Clinical case / Клинический случай
https://doi.org/10.47093/2218-7332.2026.17.1.1252

Superficial temporal artery to middle cerebral artery bypass in patient with atherosclerotic right internal carotid artery occlusive disease and impaired cerebral hemodynamics: a clinical case

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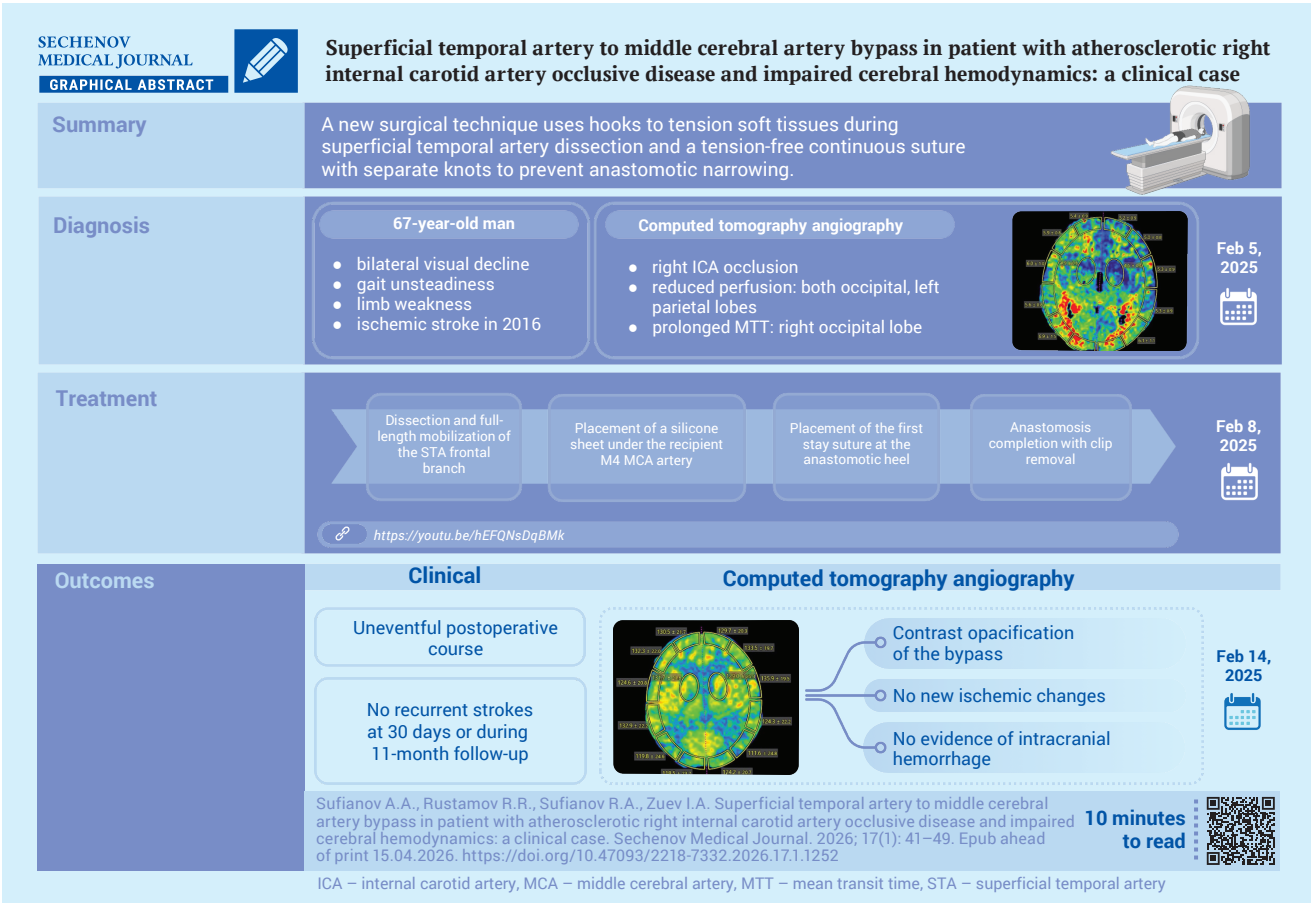

Abstract

Cerebral revascularization by superficial temporal artery (STA) to middle cerebral artery (MCA) bypass is performed in patients with moyamoya disease, complex aneurysms, and selected extra- and intracranial occlusive lesions to augment cerebral perfusion and potentially reduce the risk of ischemic complications and death.

