

ХИРУРГИЧНА КОРЕКЦИЯ НА СУПРААОРТНА СТЕНОЗА – КЛИНИЧЕН СЛУЧАЙ

Е. Нуелари¹, Е. Капедани¹, С. Куци², А. Кенга¹

*¹Отделение по съдова хирургия, ²Анестезиологично-реанимационно отделение,
Университетски болничен център „Майка Тереза“ – Тирана, Албания*

SUPRA-AORTIC STENOSIS SURGERY: CASE STUDY

E. Nuellari¹, E. Kapedani¹, S. Kuci², A. Kenga¹

*¹Vascular Surgery Service, ²Anesthesia-Reanimation Service,
University Hospital Center “Mother Teresa”, Tirana, Albania*

Резюме.

Целта на представения случай е да се демонстрира поставяне на аортокаротиден байпас при пациент със стеноза на каротидната артерия като разумен и необходим метод за превенция на исхемичен инсулт. Проучването е проведено в Университетския болничен център „Майка Тереза“ (QSUT), Тирана. Представяме 63-годишен пациент с атеросклеротична артериопатия и хипертония с епизоди на световъртеж и синкоп. Доплер-ехокардиографията разкрива увеличение на скоростта на кръвния поток в дясната и в лявата каротидна артерия с повече от 2,5 пъти. Компютърнотомографска ангиография визуализира стеноза на дясна и лява обща каротидна артерия, стеноза в началото на трункус брахиоцефаликус и оклузия на лява субклавиална артерия. Извършена е реваскуларизация на общите каротидни артерии с помощта на раздвоена 14×7 mm Dacron присадка. Проксималният край на присадката е анастомозиран към възходящата аорта, а дисталните краища са свързани към двете общи каротидни артерии. Последващата доплер-ехокардиография показва нормализиране на скоростта на кръвотока в каротидните артерии. Неврологичните симптоми на пациента напълно изчезнаха. Пациентът е изписан без усложнения след 10 дни. Методът за разрешаване на сложна мулти-сегментална стеноза чрез аортокаротиден байпас осигурява оптимална перфузия на мозъка и се предлага да се използва при подходящи условия за профилактика на исхемичен инсулт.

Ключови думи:

аорто-каротиден байпас, реваскуларизация, синтетичен графт, атеросклероза, случай

Адрес за

д-р Едмонд Нуелари, Университетски болничен център "Майка Тереза", Тирана, Албания, e-mail:

кореспонденция:

ed.nuellari@gmail.com

Abstract.

The aim of this study was to demonstrate a case of aorto-carotid bypass in a patient with carotid artery stenosis as a reasonable and necessary method for preventing ischemic stroke. The study was conducted at the University Hospital Center “Mother Teresa” (QSUT), Tirana. A 63-year-old patient with atherosclerotic arteriopathy and hypertension presented with episodes of dizziness and syncope. Doppler echocardiography revealed an increase in blood flow velocity in the right and left carotid arteries by more than 2.5 times. Computed tomography angiography visualised stenosis of the right and left common carotid arteries, stenosis of the brachiocephalic trunk at the beginning, and occlusion of the left subclavian artery. Performed revascularization of the common carotid arteries using a bifurcated 14×7 mm Dacron graft. The proximal end of the graft was anastomosed to the ascending aorta, and the distal ends were connected to both common carotid arteries. Follow-up Doppler echocardiography showed normalization of blood flow velocity in the carotid arteries. The patient’s neurological symptoms completely disappeared. The patient was discharged without complications after 10 days. The method of resolving complex multisegmental stenosis by aorto-carotid bypass ensures optimal perfusion of the brain and is proposed for use in appropriate conditions for the prevention of ischemic stroke.

