



Microsurgical removal of a cavernous malformation on the midbrain dorsal surface using the supracerebellar infratentorial approach: a clinical case

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GRAPHICAL ABSTRACT



Microsurgical removal of a cavernous malformation on the midbrain dorsal surface using the supracerebellar infratentorial approach: a clinical case

Summary

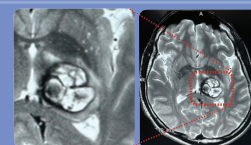
The choice of median suboccipital craniotomy and contralateral supracerebellar infratentorial approach is the preferred route for complete resection of cavernoma of dorsal midbrain surface in order to revert postoperative neurological deficits.

Diagnosis

38-year-old man

- headache and vomiting
- right-sided weakness
- strabismus
- left-sided pupillary dilatation

A cavernous malformation
(20x30x25 mm)
with hemorrhage in the dorsal
surface of the midbrain

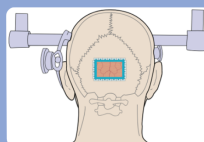


May 13,
2024



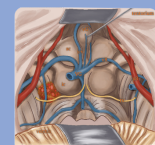
Treatment

Median
suboccipital
craniotomy



Access through the
supracerebellar
infratentorial plane and
the quadrigeminal cistern

Resection



May 28,
2024



Outcomes

Short-term

- diplopia
- moderate
pyramidal
disorders

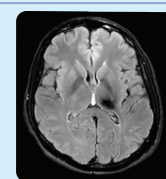


June 1
2024



Long-term

- complete resolution
signs and symptoms
- postoperative gliosis



Feb 18,
2025



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10 minutes
to read



Abstract

Common surgical approaches to the dorsal midbrain include: the occipital transtentorial, supracerebellar infratentorial, posterior subtemporal, and the tonsilloveal transaqueductal approaches.

Case report. A 38-year-old man presented with mild right-sided weakness and diplopia following an episode of headache and vomiting two weeks prior to admission. A neurological examination revealed mild right-sided weakness, a downward and outward strabismus, a mild left ocular mydriasis and accommodation paralysis alongside alternating syndrome. Magnetic resonance imaging revealed a 20x30x25 mm rupture of the cavernous malformation of the left midbrain peduncle as well as hematomas within the cavernoma. Using the supracerebellar infratentorial approach in a sitting position with minimal incision of dorsal midbrain, the cavernoma was completely resected together with

surrounding subacute hematoma. In the early postoperative period, a regression of neurological symptoms was observed.

Discussion. The choice of median suboccipital craniotomy and contralateral supracerebellar infratentorial approach is the preferred route for complete resection of cavernoma of dorsal midbrain surface in order to avoid any postoperative neurological deficit.

Keywords: cavernoma; lesion of the midbrain peduncles; access to the dorsal part of the midbrain; hematoma; removal of midbrain formations

MeSH terms:

CASE REPORTS

CENTRAL NERVOUS SYSTEM VASCULAR MALFORMATIONS – DIAGNOSTIC IMAGING

CENTRAL NERVOUS SYSTEM VASCULAR MALFORMATIONS – SURGERY

MESENCEPHALON – BLOOD SUPPLY

MESENCEPHALON – SURGERY

MICROSURGERY – METHODS

SURGICAL APPROACH

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Микрохирургическое удаление кавернозной мальформации дорсальной поверхности среднего мозга путем супрацеребеллярного инфратенториального доступа: клинический случай

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Аннотация

Известные хирургические доступы к дорсальной части среднего мозга включают: затылочный транстенториальный, супрацеребеллярный инфратенториальный, задний субтемпоральный и тонзиллоувеальный трансакведуктальный подходы.

Описание случая. 38-летний мужчина обратился с жалобами на легкую правостороннюю слабость и диплопию после эпизода головной боли и рвоты за две недели до поступления. В неврологическом статусе выявлено незначительное снижение мышечной силы с правой стороны, косоглазие вниз и наружу, легкий мидриаз и паралич аккомодации левого глаза, альтернирующий синдром. С помощью магнитно-резонансной томографии выявлен разрыв кавернозной мальформации размером 20×30×25 мм левой ножки среднего мозга, гематомы в каверноме. Путем супрацеребеллярного инфратенториального доступа в положении сидя с минимальным разрезом дорсальной части среднего мозга кавернома была полностью резецирована вместе с окружающей подострой гематомой. В раннем послеоперационном периоде наблюдался регресс неврологической симптоматики.

