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Orest I. Palamar,
Andriy P. Huk,
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Dmytro I. Okonskyi,
Nazarii V. Lazko

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Postoperative complications in endoscopic frontal transcortical surgery of lateral and third ventricle tumours. Speech disorders

Orest I. Palamar[1], Andriy P. Huk[1], Dmytro S. Teslenko[1], Ruslan V. Aksyonov[1], Dmytro I. Okonskyi[1], Nazarii V. Lazko[2]

[1] SI "Romodanov Neurosurgery Institute" NAMS of Ukraine, Kyiv, UKRAINE
[2] Municipal non-commercial enterprise "Kyiv City Clinical Hospital No. 1", Kyiv, UKRAINE

ABSTRACT

Neurosurgical approaches to lesions of the lateral and the third ventricles are divided into two fundamentally different groups: transcortical neurosurgical approaches, including - endoscopic and interhemispheric transcallosal microneurosurgical approaches. Complications in surgery of lateral and third ventricle tumours are often associated with the specific approach technique and could be transient. We analyzed postoperative neurological complications and the approach criteria on MRI or CT scans in postoperative period such as localization of corticotomy, distance from corticotomy to coronal suture, "angle of attack" after the frontal transcortical approach to the lateral and third ventricle based on 54 cases and presume transient nature of specific to approach complications and approaches' factors that have role in postoperative mutism.

Keywords
endoscopic,
lateral ventricle,
mutism.
third ventricle,
transcortical approach

Corresponding author:
Nazarii V. Lazko

SI "Romodanov Neurosurgery Institute" NAMS of Ukraine, Kyiv, Ukraine

naztar02@gmail.com

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INTRODUCTION

Neurosurgical approaches to the tumors of the lateral and the third ventricles are divided into two fundamentally different groups: transcortical neurosurgical approaches, including - endoscopic and interhemispheric transcallosal microneurosurgical approaches. Two different approaches to the ventricular system cause distinct brain injuries: tightly compressed commissural fibers of the corpus callosum are injured by the interhemispheric transcallosal approach, while the transcortical approach damages gray and white matter of the brain on its way [1,2].

Complications in surgery of lateral and third ventricle lesions are often associated with the specific approach technique and today is a widely discussed problem [3,4]. When applying the abovementioned approaches, the most common complications are aphasia, mutism, hemiparesis, seizure, memory impairment, apatheia/abulia, endocrinopathy, subdural hygroma, etc. [1,16].

Manifestations of mutism, which are currently little studied in the context of the use of these neurosurgical approaches, constitute a field of particular scientific interest. Mutism is a clinical state, in which a conscious patient is unwilling to or unable to speak, resulting in the absence or marked paucity of verbal output. The patients can be mute while their ability to write or comprehend spoken language is intact [1,11]. Mutism can occur as a result of damage to the Broca area, premotor cortex, and supplementary motor area of the dominant hemisphere, association fibers of white matter, the anterior part of the cingulate gyrus, commissural fibers of the corpus callosum, damage of the cortical-bulbar fibers bilaterally, bilateral thalamotomy and damage of reticular formation of the midbrain [7,5].

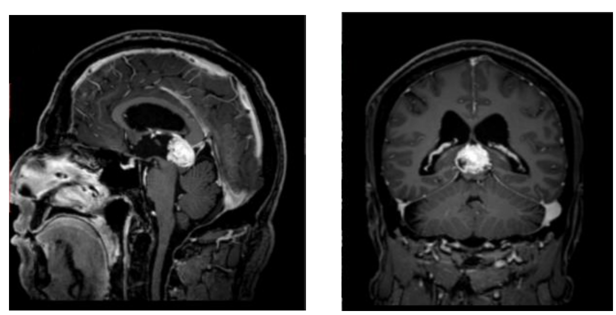
MATERIALS AND METHODS

A retrospective analysis of 54 patients with neoplasms and lesions of lateral (anterior horn, body, atrium) and third ventricles who underwent surgery in the period from October 2015 to May 2021. Male – 26 patients, the mean age was 44.5 years (range: 20-71 years), female – 28 patients, the mean age was 42.4 years. (range: 15-74 years). Mean preoperative Karnofsky Performance Statuse Score (KPS) was 76.37.

