtotal tumor resection according to surgical data, using CT and MRI, it was impossible to detect residual tumor masses against the background of postoperative hemorrhage. On the other hand, in 2 patients with total tumor resection (according to intraoperative revision data), MRI was able to detect residual tumor masses (false-negative results were obtained on CT). In another 8 patients with subtotal resection (according to intraoperative revision) of glioblastoma and anaplastic astrocytoma, only partial resection of the tumor was detected on the basis of CT and MRI data. In 4 patients, subtotally removed tumor masses (according to intraoperative revision data) were visualized only on CT and were not visible on MRI against the background of postoperative hemorrhage.

In general, in 42 (75%) of 56 patients, CT and MRI data in the early postoperative period completely coincided. At the same time, in 26 (46%) cases, both methods confirmed the radical nature of the performed surgical intervention, and in 16 (29%) cases, they were able to confidently visualize residual tumor masses based on the presence of foci of intense accumulation of the contrast agent in the form of clumps or nodules located as a rule, in the deep parts of the bed of the removed tumor. In 4 (15%) of 26 patients, CT revealed residual tumor masses against the background of hemorrhage in the area of surgical intervention, while MRI in these patients before and after intravenous contrast enhancement showed convincing data confirming their presence against the background of postoperative hemorrhage, was not received. In 6 (11%) patients in the early postoperative period, native CT in the area surrounding the tumor bed revealed massive edema, which raised the suspicion of the presence of residual tumor masses, and in 4 (7%) patients, even against the background of a slight postoperative edema, such data were not obtained. . In 10 (18%) patients after intravenous contrast enhancement, there were no convincing data on the presence of accumulation foci (residual tumor masses) in them. During MRI of these patients in the surgical area against the background of postoperative edema, 4 showed an increase in the MR signal after intravenous contrast enhancement on T1 weighted images (WI), which indicated the presence of residual masses, and 4 did not receive such data, although 2 of the tumor was removed subtotally. In 12 (21%) of 56 patients, discrepancies were noted between the intraoperative assessment of the degree of radicalness of the performed surgical intervention and CT or MRI data. In a comprehensive assessment of these neuroimaging methods, in 6 (11%) of 56 patients, their results coincided with intraoperative data, and in 6 (11%) of 56 patients, the results of CT and/or MRI made it possible to clarify the extent of the surgical intervention performed

Discussion.

The assessment of the radical nature of surgical treatment of brain tumors, despite the introduction of highly informative and minimally invasive research methods into clinical practice, continues to be an urgent problem in neurosurgery. The use of CT and MRI significantly improved not only the recognition of residual masses of brain tumors, but also made it possible to identify them against the background of postoperative edema and/or areas of hemorrhage. At the same time, today we are talking not just about diagnosis, but about the possible early recognition of non-radically removed brain tumors. Early diagnosis using a complex of radiation methods of research contributes to the improvement of the results of treatment of patients with brain tumors. At present, no one has any doubts that if residual masses of a brain tumor are suspected, CT and/or MRI with contrast enhancement should be performed. The data obtained using CT and MRI, as a rule, are sufficient to assess the volume of the surgical intervention performed [13]. In 1995, the International Society of Pediatric Oncologists (SIOP) adopted the recommendations of the Committee on Tumors of the Central Nervous System (CNS) in the study of children with CNS tumors [14]. These recommendations, among other things, include criteria for determining the scope of surgical intervention using neuroimaging research methods performed in the early postoperative period. It was noted that CT scan may be insufficient for diagnosing tumors located in the brain stem and posterior cranial fossa. Therefore, in such cases, it is mandatory to conduct an MRI of the brain in 3 projections, including T1 and T2WI without contrast enhancement and T1WI with paramagnetic contrast. During the preoperative examination, two sizes of the tumor should be measured on tomograms, the first of which is selected on the image where the tumor has the maximum size, and the second is perpendicular to the first on the same section. In case of uneven tumor growth, the second diameter can be chosen on another section, where it will be larger. It is important to record this for subsequent control studies, otherwise it will be extremely difficult