Обсуждение. Выбор медианной субокципитальной краниотомии и контралатерального супрацеребеллярного инфратенториального доступа является предпочтительным для полной резекции каверномы дорсальной поверхности среднего мозга во избежание послеоперационного неврологического дефицита.

Ключевые слова: кавернома; поражение ножек среднего мозга; доступ к дорсальной части среднего мозга; гематома; удаление образований среднего мозга

Рубрики MeSH:

ОПИСАНИЕ СЛУЧАЕВ

НЕРВНОЙ СИСТЕМЫ ЦЕНТРАЛЬНОЙ СОСУДИСТЫЕ МАЛЬФОРМАЦИИ – ДИАГНОСТИЧЕСКОЕ ИЗОБРАЖЕНИЕ
НЕРВНОЙ СИСТЕМЫ ЦЕНТРАЛЬНОЙ СОСУДИСТЫЕ МАЛЬФОРМАЦИИ – ХИРУРГИЯ

МОЗГ СРЕДНИЙ – КРОВΟΣНАБЖЕНИЕ

МОЗГ СРЕДНИЙ – ХИРУРГИЯ

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Abbreviations:

CM – cavernous malformation

CT – computed tomography

MRI – magnetic resonance imaging

Cavernous malformations (CM) or cavernomas of the central nervous system are formations consisting of multiple adjacent cavities of irregular shape (caverns), lined with endothelium and filled with blood.

According to magnetic resonance imaging (MRI) data at the screening stage and several thousand autopsies,

CM of the central nervous system is detected in 0.3–0.6% of the population [1, 2]. Most often, the first symptoms appear at a young age – on average, at 23 years [3].

Of all CMs of the brain, localization in the brainstem accounts for 19 to 30% [3], of which 14.2–25% occur in the midbrain [4]. In cerebral CMs, the annual frequency

of primary hemorrhages is 0.39-1.3%, recurrent – 4.5-22.9% [5]. It is believed that brain cavernomas located in the brainstem area are most prone to recurrent hemorrhages with an annual risk ranging from 21-60% and complications during surgical intervention than with other localizations of cavernomas [6-9]. The risk of recurrent bleeding increases with incomplete surgical resection [9, 10]. These features allow to distinguish brainstem CMs into a separate group.

The tactics of surgical treatment of primary bleeding from the midbrain CM depend on the timing of the hemorrhage, age and somatic status of the patient and necessitate an individual approach to developing an optimal treatment strategy.

The purpose of this case report is to demonstrate the experience of successful radical resection of the midbrain peduncle CM by the supracerebellar infratentorial approach as an effective surgical strategy for primary hemorrhage in a young patient.

CASE REPORT

A 38-year-old man, a builder, sought medical help at the SI “National Medical Center of the Republic of Tajikistan Shifobakhsh” on May 13, 2024 with complaints of diplopia and mild weakness in the right limbs, which arose suddenly after an episode of headache and vomiting about two weeks previously.

Clinical examination on admission: clear consciousness, 15 points according to the Glasgow Coma Scale, somatic status without any peculiarities: respiratory rate 16 per minute, heart rate 80 per minute, blood pressure 120/80 mm Hg. In the neurological status, a slight decrease in strength on the right side was

noted – IV/V degree according to the classification of muscle tone study¹, strabismus downward and outward, mild mydriasis and paralysis of accommodation of the left eye alongside alternating syndrome.

Computed tomography (CT) of the brain revealed a poorly defined hyperdense formation in the lower part of the dorsal surface of the left peduncle of the midbrain measuring 20x30x25 mm. MRI of the brain revealed a hyperintense lesion in T1- and T2-weighted images with a clearly defined hypointense rim, hematomas in a cavernoma of 20x30x25 mm (Fig. 1A-C).

Based on clinical data and neuroimaging results, the following diagnosis was made: rupture of CM of the left midbrain peduncle, hematomas in the cavernoma.

To avoid any postoperative neurological deficit (as assessed by additional scales: 4 points on the Spetzler-Martin [11] and 3 points on the Lawton-Young [12]), a median suboccipital craniotomy with a contralateral supracerebellar infratentorial approach was chosen for radical cavernoma resection (Fig. 2A-E).

