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Can surgical embolectomy or bypass surgery be the first treatment option in ischemic cerebrovascular pathologies?

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ABSTRACT

Aims: Well-established treatment methods have been utilized for intracerebral vascular occlusion, including medical thrombolytic treatments, endovascular interventions, and surgical procedures. We aimed with this study to show rapid and first-line surgical treatment is good option for recanalization.

Methods: This study focused on surgical recanalization techniques, illustrating them through seven patients. In emergency scenarios at our hospital, late term thromboembolectomy was performed on three patients who had experienced thromboembolic events. The other two patients were treated not in emergency conditions, but with by-pass surgery in the following week. Last two patients were in the group of patients who had reperfusion with recanalization surgery due to chronic ischemic intracerebral processes with clinical symptoms. This study was done retrospectively.

Results: One of the patient underwent emergency surgery for total infarction of the internal carotid artery (ICA), which remained unresponsive to other therapeutic approaches. Similarly, the second patient, who had undergone heart transplantation, required surgery due to unyielding small atheroma plaques originating from the main arteries after failed thrombolytic treatments. Similarly, after cardiac surgery, the patient who had a complete blockage at the bifurcation point of the right anal artery with an atheroma plaque was taken into emergency surgery. Successful recanalization procedures were achieved in three cases. Among the other patients who underwent semi-emergency surgery, one patient with internal carotid artery insufficiency after a traumatic process, another patient with left hemisphere vascular insufficiency after vascular disease, and another two patients who had vascular insufficiency due to occlusion of the main vascular structure by an aneurysm thrombus were operated on.

Conclusion: Our findings suggest that surgical intervention could be considered as the primary treatment option in selected cases for managing acute stroke or vascular insufficiency. In selected patients, rapid and first-line surgical treatment is satisfactory. This approach aligns with the need for more comprehensive investigations to determine the optimal approach in different scenarios of intracerebral vascular occlusion.

Keywords: Intracranial bypass, neurosurgery, recanalization surgery, stroke

INTRODUCTION

Intracerebral vascular occlusion necessitates well-established treatment strategies that have been in practice for an extended period. These interventions encompass medical thrombolytic treatments, intra-arterial thrombolytic, endovascular therapies, surgical embolectomy, and recanalization/bypass alternatives.[1,2] Among these, medical thrombolytic treatments, including tissue plasminogen activator (tPA), are the most common and easily accessible options. However, their success rates are modest. In contrast, endovascular methods have garnered favor due to their comparatively higher rates of treatment success and reduced invasiveness.

Surgical embolectomy and bypass procedures were historically recognized approaches in this context, preceding the advent of contemporary methods. Nonetheless, their popularity has waned due to their invasive nature and the requisite expertise. Earlier literature suggests limited efficacy in terms of clinical improvement associated with these approaches. However, recent studies conducted by Tetsuyoshi and Tomohiro present results that challenge this perspective, particularly in carefully selected patient populations.[1,2]

As a response to these evolving dynamics, our study aims to reevaluate the role of surgical procedures, with an emphasis on their efficacy in clinical practice. We seek to contribute to a more nuanced understanding of the optimal treatment strategies for intracerebral vascular occlusion.

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METHODS

The study was carried out with the permission of Akdeniz University Faculty of Medicine Clinical Researches Ethics Committee (Date: 23.08.2023, Decision No: KAEK-684). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Study Design and Participants

This study involved the retrospective analysis of seven patients who underwent late-term thromboembolectomy with or without by- pass as part of emergency surgical interventions for thromboembolic or vascular events at our hospital. This study was done retrospectively.

Patient 1: A 72-year-old male patient presented to the emergency department with acute aphasia, right hemiplegia, and syncope. Neurological examination prompted Computed Tomography (CT) and CT angiography assessments. CT angiography revealed complete occlusion of the left Internal carotid artery (ICA), left anterior cerebral artery (ACA), and middle cerebral artery (MCA). Given the high risk of bleeding due to extensive infarct area, medical thrombolytic treatment was excluded as an option The endovascular treatment failed to remove thrombus. The patient was subjected to emergency decompressive surgery involving thrombectomy and a superior temporal artery (STA)-MCA bypass procedure. A left frontotemporoparietal decompressive craniotomy was executed, followed by extensive Dural opening. Microsurgical Sylvain dissection facilitated access to the left MCA bifurcation. Utilizing the left STA, an end-to-side bypass was established between the STA and MCA M2 superior division. Intraoperative doppler ultrasound verified vascular anastomosis viability and distal MCA segment blood flow after bypass (Figure 1). Postoperatively, the patient exhibited improved aphasia and reduced hemiplegia to 3/5 strength. A follow-up CT angiography, conducted 24 hours' post-surgery, confirmed functional vascular anastomosis and blood flow in the left MCA feeding region.