Key words:

aorto-carotid bypass, revascularization, synthetic graft, atherosclerosis, case report

Address for

Edmond Nuellari, MD, University Hospital Center “Mother Teresa”, Tirana, Albania, e-mail:

correspondence:

ed.nuellari@gmail.com

INTRODUCTION

Cerebrovascular stroke is one of the major health care problems, leading to loss of productivity and decreased mobility in over half of patients over 65 years old [6]. Annually, stroke claims the lives of 6.5 million people. One in four people globally will experience a stroke after the age of 25 [35]. Risk factors for ischemic stroke include atherosclerotic vessel damage, hypertension, atrial fibrillation, smoking, diabetes, alcohol consumption, as well as physical inactivity and male gender [21, 33, 36]. Ischemic stroke (IS) can occur due to complete or significant disruption of blood supply through stenosis of the supra-aortic trunks and can have serious irreversible consequences for brain function, including paralysis and other neurological impairments. 10-20% of all IS cases result from stenosis of the carotid artery [29]. Stenosis in supra-aortic trunks within the framework of diffuse atherosclerosis may manifest as transient ischemic attacks or be asymptomatic, discovered incidentally during screening examinations [14, 18, 22]. Interventional procedures such as carotid endarterectomy (CEA), bypass grafting, or stenting are necessary to restore blood supply to the damaged artery. Treatment also includes medication therapy to control atherosclerosis. The reperfusion strategy is chosen individually by the surgeon for each case. Involvement of more than one segment of the artery, advanced age, and decreased vessel wall elasticity necessitate more complex interventions.

A successful combination of aorto-carotid bypass grafting (CABG) and endarterectomy in treating four cases of severe carotid artery stenosis was described by F. K. AlGhamdi et al. [2]. The authors noted possible treatment combinations for stenosis, including sequential CEA with subsequent carotid bypass, CEA after CABG, complex CABG and CEA, carotid artery stenting (CAS) followed by CABG, or simultaneous CABG and CAS. A meta-analysis of studies comparing endarterectomy and stenting in patients with carotid artery stenosis from 2015 to 2023, conducted by A.M. Vasavada [34], found that endarterectomy has more favourable outcomes regarding mortality and stroke compared to stenting but less favourable outcomes regarding myocardial infarction.

In a study of six cases of complete occlusion of the common carotid artery (CCAO) type 1A according to Rayle, conducted by Z. Li et al. [17], it was noted that all patients who underwent surgical intervention (carotid-carotid crossover bypass and hybrid operation with ring cleaning) achieved better therapeutic outcomes. The advantage of crossover bypass is bilateral intervention and the absence of the need for a hybrid operation. Disadvantages include blood flow blockage, technical complexity, and longer operation time. The use of synthetic vascular grafts is also a drawback. During the hybrid operation, unilateral intervention is performed, there is no blood flow

blockage, the method is technically easier, and the operation and recovery times are shorter.

CABG for the treatment of cerebral dysperfusion caused by supra-aortic branch lesions was utilized by J. Tesar et al. [31]. A case report of an 80-year-old woman with hypostatic mediated dysperfusion due to severe atherosclerotic disease of the unnamed and carotid arteries, successfully treated with bypass, underscores the role of this procedure in rare and atypical cases. The authors call for greater awareness of the potential of CABG as a safe and effective treatment method in patients with similar secondary dysperfusions.

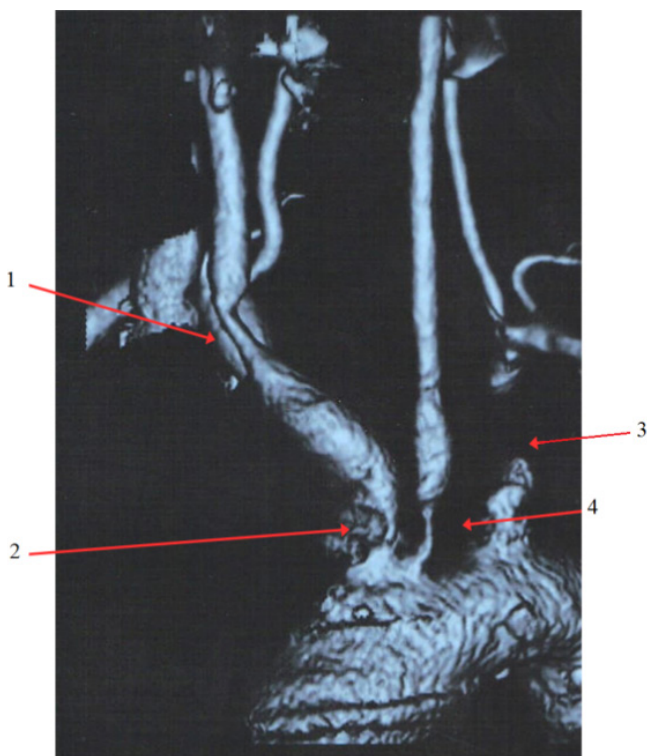
Using data from over 6,000 participants and observing them over a long period, A. Rerkasem et al. [27] found that surgical intervention reduces the risk of further stroke or death in carotid artery stenosis over 30%. The risk benefit was found to depend on the degree of stenosis, where higher degrees of stenosis were associated with greater benefit from endarterectomy. However, the studies were conducted before the widespread use of statins and other modern medical interventions, which may affect the relevance of the results in the current context. Thus, while the advantages of endarterectomy may remain significant, modern treatment modalities may also alter the dynamics of stroke and death risk in patients with carotid artery stenosis.