to assess the dynamics of the process. It should be emphasized that diagnostic CT and/or MRI should be performed no more than 10–14 days before surgery so that the neurosurgeon has reliable information about the tumor process in the CNS and can adequately plan the scope of the operation. Postoperative examination (CT and/or MRI with contrast enhancement) must be carried out no later than the 3rd day after the operation. This is explained by the fact that the consequences of a violation of the blood-brain barrier, as well as a barrier between normal brain tissue and a tumor in the form of hemorrhages, edema and other postoperative changes, can distort the data of a neuroradiological examination performed more than 3-5 days after surgery and make it difficult to adequately assess [7, 8]. At present, there have been isolated works [9–12] on the possibilities of MRI in visualizing tumor remnants, as well as on a comparative assessment of the possibilities of CT and MRI in resolving this issue [3]. In MRI performed on the 1st day after surgery, a 44% increase in the signal from methemoglobin made it difficult to interpret the data obtained. In 79% of cases, it was possible to detect contrasting of residual tumor masses, and in 12% - linear contrasting along the edge of the surgical wound due to postoperative changes [3]. G.E. Trufanov et al. [11] revealed a linear accumulation of the contrast agent associated with postoperative changes in 64% of cases, which made it difficult to detect residual tumor masses. In [2], it was indicated that CT performed on the 1st day after surgery revealed tumor remnants in 32% of cases, and MRI, in 84%. With CT, the absence of contrast was noted in 43%, the results were uninformative in 24% of cases, with MRI - in 11 and 5%, respectively. Difficulties for CT were presented by cases with blood clots and air accumulations located near the edges of the surgical wound, for MRI - with the presence of areas of linear enhancement along the resection edges. In no case did the emerging methemoglobin impede the interpretation of MRI data. There is a point of view [12, 15] that using CT and MRI, even with the use of contrast enhancement, it is impossible to distinguish between early postoperative changes and residual tumor masses. According to A.K. Gnekow [14], the surgical assessment of the volume of the operation should be carried out according to the data of the surgical intervention using the following criteria: S1 - complete removal, no residual tumor; S2 - the volume of the residual tumor on tomograms is no more than 1.5 cm2, local invasion is possible; S3 – volume of residual tumor on tomograms more than 1.5 cm2; S4 - large residual tumor (scope of operation - biopsy). Estimation of the volume of surgery using early CT and/or MRI should be carried out according to the following criteria: R1 - no signs of a tumor on CT/MRI performed with contrast enhancement, the volume of resection is total; R2 - marginal accumulation of a contrast agent (only at the site of surgery); R3 - the residual tumor is determined, while two sizes are indicated; R4 - no changes compared to preoperative studies. Determining the volume of tumor resection should be based on an assessment of the results of the operation (the protocol of the operation with the surgeon's assessment of the volume of tumor removal - position S) and CT / MRI data performed in the early postoperative period (position R). Depending on the combination of different values of the positions S and R, four criteria can be distinguished: S1 and R1 - total removal of the tumor; S2 and R1–2, subtotal removal; S1-3 and R3 - partial removal; S4 and R4, tumor biopsy [14]. I.N. Pronin [2] suggests that in the absence of contrast enhancement, consider that the tumor is removed completely, and evaluate the remaining tumor masses as a percentage of the volume of the primary tumor. Residual masses, constituting 10-15% of the primary tumor, are subtotal removal, more than 15% - partial. We also used these criteria, as they offer an assessment of the radicalness of the performed surgical intervention, taking into account the size of the primary tumor. In our observations, according to the results of surgical intervention, total removal of the tumor was performed in 32 patients, subtotal – in 18, partial – in 6, according to neuroimaging methods – in 30, 16, and 10 patients, respectively (see Table 2). According to the results of CT and MRI in 6 (11%) of 56 patients, it was possible to clarify the degree of

radicalness of the performed surgical intervention compared with intraoperative data, and in 2 patients (with melanoma and anaplastic astrocytoma), tumor masses were not diagnosed with their subtotal removal by neuroimaging methods. Based on the results of our studies, it can be assumed that the volume of the resection performed is best assessed on the basis of MRI data, since in case of edema and ischemia on the background of an operating injury, the residual masses of the tumor are visualized more clearly. In our studies, in 12 (21%) of 56 patients, the results of CT were doubtful - in 6 of them, a massive edema was detected in the area surrounding the tumor bed, which aroused the suspicion of the presence of residual tumor masses. In 4 patients, even against the background of a slight postoperative edema, such data were not obtained. In another 2 cases, tumor masses were not visualized against the background of hemorrhage during CT scan. In all 12 observations after intravenous contrast enhancement, no convincing data were obtained on the presence of accumulation foci (residual tumor masses). During MRI of these patients against the background of postoperative edema, 8 patients showed an increase in the MR signal after intravenous contrast enhancement on T1WI (including 4 patients with no data on residual tumor masses on CT), which indicated the presence of residual tumor masses, and 4 did not receive such data. On the other hand, when detecting residual tumor masses against the background of postoperative hematoma, the use of CT with intravenous contrast enhancement is even more preferable, although there are works [16] that indicate that tumors can be poorly differentiated against the background of hemorrhages on CT. So, in 4 of our patients, CT revealed residual tumor masses against the background of hemorrhage in the area of surgical intervention, while MRI in these patients before and after intravenous contrast enhancement did not provide convincing data on their presence against the background of postoperative hemorrhage. Thus, the degree of radicalness of the surgical intervention performed using CT was clarified in 22 (79%) of 28 patients. The combined use of these methods made it possible to establish the correct diagnosis in 27 (96%) of 28 cases.

Conclusions:

1. In case of edema and ischemia of the perifocal brain tissue, the volume of the resection performed is best assessed on the basis of MRI data, since the residual tumor masses are visualized more clearly.
2. To detect residual tumor masses against the background of postoperative hemorrhage, it is preferable to use CT with intravenous contrast enhancement.
3. According to the results of CT and MRI in 11% of patients, it is possible to clarify the degree of radicalness of the performed surgical intervention in comparison with intraoperative data.
4. The accuracy of CT in determining the degree of radicalness of the performed surgical intervention is 79%, and MRI is 96%. The combined use of these methods made it possible to establish the correct diagnosis in 96% of cases.

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