Surgery Procedure

The operation was performed on May 28, 2024 under general endotracheal anesthesia with the patient in a sitting position – to give the back a vertical position, and with the head tilted forward to smooth the angle of the tentorium. The patient's head was rigidly fixed using a Mayfield-Keys clamp. The Carl Zeiss OPMI Vario S88 operating microscope (Carl Zeiss, Germany) was used during the operation.

Surgical access was achieved through a 12 cm long linear skin incision in the parietal-occipital region. A burr hole was created in the occipital protuberance region,

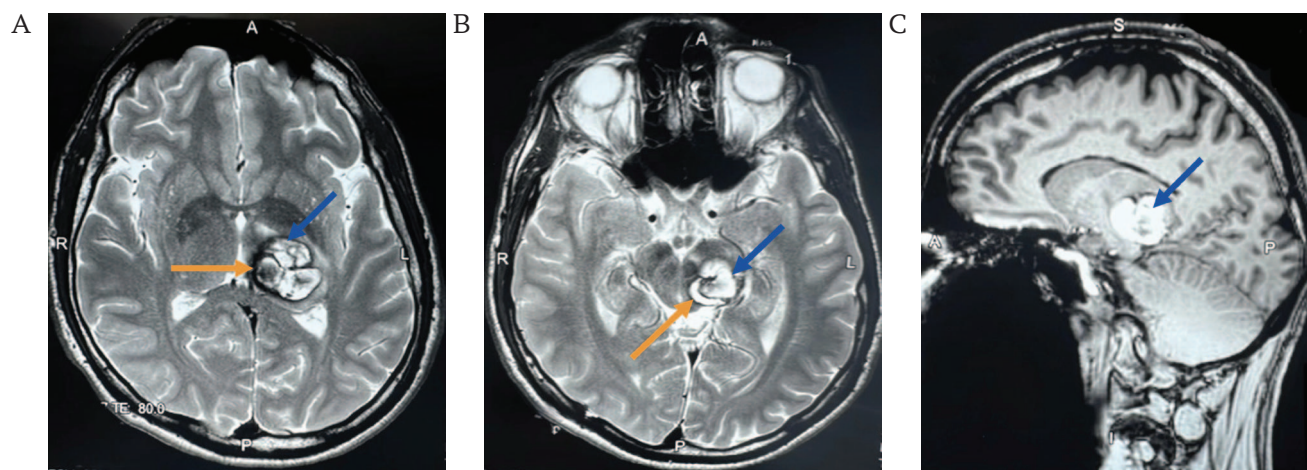


FIG. 1. Magnetic resonance imaging of a 38-year-old patient with a cavernous malformation measuring 20x30x25 mm in the dorsal part of the left peduncle of the midbrain (May 13, 2024).

A, B. Axial sections, T2-weighted image: cavernous malformation (blue arrow), hematomas in the cavernoma (orange arrow).

C. Sagittal section, T1-weighted image: cavernous malformation (arrow).

¹ Index of Clinical Guidelines by the Russian Ministry of Health / Clinical Guidelines / Mononeuropathies (Approved by the Ministry of Health of the Russian Federation) https://cr.minzdrav.gov.ru/preview-cr/166_2 (access date: 13.05.2024).

