

OPERATIVNI TRETMAN ANEURIZME INTRATORAKALNOG SEGMENTA LEVE POTKLJUČNE ARTERIJE U DVA AKTA NAKON PRETHODNE KORONARNE HIRURGIJE

PRIKAZ SLUČAJA

CASE REPORT

TWO-STAGE REPAIR OF THE INTRATHORACIC PORTION OF A LEFT SUBCLAVIAN ARTERY ANEURYSM AFTER PREVIOUS CORONARY ARTERY BYPASS SURGERY

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SAŽETAK

Uvod: Predstavljamo slučaj sedamdesetogodišnjeg pacijenta koji je uspešno operisan zbog aneurizme leve potključne arterije (AnPA), u dva akta, nakon prethodnog aortokoronarnog bajpasa (AoKB).

Prikaz slučaja: Pacijentu je prethodno urađen trostruki AoKB uz primenu bajpasa leve unutrašnje mamarne arterije na levu prednju silaznu arteriju (LIMA-LAD) (engl. *left internal mammary artery [LIMA] to left anterior descending artery [LAD]*). Preoperativno je učinjena perkutana koronarna intervencija (engl. *percutaneous coronary intervention [PCI]*) i rekanalizacija LAD u slučaju eventualne intraoperativne okluzije LIMA-LAD bajpasa. Zbog nemogućnosti hibridnog tretmana usled kratke proksimalne zone naleganja stent-grafta i anomalije luka aorte (bovin tip), na vaskularno-hirurškom konzilijumu odlučeno je da se sprovede otvorena hirurgija u dva akta. Prvo je pacijentu učinjen levostrani karotidno-subklavijalni (C-S) (engl. *carotid-subclavian [C-S]*) bajpas sa Dakron graftom koristeći supraklavikularni pristup. Posle nekoliko dana, druga operacija je učinjena levostranim posterolateralnim torakotomnim pristupom. Leva potključna arterija (PA) je ligirana distalno od leve AnPA i proksimalno od ishodišta LIMA. Distalni luk aorte na mestu leve AnPA je parcijalno klemovan, a aneurizma ekscidirana. Defekt na luku aorte je ušiven i ojačan filcom. Pacijent je imao uredan postoperativni tok, bez znakova povrede miokarda ili drugih hirurških komplikacija.

Zaključak: Pažljivo planiranje i otvorena hirurgija leve AnPA u dva akta, najpre levostranim karotidno-subklavijalnim bajpasom, a zatim ekskluzijom i suturom aneurizme na spoljašnjoj krivini luka aorte, može biti jedna od opcija lečenja za pacijente kod kojih nije izvodljiv hibridni tretman.

Glavne reči: potključna arterija (PA), aneurizma potključne arterije (AnPA), otvorena hirurgija, hirurgija u dva akta

ABSTRACT

Introduction: We present a case of a 70-year-old patient who underwent successful two-stage repair of an intrathoracic left subclavian artery aneurysm (SAA) and who had previously undergone CABG.

Case presentation: The patient had previously undergone three-vessel coronary artery bypass graft (CABG) repair with the use of the left internal mammary artery (LIMA) to left anterior descending artery (LAD). Percutaneous coronary intervention (PCI) was performed as a back-up option in case of potential intraoperative LIMA-LAD bypass occlusion. Owing to the impossibility of hybrid repair due to a short proximal landing zone and aortic arch anomaly (bovine type), the vascular surgery review board decided to perform two-stage open surgery. Firstly, the patient underwent left carotid-subclavian (C-S) bypass with the Dacron graft, with the application of the standard supraclavicular approach. After a few days, the second procedure, through the left posterolateral thoracotomy was performed. The left subclavian artery (SA) was ligated distally to the SAA but proximally to the origin of the LIMA. The distal aortic arch at the site of the left SAA was clamped partially and the aneurysm was excised. The defect of the aortic arch was sutured and reinforced with a felt patch. Postoperatively, the patient had a good recovery, without any signs of myocardial injury or any surgery-related issues.

Conclusion: Careful planning and two-stage open surgical treatment of the left SAA, first with a left carotid-subclavian bypass, followed by aneurysm exclusion and suture of the outer aortic arch curvature may be a treatment option for patients not amenable to hybrid treatment.

Key words: subclavian artery (SA), subclavian artery aneurysm (SAA), open surgery, staged surgery

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UVOD

Aneurizme leve potključne arterije (AnPA) su retke u poređenju sa aneurizmama koje uključuju druge periferne arterije. AnPA aneurizme mogu za posledicu imati ozbiljne komplikacije i mogu dovesti do rupture, tromboze, distalne embolizacije i kompresije okolnih struktura [1]. Ima malo podataka u literaturi u vezi sa hirurškim pristupom i primenom hirurških tehnika u lečenju AnPA, naročito kada aneurizma obuhvata prvi (intratorakalni) segment potključne arterije (PA). Stanje se još više komplikuje kod slučajeva prethodnog aortokoronarnog bajpasa (AoKB) kod kojeg je upotrebljena leva unutrašnja mamarna arterija (LIMA) kao graft. Predstavljamo slučaj sedamdesetogodišnjeg pacijenta kod kojeg je uspešno operisana aneurizma leve potključne arterije (AnPA), u dva akta, nakon prethodnog aortokoronarnog bajpasa (AoKB).