Case report. A 67-year-old patient presented with severe visual impairment (mainly on the right), gait unsteadiness, episodic subjective limb weakness, and marked fatigue. He had a significant medical history, having suffered an

ischemic stroke in 2016 in the territory of the right MCA. A computed tomography angiography demonstrated occlusion of the right internal carotid artery and reduced cerebral blood flow in both occipital lobes and the left parietal lobe. An STA-MCA bypass anastomosis was performed. The postoperative course was uneventful; follow-up computed tomography angiography confirmed bypass patency without intracranial hemorrhage or new ischemic lesions, and a 10–15% increase in the cerebral blood volume index (up to 8.6 mL/100 g). No recurrent strokes were observed within 30 days and during 11 months of follow-up.

Discussion. Creation of an STA-MCA anastomosis may offer prospects for improving quality of life after ischemic stroke, including potential amelioration of post-stroke depression and other associated emotional disturbances.

Keywords: cerebral revascularization; extracranial-intracranial bypass; ischemic stroke; low flow bypass; cerebral blood volume

MeSH terms:

BRAIN ISCHEMIA – PHYSIOPATHOLOGY
BRAIN ISCHEMIA – SURGERY
TEMPORAL ARTERIES – SURGERY
CAROTID ARTERY, INTERNAL – SURGERY
MIDDLE CEREBRAL ARTERY – SURGERY
CEREBRAL REVASCULARIZATION – METHODS
ANASTOMOSIS, SURGICAL
CASE REPORTS

For citation: Sufianov A.A., Rustamov R.R., Sufianov R.A., Zuev I.A. Superficial temporal artery to middle cerebral artery bypass in patient with atherosclerotic right internal carotid artery occlusive disease and impaired cerebral hemodynamics: a clinical case. Sechenov Medical Journal. 2026; 17(1): 41–49. Epub ahead of print 15.04.2026. https://doi.org/10.47093/2218-7332.2026.17.1.1252

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Compliance with ethical standards. Consent statement. The patient consented to the publication of the article "Superficial temporal artery to middle cerebral artery bypass in patient with atherosclerotic right internal carotid artery occlusive disease and impaired cerebral hemodynamics: a clinical case" in the "Sechenov Medical Journal".
Conflict of interest. Albert A. Sufianov is a member of the editorial board and did not participate in the editorial review or decision-making on this article. Rakhmonzhon R. Rustamov, Rinat A. Sufianov, Ilya A. Zuev declare that there is no conflict of interest.
Financing. The study had no sponsorship (own resources).
Use of artificial intelligence. No artificial intelligence tools were used in the preparation of this manuscript.

Received: 21.09.2025
Accepted: 25.12.2025
Date of publication online: 15.04.2026
Date of publication: 29.05.2026

УДК 616.133.27-089.843

Обходной анастомоз поверхностной височной артерии к средней мозговой артерии при атеросклеротической окклюзии правой внутренней сонной артерии с нарушением церебральной гемодинамики: клинический случай

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Аннотация

Хирургическая реваскуляризация головного мозга посредством шунтирования поверхностной височной артерией (ПВА) и средней мозговой артерией (СМА) выполняется пациентам с болезнью моямоя, сложными аневризмами, окклюзионными заболеваниями экстра- и интракраниальных артерий с целью усиления церебральной перфузии и потенциального снижения риска ишемических осложнений и летального исхода.

Описание случая. Пациент 67 лет поступил с жалобами на выраженное снижение зрения (преимущественно справа), неустойчивость походки, эпизодическую слабость в конечностях и выраженную утомляемость. В 2016 году перенес острое нарушение мозгового кровообращения по ишемическому типу в бассейне правой СМА. По данным компьютерной томографической ангиографии выявлена окклюзия правой внутренней сонной артерии и снижение церебрального кровотока в обеих затылочных долях и левой теменной доле. Выполнен обходной анастомоз ПВА к СМА. Послеоперационный период протекал без осложнений; контрольная компьютерная томографическая ангиография подтвердила проходимость шунта при отсутствии внутричерепного кровоизлияния и новых ишемических очагов, а также отмечено увеличение индекса объема циркулирующей крови на 10–15% (до 8,6 мл/100 г). В течение 11 месяцев наблюдения рецидивов инсульта не зарегистрировано.

Обсуждение. Наложение анастомоза ПВА к СМА открывает перспективы для улучшения качества жизни пациентов после перенесенного ишемического инсульта, в том числе для коррекции постинсультной депрессии и других сопутствующих эмоциональных расстройств.