Localization of neoplasm: the third ventricle - 41 (75.9 %) patients; lateral ventricular tumors - 13 (24.1 %) patients. Histological distribution depending on the location is given in Table. No. 1. Histopathological evaluation of these 54 neoplasms and lesions indicated 15 distinct diagnostic entities including brain tumors of glial origin with invasion in the ventricular system (diffuse and anaplastic astrocytoma, glioblastoma, oligodendroglioma, and anaplastic oligoastrocytomas) accounted for 35,2% (Fig. 1), subependymoma and ependymomas varying degrees of malignancy – 14,8%, colloid cysts - 13%, central neurocytomas - 11.1%, craniopharyngiomas 11.1%, germinomas - 7.4%, others - 7.4%

Histopathology	Lateral ventricles (n-13)	Third ventricle (n-41)
Pilocytic astrocytoma, WHO Gr I	-	1
Diffuse astrocytoma, WHO Gr II	2	3
Anaplastic astrocytoma, WHO Gr III	-	3
Glioblastoma, WHO Gr IV	1	5
Oligodendroglioma, WHO Gr II	1	2
Anaplastic oligoastrocytomas WHO Gr III	1	-
Subependymoma, WHO Gr I	1	1
Typical and atypical meningiomas, WHO Gr I та II	2	-
central neurocytomas, WHO Gr II	4	2
Pineoblastoma, WHO Gr IV	-	1
Ependymoma, WHO Gr II, anaplastic ependymoma WHO Gr III	1	5
Craniopharyngioma, WHO Gr I	-	6
Colloid cysts	-	7
Germinomas	-	4
Mature teratoma	-	1

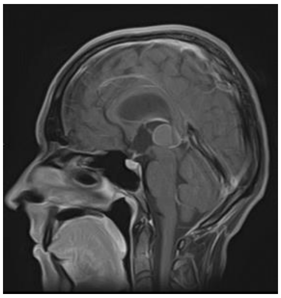
Table 1. Histopathology of intraventricular neoplasms.



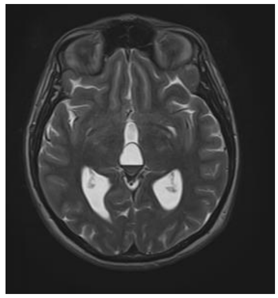
A. **B.**

Figure 1. A-B. Tumor in the posterior part of the third ventricle (Glioblastoma), preoperative contrast-enhanced, T1W images.

Preoperative symptoms include: cephalalgia - 49 (90.7 %) patients, sings of elevated ICP - 32 (59.25 %) patients, neurocognitive disorders and psychoorganic syndrome - 10 (18.5%) patients, oculomotor dysfunction - 10 (18.5%) patients, motor deficits - 9 (16.6%) patients, short term memory loss-8 (14.8%) paients, decreased visual acuity and loss of peripheral vision - 7 (12.9%) patients, endocrinopathy - 4 (7.4%) patients, seizures - 2 (3.7%) patients.



A.



B.

Figure 2. A-B. Tumor in the posterior part of the third ventricle (ependymoma), preoperative contrast-enhanced T1W images and T2W images.

Preoperative contrast-enhanced magnetic resonance imaging (MRI) (Fig.2) of the brain and computer tomography (CT) were also used for the preoperative planning of the approach side, optimal for the resection of the neoplasm and minimization of postoperative complications. We analyzed the localization of the neoplasms in the ventricular system, the side with greater distribution, signs of occlusive hydrocephalus, the side with the wider interventricular foramen of Monro, localization of estimated corticotomy ("entry point"), and the best "angle of attack ".

In surgery of neoplasms of the lateral (anterior horn, body, atrium) and third ventricle, we use endoscopic frontal (craniotomy over the frontal lobe) transcortical (corticotomy through the upper or middle frontal gyrus) approache. We perform an endoscopic frontal transcortical approach via parasagittal craniotomy over the non-dominant hemisphere of the brain (or over the priority hemisphere for approach) with the centration at the Kocher's point. Corticotomy up to 2.2 cm. is carried out through the top of the middle or upper frontal gyrus. The next stage is white matter fibers dissection to the front horn of the lateral ventricle and the subsequent introduction of intracerebral retractors.

Depending on the location of the tumor or lesion in the third ventricle, its size, and available hydrocephalus we used transventricular (through the cavity of the lateral ventricles) approach and further transforaminal (approach to the third ventricle through the interventricular foramen of Monro) or extended transforaminal transchoroidal approach (approach to the third ventricle through the interventricular foramen of Monro with the anterior choroidal dissection). Surgery was performed using an endoscopic stand based on the HD- endoscope "Image-1HD" (Karl Storz, Germany). Rigid endoscopes "Karl Storz" 4 mm in diameter with viewing angles of 0 and 35 degrees were used as the main tool for visualization of the operating field.