PRIKAZ SLUČAJA

Sedamdesetogodišnji pacijent je prvobitno primljen u bolnicu zbog sakularne aneurizme prvog (intratorakalnog) segmenta leve potključne arterije, koja je klinički prezentovala disfonijom. Prethodno je operisan usled velike (70 mm) pararenalne aneurizme abdominalne aorte (AAA) i bio je podvrgnut trostrukom AoKB-u, koji je sproveden primenom bajpasa leve unutrašnje mamarne arterije na levu prednju silaznu arteriju (LIMA-LAD) i dva bajpasa venom safenom (jednog za desnu koronarnu arteriju a drugog za cirkumfleksnu koronarnu ar-



Slika 1. Preoperativni snimak koji pokazuje sakularnu aneurizmu intratorakalnog segmenta leve potključne arterije sa prohodnim LIMA-LAD (engl. *left internal mammary artery [LIMA] to left anterior descending artery [LAD]*) bajpasom

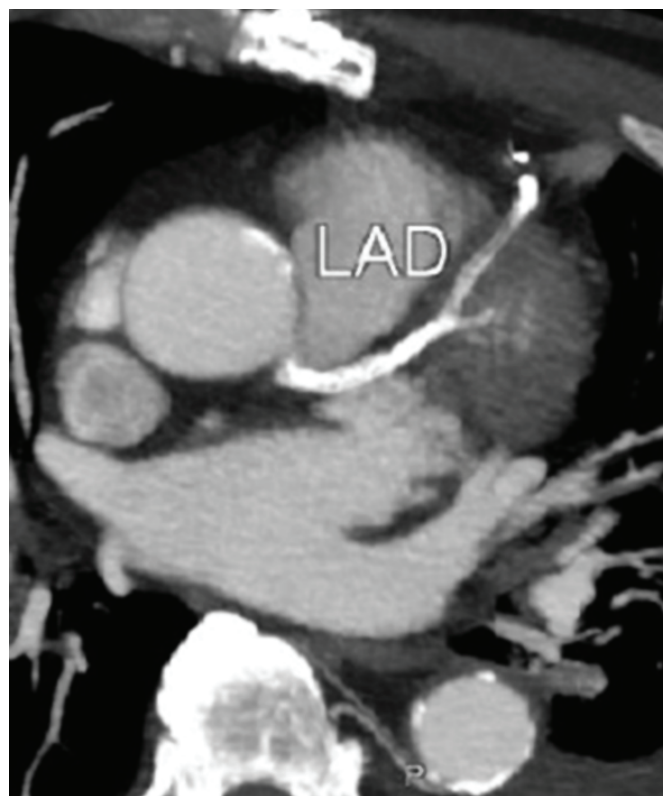
Figure 1. Preoperative scan showing the saccular aneurysm of the intrathoracic part of the left subclavian artery with the patent LIMA-LAD (left internal mammary artery to left anterior descending artery) bypass

INTRODUCTION

Subclavian artery aneurysms (SAAs) are rare, compared to aneurysms involving other peripheral arteries. SAA can result in severe complications and may lead to rupture, thrombosis, distal embolization and compression of adjacent structures [1]. There is paucity of data in literature regarding the surgical approach and the use of intraoperative techniques in the treatment of SAAs, especially when the aneurysm involves the first (intrathoracic) portion of the subclavian artery (SA). The situation becomes even more complicated in case of previous coronary artery bypass surgery (CABG) where the left internal mammary artery (LIMA) had been used as a graft. We present a case of a 70-year-old patient who underwent successful two-stage repair of an intrathoracic left SAA, and who had previously undergone coronary artery bypass grafting (CABG).

CASE REPORT

A 70-year-old patient was initially admitted to hospital due to a left saccular SAA of the first (intrathoracic) SA portion, presenting with dysphonia. Previously he



Slika 2. Preoperativni nalaz koronarne angiografije koji pokazuje subokluziju leve prednje silazne arterije (engl. *left anterior descending artery - LAD*) proksimalno od anastomoze LIMA-LAD (engl. *left internal mammary artery to left anterior descending artery*) bajpasa

Figure 2. Preoperative scan showing the saccular aneurysm of the intrathoracic part of the left subclavian artery with the patent LIMA-LAD (left internal mammary artery to left anterior descending artery) bypass

teriju) (Slika 1). Preoperativno je sprovedena koronarna angiografija. Nalaz je pokazao da su oba venska grafta kao i LIMA-LAD bajpasi bili prohodni (Slika 2).