Ключевые слова: церебральная реваскуляризация; экстракраниально-интракраниальный шунт; острое нарушение мозгового кровообращения по ишемическому типу; низкопоточный анастомоз; объем мозгового кровотока

Рубрики MeSH:

МОЗГА ГОЛОВНОГО ИШЕМИЯ – ПАТОФИЗИОЛОГИЯ
МОЗГА ГОЛОВНОГО ИШЕМИЯ – ХИРУРГИЯ
ВИСОЧНЫЕ АРТЕРИИ – ХИРУРГИЯ
СОННАЯ АРТЕРИЯ ВНУТРЕННЯЯ – ХИРУРГИЯ
ЦЕРЕБРАЛЬНАЯ АРТЕРИЯ СРЕДНЯЯ – ХИРУРГИЯ
ЦЕРЕБРАЛЬНАЯ РЕВАСКУЛЯРИЗАЦИЯ – МЕТОДЫ
АНАСТОМОЗ ХИРУРГИЧЕСКИЙ
ОПИСАНИЕ СЛУЧАЕВ

Для цитирования: Суфианов А.А., Рустамов Р.Р., Суфианов Р.А., Зуев И.А. Обходной анастомоз поверхностной височной артерии к средней мозговой артерии при атеросклеротической окклюзии правой внутренней сонной артерии с нарушением церебральной гемодинамики: клинический случай. Сеченовский вестник. 2026; 17(1): 41–49. Epub ahead of print 15.04.2026. https://doi.org/10.47093/2218-7332.2026.17.1.1252

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Соблюдение этических норм. Заявление о согласии. Пациент дал согласие на публикацию представленной выше статьи «Обходной анастомоз поверхностной височной артерии к средней мозговой артерии при атеросклеротической окклюзии правой внутренней сонной артерии с нарушением церебральной гемодинамики: клинический случай» в журнале «Сеченовский вестник».
Конфликт интересов. А.А. Суфианов – член редакционной коллегии, не принимал участия в редакционном рассмотрении и принятии решений по данной статье. Р.Р. Рустамов, Р.А. Суфианов, И.А. Зуев заявляют об отсутствии конфликта интересов.
Финансирование. Исследование не имело спонсорской поддержки (собственные ресурсы).
Использование искусственного интеллекта. Инструменты искусственного интеллекта не использовались при подготовке данной рукописи.

Поступила: 21.09.2025
Принята: 25.12.2025
Дата публикации онлайн: 15.04.2026
Дата печати: 29.05.2026

Abbreviations:

CT – computed tomography
ICA – internal carotid artery
MCA – middle cerebral artery
STA – superficial temporal artery

HIGHLIGHTS	КЛЮЧЕВЫЕ ПОЛОЖЕНИЯ
Superficial temporal artery-middle cerebral artery bypass is technically feasible in patients with ischemic stroke, with potential to improve post-stroke quality of life.	Экстра-интракраниальный микроанастомоз между поверхностной височной артерией и средней мозговой артерией технически выполним у пациентов с ишемическим инсультом и потенциально может способствовать улучшению качества жизни в постинсультном периоде.
A modified superficial temporal artery dissection using hooks helps to achieve adequate soft-tissue tension and facilitate vessel mobilization.	Модифицированная диссекция поверхностной височной артерии с использованием крючков позволяет создать адекватное натяжение мягких тканей и облегчить мобилизацию сосуда.
Applying a continuous suture to one edge of the vessel without tension and tying individual knots prevents the anastomosis from narrowing.	Наложение непрерывного шва по одному краю сосуда без натяжения с последующим завязыванием отдельных узлов предотвращает сужение анастомоза.

Internal carotid artery (ICA) occlusion accounts for 15-20% of ischemic strokes and carries substantial risk of recurrent cerebrovascular events despite optimal medical management. Atherosclerotic ICA occlusion causes approximately 10% of transient ischemic attacks and 15% to 25% of ischemic strokes in the carotid territory [1–3]. The 2-year risk of subsequent ipsilateral ischemic stroke while a patient receives medical therapy is 10% to 15% [4]. While endovascular techniques address acute occlusions, chronic ICA occlusion remains resistant to recanalization, necessitating alternative revascularization approaches.