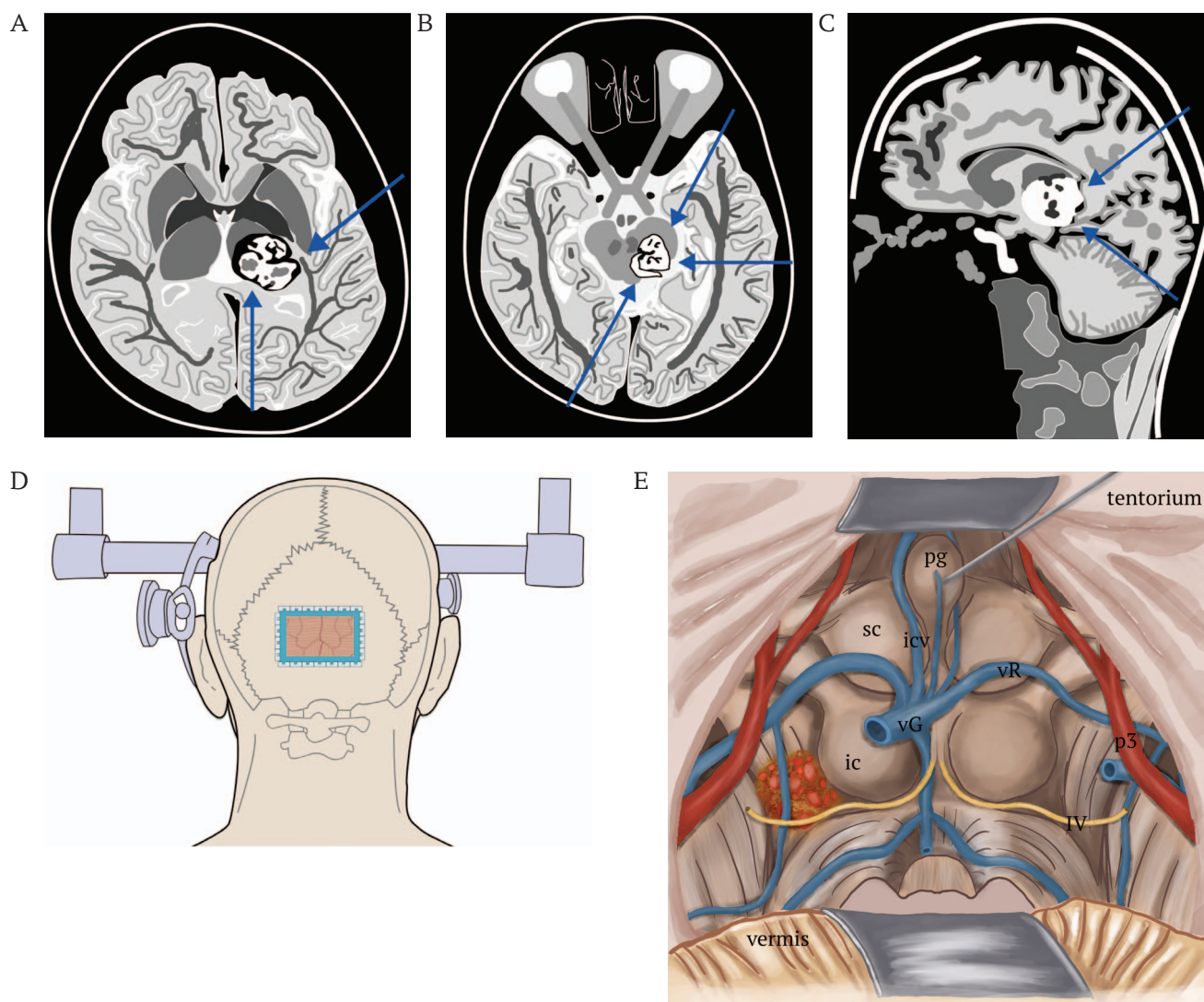


FIG. 2. Schematic representation of the localization of the cavernoma of the dorsal surface of the midbrain and the choice of strategy for its resection.

A. Axial section. The arrows indicate the approaches to the midbrain: left lower – supracerebellar infratentorial; right upper – posterior subtemporal.

B. Axial section. The arrows indicate the approaches to the midbrain: left lower – contralateral supracerebellar infratentorial; right upper – anterior subtemporal; right lower – posterior subtemporal approaches.

C. Sagittal section. The arrows indicate the approaches to the midbrain: right upper – occipital transtentorial; right lower – supracerebellar infratentorial.

D. Exposure of the cavernoma using torcular craniotomy and supracerebellar infratentorial approach (blue line).

E. Access to the cavernoma through the supracerebellar infratentorial plane and the quadrigeminal cistern; identification of the ascending deep cerebral veins; determination of the feeding arteries of the pons and midbrain; review of the lateral sections; dissection of the quadrigeminal cistern to provide a free corridor (superior view of the midbrain, pons, tentorium from the pineal region and superior cerebellar peduncle); mobilization of the vessels and veins draining into the superior sagittal sinus.

Note: ic – inferior colliculus; icv – internal cerebral vein; pg – pineal gland; p3 – posterior cerebral artery (segment p3); sc – superior colliculus; vG – vein of Galen; vR – vein of Rosenthal; IV – cranial nerves (IV pair).

which provided a circular craniotomy measuring 80x60 mm with exposure of the sinus drain and contralateral supracerebellar infratentorial access with gravitational retraction of the cerebellum. The upper edge of the bone flap was located on the transverse sinus.

