

Exposure of the petrosal segment of the internal carotid artery as a method for preventing intraoperative bleeding during clipping of carotid-ophthalmic aneurysms: a clinical case

Vyacheslav V. Tkachev^{1,2}, Dmitry V. Litvinenko^{1,✉}, Arkady D. Fedorenko², Irina N. Sever²

¹Scientific Research Institute – Regional Clinical Hospital No. 1 named after professor S.V. Ochapovsky
167, 1 May str., Krasnodar, 350086, Russia

²Kuban State Medical University
4, Mitrofan Sedin str., Krasnodar, 350063, Russia

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GRAPHICAL ABSTRACT



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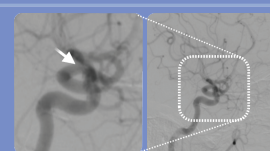
Summary

Temporarily clipping the internal carotid artery (ICA) in the carotid canal enables the risk of bleeding from the main surgical access to be controlled without isolating the neurovascular bundle of the neck. This reduces the traumatic nature of the operation and is preferable from a cosmetic point of view.

Diagnosis

46-year-old man
periodic headaches

A saccular aneurysm
of the right ophthalmic artery
measuring 4.0 x 3.9 mm with
a neck of 3.3 mm



March 13,
2025

Treatment

Mobilization and
temporary clipping of
the petrosal segment
of the ICA were
performed

The distal dural ring was
dissected, the dome and neck
of the aneurysm were exposed

Clipping of the
aneurysm of
the right
ophthalmic artery
was performed

The temporary clip
from the petrosal
segment of ICA was
removed

March 18,
2025

<https://youtu.be/EoHpNJ5TgcA>

Outcomes

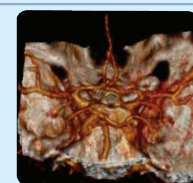


Clinical:

- No increase in neurological symptoms
- The patient was discharged for outpatient follow-up on the 9th day

Computed tomography angiography:

- Total clipping
- No residual aneurysm
- Cerebral blood flow not compromised



March 19,
2025

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Abstract

Microsurgical treatment of ocular artery aneurysms is classified as high-risk surgery. It is anatomically impossible to prevent and stop bleeding from ophthalmic aneurysms by applying a standard clip proximal to the aneurysm.

Case report. A 46-year-old man was admitted complaining of periodic headaches for 6 months. Outpatient magnetic resonance imaging revealed an aneurysm of the right internal carotid artery (ICA). According to computed tomography and cerebral angiography, an aneurysm of the ocular artery was verified. The patient chose an open surgery from the proposed treatment methods. Clipping of the aneurysm of the ocular artery mouth was performed by pterion access with an extradural extraction of the petrosal segment of the ICA to prevent intraoperative bleeding. The course of the postoperative period was smooth, without neurological symptoms, and the stitches were removed on the 9th day. The patient was discharged under outpatient supervision with a recommendation to control the radicality of clipping after 6 months.

Discussion. Temporary clipping of the ICA in the carotid canal during microsurgical operations for ocular artery aneurysms allows controlling the risk of bleeding from the main surgical access without isolating the neurovascular

bundle of the neck, which reduces the traumatic nature of the operation and is preferable from a cosmetic point of view.

Keywords: carotid-ophthalmic aneurysms; removal of the anterior oblique process; proximal bleeding control; petrosal segment of the internal carotid artery; internal carotid artery mobilization in the carotid canal

MeSH terms:

ANEURYSM – DIAGNOSTIC IMAGING
ANEURYSM – SURGERY
OPHTHALMIC ARTERY – DIAGNOSTIC IMAGING
OPHTHALMIC ARTERY – SURGERY
CAROTID ARTERY, INTERNAL – DIAGNOSTIC IMAGING
CAROTID ARTERY, INTERNAL – SURGERY
MICROSURGERY – METHODS
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CONTACT INFORMATION:

Dmitry V. Litvinenko, Cand. of Sci. (Medicine), neurosurgeon, Department of Neurosurgery No. 2, SRI – Regional Clinical Hospital No. 1 named after prof. S.V. Ochapovsky.

