Burdenko's Journal of Neurosurgery
2025, No. 2, pp. 14–22
https://doi.org/10.17116/neiro20258902114

Microsurgical resection of dominant hemisphere gliomas with intraoperative speech mapping by a staff neurologist

© A.V. SEMENOV[1], K.A. RUMYANTSEVA[1], M.E. EROSHENKO[1], V.V. EGORENKOV[1], V.M. MOISEENKO[1], M.V. SINKIN[2, 3]

[1]Napalkov Saint-Petersburg Clinical Scientific Practical Center for Specialized Medical Care, Saint-Petersburg, Russia;
[2]Sklifosovsky Research Institute for Emergency Care, Moscow, Russia;
[3]Pirogov Russian National Research Medical University, Moscow, Russia

ABSTRACT
Intraoperative awakening with speech mapping is used to minimize the risk of irreparable neurological deficit in patients with tumors located near speech zones. However, the lack of staff neurolinguist or neuropsychologist in the majority of neurosurgical departments is one of the limiting factors.
Objective. To analyze surgical treatment of patients with glial tumors near speech and motor centers using intraoperative awakening with speech mapping by staff neurologist.
Material and methods. We analyzed postoperative outcomes in 15 patients with dominant hemisphere gliomas of functionally significant areas between 2020 and 2024. All surgeries were accompanied by multimodal neurophysiological monitoring including intraoperative awakening and mapping by staff neurologist without neuropsychologist or neurolinguist. Intraoperative contrast-enhanced MRI was performed in 3 (20.0%) patients (T2WI and T1WI). Postoperative MRI was performed on the first postoperative day in all patients for objective assessment of resection quality.
Results. Total resection was achieved in 13 (86.7%) cases, subtotal — in 2 (13.3%) cases. In 11 (73.3%) patients, no postoperative neurological deficit was detected. Three (20.0%) patients had transient speech impairment with regression throughout a month. Persistent deficit developed in 1 (6.7%) patient.
Conclusion. Standardized speech mapping methods and staff neurologist for cortical mapping during resection of gliomas near functionally significant speech zones maintain high extent of resection without higher risk of permanent speech disorders. Widespread speech mapping by staff neurologists of neurosurgical departments will increase the number of function-preserving surgeries in all regions of the Russian Federation.

Keywords: *intraoperative awakening, brain tumors, functionally significant zones, intraoperative magnetic resonance imaging, speech paradigm.*

INFORMATION ABOUT THE AUTHORS:
Semenov A.V. — https://orcid.org/0009-0000-4940-1639
Rumyantseva K.A. — https://orcid.org/0000-0002-3963-2393
Eroshenko M.E. — https://orcid.org/0000-0002-8832-4872
Egorenkov V.V. — https://orcid.org/0000-0002-3473-2053
Moiseenko V.M. — https://orcid.org/0000-0003-4807-7915
Sinkin M.V. — https://orcid.org/0000-0001-5026-0060
Corresponding author: Rumyantseva K.A. — e-mail: rumiantsevaks@gmail.com

TO CITE THIS ARTICLE:
Semenov AV, Rumyantseva KA, Eroshenko ME, Egorenkov VV, Moiseenko VM, Sinkin MV. Microsurgical resection of dominant hemisphere gliomas with intraoperative speech mapping by a staff neurologist. *Burdenko's Journal of Neurosurgery*. 2025;89(2):14–22. (In Russ.).
https://doi.org/10.17116/neiro20258902114

Introduction

Surgical treatment of gliomas adjacent to speech and/or motor zone is associated with high risk of appearance or progression of neurological symptoms.

Intraoperative monitoring (IOM) of speech functions requires awakening the patient for assessment of speech changes following direct cortical and subcortical stimulation [1]. Direct cortical stimulation is the "gold standard" for verifying any functional zones [2]. Functional MRI (fMRI) in neuronavigation system does not guarantee accurate indication of functionally significant areas of the brain due to possible intraoperative brainshift. Therefore, these results cannot be used as the sole justification for extent of resection [3].

The traditional approach in large federal research centers in the Russian Federation is involvement of speech analysis specialist in mapping, usually neurolinguist or neu-

ropsychologist. However, such a specialist is not available according to staffing standards for neurosurgery departments in hospitals level 2 and 3. This often complicates intraoperative speech mapping even if tumor is localized near speech centers. In addition, there is no a single protocol for neurophysiological support in the operating theater in the Russian Federation, and IOM modalities depend only on decision of surgical team.