Extracranial-intracranial arterial bypass surgery was developed to prevent subsequent strokes by improving hemodynamics distal to the occluded artery [5, 6]. In 1985, a randomized trial demonstrated no benefit of this surgery in 808 patients with symptomatic carotid artery occlusion [6–8]. This trial was criticized for failing to identify the subgroup of patients with hemodynamic cerebral ischemia due to poor collateral circulation for whom surgical revascularization might be of greatest benefit [3, 5, 9]. Contemporary neuroimaging, e.g. positron emission tomography, single photon emission computed tomography, computed tomography (CT) / magnetic resonance perfusion, enables precise identification of patients with hemodynamic cerebral ischemia. The Japanese extracranial-intracranial Bypass Trial and Carotid Occlusion Surgery Study demonstrated potential benefit in highly selected patients with severe hemodynamic compromise and increased oxygen extraction fraction, underscoring the importance of rigorous assessment and technical expertise [10, 11].

The aim of this case report is to demonstrate the experience of superficial temporal artery (STA) to

middle cerebral artery (MCA) bypass in a patient with atherosclerotic right ICA occlusive disease and impaired cerebral hemodynamics.

CASE REPORT

A 67-year-old man was admitted to the Cerebrovascular Pathology Department of Federal Center of Neurosurgery (Tyumen, Russia) on February 5, 2025, for evaluation of progressive bilateral visual loss (more on the right) and gait unsteadiness with staggering. He also reported intermittent subjective weakness in the arms and legs, generalized asthenia, and easy fatigability for a prolonged period. His medical history included an ischemic stroke in 2016 in the territory of the right MCA. Cardiovascular comorbidities comprised ischemic heart disease and atherosclerotic heart disease, post-infarction cardiosclerosis (since 2012), status post percutaneous transluminal coronary angioplasty with stent implantation, and stage III arterial hypertension.

On neurologic examination, consciousness was clear; memory was mildly reduced. Meningeal signs were absent. Cranial nerve assessment demonstrated marked bilateral visual impairment, more pronounced on the right. The range of motion in the limbs and trunk was preserved; muscle strength was symmetric (Medical Research Council grade 5/5 in both upper and lower extremities), despite episodic hand clumsiness (difficulty holding cutlery) and transient leg "weakness" by history. Sensory modalities were intact. Muscle tone was normal and symmetric (D=S). Deep tendon reflexes were brisk and symmetric in the upper and lower limbs; pathological reflexes were absent. He was unstable in the Romberg position. No clinically relevant abnormalities were detected on autonomic nervous system assessment;