Address: 167, May 1 str., Krasnodar, 350086, Russia

E-mail: dlmalit73@yandex.ru

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Выделение петрозального сегмента внутренней сонной артерии как метод профилактики интраоперационного кровотечения при клипировании каротидно-офтальмических аневризм: клинический случай

В.В. Ткачев^{1,2}, Д.В. Литвиненко^{1,✉}, А.Д. Федоренко², И.Н. Север²

¹ ГБУЗ «Научно-исследовательский институт – Краевая клиническая больница № 1 имени профессора С.В. Очаповского» Министерства здравоохранения Краснодарского края
ул. 1 Мая, д. 167, г. Краснодар, 350086, Россия

² ФГБОУ ВО «Кубанский государственный медицинский университет»
Министерства здравоохранения Российской Федерации
ул. им. Митрофана Седина, д. 4, г. Краснодар, 350063, Россия

Аннотация

Микрохирургическое лечение аневризм глазной артерии относят к хирургии высокого риска. Профилактика и остановка кровотечения из офтальмических аневризм стандартным наложением клипса проксимальнее аневризмы анатомически невозможно.

Описание случая. Пациент 46 лет поступил с жалобами на периодические головные боли в течение шести месяцев. Амбулаторно на магнитно-резонансной томографии выявлена аневризма правой внутренней сонной артерии (ВСА). По данным компьютерно-томографической и церебральной ангиографий верифицирована аневризма глазной артерии. Пациент из предложенных методов лечения выбрал открытую операцию. Проведено клипирование аневризмы устья глазной артерии птериональным доступом с экстрадуральным выделением петрозального сегмента ВСА с целью профилактики интраоперационного кровотечения. Течение послеоперационного периода гладкое, без неврологической симптоматики, швы сняты на 9-е сутки. Пациент выписан под амбулаторное наблюдение с рекомендацией контроля радикальности клипирования через 6 месяцев.

Обсуждение. Временное клипирование ВСА в сонном канале при микрохирургических операциях по поводу аневризм глазной артерии позволяет контролировать кровотечение из основного операционного доступа – без выделения сосудисто-нервного пучка шеи, что снижает травматичность операции и является предпочтительным с косметической точки зрения.

Ключевые слова: каротидно-офтальмические аневризмы; удаление переднего наклоненного отростка; проксимальный контроль кровотечения; петрозальный сегмент внутренней сонной артерии; мобилизация внутренней сонной артерии в сонном канале

Рубрики MeSH:

АНЕВРИЗМА – ДИАГНОСТИЧЕСКОЕ ИЗОБРАЖЕНИЕ

АНЕВРИЗМА – ХИРУРГИЯ

ГЛАЗНАЯ АРТЕРИЯ – ДИАГНОСТИЧЕСКОЕ ИЗОБРАЖЕНИЕ

ГЛАЗНАЯ АРТЕРИЯ – ХИРУРГИЯ

СОННАЯ АРТЕРИЯ ВНУТРЕННЯЯ – ДИАГНОСТИЧЕСКОЕ ИЗОБРАЖЕНИЕ

СОННАЯ АРТЕРИЯ ВНУТРЕННЯЯ – ХИРУРГИЯ

МИКРОХИРУРГИЯ – МЕТОДЫ

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КОНТАКТНАЯ ИНФОРМАЦИЯ:

Литвиненко Дмитрий Викторович, кандидат медицинских наук, врач-нейрохирург нейрохирургического отделения № 2 ГБУЗ «НИИ – Краевая клиническая больница № 1 им. профессора С.В. Очаповского» Минздрава Краснодарского края

Адрес: ул. 1 Мая, д. 167, г. Краснодар, 350086, Россия

E-mail: dlmalit73@yandex.ru

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Abbreviations:

ICA – internal carotid artery

HIGHLIGHTS

Despite the development of endovascular methods, proximal bleeding control for carotid-ophthalmic aneurysms is carried out through open intervention.