The purpose of the study was to analyze surgical treatment of patients with glial tumors near speech and motor centers using intraoperative awakening with speech mapping by staff neurologist.

Material and methods

Characteristics of patients

Fifteen patients underwent surgical intervention with asleep-awake-asleep protocol of intraoperative awakening between 2020 and 2024. The study group included patients with glial tumors of functionally significant areas of dominant brain hemisphere (9 (60.0%) men and 6 (40.0%) women). In all cases, neoplasms were localized in projection of the left frontal and/or temporal/insular lobes within 10 mm from functionally significant areas (Broca's area, Wernicke's area, arcuate fasciculus). Patients with severe baseline impairment of speech function (naming less than 50% of relevant tasks), low level of contact, psychologically unprepared for intraoperative awakening, as well as pediatric patients were not subject to intraoperative speech mapping.

The median age of patients was 40 years (29—58 years). The summarized data are presented in **Table**. Satisfactory results of interventions implied no persistent neurological deficit and significant speech disorders. Transient speech disorders that arose after surgery and regressed within 24 hours were not assessed as significant. We did not include these events in the group of patients with postoperative deficit. Aphasia that was not detected at follow-up examination after a month was recorded as transient.

Ethical standards

The authors confirm that the rights of people participating in the study have been observed, including in-

Characteristics of patients

No.	Gender	Age	Grade	Localization (lobe)	Extent of resection	Positive mapping	Postoperative deficit	Persistent deficit
1	F	41	LGG	Left temporal	Total	Paraphasia	No deficit	No deficit
2	M	34	HGG	Left frontal	Total	—	Transient motor aphasia	No deficit
3	M	32	HGG	Left insular, temporal	Total	Stopping speech, slurred speech	Motor aphasia (stroke) with subsequent partial regression	Motor aphasia
4	F	39	HGG	Left frontal	Total	Paraphasia	No deficit	No deficit
5	M	40	LGG	Left frontal and temporal	Total	Stopping speech	Transient motor aphasia	No deficit
6	F	29	LGG	Left frontal	Subtotal	Stopping speech	No deficit	No deficit
7	M	63	HGG	Left frontal, insular, temporal	Subtotal	Paraphasia, stopping speech	Transient aphasia and hemiparesis with regression	No deficit
8	M	42	LGG	Left frontal and temporal	Total	Stopping speech	No deficit	No deficit
9	M	38	HGG	Left frontal	Total	Slurred speech	No deficit	No deficit
10	M	43	HGG	Left frontal	Total	Slurred speech	No deficit	No deficit
11	F	36	LGG	Left frontal and temporal	Total	Paraphasia	No deficit	No deficit
12	F	51	LGG	Left frontal	Total	Slurred speech	No deficit	No deficit
13	M	33	LGG	Left frontal	Total	Stopping speech	No deficit	No deficit
14	F	49	HGG	Left frontal and temporal	Total	Slurred speech	No deficit	No deficit
15	M	58	HGG	Left frontal and temporal	Total	Stopping speech	No deficit	No deficit

Note. M — male; F — female; LGG — low-grade glioma; HGG — high-grade glioma.

formed consent where necessary. The rules for handling animals were observed when they were used in the study.

Preoperative management

All patients underwent preoperative contrast-enhanced MRI of the brain and MR tractography with reconstruction of arcuate fasciculus and corticospinal tract (Brain Lab workstation, Germany). Arcuate fasciculus was chosen as the main one, since it was verified after MR tractography in all patients. The template for its visualization was incorporated into the BrainLab software package for processing of diffusion-weighted images. Pre- and postoperative linguistic testing was carried out taking into account localization of lesion. We used the battery of tests for naming objects and/or actions developed at the Center for Language and Brain of the National Research University "Higher School of Economics" [4].

Appropriate test tasks were selected depending on localization of lesion: naming of actions (verbs) for Broca's area, naming of objects and completion of sentences for Wernicke's area, repetition of phrases and free conversation for arcuate fasciculus. To differentiate anomia and episodes of speech arrest, the patient said "this"/"here" before naming an object/action [5].