Approach through the right hemisphere has been performed in 38 (70.4 %) cases and through the left one in 16 (29, 6 %) cases. Endoscopic frontal transcortical approach to the lateral ventricles was used in 13 (24.1 %) cases; endoscopic frontal transcortical transentricular transforaminal approach to the third ventricle - 13 (24.1 %) cases, extended transforaminal transchoroidal approach - 28 (52%) cases. In all cases, a 100% endoscopic technique ("fully endoscopic resection") was performed.

In case of clinical and MR signs of occlusive hydrocephalus and with the purpose of preventing the progression of hydrocephalus in 22 (40.7%) cases with simultaneous resection of tumor we performed endoscopic third ventriculostomy.

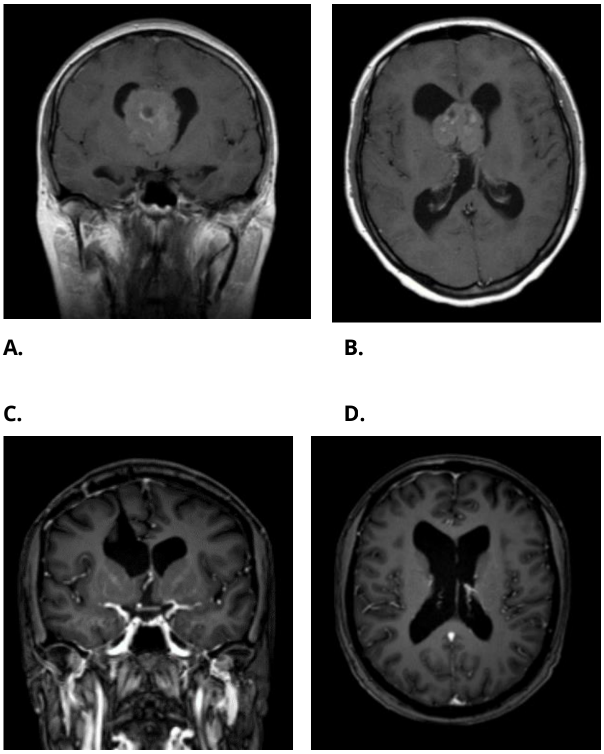
In the early postoperative period, all patients underwent contrast-enhanced CT or MRI in order to detect residual component of the tumor, potential postoperative ischemia and bleeding, and evaluations of the ventricular system.

The follow-up ranged from 3 to 42 months, at average 12.5 months. During the follow-up examination of patients, which was performed approximately 2-4 months after the surgery, we assessed the overall health status, neurological status, contrast-enhanced MRI of the brain (Fig. 3). On MRI we evaluated the presence of residual component of the tumor or tumor growth, ventricular system (presence of hydrocephalus), expansion/narrowing of the transcortical channel in the matter of the frontal lobe.

Results and Discussion

Extent of resection in our series: gross total resection/near total resection - 34 (63 %) patients, subtotal/partial resection - 15 (27.7 %) cases, biopsy - 5 (9.2 %) cases.

39 (72.2 %) patients had no postoperative complications, 15 (27.7 %) patients had at least one postoperative complication. Postoperative complications included:



A. B.

C. D.

Figure 3. A-B. Tumor in the right lateral ventricle (ependymoma), preoperative T1W images.

C-D. 5-month postoperative contrast-enhanced T1W images depicted gross total resection of the tumor.