Temporary clipping of the internal carotid artery in the carotid canal through the Kawase triangle effectively prevents intraoperative bleeding without accessing the neck vessels.

The proposed modified technique for proximal control in the carotid canal is anatomically gentle, since it preserves the auditory tube, greater petrosal and trigeminal nerves, does not require mobilization of the temporal lobe pole and reduces the risk of vascular wall injury.

Open exclusion of carotid-ophthalmic aneurysms is a non-trivial task due to the peculiarities of their anatomy [1], inaccessibility, difficulty in stopping possible bleeding from the aneurysm, as well as the risks of deterioration of visual functions [2]. Currently, the choice of treatment for ophthalmic aneurysms is intravascular interventions, but a significant proportion of patients continue to undergo open surgeries for various reasons [3].

The issue of prevention and effective control of bleeding remains a cornerstone of microsurgery for ophthalmic aneurysms. Proximal bleeding control is traditionally achieved by dissecting the cervical segment of the internal carotid artery (ICA), which de facto means performing an additional operation with potential complications and cosmetic defects [4]. The use of temporary clipping of the ICA in the carotid canal allows for the effective cessation of antegrade blood flow in the proximal segments of the ICA without dissection of the cervical neurovascular bundle, thereby reducing the trauma of the operation and the risks of perioperative complications and improving cosmetic results [5–7].

The aim of this case report is to demonstrate the experience of temporary clipping of the ICA in the carotid canal using an open approach during microsurgical exclusion of an aneurysm of the right ophthalmic artery.

CASE REPORT

A 46-year-old patient was admitted to the clinic of the Scientific Research Institute – Regional Clinical Hospital No. 1 named after Prof. S. V. Ochapovsky on March 13, 2025. The patient complained of periodic headaches that had been bothering him for the past six months. An outpatient magnetic resonance imaging scan of the brain revealed an aneurysm of the right ICA. The patient was hospitalized for digital subtraction cerebral angiography and surgical treatment. On examination: the neurological status without focal neurological symptoms, the somatic status without abnormalities. Computed tomography angiography and cerebral angiography verified a saccular aneurysm of the right ophthalmic artery measuring 4.0×3.9 mm with a neck of 3.3 mm (Fig. 1A–D).

After consultation with endovascular surgeons, the patient was offered a choice: endovascular treatment using an intracranial stent or open aneurysm exclusion. The potential risks of open and endovascular treatment were explained. The patient preferred open surgery and signed the relevant consent form.

Surgical technique

The operation was performed on March 18, 2025. A limited incision of the dura mater was made using the standard pterional approach. The cistern of the lateral cerebral fossa (Sylvian cistern) was opened to relax the brain. An extradural subfrontal approach was used to resect the lesser wing of the sphenoid bone and remove the anterior clinoid process. Hemostasis was achieved. After the final opening of the dura mater and dissection of the basal cisterns, the optic nerve, ICA, and aneurysm dome were identified.

An extradural subtemporal approach to the anterior surface of the temporal bone pyramid was performed to ensure proximal control of possible bleeding. The foramen spinosum and foramen ovale were identified. Partial peeling of the outer wall of the cavernous sinus was performed, exposing the mandibular nerve. The greater petrosal nerve was identified.

After skeletonization of the apex of the petrous bone and trepanation of the upper wall of the carotid canal (Fig. 2A), mobilization and temporary clipping of the petrosal segment of the ICA were performed (Fig. 2B). Then the distal dural ring was dissected, the dome and neck of the aneurysm were exposed (Fig. 2C). Clipping of the aneurysm of the right ophthalmic artery was performed (Fig. 2D). After checking the patency of the ophthalmic artery, coagulation of the aneurysm dome was performed. The temporary clip from the ICA was removed, hemostasis was achieved in the area of the petrosal segment of the ICA, and the surgical wound was sutured. A video of the operation is available at the link: <https://youtu.be/EoHpNJ5TgcA>.