Preoperative speech testing was carried out in all patients twice. We excluded the tasks that were interpreted incorrectly or caused pronunciation difficulties.

Surgical stage

All interventions were performed using a Carl Zeiss OPMI Pentero 900 surgical microscope with a fluorescent module, BrainLab neuronavigation station and Nicolet Viking Select/Inomed ISIS neurophysiological monitoring system. Two hours before surgery, patients received 5-ALA (Alasens) 20 mg/kg orally. Induction of anesthesia with propofol, fentanyl and clonidine was followed by orotracheal intubation. After surgical access and locoregional anesthesia with ropivacaine, opening of dura mater, we removed endotracheal tube. The patient was awakened for subsequent motor cortex mapping (depending on localization of lesion).

Mapping methods

Four (26.6%) patients with large gliomas near speech zones and motor cortex additionally underwent multimodal neurophysiological monitoring at different stages including transcranial electrical stimulation (at the asleep stages), direct stimulation of motor cortex (Medtronic monopolar stimulator, cathodal stimulation in bursts of five stimuli with stimulation frequency 0.5—2 Hz and strength 5—25 mA), subcortical mapping (with gradual decrease in current strength from 10 mA until motor responses at 2—3 mA) and recording of somatosensory evoked potentials (SSEPs).

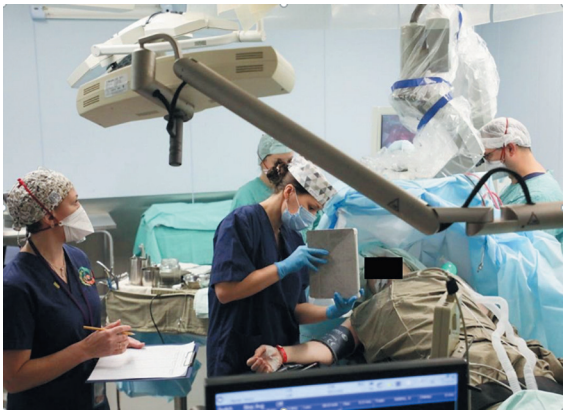


Fig. 1. **Speech function testing following resection of the left frontal lobe tumor.**
Operating team is presented. Neurologist presents the patient with test tasks on the tablet and evaluates correctness of pronunciation. Anesthesiologist keeps the mapping protocol.

Speech function testing

After awaking the patient with available speech contact, we performed speech cortex mapping using Medtronic bipolar stimulator in projection of Broca's and Wernicke's areas, as well as arcuate fasciculus (using monopolar Raabe probe-aspirator or loop electrode on the aspirator) with the following parameters: biphasic square pulses with duration 1—1.25 ms in 4-s bursts, strength 2—5 mA (start with 2 mA, mean 2.5 mA, max 5 mA) and frequency 50 Hz. Electrocorticography (EcoG) was not performed due to no technical capability.

Cortical stimulation points were established at a distance of about 1 cm from each other. To achieve maximum reliability, we performed stimulation at each point 3 times, but not in a row [6]. Speech impairment signs following stimulation were slowing down or stopping of speech, paraphasia (literal with replacement of sounds/letters and verbal with replacement of words), slurred speech, perseverations. Functional speech zone within stimulation site implied inability to perform 2 out of 3 attempts of one task [7]. Corticotomy was performed outside these zones.

To demonstrate images for speech function testing, a tablet with loaded images was used. Images changed every 4 seconds **(Fig. 1)**. To synchronize stimulation with stimulus, image change was accompanied by sound signal. At this moment, neurosurgeon changed cortical stimulation point. During testing, neurologist announced the result as briefly and clearly as possible for the operating team: "correct", "error", "speech arrest". The mapping protocol was kept by anesthesiologist on a special form.