Significant advances have been made in the treatment of supra-aortic stenosis over the past three decades, but standardized approaches are still lacking. This article presented a case of alleviating stenosis of the common carotid arteries through aorto-carotid bypass grafting, mimicking the natural vascular arrangement.

CASE PRESENTATION

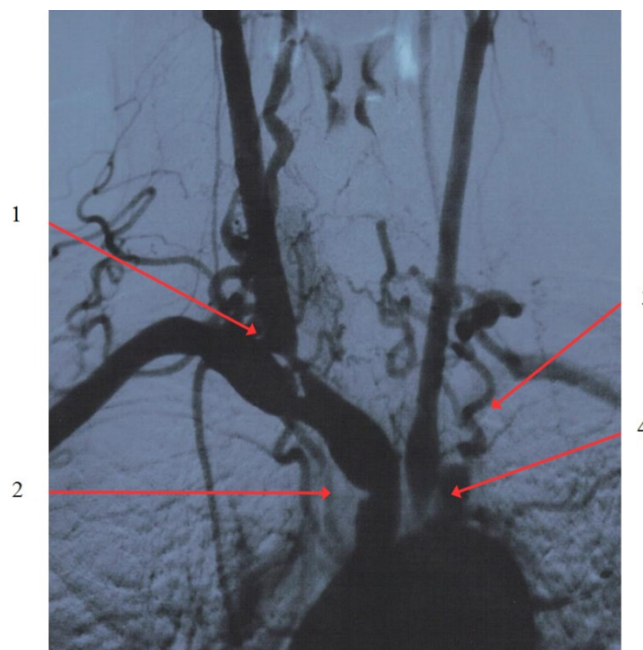
A 63-year-old male, presented himself with recurrent bouts of dizziness accompanied by a singular syncope episode. Symptoms have shown a progressive worsening trend over the past few months. Additionally, the patient experienced intermittent headaches. Notably, the patient did not manifest any signs indicative of visual disturbances, muscular weakness, or sensory numbness. His medical dossier delineates a history fraught with diffuse atherosclerotic arteriopathy, a diagnosis of arterial hypertension made about ten years ago, and a protracted habit of tobacco consumption spanning numerous years. Pertinently, there exists no documented chronicle of dyslipidaemia or diabetes mellitus within his medical history. Family history increases the predisposition to cardiovascular diseases on the patient's maternal side. In his medical history, there are no previous surgical interventions aimed at cardiovascular diseases, blood transfusions, infectious pathologies, allergies or drug intolerance.

Given the combination of vascular risk factors and neurologic manifestations, immediate referral was arranged for a comprehensive investigation of the vessels of the neck. Doppler ultrasonography revealed an increased antegrade blood flow velocity exceeding a threshold value of 2.5 in the bilateral common carotid arteries, indicating hemodynamic consequences of stenosis aggregating to a degree greater than 70% [7, 16]. Furthermore, a conspicuous absence of flow was discerned within the left subclavian artery, denoting its occlusive status. Notably, no discernible stenotic lesions were observed within the carotid bulb. After the Doppler ultrasound assessment, the patient underwent contrast-enhanced computed tomography (CT) angiography, which corroborated the diagnostic impressions. The radiological imaging unequivocally delineated stenotic lesions pervading both the right and left common carotid arteries, concomitant with stenosis affecting the brachiocephalic trunk. Visualising the subclavian artery was impeded by its occlusive pathology. Detailed anatomical delineation, as shown in Figures 1 and 2, delineates the occlusive defects affecting the vessels of the supra-aortic trunk. Following deliberation with a vascular surgery specialist, a consensual decision was reached to proceed with the orchestration of a meticulously planned surgical intervention.