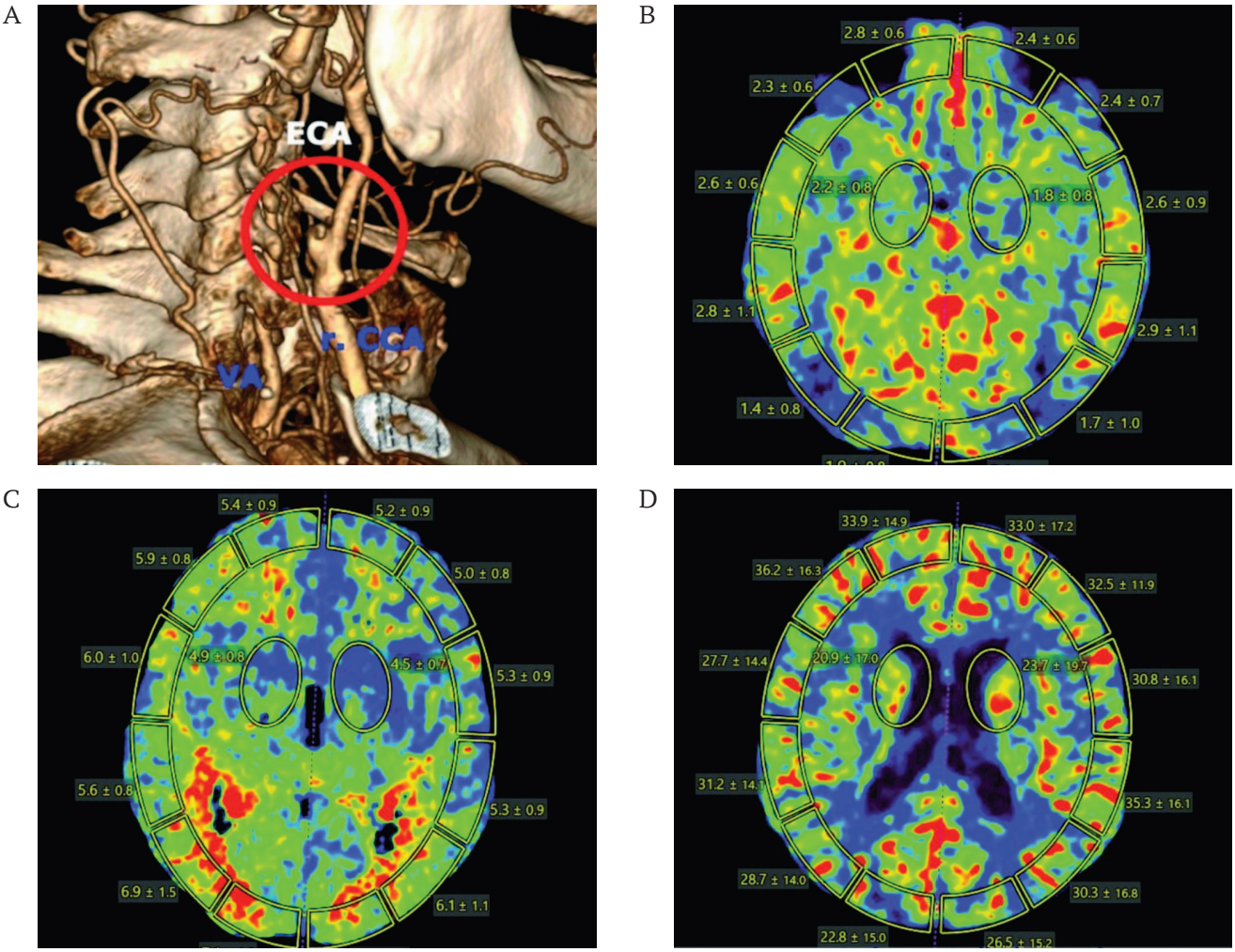

FIG. 1. Computed tomography angiography of the brachiocephalic and cerebral arteries, February 5, 2025 (A), brain computed tomography perfusion, February 6, 2025 (B, C, D) before surgery.
A. Occlusion of the right internal carotid artery.
B. Decreased cerebral blood flow in the right occipital lobe.
C. Decreased cerebral blood volume in the right occipital lobe.
D. Increase mean transit time in the right occipital lobe.
Note: CCA – common carotid artery; ECA – external carotid artery; VA – vertebral artery.

the somatic status was notable for generalized weakness and fatigue.

CT angiography of the brachiocephalic and cerebral arteries revealed occlusion of the right ICA (Fig. 1A). Brain CT perfusion demonstrated decreased cerebral blood flow and cerebral blood volume in both occipital lobes and in the left parietal lobe, together with prolonged mean transit time in the right occipital lobe (Fig. 1B–D).

The diagnosis was atherosclerosis of the brachiocephalic and cerebral arteries with occlusion of the right ICA; stenosis of the right common carotid artery up to 60% according to European Carotid Surgery Trial (ECST) criteria [11]; stenosis of the left ICA up to 30%; and 70% stenosis of the intracranial segment of the left ICA, complicated by vestibulo-ataxic syndrome.

Surgical technique

The STA was marked preoperatively with Doppler ultrasonography. With the patient in the supine position, the head was rotated to the left and rigidly fixed in a Mayfield clamp. A skin incision was made along the course of the STA. The wound edges were retracted with skin hooks to optimize exposure. Layer-by-layer dissection of the subcutaneous tissue was performed over the course of the STA. The frontal branch was dissected and mobilized along its accessible length. Both frontal and parietal branches of the STA were isolated (Fig. 2A). A frontotemporal (dermofascial) flap was then elevated over the temporalis muscle. The temporalis fascia was incised, and the temporalis muscle was split and retracted to expose the calvarium.

A standard craniotomy was performed, and the dura mater was opened in a curvilinear fashion. Under the operating microscope, a cortical recipient vessel corresponding to the M4 segment of the right MCA was identified and sharply dissected from the arachnoid adhesions. The recipient artery was mobilized sufficiently to allow microsurgical manipulation, and a silicone background sheet was placed beneath the vessel (Fig. 2B).

The donor STA branch was prepared by gentle adventitial dissection and irrigation with heparinized saline. The distal end was trimmed in a fish-mouth configuration to match the arteriotomy. After systemic heparinization according to institutional protocol, temporary microvascular clips were applied proximally and distally on the recipient artery. The intended