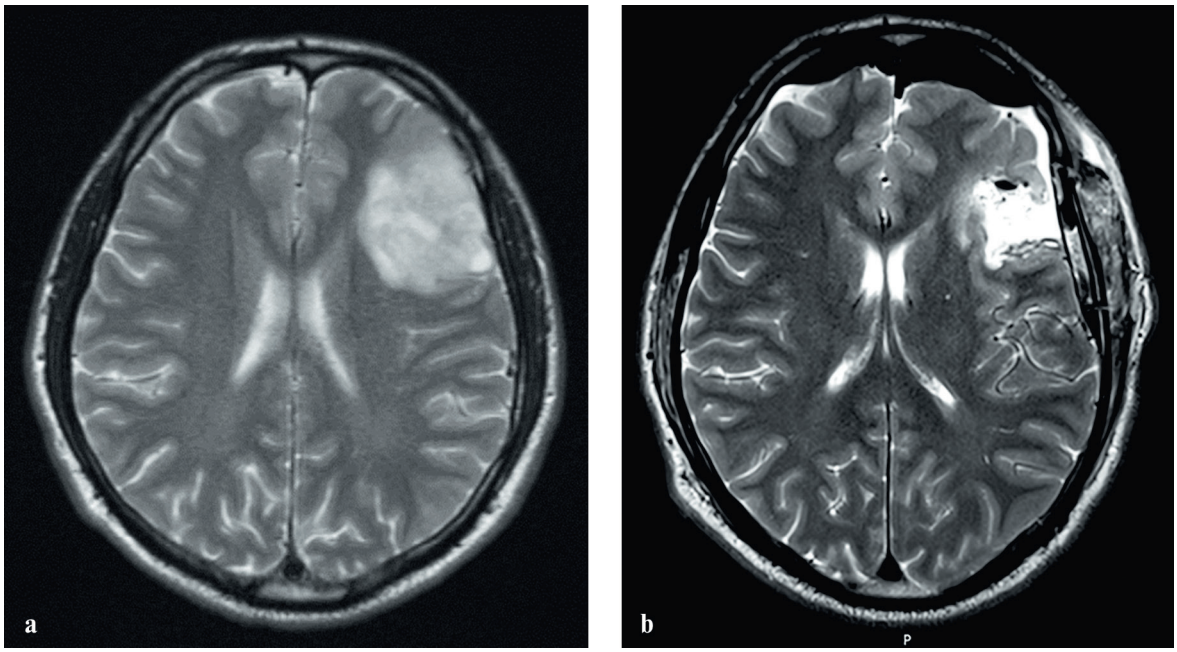


Fig. 2. **Total resection with intraoperative awakening in patient #9 with grade III glioma of the left frontal lobe.**
a — preoperative axial T2WI; b — postoperative axial T2WI on the 1st day after surgery.

In most cases (14 (93.3%) patients), we successfully identified functionally significant areas of speech after cortical stimulation. The last ones manifested themselves as episodes of paraphasia (verbal and literal), arrest or slurred speech. One patient developed focal seizure in contralateral facial muscles during cortical stimulation (stopped by irrigating the cortex with Ringer's solution).

After localizing the speech and/or motor zones, we resected tumor with continuous verbal contact and periodic performance of tests. At this time, we performed subcortical monopolar cathodic stimulation using a Raabe aspirator with the same parameters as for cortical stimulation with decrease in current from 5 to 3 mA. Resection was stopped when speech disorders appeared at free conversation and stimulation strength 3 mA. After tumor resection, patients were immersed in anesthesia until the end of surgery. If necessary, further monitoring for motor function mapping was performed according to the above-described protocol.

Evaluation of resection quality

Postoperative contrast-enhanced MRI of the brain was performed in all patients on the 1st day after surgery for assessing the extent of resection **(Fig. 2)**. Intraoperative contrast-enhanced MRI in T2- and T1-weighted mode was performed in 3 (20.0%) patients for objective assessment of resection quality. Intraoperative MRI is reasonable for real-time assessing the extent of resection with trivial prolongation of surgery.

Results

Satisfactory results were achieved in 14 (93%) patients. There was total (86.7%) or subtotal (13.3%) resection. Total resection was not performed in 2 cases (13.3%) due to intraoperative detection of functionally significant zones in resection area.

Diffuse astrocytoma grade III IDH (+) was detected in 4 patients (26.6%), glioblastoma grade IV — in 4 (26.7%), oligodendroglioma grade II, IDH (+), codeletion 1p/19q (+) — in 5 (33.4%), diffuse astrocytoma grade II IDH (+) — in 2 (13.3%) cases.