- speech disorders such as mutism - 6 (11.1 %) patients and apathia/abulia - 5 (9.2%) patients . We observed that 4 patients with postoperative manifestations of apathia/abulia also had concomitant mutism. In the postoperative period, at the follow-up examination 2-4 months after the surgery, a complete or partial regression of both mutism and apathia/abulia was observed in all 6 patients;
- short term, "fixation" memory loss - 5 (9.2 %) patients. In all 5 cases the endoscopic transcortical transventricular transforaminal or extended transforaminal transchoroidal approach to the third ventricle was applied. In the postoperative period, at the follow-up examinations during the next 2-6 months after the surgery, a complete or partial regression was observed in 3 patients;
- oculomotor dysfunction - 5 (9.2%) patients. Oculomotor dysfunction included paresis of n. oculomotorius and/or Parinaud syndrome and in all 5 cases have been associated with tumor resection of the posterior part of the third ventricle. In the postoperative period, complete or partial regression was observed in 1 patient;
- motor deficits - 4 (7, 4%) patients. In our series, we associate the occurrence of this complication either with resection of the glial tumor (originated in close proximity to corticospinal tracts) with the invasion in the third ventricle or with the premotor cortex and supplementary motor area injury. We observed the complete regression in 2 patients during the next 4 months after the surgery;
- neurocognitive disorders - 4 (7.4%) patients which regressed in 1 patient 4 months after the surgery;
- endocrinopathy - 3 (5.5%) patients. We associate this complication with the resection of tumors that have been tightly fused to the hypothalamic area of the bottom of the third ventricle. Regression was observed in 1 patient after 3 months.
- postoperative hemorrhage – 2 (3,7%) patients;
- postoperative wound infection occurred in 1 (1.85%) patient;
- postoperative meningitis - 1 (1.85%) patient.

In our series, seizures, as a postoperative complication, did not occur.

Postoperative mortality - 1 (1.9%) patients due to hypothalamic dysfunction, leading to acute electrolyte shifts, after the resection of craniopharyngioma with the significant spread in the third ventricle.

Compared with the series Brian D. Milligan at al in the group transcortical approach, short-term memory loss in the postoperative period was recorded in 6 (12 %) patients, that is 2.8% higher than in our series. Motor deficits were recorded in 18 (35%) patients, that is 27.6 % higher than in our series. Neurocognitive disorders were 4.6% higher than in our series, and the percentage of patients with endocrinopathy was the same as in the series Brian D. Milligan at al. [16]

The average KPS on the day of discharge was 83,35%.

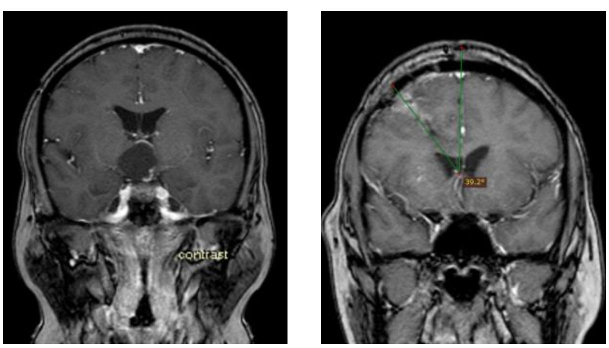
In the early postoperative period, all patients underwent contrast-enhanced CT or MRI of the brain and, among other things, we evaluated the following approach criteria (Table. 2) using RadiAnt DICOM Viewer software:

1) localization of corticotomy, "entry point" (upper/middle frontal gyrus (upper parts);

2) the distance from the coronal suture to the corticotomy in front;
3) "Angle of attack " (the angle between the sagittal plane and plain "entry point" - the point of entry into the frontal horn of the lateral ventricle). (Fig. 4).

Localization of corticotomy	**Right hemisphere n-38 (70,4%)**	**Left hemisphere n -16 (29,6%)**
Upper frontal gyrus	12 (31,5 %)	7 (43,7%)
Middle frontal gyrus, upper part	26 (68,5 %)	9 (56,3%)
Distance from the coronal suture to the corticotomy (mean, min-, max).	2,8 cm, min- 1,2, max- 3,6	2,8 cm, min- 0,5, max- 2,9
"Angle of attack" (mean, min-, max).	27,4°, min-17°, max- 35°	26,7°, min-21°, max- 34°

Table 2. Approach criteria



A. **B.**

Figure 4. A.Tumor of the third ventricle (craniopharyngioma), preoperative, contrast-enhanced T1W image.
B. 4-month postoperative contrast-enhanced T1W images, “angle of attack” calculation using using RadiAnt DICOM Viewer software.

In our series, mutism, as a manifestation of specific speech disorders caused by the frontal transcortical approach to the lateral and third ventricles, was observed in the postoperative period in 6 (11.1 %) patients (approach on the left - 6 patients). This clinical condition was transient and regressed within 4 months after the surgery. We indicate that corticotomy in patients who had postoperative mutism was performed in the upper frontal gyrus – 4 patients, in the middle frontal gyrus – 2 patients. We presume that postoperative mutism is related to the following features of the approach:

1) the approach side - dominant hemisphere.
2) corticotomy in the upper frontal gyrus and at a distance of less than 2 cm. from the coronal suture.
3) "angle of attack" less than 26.7○.