A semi-oval incision of the dura mater, reinforced with interrupted sutures, was made, which elevated the transverse sinuses and provided entry into the supracerebellar infratentorial plane. The sagging of the cerebellum widened the natural corridor to the

quadrigeminal cistern. Cerebrospinal fluid was drained from the cisterna magna, and the cerebellum was retracted by dissection of the arachnoid adhesions connecting the posterior superior border of the cerebellum to the outer edge of the tentorium. To access the free edge of the tentorium, the bridging veins between the cerebellum and the tentorium were divided. The arachnoid membrane dissection of the posterior edge of the quadrigeminal cistern was performed to visualize the dorsal part of the midbrain.

The supracerebellar infratentorial approach in the sitting position opens the anatomical plane so widely that dissection is significantly facilitated. Any discomfort from working with raised arms is compensated by the panorama without a retractor and the operative field cleared by gravity (Fig. 3A). Arachnoid dissection was performed, and large deep veins (V. Galen, internal cerebral veins, internal occipital veins, basal veins of Rosenthal, pericentral veins of the cerebellum) were identified. The contralateral approach allowed visualization of the IV pair of cranial nerves and the P3 segment of the posterior cerebral artery.

With a minimal incision in the dorsal part of the midbrain (Fig. 3B), the cavernoma was completely resected together with the surrounding subacute hematoma measuring $2 \times 3 \times 2.5$ cm (Fig. 3C). Hemostasis was achieved until the lavage water was clear. A hemostatic collagen sponge was placed in the cavernoma bed. The dura mater was sutured hermetically. The bone flap was fixed with threads. Layer-by-layer suturing of the wound was performed. An aseptic dressing was applied. The total blood loss was 250 ml.

A control CT scan in the postoperative period was performed on the third day; according to the study data, the condition after median suboccipital craniotomy, residual cavernoma, and repeated hemorrhage were not detected (Fig. 4A, B).

In the postoperative period, the patient's consciousness is clear (15 points on the Glasgow Coma Scale), diplopia and moderate pyramidal disorders disappeared on the 12th day. The course of the postoperative period is smooth, without the development of postoperative complications. The patient was discharged from the hospital on the 15th day after the surgical intervention.

The patient came for a follow-up examination and assessment of the long-term treatment results on February 18, 2025. During the examination, the patient's consciousness was clear. No sensory or motor disturbances were observed after the surgery. He was able to walk and take care of himself independently. The patient has fully recovered and returned to professional activities without any restrictions.

A MRI of the brain was undertaken on February 18, 2025, and here we can observe the brain's condition after removal of the cavernoma. The MR showed signs of postoperative gliosis changes. No residual cavernoma or recurrent hemorrhage was detected (Fig. 5A, B).

DISCUSSION

At present, one of the main issues in treating midbrain CM is determining the timing of the surgical intervention, be it in the acute or the subacute period.

In our case, the patient was operated on the 20th day after the primary hemorrhage. The cavernoma was located in the subacute hematoma, which made it easy to remove together with the cavernoma itself.

According to generally accepted practice and in line with our clinical experience, surgical treatment in the subacute stage of hemorrhage, when the hematoma is liquefied, is effective for maximum removal of the hematoma with minimal incision of the brainstem [13]. In such cases, a limited incision of the brainstem contributes to the most complete neurological recovery.

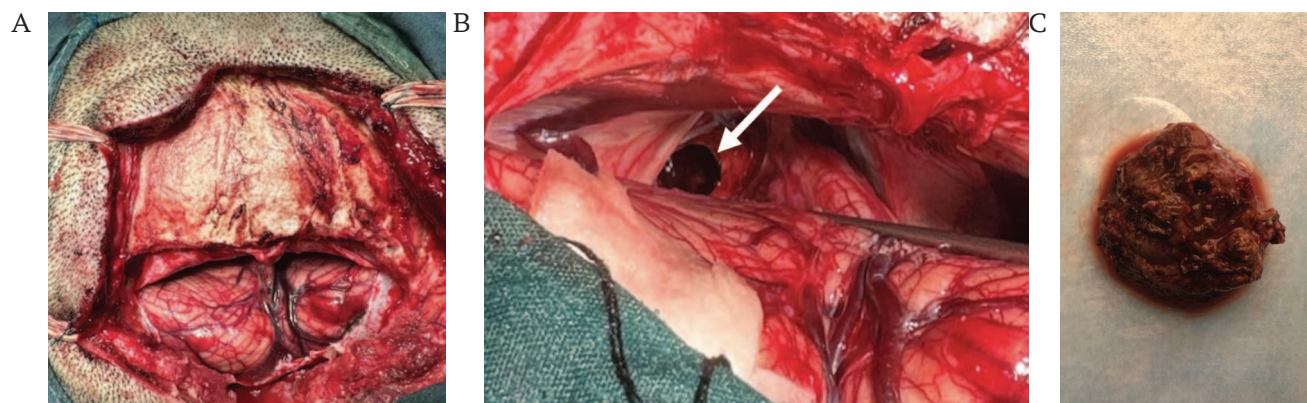


FIG. 3. Resection of the cavernous malformation of the midbrain peduncle via the supracerebellar infratentorial approach in a 38-year-old man (May 28, 2024).