The postoperative period was uneventful, with no increase in neurological symptoms. Follow-up computed tomography and computed tomography angiography scans performed one day after surgery (March 19, 2025) revealed no residual aneurysm (Fig. 3A–C). The wound healed by primary tension, the sutures were removed on the 9th day, and the patient was discharged for outpatient follow-up with a recommendation to check the radicality of clipping in 6 months.

DISCUSSION

Performing open surgeries on cerebral aneurysms is associated with an increased risk of intraoperative bleeding during dissection of the aneurysm dome and neck [8].

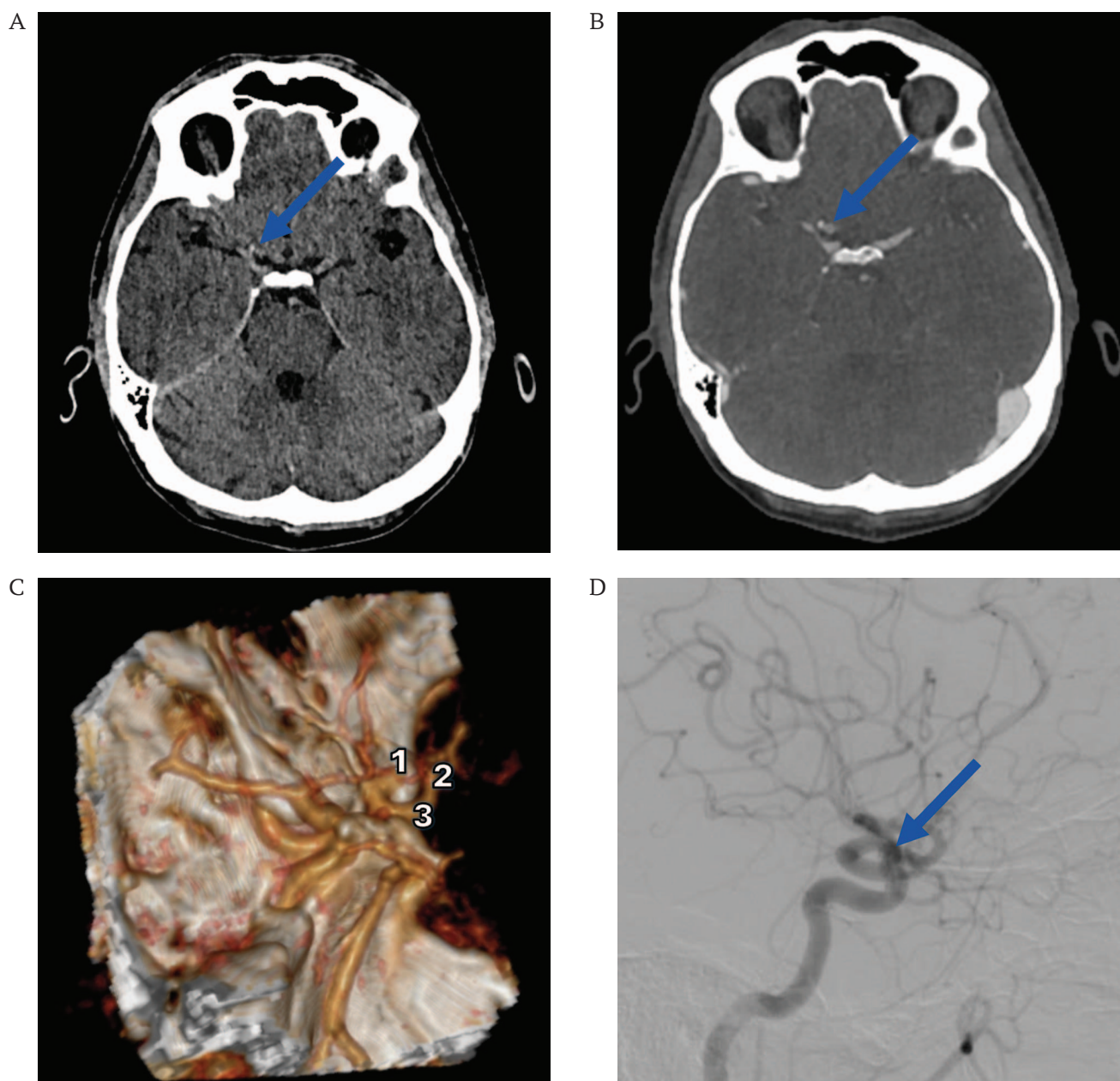


FIG. 1. Computed tomography (A), computed tomography angiography (B, C), and cerebral angiography (D) of a 46-year-old patient with an aneurysm of the ophthalmic artery orifice before surgery.

A, B. Axial section: aneurysm dome (arrow), no signs of hemorrhage.

C. 3D reconstruction: 1 – aneurysm dome, 2 – M2 segment of the middle cerebral artery, 3 – C7 segment of the internal carotid artery.

D. Lateral projection: aneurysm dome (arrow).

Patients with ophthalmic artery aneurysms, which are anatomically complex and difficult to access for surgery, are operated on mostly using intravascular methods. These include occlusion using microcoils: balloon and stent assistance, as well as the installation of flow-diverting devices [9–11].

In open surgery, prevention and control of bleeding from intradural and transit aneurysms of the ophthalmic segment of the ICA are particularly important, since routine application of temporary clips proximal to the

aneurysm is impossible due to anatomical conditions. To date, the main method for controlling bleeding from ophthalmic aneurysms remains the exposure of the bifurcation of the common carotid artery into the internal and external branches in the neck. This method of proximal control involves the use of a second surgical approach with possible complications: paresis of the vocal cords and tongue; hematoma in the surgical area, causing compression of the trachea and severe breathing difficulties, in some cases requiring intubation or