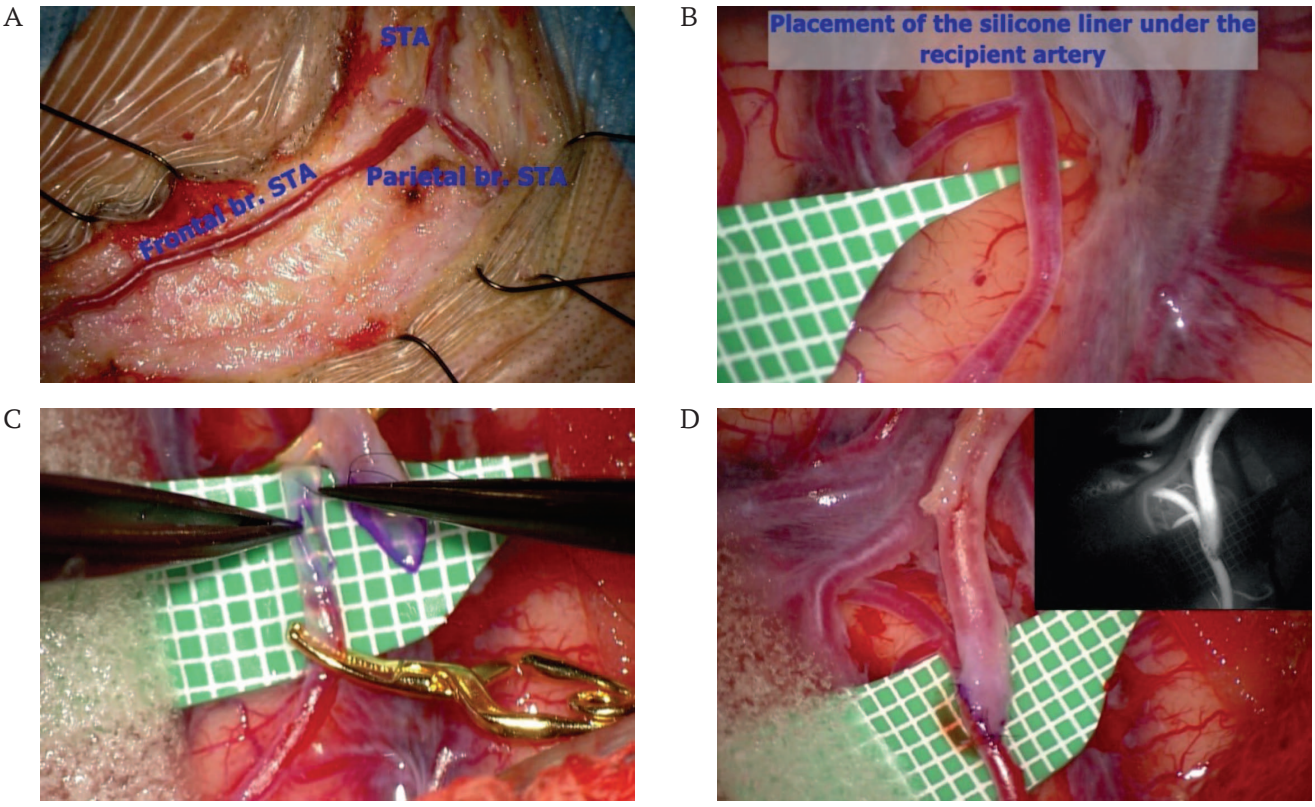

FIG. 2. Bypass anastomosis of the superficial temporal artery to the middle cerebral artery.
A. Frontal branch of the superficial temporal artery was dissected and mobilized along its entire length.
B. A silicone background sheet was positioned beneath the recipient cortical artery.
C. Placement of the first stay suture at the heel of the anastomosis.
D. Completion of the anastomosis: final sutures placed, and temporary clips removed; intraoperative indocyanine green video-angiography confirmed bypass patency and flow.
Note: STA – superficial temporal artery.

arteriotomy margins were marked, and a linear arteriotomy was performed.

An end-to-side STA–MCA anastomosis was constructed using standard microsurgical technique (Fig. 2C). Stay sutures were placed at the heel and tip to secure alignment and prevent torsion. The anastomosis was completed with sequential suturing along both vessel walls; in this case, a running technique with intermittent knot tying after division of the suture line was employed. Throughout the anastomosis, the field was continuously irrigated with heparinized saline to prevent desiccation of the intima and reduce the risk of thrombosis. The opposite wall was closed in a similar fashion, and the suture line was inspected for gaps and intimal inversion. A video of the operation is available at the link: https://youtu.be/hEFQNsDqBMk

Following completion, the temporary clips were removed to re-establish flow in the donor and recipient vessels. Intraoperative indocyanine green video-angiography confirmed immediate patency and antegrade flow through the bypass (Fig. 2D). Doppler ultrasonography further verified graft flow and anastomotic integrity (Fig. 3A–B). Postoperative CT angiography demonstrated contrast opacification of the bypass without evidence of intracranial hemorrhage or new ischemic changes. On follow-up imaging, perfusion assessment showed a moderate increase in the cerebral blood volume index by approximately 10–15%, reaching 8.6 mL/100 g (Fig. 3C–D).