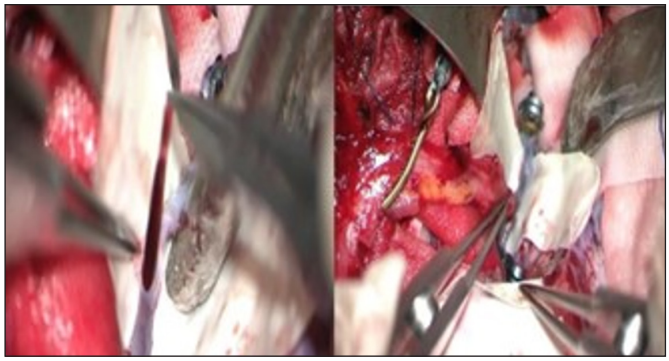

Figure 1. Intraoperative picture of thrombectomy and bypass procedure.

Patient 2: A 38-year-old male patient presented with left hemiplegia six hours after heart transplantation. Brain CT revealed extensive infarction, edema, and midline shift in the right hemisphere. CT angiography indicated absent vascular flow in the right MCA bifurcation, the right distal Anterior cerebral artery's A3 segment, and the right posterior cerebral artery's (PCA) P3 segment, attributed to micro emboli. Emergency a right frontotemporoparietal decompressive craniectomy and embolectomy were performed, and dura was widely opened. During surgery, intervention focused on the MCA artery occlusion, facilitated by the accessible edematous brain tissue. A vertical incision was made on the MCA to remove the plaque causing the obstruction. Restoration of flow obviated the need for bypass, and the vessel was closed with a primary suture. Due to the limited feasibility of other vessels, the procedure concluded with duraplasty and cranial bone retention for decompression (Figure 2). A subsequent CT angiography, conducted 24 hours after surgery, indicated restored blood flow in the right MCA feeding area. However, the extensive infarct area in the feeding territories of the right ACA and PCA persisted.

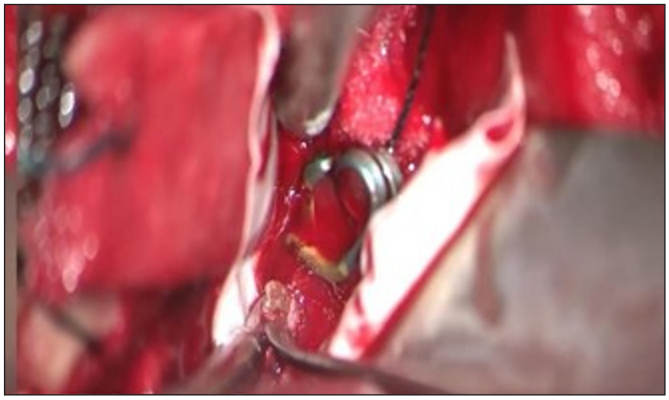

Figure 2. Intraoperative picture of embolectomy.

Over two months, the patient's hemiplegia gradually improved to 3/5 strength.

Patient 3: A-24 years old male patient presented with post-traumatic right-sided hemiparesis. CT angiography was performed after Subarachnoid hemorrhage was seen on computed tomography. The patient had right posterior communicating artery aneurysm and also vascular insufficiency due to dissection of the left internal carotid artery. (Figure 3) Because of the patient's left anterior cerebral artery was hypoplastic, all feeding area on the left side was via the left carotid artery and the flow in this artery did not provide adequate cerebral nutrition. The urgent by-pass surgery procedure performed to patient. After the surgery, clinical hemiparesis improved 3/5 to 5/5 strength.