In their series, S. Asgari et al reported that when applying the transcortical approach, transient mutism occurred in 11% of patients, while via interhemispheric/transcallosal approach in 18% of patients, that equals and is 8.2% higher compared to our series respectively [7]. R. G. Ellenborg concluded that speech disorders are a fairly common complication when applying a transcortical approach through the dominant hemisphere and occur in 10-30% of patients [13]. In the article by Brian D. Milligan et, when comparing transcortical and interhemispheric approaches, mutism is not distinguished as a complication, instead this clinical condition is classified as a separate group of complications - aphasia/abulia, which occurs in 31% and 25% of cases, respectively, when applying transcortical and transcallosal approaches [16]. In our series of cases, aphatia/abulia manifested in the postoperative period in 5 (9.2%) patients, in all cases - together with mutism. It is uncertain whether there is a direct link between apathy, abulia and mutism. However, there is some evidence that the medial part of the frontal lobes, especially the cortex and fibers of the anterior cingulate gyrus, may play a role in manifestations of aphatia/abulia along with signs of mutism, as well as akinetic mutism [12]. The anterior part of the cingulate gyrus has a complex relationship with the limbic structures, other parts of the frontal cortex and periaqueductal gray matter of the midbrain. It is involved in interaction between the decision-making process and the "emotional" world of the limbic system, which is considered crucial for the start of speech and vocalization [6,19].

Functionally, the corpus callosum is closely related to speech function [9,20]. Mutism often occurs in the postoperative period after the interhemispheric approach with callosotomy [8,18]. Jin Hong et al suggested that damage to the corpus callosum can lead to speech disorders [15]. Ishizaki et al describe that transcallosal diaschisis is a possible mechanism of aphasia [14]. In our opinion, the commissural fibers of the corpus callosum and forceps minor fibers injury while applying the transcortical approach to the ventricular system, may play a role in the development of transient mutism.

Utilizing magnetic resonance diffusion-tensor tractography and comparing two different localizations of corticotomy (through the middle frontal gyrus and through the upper frontal gyrus) applying transfrontal transcortical access, T. Szmuda et al concluded that the application of access through the upper and middle frontal gyrus one way or another leads to trauma, including the upper longitudinal fascicles II, which is partially responsible for the relationship between the fields of Brock and Wernicke [21]. Although most of the fibers involved in the speech network and connecting the middle and lower frontal gyrus and posterior part of superior temporal gyrus are a part of the so-called upper longitudinal fasciculus III (anterior fibers of arcuate), they are located more caudally to the potential injury of the white matter via frontal transcortical approach in our cases [17].

Injury to the supplementary motor area and the premotor cortex, especially of the dominant hemisphere of the brain, can also cause mutism. Penfield and Welch used cortical stimulation to identify the boundaries and functions of this area. The connections of this cortex are quite branched and include the upper temporal gyrus, the intraparietal sulcus, the caudate nucleus, the thalamus, and other. [10]

Conclusion

The endoscopic frontal transcortical approach in surgery of neoplasm and lesions of the lateral and third ventricle is effective and minimally invasive approach. The transient nature of postoperative complications is due to the gentle manipulations of anatomical structures when applying this approach. Specific surgical approach complications such as mutism, apathia/abulia, motor deficits (due to the injury of the premotor cortex and supplementary motor area) were mostly transient and had a tendency to regress immediately in the postoperative period and most of them completely regressed from 2 to 4 months after the surgery.

The nature of mutism as a manifestation of speech complications when applying endoscopic frontal transcortical approach is multifactorial. The development of postoperative speech complications, namely of transient mutism when applying the endoscopic frontal transcortical approach is not a frequent complication and according to our observations regresses within 4 months. In our opinion, in order to reduce the risk of mutism in the postoperative period, endoscopic frontal transcortical approach should be performed via the non-dominant hemisphere (unless otherwise specified during preoperative planning) and in the upper part of the middle frontal gyrus at a distance more than 2 cm from the coronal suture. Corticotomy should be gentle and based on our series no more than 2.2 cm in length, "angle of attack" should be no less than 26.7○ which reduces cerebral cortex and white matter injury and the risk of postoperative complications associated with the application of this approach, including manifestations of mutism.