DISCUSSION

In this case, the surgery was followed by an uneventful postoperative course with radiological confirmation of bypass patency on CT angiography and no evidence of intracranial hemorrhage or new ischemic lesions. Perfusion imaging performed on postoperative day 6

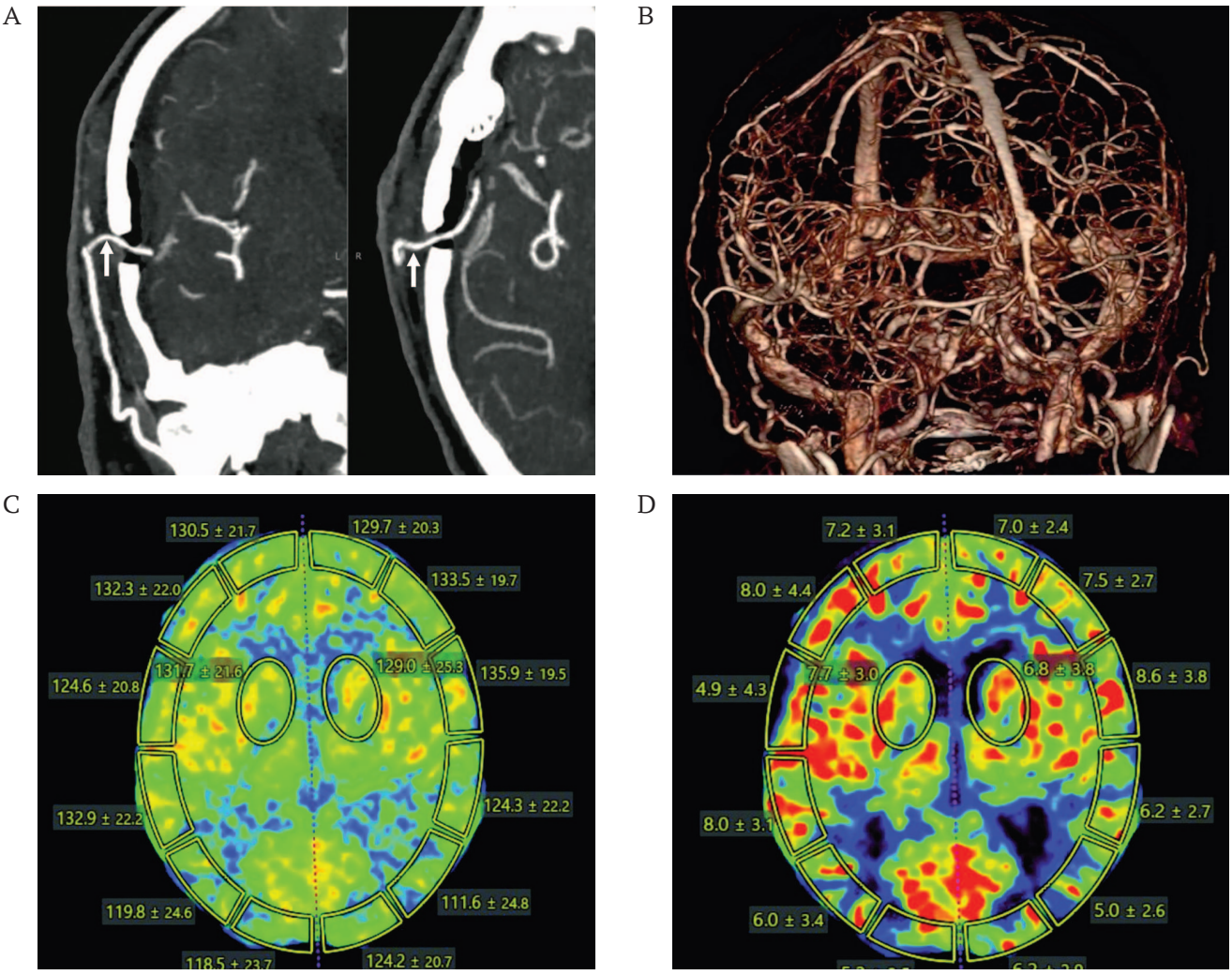

FIG. 3. Postoperative computed tomography angiography (A, B) and computed tomography perfusion (C, D) obtained 6 days after surgery.
A. Coronal and axial reconstructions demonstrating contrast opacification of the superficial temporal artery–middle cerebral artery bypass microanastomosis (white arrows).
B. 3D reconstruction of the cerebral arteries without radiologic evidence of intracranial hematoma or acute ischemic changes.
C, D. Increased cerebral blood volume in the right occipital lobe.