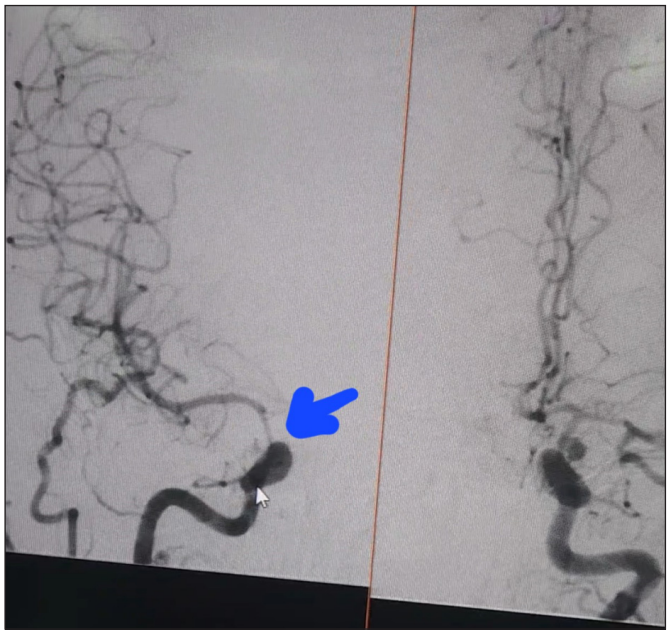

Figure 3. Selective Cerebral angiography of stenotic internal cerebral artery and successful bypass

Patient 4: A 64-year-old male patient was admitted to the emergency department due to a giant aneurysm in the left middle cerebral artery that caused thrombus. The patient had right hemiplegia and speech disorder due to insufficiency in the middle cerebral artery irrigation area. Surgery was performed on the patient under urgent conditions. The aneurysm was excised. The thrombus obstructing the middle cerebral artery was removed. (Figure 4) Recanization was achieved. In the first month after the operation, the patient improved to 3/5 hemiparesis. But speech disorder did not improve.

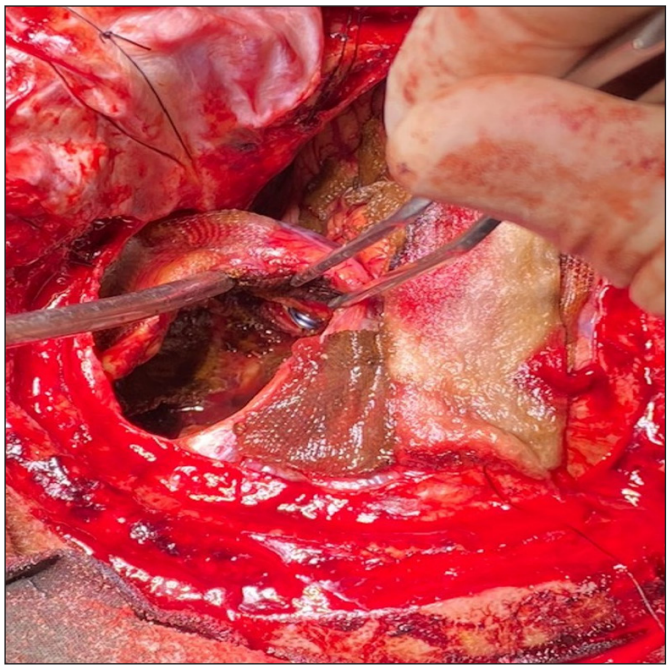

Figure 4. Intraoperative picture of thrombus in aneurysm

Patient 5: 35 years old female patient presented severe headache and right hemiparesis and seizure. The CT Angio and selective cerebral angiography demonstrated, left internal cerebral artery severe stenosis. Surgery was performed on the patient under urgent conditions. Cerebral By-pass procedure was performed. Superior temporal artery harvested with two branches and anastomosed to middle cerebral artery M2 and M4 segments. The cerebral blood flow has been adequately restored. (Figure 5) After the surgery, clinical hemiparesis improved 3/5 to 5/5 and headache resolved. In the follow-up, the patient has not had a seizure for 9 months.