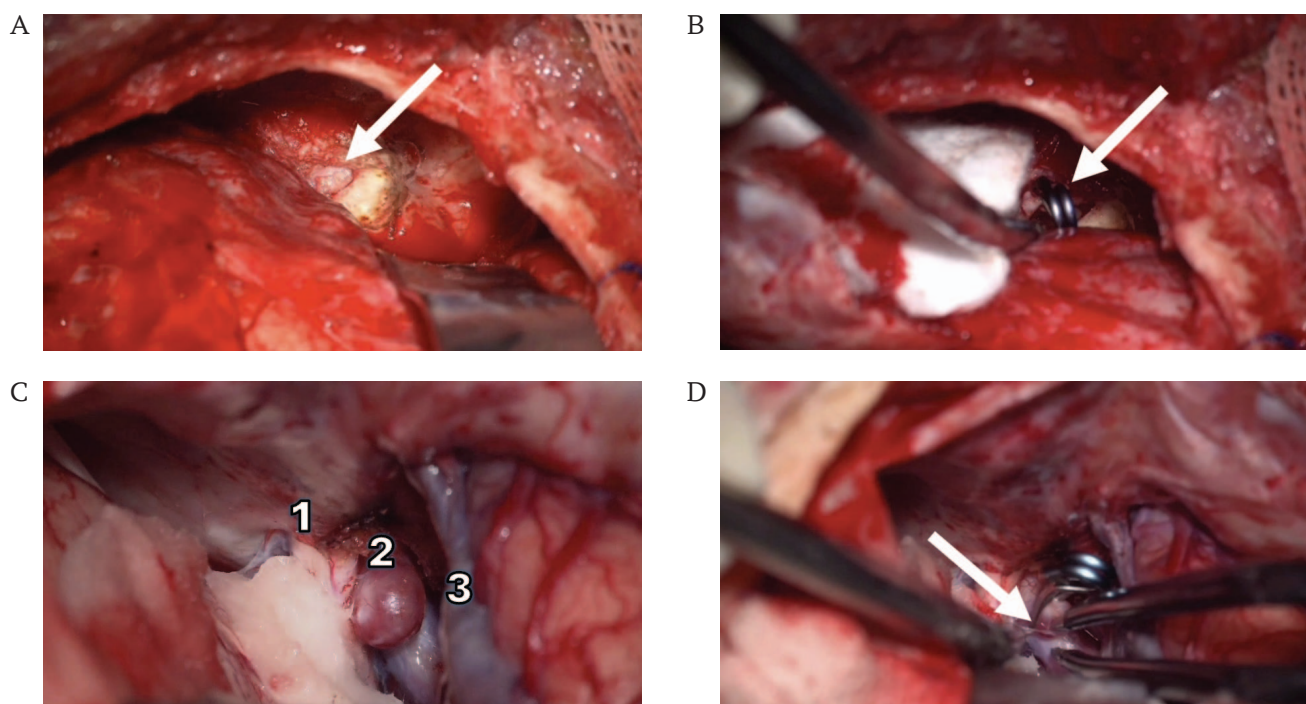


FIG. 2. Clipping of the aneurysm of the right ophthalmic artery orifice in a 46-year-old patient.

A. Removal of the superior wall of the carotid canal, exposure of the petrous segment of the internal carotid artery (arrow).

B. Temporary clipping of the C2 internal carotid artery (arrow).

C. Dissection of the aneurysm of the ophthalmic artery orifice: 1 – optic nerve, 2 – aneurysm dome, 3 – internal carotid artery.

D. Clipping of the ophthalmic artery aneurysm (arrow).

tracheostomy; dissection of the exposed arteries. Access to the neck vessels may be difficult or impossible in the presence of cicatricial adhesive process after previous surgery or radiation therapy [4].

Occlusion of the ICA in the neck often does not lead to complete cessation of antegrade blood flow through the ophthalmic segment, which is associated with the presence of distal anastomoses between the ICA and branches of other brachiocephalic arteries [12].

Methods for mobilizing the ICA proximal to its cerebral portion, in the ICA carotid canal, were proposed quite some time ago [6, 7], but they did not become widely used due to the complexity of their technical implementation and the presence of a number of shortcomings. The intradural access to the petrosal part of the ICA proposed by T.M. Wascher et al. [6], involved complete mobilization of the temporal lobe pole, which significantly increased the risk of developing venous cerebral infarction in the surgical area, and the use of a balloon catheter for occlusion of the ICA carried the risks of incomplete occlusion or excessive compression, leading to damage to the arterial wall.

In the technique described by L.N. Sekhar et al. [7], orbitomaxillofacial craniotomy was proposed for the isolation of the petrosal segment of the ICA, which made the operation more traumatic and worsened cosmetic results. In addition, in all cases, when drilling the carotid canal in the posterolateral

triangle (Glasscock triangle) required opening the bony part of the auditory tube, which increased the risk of developing inflammation of the middle ear inflammation and hearing loss. Both techniques involved transection of the greater petrosal nerve, creating a potential risk of complications due to denervation of the lacrimal gland on the access side.

In the described case, a modified method of proximal bleeding control was used (video) [5]. To perform this procedure, after standard pterional craniotomy, the upper wall of the carotid canal in the posteromedial triangle (Kawase triangle) is resected using an extradural approach. The roots of the trigeminal and greater petrosal nerves are preserved; the Eustachian tube, cochlea, and internal auditory canal remain intact. The ICA is mobilized in a sheath of periosteum lining the walls of the carotid canal, which minimizes its trauma, and occlusion of the ICA with clips with a specified degree of compression of their branches reliably stops blood flow without damaging the vascular wall.