Note: 1 – stenosis of the right common carotid artery, 2 – stenosis of the brachiocephalic trunk, 3- occlusion of the left subclavian artery, 4 – stenosis of the left common carotid artery at its origin. Source: compiled by the authors.

Fig. 1. Preoperative KT angiography of the patient's aortic arch and supra-aortic branch



Note: 1 – stenosis of the right common carotid artery, 2 – stenosis of the brachiocephalic trunk, 3- occlusion of the left subclavian artery, 4 – stenosis of the left common carotid artery at its origin. Source: compiled by the authors.

Fig. 2. Preoperative KT angiography of the patient's aortic arch and supra-aortic branch

The patient was admitted to the University Hospital Center "Mother Teresa" (QSUT), Tirana, for elective surgical correction of stenosis of the common carotid arteries by aorto-carotid bypass. The method is effective in the long term. At the time of hospitalization, the patient's condition was relatively satisfactory, with clear consciousness. The patient is spatially oriented and responsive to questions. Temperature of 36.8°C, blood pressure of 135/85 mmHg, heart rate of 85 beats per minute, and SpO₂ of 95%. The skin was of normal colour, without rashes. Visible mucous membranes were moist and pale pink. The tonsils were not enlarged, and there were no deposits or plugs. Lymph nodes were unremarkable. Peripheral edema was absent. The chest was of normal build and participated in breathing. The respiratory rate was 16 breaths per minute. Lung auscultation revealed vesicular breath sounds without rales. Heart sounds were dull but rhythmic. The abdomen was soft and non-tender upon palpation. The symptom of pain in the costovertebral angle is negative on both sides. Defecation and urination without features. Neurological examination shows no critical changes. Muscle strength is preserved in both upper and lower extremities. Ataxia is not observed. Sensation to touch, pain, and temperature is preserved in both extremities. Can perform simple and complex coordination exercises without significant impairments. Gait is normal, no asymmetry or instability observed.

Reflexes are preserved in both upper and lower extremities. Additional examinations included complete blood count and urinalysis, which showed no significant abnormalities. Lipid profile, coagulation profile, electrolytes, liver enzymes, and blood glucose were within normal limits. Creatinine clearance showed no significant changes, and the electrocardiogram (ECG) revealed sinus rhythm. There were no contraindications to surgery in the patient.

The complex bypass procedure was performed by cardiothoracic and vascular surgeons. Orthotopic bypass was performed with sternotomy from the ascending aorta to the left and right common carotid arteries. The operation was performed under general anaesthesia. A midline sternotomy incision was made with an oscillating saw, extending to the anterior border of the right sternocleidomastoid muscle. Soft tissues were dissected, the pericardium was opened, and the ascending aorta, brachiocephalic vein, innominate artery, carotid arteries, and subclavian arteries were exposed. Oxygen and blood pressure were monitored during artery clamping. A bifurcated Dacron graft measuring 14 × 7 mm was used as the artificial blood vessel. The proximal anastomosis was performed with continuous polypropylene sutures, with partial clamping of the ascending aorta using an occlusive clamp. To prevent embolization, the patient was placed in the Trendelenburg position. After clamping the graft with the occlusive clamp, the patient was returned to the initial position. The distal ends of the graft were anastomosed to the left and right common carotid arteries (Fig. 3).



Source: compiled by the authors.