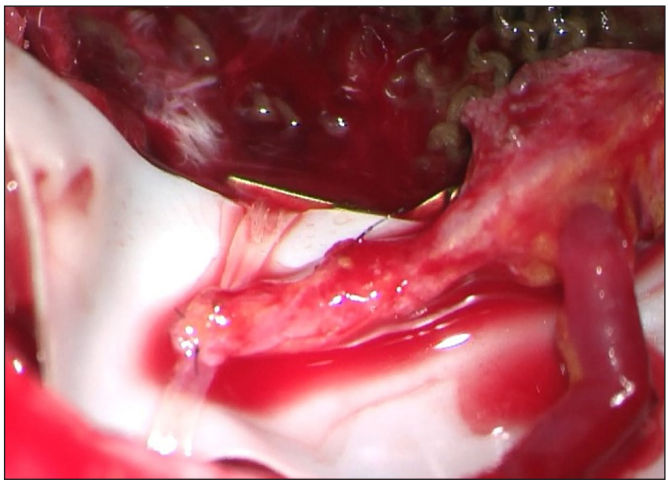

Figure 5. Intraoperative picture of double bypass procedure.

Patient 6: A 46-year-old female patient applied to the external center emergency service with numbness and syncope in the left half of her body, which has been 20-25 days. Upon detection of a 2 cm diameter hyperdense lesion adjacent to the right sphenoid bone ala major in Brain CT, we were referred to us. CT angiography was performed. Saccular aneurysmatic dilatation, 2.5 cm of which was thrombosed and 6 mm in diameter, was observed in the distal right middle cerebral artery M1 segment. Surgery was performed on the patient under urgent conditions. During surgery, it was observed that there was weak flow in the middle cerebral artery M2 segment in the distal of the aneurysm with Doppler USG and it was occluded by thrombus. First, the aneurysm was clipped and the thrombus within the aneurysm dome was excised. Then, the M2 segmental thrombus was removed by thrombectomy, and flow was restored (Figure 6).

Patient 7: A 65-year-old male patient presented with left hemiplegia eigth hours after heart bypass surgery. Brain CT revealed extensive infarction, and midline shift in the right hemisphere. CT angiography indicated absent vascular flow in the right MCA bifurcation. A right frontotemporoparietal decompressive craniectomy

and embolectomy were performed to patient. A vertical incision was made on the MCA. The plaque removed who causing the obstruction. Restoration of flow preserved, and the vessel was closed with a primary suture. A subsequent CT angiography, conducted 24 hours after surgery, indicated restored blood flow in the right MCA feeding area (Figure 7)

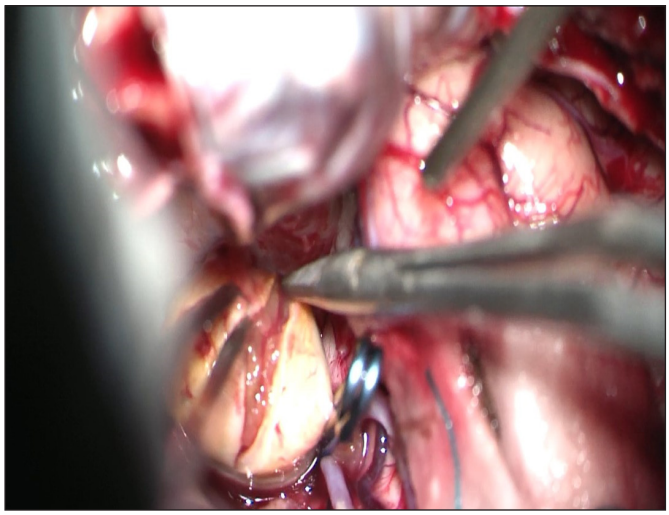

Figure 6. Intraoperative picture of removing the thrombus in aneurysm

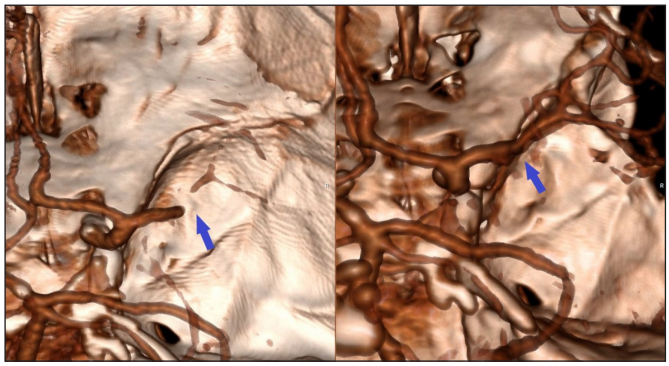

Figure 7. Preoperative and postoperative 3 D CT Angio of MCA embolectomy and recanalization area (blue arrows)