There was no postoperative speech impairment in 11 cases (73.3%). Transient deterioration was observed in 3 (20.0%) patients. Two (13.3%) patients had literal paraphasia for several days with subsequent regression of these disorders. One (6.7%) bilingual patient with diffuse astrocytoma grade III IDH (+) developed severe anomia in both languages during corticotomy due to lesion of a large draining vein. This prevented intraoperative speech testing. Postoperative MRI of the brain revealed ischemic zone in the left frontal lobe. One month after surgery, elements of motor aphasia in native language persisted, while Russian language and writing were not fully restored.

Discussion

Identification and preservation of verbal centers and speech pathways improve social adaptation of patients after resection of supratentorial gliomas [8].

Multimodal neurophysiological monitoring including various protocols for mapping the speech, motor and sensory cortex under intraoperative awakening became widespread in surgery for tumors of functionally significant zones [9].

Despite widespread awake craniotomy, there is still no single protocol for intraoperative neurophysiological speech monitoring. At baseline, neurolinguistic testing was used in epilepsy surgery. Later, this approach became widespread in onco-neurosurgery [10].

According to methodological manuals for cerebral cortex mapping, speech specialist (neuropsychologist or neurolinguist) should prepare tasks and perform testing [11]. In most original studies devoted to resection of tumors in functional zones, the authors do not specify what specialist conducted intraoperative speech function testing.

There are Russian-language studies devoted to intraoperative mapping of speech zones [12]. However, there are still no clinical recommendations and standards for this modality of neurophysiological monitoring.

There is an extensive experience in participation of neurolinguist and neuropsychologist in intraoperative speech testing in the Russian Federation. According to the Burdenko Neurosurgery Center data, unfavorable outcomes after awake craniotomies were noted in 6% of cases (deterioration or appearance of neurological deficit). These disorders were associated with ischemic damage to internal capsule and lenticulostriate arteries [13]. Favorable postoperative outcomes in 94% of patients allowed us to conclude advisability of awake craniotomy for patients with lesions near speech zones.

Intraoperative involvement of neurolinguist or neuropsychologist certainly has certain advantages for mapping with narrow tasks, for example, localization of individual tracts or parameters of higher nervous activity [14]. In practice, a binary approach is essentially sufficient for surgeon when mapping and monitoring speech function: whether speech disorders occur or not at the moment of applying current to brain tissue regardless of their nature (aphasia, anarthria, paraphasia, etc.). Moreover, complex tasks for speech testing and numerous speech paradigms increase patient fatigue and surgery time. This can also affect the quality of speech contact and mask paraphasia or slurred speech. A well-experienced neurologist always can detect "simple" disorders. Indeed, professional standards of this specialist imply neurological examination, including speech assessment and classification of its disorders. An alternative approach may be involvement of speech therapist, although his tasks usually include speech rehabilitation. For example, the authors from the Neurology Research Center presented interaction between speech therapist, patient and surgical team at all stages of treatment including intraoperative assessment of speech function [15]. Speech therapist analyzed speech comprehension in a dialogue, naming objects and actions, understanding phrases and following instructions. Thus, these are basic paradigms whose assessment may be successfully performed by any neurologist.

Colleagues from Uzbekistan and Egypt also followed the path of simplifying the methodology of intraoperative speech function testing. They described awake craniotomy for resection of glioma without involvement of neurolinguist only with participation of neurologist [16, 17].

Importantly, neurologist should be included in the staff of neuro-oncology department according to current rules for organizing the activities of neurosurgical department. At the same time, neurolinguist and neuropsychologist are not mentioned in staffing schedule of municipal hospitals.

Such a discrepancy between staffing schedule of leading national medical centers and neurosurgical departments of hospitals level 2 and 3 can lead to refusal of awake craniotomy and mapping of speech zones. This obviously worsens treatment outcomes in patients with glial tumors. Our report confirms that modern staffing schedule of neurosurgery departments is sufficient for speech mapping with participation of neurologist. In this case, functional outcomes are comparable to those in large federal centers.

Conclusion

Compared with neuropsychologist/neurolinguist, speech testing by a full-time neurologist during resection of tumors near functionally significant cerebral areas demonstrates similar results regarding speech disorders. A tablet application with paradigms for speech testing in accordance with localization of pathological process seems perspective. This will significantly simplify intraoperative work and contribute to more widespread awake craniotomies.

The authors declare no conflicts of interest.