Fig. 3. Postoperative photo of aorto-carotid bypass. A Dacron graft was sutured to the aorta and common carotid arteries bilaterally

There were no postoperative complications, side effects, or unforeseen events observed. The patient was under the supervision of a cardiothoracic surgeon and a neurologist. The patient's clinical condition after the operation was assessed as satisfactory. On the follow-up echo-Doppler examination, there was no increase in blood flow velocity in the carotid arteries, and the patency of the graft was preserved. Neurological assessment after the operation was appropriate for the patient's age. The patient fully recovered and was discharged 10 days after the procedure. He was continuously monitored, received antiplatelet therapy, and had his antihypertensive therapy adjusted. During the three-month follow-up, the patient was satisfied with the treatment, reported no syncope, dizziness, or other neurological symptoms. Echo-Doppler control showed no hemodynamic stenosis. The patient's observation continued on an outpatient basis. The patient was advised to change their lifestyle, specifically to quit smoking, eat healthily, and engage in physical exercise.

DISCUSSION

Asymptomatic carotid stenosis, in the context of arterial hypertension and atherosclerosis, is a common condition in medical practice. In this case, the patient did not experience transient ischemic attacks or strokes, but episodes of dizziness and syncope were noted. The absence of significant neurological deficit symptoms indicates a chronic course of the atherogenic process, adaptation to reduced cerebral perfusion, and sufficient reserve of compensatory collaterals [20]. The patient had a history of atherosclerosis, hypertension, and prolonged smoking. Most societies do not recommend screening tests for vessel visualization for all asymptomatic patients without risk factors for atherosclerosis. Screening is advisable for patients with two or more atherosclerosis risk factors and the presence of atherosclerotic disease itself [19].

The patient exhibited nonspecific neurological symptoms, which, combined with Doppler study data, indicated a significant degree of stenosis of the common carotid arteries. Additionally, the results of visualization studies confirmed the diagnosis. Several factors, including the patient's age, severe degree of stenosis exceeding 70% and the presence of stroke risk factors, were considered in determining the most appropriate course of action for treatment [23]. Considering the severity of stenosis, surgical intervention became the preferred approach. However, the choice of surgical strategy can vary significantly. Among the available options for revascularization, aorto-carotid bypass was recognized as the optimal choice for restoring the carotid segment due to its effectiveness compared to alternative methods. Stenting may be inappropriate in

conditions of rigid, calcified arteries in elderly patients with comorbidities and a high frequency of restenosis [3, 9]. C. J. Lee and M. D. Morasch [15] reported that the frequency of stroke and nerve damage after primary endarterectomy is lower compared to carotid bypass (0.5-0.8% and 10%, respectively). However, these data pertain to repeat operations and severe clinical conditions requiring more complex interventions. In the short term, stenting and surgical intervention have similar outcomes [26]. Surgical treatment of aortic dissection with occlusion of the innominate artery was studied by H. Sasaki et al. [30]. A total of 127 patients underwent a procedure of aorto-carotid bypass with immediate central reperfusion, conducted under conditions of hypothermic circulatory arrest with cardiopulmonary bypass. The authors suggested that this approach represents optimal treatment for high-risk patients with acute aortic dissection and innominate artery occlusion, emphasizing the importance of rapid restoration of blood flow to prevent further complications.

The patient underwent orthotopic access, where the replacement graft was placed in the same anatomical location as the affected vessel, with access to the ascending aorta and the right and left common carotid arteries. The route and positioning of the graft determine the difference between orthotopic and extraanatomical techniques for restoring blood flow. The orthotopic approach mimics the normal position of vessels without significant deviation from the natural course of blood flow, providing better patency rates [25]. The orthotopic technique requires a sternotomy incision with significant surgical risk, being more relevant for procedures involving multiple sections. This method is suitable for young active patients with an acceptable risk profile. The extraanatomical technique provides greater flexibility in graft placement, involves superficial interventions, avoiding sternotomy. Typically, this technique is associated with lower surgical risk by avoiding the complexities of the natural anatomical pathway. This method is desirable in cases of single artery involvement, for patients with high surgical risk, or in emergency situations. Extraanatomical repairs can be carotid-carotid, carotid-subclavian, subclavian-subclavian bypass [8, 28].