- A. General view of the supracerebellar infratentorial approach after opening the dura mater.
 B. Incision of the dorsal part of the midbrain, approach to the cavernoma (arrow).
 C. Macro-preparation of the removed cavernoma $2 \times 3 \times 2.5$ cm.

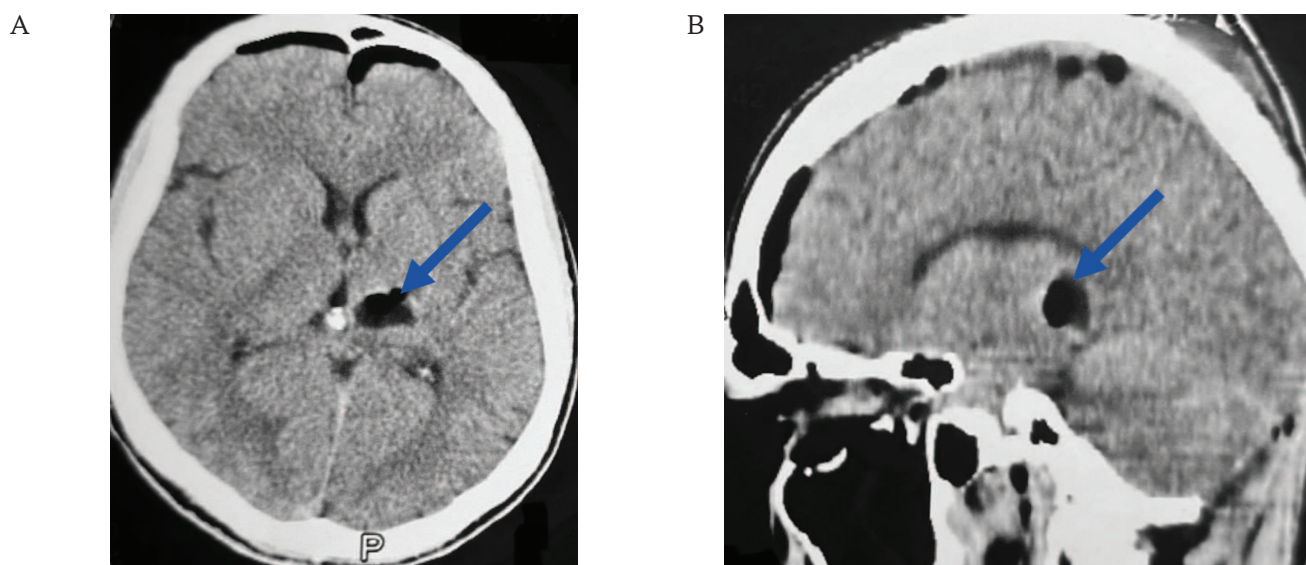


FIG. 4. Computed tomography of a 38-year-old patient on the 4th day after removal of a cavernous malformation in the dorsal part of the left peduncle of the midbrain (June 01, 2024).