REFERENCES

1. Staub-Bartelt F, Rapp M, Sabel M. Feasibility of intraoperative neuromonitoring and cortical/subcortical mapping in patients with cerebral lesions of highly functional localizations — pathway to case adapted monitoring and mapping procedures. *Frontiers Oncology*. 2023;13:1235212. https://doi.org/10.3389/fonc.2023.1235212
2. Hamer RP, Praeger AJ. Facilitating complete resection of intrinsic motor cortex glioma with titration of high-frequency cortico-subcortical mapping train count informed by navigated transcranial magnetic stimulation: illustrative case. *J Neurosurg Case Lessons*. 2024;8(2):CASE24197. https://doi.org/10.3171/CASE24197
3. Fabian C, Watson JC. Reconciling Functional MRI Findings With Intraoperative Anatomy in Brain Tumor Surgery: Stereotactic-Guided Resection of Glioma in Broca's Area. *Cureus*. 2020;12(7):e9220. https://doi.org/10.7759/cureus.9220
4. Dragoy O, Chrabaszcz A, Tolkacheva V, Buklina S. Russian intraoperative naming test: a standardized tool to map noun and verb production during awake neurosurgeries. *The Russian Journal of Cognitive Science*. 2016;3(4):4-25. (In Russ.).
5. De Witte E, Satoer D, Robert E, Colle H, Verheyen S, Visch-Brink E, Mariën P. The Dutch Linguistic Intraoperative Protocol: A valid linguistic approach to awake brain surgery. *Brain and Language*. 2015;140:35-48. https://doi.org/10.1016/j.bandl.2014.10.011
6. Gogos AJ, Young JS, Morshed RA, Hervey-Jumper SL, Berger MS. Awake glioma surgery: technical evolution and nuances. *Journal of Neuro-Oncology*. 2020;147(3):515-524. https://doi.10.1007/s11060-020-03482-z
7. Al-Adli NN, Young JS, Sibih YE, Berger MS. Technical Aspects of Motor and Language Mapping in Glioma Patients. *Cancers*. 2023;15(7):2173. https://doi.org/10.3390/cancers15072173
8. Dmitriev AYu., Sinkin MV, Skalnaya AA, Solodov AA, Dashyan VG. Awake surgery in neuro oncology. Part 2. Functional intraoperative mapping. *Russian journal of neurosurgery*. 2024;26(1):130-136. (In Russ.). https://doi.org/10.17650/1683-3295-2024-26-1-130-136
9. Gerritsen J, Broekman M, De Vleeschouwer S, Schucht P, Jungk C, Krieg SM, Nahed BV, Berger MS, Vincent A. Global comparison of awake and asleep mapping procedures in glioma surgery: An international multicenter survey. *Neuro-Oncology Practice*. 2022;9(2):123-132. https://doi.org/10.1093/nop/npac 005
10. Jahangiri FR, Chima GS, Pearson M, Jackson J, Siddiqui AA. Mapping of the Language Cortex. *Cureus*. 2021;13(5):e14960. https://doi.org/10. 7759/cureus.14960
11. Duffau H. *Brain mapping. From Neural Basis of Cognition to Surgical Application*. New York: Springer-Verlag/Wien; 2011. https://doi.org/10.1007/978-3-7091-0723-2
12. Zuev AA, Korotchenko EN, Ivanova DS, Pedyash NV, Teplykh BA. Surgical treatment of eloquent brain area tumors using neurophysiological mapping of the speech and motor areas and conductiontracts. *Burdenko's Journal of Neurosurgery*. 2017;81(1):39-50. (In Russ.). https://doi.org/10.17116/neiro201780739-50
13. Kulikov AS, Kobiakov GL, Gavrilov AG, Lubnin AYu. Awake craniotomy: analysis of complicated cases. *Burdenko's Journal of Neurosurgery*. 2015;79(6):15-21. (In Russ.). https://doi.org/10.17116/neiro201579615-21
14. Zhukov VYu, Goriaĭnov SA, Buklina SB, Vologdina YaO, Batalov AI, Ogurtsova AA, Kulikov AS, Kobiakov GL. Intraoperative mapping of long association fibers in surgery of gliomas of the speech-dominant frontal lobe. *Burdenko's Journal of Neurosurgery*. 2018;82(5):5-20. (In Russ.). https://doi.org/10.17116/neiro2018820515
15. Berdnikovich ES, Orlova OS. Logopedist's role in performing intraoperative mapping of speech zones under awake craniotomy conditions. *Special Education*. 2022;4(68):202-213. (In Russ.). https://doi.org/10.26170/1999-6993_2022_04_14
16. Mamadaliev DM, Kariev GM, Asadullaev UM. Simplifying the Technique of Awake Brain Surgery in a Condition of Less Equipped Neurosurgical Institution in Uzbekistan. *Asian Journal of Neurosurgery*. 2023;18(3):636-645. https://doi.org/10.1055/s-0043-1771326
17. Abdelhameed E, Abdelghany MS, Abdelkhalek H, Elatrozy HIS. Awake surgery for lesions near eloquent brain under scalp block and clinical monitoring: experience of single center with limited resources. *The Egyptian Journal of Neurology, Psychiatry and Neurosurgery*. 2021;57(1):78. https://doi.org/10.1186/s41983-021-00333-0