References

1. Altshuler LL, Cummings JL, Mills MJ (1986) Mutism: review, differential diagnosis, and report of 22 cases. Amer J Psychiatry 143:1409 1414.
2. Anderson RC, Ghatan S, Feldstein NA. Surgical approaches to tumors of the lateral ventricle. Neurosurg Clin N Am. 2003;14(4):509-525.
3. Apuzzo ML, Chikovani OK, Gott PS, et al. Transcallosal, interfornicial approaches for lesions affecting the third ventricle: surgical considerations and consequences. Neurosurgery. 1982;10(5):547-554.
4. Apuzzo MLJ (1987) Surgery of the third ventricle. Williams & Wilkins, Baltimore.
5. Apuzzo MLJ, Litofsky NS. Surgery in and around the anterior third ventricle. In: Apuzzo MLJ, ed. Brain Surgery: Complication Avoidance and Management. New York: Churchill-Livingstone; 1993:541-579.
6. Arnts H, van Erp WS, Lavrijsen JCM, van Gaal S, Groenewegen HJ, van den Munckhof P. On the pathophysiology and treatment of akinetic mutism. Neurosci Biobehav Rev. 2020 May;112:270-278.
7. Asgari S, Engelhorn T, Brondics A, Sandalcioglu IE, Stolke D. Transcortical or transcallosal approach to ventricle-associated lesions: a clinical study on the prognostic role of surgical approach. Neurosurg Rev. 2003 Jul;26(3):192-7.
8. Bogen JE (1987) Physiologicai consequences of complete or par- tial commissural section. In: Apuzzo MLJ (ed) Surgery of the third ventricle. Williams & Wilkins, Baltimore London Los An- geles Sydney, pp 175-194.
9. Catani M, Jones DK, Ffytche DH, et al. Perisylvian language networks of the human brain. Ann Neurol 2005;57:8–16.
10. Crutchfield JS, Sawaya R, Meyers CA, Moore BD 3rd. Postoperative mutism in neurosurgery. Report of two cases. J Neurosurg. 1994 Jul;81(1):115-21.
11. Cummings JL, Benson DF, Houlihan JP, etal (1983) Mutism: loss of neocortical and limbic vocalization. J Nerv Ment Dis 171:255-259.
12. Darby RR, Joutsa J, Burke MJ, Fox MD. Lesion network

localization of free will. Proc Natl Acad Sci U S A. 2018 Oct 16;115(42):10792-10797.
13. Ellenbogen RG. Transcortical surgery for lateral ventricular tumors. Neurosurg Focus. 2001 Jun 15;10(6):E2.
14. Ishizaki M, Ueyama H, Nishida Y, et al. Crossed aphasia following an infarction in the right corpus callosum. Clin Neurol Neurosurg 2012;114:161–5.
15. Jin Hong , Song Xiaojing , Song , et al. Clinical analysis of 14 cases of corpus callosum infarction. Chin J Clin Res 2010;23:1016–1016.
16. Milligan BD, Meyer FB. Morbidit y of transcallosal and transcor tical approaches to lesions in and around the lateral and third ventricles: a single-institution experience. Neurosurgery. 2010 Dec;67(6):1483-96; discussion 1496.
17. Nakajima R, Kinoshita M, Shinohara H, Nakada M. The superior longitudinal fascicle: reconsidering the fronto-parietal neural network based on anatomy and function. Brain Imaging Behav. 2020 Dec;14(6):2817-2830.
18. Sass KJ, Novelly RA, Spencer DD, Spencer SS. Postcallosotomy language impairments in patients with crossed cerebral dominance. J Neurosurg. 1990 Jan;72(1):85-90.
19. Shenhav A, Botvinick MM, Cohen JD. The expected value of control: an integrative theory of anterior cingulate cortex function. Neuron. 2013 Jul 24;79(2):217-40.
20. Sussman NM, Gur RC, Gur RE, O'Connor MJ. Mutism as a consequence of callosotomy. J Neurosurg. 1983 Sep;59(3):514-9. doi: 10.3171/jns.1983.59.3.0514.
21. Szmuda T, Słoniewski P, Szmuda M, Waszak PM, Starzyńska A. Quantification of white matter fibre pathways disruption in frontal transcortical approach to the lateral ventricle or the interventricular foramen in diffusion tensor tractography. Folia Morphol (Warsz). 2014 May;73(2):129-38.