CONCLUSION

The use of modern methods of proximal bleeding control during open surgery in patients with aneurysms of the ophthalmic segment of the ICA, including temporary clipping of the petrosal segment of the ICA, allows for the optimization of surgical technique. This results in increasing the safety of the intervention due to

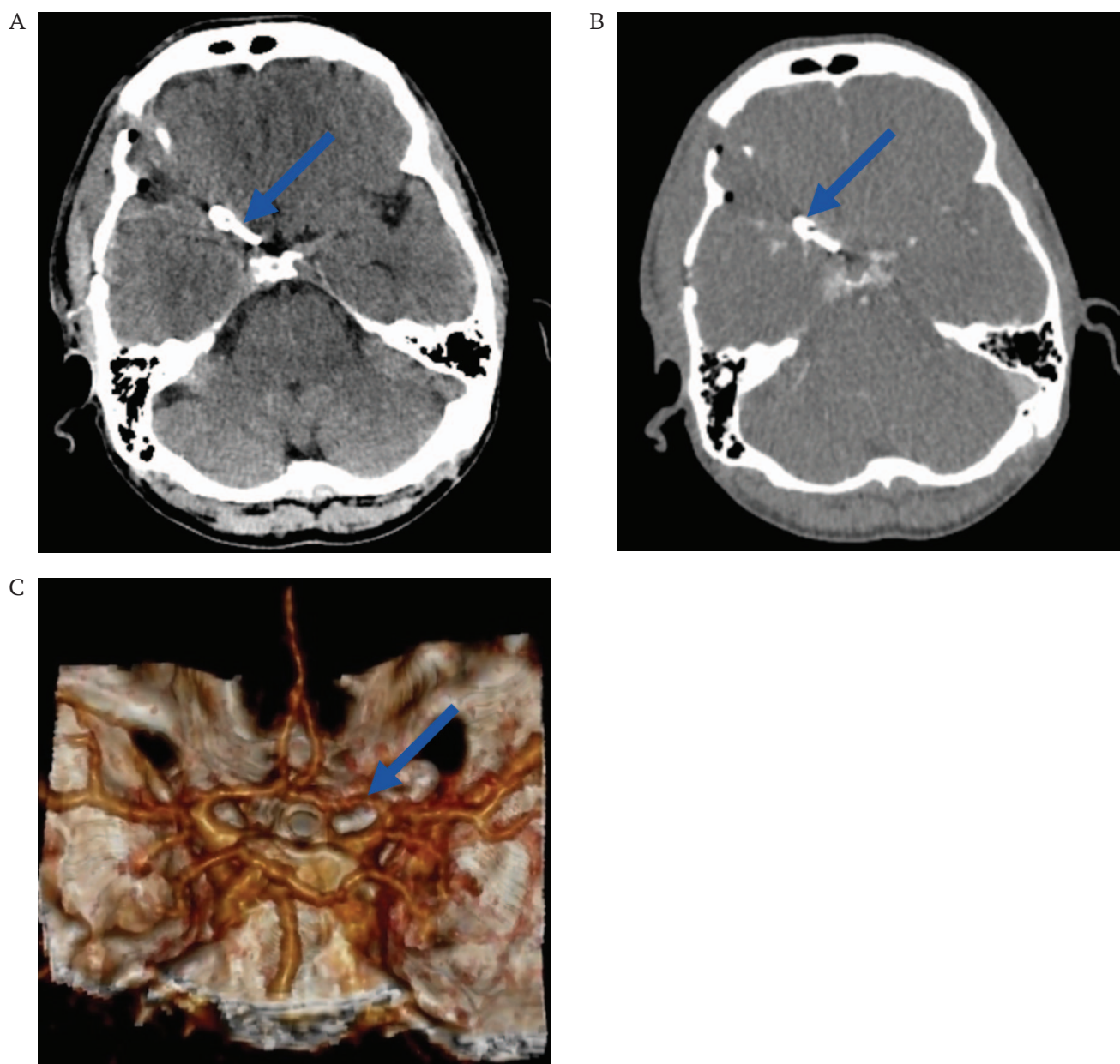


FIG. 3. Computed tomography (A), computed tomography angiography (B, C) of a 46-year-old patient with an aneurysm of the ophthalmic artery ostium 24 hours after surgery. Total clipping, cerebral blood flow not compromised.