Received 08.10.2024
Accepted 30.01.2025

COMMENT

The manuscript is devoted to surgery of glial tumors in functionally significant areas of the brain. Multimodal neurophysiological monitoring is currently a prerequisite for resection of such neoplasms. Surgeon can perform functional mapping of brain surface and localize white matter tracts using neurophysiological monitoring. This significantly reduces the risk of persistent postoperative deficit. According to various authors, the incidence of adverse outcomes is reduced by two or more times. Despite all the advantages of this technique, it is not widespread in clinics of the Russian Federation due to several factors, i.e. technical (lack of equipment, well-experienced neurophysiologist, consumables) and ideological (practice of certain hospital, reluctance of anesthesiologists, no understanding of advantages of this method by neurosurgeons, neurosurgeon's trust in technique and competence of neurophysiologist and/or anesthesiologist). If the first group of factors is quite easy to be eliminated, then changing stereotypes in glioma surgery is much more difficult. Mistrust and errors at early stages of neurophysiological service are often a brake for development of techniques.

Safe resection of gliomas combines all preoperative and intraoperative techniques increasing resection quality and reducing the risks of surgeries for intracerebral neoplasms. These methods include preoperative planning (structural MRI, 3D model of cerebral cortex, functional MRI, tractography), multimodal neurophysiological monitoring (brain matter mapping with ascertaining the fact of damage to functional zones), intraoperative visualization (fluorescence, intraoperative ultrasound, intraoperative MRI), microsurgical technique with preservation of vessels.

The authors correctly conclude that full-time neurologist is sufficient for awake surgery. I would even say that full-time neurosurgeon would also be sufficient. Indeed, the answer to only one question is important for us when planning surgery. Are there any speech disorders during this or that testing? Neurolinguists, neuropsychologists and speech therapists are needed for a more detailed study of speech problems, organization of speech connectome and fundamental researches. These ones will make resection of tumors near functional zone even safer in the fu-

ture. I see creation of a universal test task that can identify speech disorders in any part of the brain and which can be used by doctors without special training as an urgent task for the near future.

It is a little disconcerting that any early postoperative disorders occurred in only 4 patients. This does not correspond to available world data. As a rule, more than half of patients have transient neurological disorders after manipulations near functional zones. But is this related to assessment of postoperative disorders by neurologist?

In our practice, we perform mapping of not only arcuate tract to prevent speech disorders, especially if tumor is localized in insular lobe. To date, international standards include arcuate fasciculus, ILF, IFOF, ASLANT, uncinate. The authors refer to some studies describing feasibility of including these tracts in the area of interest, but do not examine them during surgery. The authors indicate intraoperative mapping of arcuate fasciculus. However, there is no further mention of this in the article. What did this mapping lead to? Was it possible to recognize arcuate fasciculus?

I agree with the authors that ischemic disorders are the most common cause of persistent neurological deficit after resection of tumors in functionally significant areas. It is very difficult to intentionally damage the functional cortex or tract after neurophysiological mapping. So, it is necessary to be extremely careful with all vessels passing through surgical area. Preservation of these vessels and resection through "vascular windows" are necessary.

Importantly, all patients underwent MRI in early postoperative period. Surgeons can, firstly, objectively assess extent of resection, secondly, understand pathogenesis of certain complications, and, thirdly, analyze errors for their subsequent prevention.

Zuev A.A. (Moscow)