demonstrated a moderate increase in the cerebral blood volume index in the right occipital lobe. Although cerebral blood volume is an indirect surrogate of hemodynamic improvement and should be interpreted together with additional perfusion parameters, the observed direction of change is consistent with improved collateral supply after flow augmentation. Clinically, no recurrent strokes were observed within 30 days and during 11 months of follow-up which supports technical feasibility and short- to mid-term safety of the procedure in this highly selected patient with documented preoperative hemodynamic impairment.

The STA-MCA bypass technique developed by M.G. Yaşargil and R.M.P. Donaghy in the 1960s was rapidly adopted throughout the world as a procedure for surgical flow augmentation for ischemic cerebrovascular disease. The initial enthusiasm for revascularization in atherosclerotic cerebrovascular disease was substantially tempered by the landmark 1985 Extracranial-intracranial Bypass Study Group trial demonstrating failure to reduce stroke risk in 1377 patients with symptomatic disease [4]. Despite high graft patency and improved hemodynamic metrics, perioperative stroke and death rates in early trials were substantial, limiting net clinical benefit. Subsequently, the Carotid Occlusion Surgery Study reported by Powers et al. in 2011 attempted to identify patients with hemodynamic compromise through elevated oxygen extraction fraction on positron emission tomography imaging, but demonstrated no benefit of bypass over medical therapy with a 21% stroke rate at 2 years in the surgical group compared to 23% in medical therapy, complicated by 15% perioperative stroke rate [8–10].

In contrast, moyamoya disease has emerged as a clear indication for revascularization, with the Japan Adult Moyamoya Trial demonstrating that direct bypass prevents ischemic strokes and may reduce hemorrhagic risk by offloading hemodynamic stress from fragile moyamoya vessels [12]. Another established indication is flow preservation when planned vessel sacrifice is necessary for complex aneurysms or skull base tumors, though balloon test occlusion has limitations with approximately 3.7% ischemic events occurring despite passing BTO [2, 4, 10, 11, 13].

Technical approaches of bypass surgery are divided into low-flow and high-flow constructs. STA-MCA anastomosis remains the most widely employed low-flow technique, providing flows of 30–50 mL/min through end-to-side anastomosis using 10-0 or 11-0 microsutures with temporary recipient vessel occlusion for 25–40 minutes [3, 6]. The number of research articles reassessing bypass surgery with appropriate indications and high quality of care has recently increased, and carotid artery and MCA occlusion surgery studies designed with careful consideration for several criticisms against Carotid Occlusion Surgery Study are now being conducted in many countries [10, 13].

CONCLUSION

This case illustrates the technical feasibility of an STA-MCA bypass in a patient with chronic carotid occlusion and documented hemodynamic impairment. This procedure may offer potential quality-of-life benefits after stroke, including improvement of post-stroke depressive symptoms and other emotional disturbances, although such outcomes require systematic assessment. We demonstrate a modified technique for STA dissection using hooks to achieve adequate soft-tissue tension. In addition, a continuous suturing along one edge without tension combined with individually tied knots may help prevent anastomotic narrowing. Collectively, these technical nuances may facilitate STA–MCA bypass construction, enhance surgeon confidence, and potentially reduce procedure-related complications.

AUTHOR CONTRIBUTIONS

Albert A. Sufianov performed the surgical procedure described in the submitted publication, made a major contribution to its conception and design, and supervised the writing and editing of the scientific article. Rakhmonzhon R. Rustamov, Rinat A. Sufianov and Ilya A. Zuev contributed to the conception and design of the publication, prepared materials, wrote and edited the text, and created the illustrations and video. All authors approved the final version of the article and take responsibility for all aspects of the submitted work.

ВКЛАД АВТОРОВ

А.А. Суфианов выполнил хирургическую операцию, описанную в представленном клиническом случае, внес основной вклад в концепцию и дизайн, а также руководил процессом написания и редактирования статьи. Р.Р. Рустамов, Р.А. Суфианов и И.А. Зуев участвовали в разработке концепции и дизайна статьи, подготовке материалов, написании и редактировании текста, а также подготовке иллюстраций и видео. Все авторы одобрили окончательный вариант статьи и готовы взять на себя ответственность за все аспекты представленной публикации.

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