A. Axial section: the cavernoma with the hematoma capsule is completely resected (arrow).

B. Sagittal section: the cavernoma with the hematoma capsule is completely resected (arrow).

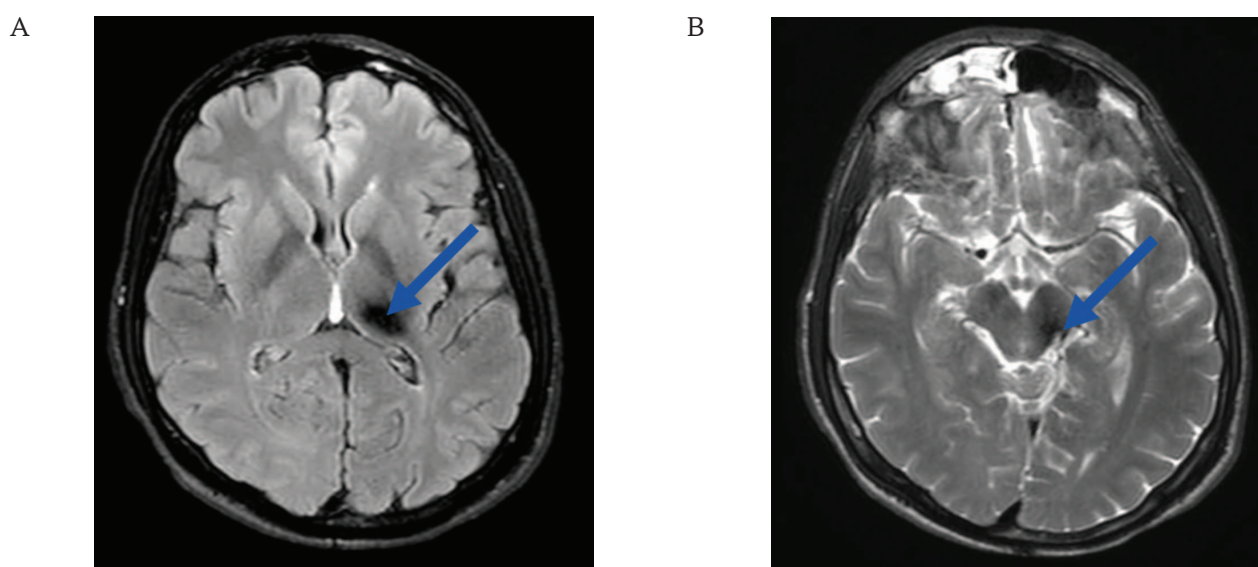


FIG. 5. Magnetic resonance imaging of the brain of a 38-year-old patient 9 months after resection of a cavernous malformation in the dorsal part of the left peduncle of the midbrain (February 18, 2025)

A, B. Axial sections: postoperative gliotic changes (arrows).

The next question concerns the choice of tactics for a safe approach to the midbrain area.

Dorsal lesions are localized in the zones of two thin horizontal lines immediately above and below the quadrigeminal plate. For their surgical treatment, supratentorial suboccipital, occipital transtentorial, supracerebellar infratentorial, posterior subtemporal and tonsillouveal transaqueductal approaches are used [14].

In the presented case, the infratentorial approach to the posterior fossa was used to remove the midbrain CM – this method is most often used by leading neurosurgeons around the world such as M. Lawton and R. Spetzler [3–5]. The two principal craniotomies were used to access the posterior fossa: retrosigmoid (lateral suboccipital) craniotomy and medial suboccipital craniotomy. The retrosigmoid supracerebellar approach was used to reach the lateral midbrain. The medial

suboccipital supracerebellar approach was used to reach the dorsal part of the midbrain and the quadrigeminal plate [15].

The surgical tactics used in the subacute period of hemorrhage from the cavernoma allowed for radical removal of the midbrain CM, ensuring complete neurological recovery of the patient. The patient was able to carry on with his work as usual and there were no signs of a reoccurring hemorrhage (the observation time was 6.5 months).

Knowledge of the brainstem corridors is necessary for planning microsurgical interventions on brainstem

formations so as to minimize the risk of damage to nearby structures.

CONCLUSION

The subacute phase of midbrain CM bleeding may be the best time for surgical resection of the cavernoma. The contralateral supracerebellar infratentorial approach is one of the available options for resection of dorsal midbrain CM. It can be considered if the formation is located behind the cerebral peduncle, facing the intrapeduncular fossa and interpeduncular cistern and extends to the dorsal side.

AUTHORS CONTRIBUTIONS

Narzullo O. Rahimov and Khurshed J. Rakhmonov performed surgical treatment and developed the concept of scientific work. Dzhumaboy R. Sanginov, Mahmarajab A. Khasanov developed the methodology for selecting and describing CT and MRI images. Narzullo O. Rahimov collected the material and analyzed the literature data. All authors approved the final version of the publication.

ВКЛАД АВТОРОВ

Н.О. Рахимов и Х.Д. Рахмонов провели хирургическое лечение и разработали концепцию научной работы. Д.Р. Сангинов, М.А. Хасанов отвечали за подбор и описание снимков КТ и МРТ. Н.О. Рахимов осуществил сбор материала и анализ литературных данных. Все авторы одобрили окончательную версию публикации.

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