RESULTS

Surgical intervention was deemed necessary for the first patient due to an ICA total infarction that remained refractory to alternative treatments. The same applied to the second patient, where small atheroma plaques ruptured from main arteries during heart transplantation, and conventional thrombolytic treatments yielded no response. In all cases, thromboembolic drugs and endovascular methods are insufficient to restore flow. The reason for this is that the causes that prevent vascular flow are not only thrombus, but also atheroma plaques and mechanical causes.

In all cases, surgical procedures emerged as the primary and optimal approach. Decompression of brain parenchyma and restoration of arterial flow were the primary outcomes of these surgeries.

For the first patient, successful vascular anastomosis facilitated robust blood flow, effectively nourishing the MCA feeding area (Figure 8). As a result of this early intervention, neurological deficits exhibited rapid improvement. Notably, aphasia resolved, and hemiplegia transitioned to hemiparesis (3/5).

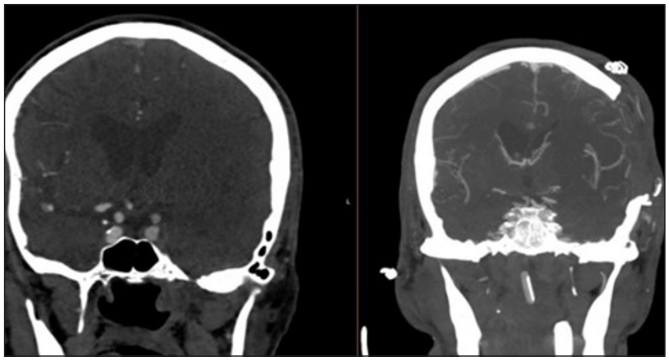

Figure 8. Preoperative and post operative CT Angio of Bypass procedure.

The second patient's case posed greater challenges. Neurological deficits remained undetected until the patient regained consciousness after the transplant surgery. Furthermore, extensive brain parenchymal areas suffered due to multiple occlusions of small-sized vessels. The objective of the surgery was to alleviate the affected brain parenchyma through decompression and to restore accessible vessel blood flow. Given its accessibility and significance in supplying crucial brain regions, the right MCA emerged as the most suitable option. Subsequent CT angiography confirmed restored blood flow in the right MCA feeding area. However, due to other concurrent vascular occlusions, the patient's neurological condition experienced gradual and partial improvement (Figure 9).

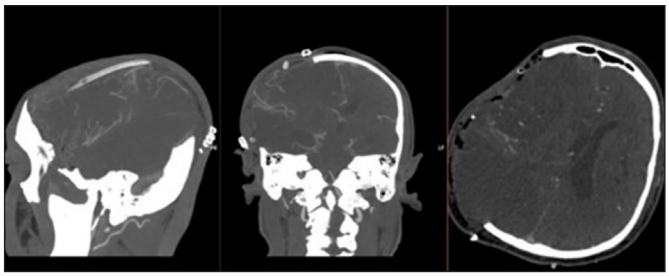

Figure 9. Post operative CT Angio of embolectomy procedure.

All patients benefited from urgent surgery. Their neurological deficits improved and quality of life improved.

The study outcomes underscore the efficacy of surgical procedures in addressing complex cases of thromboembolic events, particularly when other treatment avenues prove inadequate.

DISCUSSION

In the current healthcare landscape, cases of infarction resulting from cerebrovascular occlusions are commonly managed by neurologists employing medical therapy and antithrombotic agents. In specialized centers with proficient endovascular teams and technical capabilities, endovascular treatment methods have proven effective. However, the documented success rate of surgical embolectomy/thrombectomy, bypass procedures, and recanalization surpasses these approaches. This heightened success, however, hinges on the presence of an experienced medical team and appropriate patient selection for revascularization, highlighting the critical role of expertise in this context. Differing opinions concerning the timing of surgical intervention and patient selection further complicate this landscape.