The sternotomy incision used in this case is a safe and straightforward method that provides necessary access to the aorta and supra-aortic vessels, allowing adequate manipulation during surgery and minimizing the risk of damaging surrounding tissues and structures. A disadvantage of sternotomy is the large scar and the risk of mediastinal infection (1-5%) [5]. In this case, no complications related to sternotomy were noted. Despite the patient's advanced age, comorbidities, and surgical complexity, the reduction in blood flow velocity on echo-Doppler examination and improvement in the patient's condition indicate the success of the method employed. H.S. Han et al. [10], in a review of 19 cases of aorto-carotid bypass in patients with Takayasu's arteritis, reported the effectiveness of this method in preventing

cerebrovascular ischemia. Complications after surgery, such as intracranial haemorrhage, were associated with uncontrolled blood pressure.

The advantages of the Dacron graft used in this patient include the material's strength, extremely low immunogenicity, elasticity, and durability [13]. Due to its folds, the graft slightly elongates in response to blood pressure during systole, reducing stress and maintaining proper blood flow. Using computer modelling to analyse the reactivity of the aortic segment with a Dacron graft to blood flow, R. Jayendiran et al. [11] investigated the stresses occurring in different layers of the aortic wall and within the graft itself, considering various conditions such as material elasticity and orientation. The results showed that the stress at the interface between the aorta and Dacron was lower than the strength of the aorta, indicating that this interface is not a weak point in the system. Some surgeons use autologous veins, and tissue-engineered vascular grafts are actively being developed [4, 32].

Preventing perioperative complications and refining the method of carotid endarterectomy with continuous cerebral blood flow were achieved by M. Piazza et al. [24] through the use of the Pruitt-Inahara shunt. Before closure, the shunt was removed, arteries flushed, and the suture finally secured. This method reduces the risk of neurological complications to less than 1% and ensures a low stroke risk in patients with severe carotid artery stenosis. There are numerous shunts with different properties (Sundt, Javid, Burbank, Argyle, Pruitt-Inahara, Brenner), including those for cerebral protection during surgery. The choice of shunt type depends on the surgeon's preferences and experience, as there have been no studies on the advantages or effectiveness of different types of shunts for cerebral protection during surgery [12].

Modern medical therapy has achieved a high level of control over blood pressure, glucose, cholesterol, and coagulation parameters, leading to a reduced risk of stroke in patients with cardiovascular diseases. An analysis of 11 studies covering 3,724 patients (from 1985 to 2007) with carotid artery stenosis who received traditional conservative treatment methods showed a significant reduction in the annual stroke risk from 2.8% to 1.4% [1].

Overall, this case underscores the importance of comprehensive assessment, timely diagnosis, and appropriate treatment of vascular risk factors to prevent potentially serious complications such as stroke. It also emphasizes the significant role of surgical intervention in restoring vessel patency and improving patient outcomes.

CONCLUSIONS

The report emphasises the importance of recognising and managing vascular risk factors, especially in individuals with neurological symptoms such as dizziness and syncope. In this case, a patient with diffuse atherosclerotic arteriopathy, hypertension, and smoking history pre-

sented symptoms suggestive of carotid artery stenosis. Timely referral for further investigations, including echo Doppler and CT angiography, led to the diagnosis of significant stenosis requiring surgical intervention.

Results showed increased blood flow velocity >2.5 in the bilateral carotid arteries. CT revealed stenosis of the bilateral carotid arteries, brachiocephalic trunk, and occlusion of the left subclavian artery. Surgical intervention was performed using a bifurcated Dacron graft as a synthetic vessel. The procedure involved a sternotomy incision followed by anastomosis of the graft from the ascending aorta to both carotid arteries. There were no postoperative complications or adverse events observed. The patient was discharged 10 days post-surgery. Follow-up echo Doppler examination showed normal blood flow velocity. The sample size and lack of long-term data for further patient observation limit the generalizability of the results. However, the successful outcome of surgical bypass in this case highlights the effectiveness of timely intervention in such cases. Postoperative management, including antiplatelet therapy and optimization of antihypertensive therapy, contributed to the patient's recovery and absence of recurrent symptoms during a three-month follow-up.

The contemporary medical approach to stroke prevention effectively reduces its risks, leading to a decrease in the frequency of surgical interventions. Considering the shortage of studies covering a large number of patients post-stenosis surgery, insufficient duration of patient follow-up, and the ongoing need for technique refinement, further long-term research in this field is necessary.

No conflict of interest was declared

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