A, B. Axial section: clip on the aneurysm (arrow).

C. 3D reconstruction: clip on the aneurysm (arrow).

the reliable prevention of bleeding, as well as minimizing the amount of tissue trauma, and improving cosmetic and

functional outcomes. All of these factors are important for the patient's quality of life.

AUTHOR CONTRIBUTIONS

Vyacheslav V. Tkachev performed the surgery, made the main contribution to the concept and design of the article, and supervised the writing and editing process. Dmitry V. Litvinenko, Arkady D. Fedorenko participated in the development of the concept and design of the article, writing and editing the text, as well as preparing illustrations and video. Irina N. Sever participated in the analysis of literature data, processing of illustrations and video, editing the text. All authors approved the final version of the article.

ВКЛАД АВТОРОВ

В.В. Ткачев выполнил хирургическую операцию, внес основной вклад в концепцию и дизайн статьи, а также руководил процессом написания и редактирования. Д.В. Литвиненко, А.Д. Федоренко участвовали в разработке концепции и дизайна статьи, написании и редактировании текста, а также подготовке иллюстраций и видео. И.Н. Север участвовала в анализе данных литературы, обработке иллюстраций и видео, редактировании текста. Все авторы одобрили окончательный вариант статьи и готовы взять на себя ответственность за все аспекты представленной публикации.

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INFORMATION ABOUT THE AUTHORS / ИНФОРМАЦИЯ ОБ АВТОРАХ

Vyacheslav V. Tkachev, Dr. of Sci. (Medicine), Professor, Department of Neurology and Neurosurgery, Associate Professor, Department of Surgery No. 1, Kuban State Medical University; Head of the Department of Neurosurgery No. 2, SRI – Regional Clinical Hospital No. 1 named after prof. S.V. Ochapovsky.
ORCID: <https://orcid.org/0000-0002-5600-329X>

Dmitry V. Litvinenko✉, Cand. of Sci. (Medicine), neurosurgeon, Department of Neurosurgery No. 2, SRI – Regional Clinical Hospital No. 1 named after prof. S.V. Ochapovsky.
ORCID: <https://orcid.org/0000-0002-4831-1874>

Arkady D. Fedorenko, resident, Department of Neurology and Neurosurgery, Kuban State Medical University.
ORCID: <https://orcid.org/0009-0004-1461-553X>

Irina N. Sever, postgraduate student, Department of Neurology and Neurosurgery, Kuban State Medical University.
ORCID: <https://orcid.org/0009-0008-4737-3994>

Ткачев Вячеслав Валерьевич, д-р мед. наук, профессор кафедры неврологии и нейрохирургии, доцент кафедры хирургии № 1 ФГБОУ ВО КубГМУ Минздрава России; заведующий нейрохирургическим отделением № 2 ГБУЗ «НИИ – Краевая клиническая больница № 1 им. профессора С.В. Очаповского» Минздрава Краснодарского края.
ORCID: <https://orcid.org/0000-0002-5600-329X>

Литвиненко Дмитрий Викторович✉, канд. мед. наук, врач-нейрохирург нейрохирургического отделения № 2 ГБУЗ «НИИ – Краевая клиническая больница № 1 им. профессора С.В. Очаповского» Минздрава Краснодарского края.
ORCID: <https://orcid.org/0000-0002-4831-1874>

Федоренко Аркадий Дмитриевич, ординатор кафедры неврологии и нейрохирургии ФГБОУ ВО КубГМУ Минздрава России.
ORCID: <https://orcid.org/0009-0004-1461-553X>

Север Ирина Николаевна, аспирантка кафедры неврологии и нейрохирургии ФГБОУ ВО КубГМУ Минздрава России.
ORCID: <https://orcid.org/0009-0008-4737-3994>

✉ Corresponding author / Автор, ответственный за переписку