Central to the acute stroke treatment are the principles of recanalization of occluded arteries, tissue reperfusion, optimization of collateral flow, and prevention of secondary injuries.[3] Indeed, the reopening of a partially occluded artery that causes hypoperfusion without infarction holds significant importance. Within the affected region, there is a critical area called the "penumbra," which surrounds the core infarct zone. Collateral circulation sustains this penumbra area, providing sufficient blood flow to prevent critical ischemia or infarction. However, it is inadequate to maintain normal cellular function. This explains why neurological damage improves after recanalization. Without recanalization, the penumbra transforms into an infarction.[3-16]

The utilization of intravenous tPA was initially endorsed for the treatment of acute ischemic stroke within the first 3 hours, a milestone established in 1996. The European Cooperative Acute Stroke Trial II (ECASS II) findings later extended the therapeutic window for tPA to 4.5 hours. Additionally, the time frame for intra-arterial mechanical thromboembolectomy was expanded to 6 hours in 2018. The American Stroke Association (ASA) subsequently asserted that mechanical thrombectomy remained effective within 24 hours of symptom onset. Substantiating this, studies such as DAWN and DEFUSE underscored the advantages of mechanical thrombectomy within the 24-hour window.[4,5,20]

The American Heart Association Guideline outlines the indications and contraindications for tPA treatment. Indications encompass diagnosed ischemic stroke with neurological deficits within 4.5 hours of symptom onset, as well as wake-up stroke cases exhibiting MRI mismatches and age exceeding 18 years. Conversely, contraindications encompass severe head trauma within three months, previous ischemic strokes within the same time frame, recent intracranial hemorrhage, suspected subarachnoid hemorrhage, infected endocarditis, aortic arch dissection, intracranial neoplasms, gastrointestinal or malignancy, bleeding diathesis, active internal bleeding, high blood pressure (systolic >180 mmHg or diastolic >110 mmHg), platelet count below 100,000/mm^2, acute hemorrhage on CT scan, and INR >1.7.3 The potentially more effective thrombolytics is still tenecteplase but some of the other thrombolytics, such as desmoteplase, have been unsuccessful in clinical trials.[10]

Endovascular Stroke Therapy (EST) becomes the viable alternative when contraindications to tPA treatment are present.[6,18,19] Optimal candidates for EST are individuals aged >18 years with National Institutes of Health Stroke Scale (NIHSS) scores >6, good prestroke functional status, intracranial artery occlusion, and symptom onset within 24 hours. As an invasive treatment, this method is associated with various complications.[7] A few numbers of published trials established the superiority of endovascular thrombectomy over medical trombectomy for the treatment of anterior circulation large vessel occlusion.[9,11-14]

As soon as possible after symptom onset, thrombectomy should be performed. Mechanical thrombectomy is recommended in acute ischemic stroke patients especially if intravenous thrombolysis is contraindicated.[8]

Surgical thrombectomy emerges as a definitive approach to recanalization. When intravenous tPA and endovascular recanalization are unfeasible due to contraindications or unavailability, surgical intervention becomes the primary choice. Furthermore, when surgical procedures like decompression or hematoma evacuation are warranted, simultaneous recanalization surgery can be executed.

The physiotherapy given after stroke has also been shown to benefit survival.[15-17]

In our reported cases, patients underwent recanalization concurrent with decompression surgery due to acute stroke and thromboembolic events. The first case exhibited large vessel occlusion with thrombus, while the second manifested occlusion in smaller-caliber vessels due to atheroma plaques. In other cases, the cause was not only thromboembolism, there were also accompanying pathologies such as aneurysm. Therefore, it was easier to decide on surgery. Notably, tPA and endovascular treatments failed to reopen occluded vessels in both cases, further emphasizing the primacy and efficacy of surgical intervention in such scenarios.

CONCLUSION

While tPA and endovascular treatments have gained significant popularity in recent times, surgical intervention remains a superior choice, particularly when other options are contraindicated, and especially for cases where atheromatous plaques prove challenging to eliminate through non-surgical means. Moreover, the window for surgical intervention can be extended to encompass up to 24 hours following the onset of symptoms. In selected patients, rapid and first-line surgical treatment is satisfactory.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Akdeniz University Faculty of Medicine Clinical Researches Ethics Committee (Date: 23.08.2023, Decision No: KAEK-684).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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