Zbog rizika od okluzije LIMA-LAD bajpasa tokom operacije leve AnPA, na zajedničkom vaskularno-hirurškom i kardio-hirurškom konzilijumu, odlučeno je da se, kao rezervna strategija, prvo izvede perkutana koronarna intervencija (PCI) na levoj prednjoj silaznoj arteriji (LAD), proksimalno u odnosu na LIMA-LAD bajpas, za slučaj eventualne okluzije bajpasa tokom vaskularne intervencije.

Pacijent je prvo podvrgnut planiranoj perkutanoj koronarnoj intervenciji (PCI). Postoperativni tok je bio bez komplikacija i pacijent je ponovo primljen u bolnicu nakon šest meseci, radi operacije leve AnPA. Prvobitno je pacijent bio razmatran za hibridni tretman (implantacija stent-grafta u luk aorte + ekstraanatomska rekonstrukcija supraaortnih grana). Međutim, ovo nije bilo moguće zbog kratke proksimalne zone naleganja stent-grafta i anomalije luka aorte (bovin tip). Zbog visokog rizika koji nosi totalna ekstraanatomska rekonstrukcija grana luka aorte (prethodna sternotomija sa AoKB), odlučeno je da se izvede otvorena hirurgija na AnPA u dva akta: prvo levostrani karotidno-subklavijalni (C-S) bajpas, a potom ekscizija leve AnPA levostranim posterolateralnim torakotomnim pristupom.

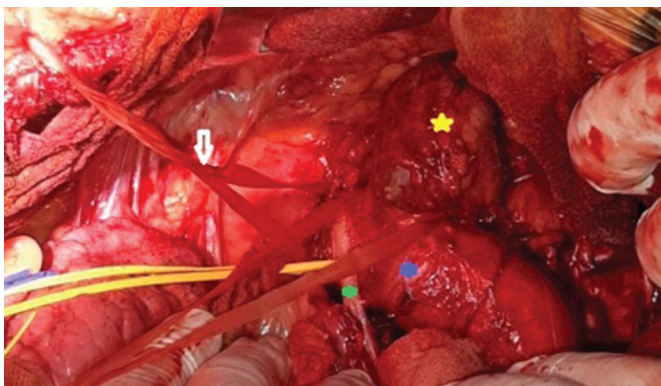
Prvo je pacijentu učinjen levostrani karotidno-subklavijalni (C-S) bajpas sa Dakron graftom koristeći standardni supraklavikularni pristup. Vertebralna arterija i LIMA nisu mogle biti identifikovane; stoga, leva PA nije proksimalno ligirana. Posle nekoliko dana, učinjena je druga

had been operated on due to a large (70 mm) pararenal abdominal aortic aneurysm (AAA) and had undergone three-vessel CABG repair, performed with the use of the left internal mammary artery (LIMA) to left anterior descending artery (LAD) and two saphenous vein bypasses (one to the right coronary artery and the second to the circumflex coronary artery) (Figure 1). Coronary angiography was performed preoperatively. It was noted that both of the venous grafts as well as the LIMA-LAD bypasses were patent (Figure 2).

Due to a risk of occlusion of the LIMA-LAD during left SAA surgery, a joint cardiothoracic and vascular surgery board review meeting was convened, and it was decided, as a back-up strategy, to first perform a percutaneous coronary intervention (PCI) of the LAD, proximally to the LIMA-LAD bypass, in case of potential bypass occlusion during the vascular procedure.

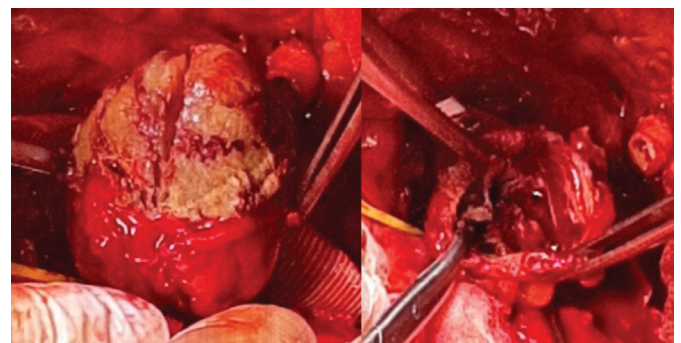
The patient first underwent the planned PCI. The subsequent postintervention recovery was uneventful, and the patient was readmitted six months later for left SAA surgery. The patient had initially been considered for hybrid repair (aortic arch stent-graft implantation + extra-anatomic supra-aortic branch reconstruction). However, this was not feasible due to a short proximal landing zone associated with arch anomaly (bovine type). Due to the high risk that total aortic debranching carries (previous sternotomy with CABG), it was decided to perform two-stage open repair of the left SAA: first the left carotid-subclavian (C-S) bypass and second the excision of the left SAA through left posterolateral thoracotomy.

First, the patient underwent left C-S bypass with the Dacron graft with the application of the standard supraclavicular approach. The vertebral artery and LIMA could not be identified; therefore, the left SA was not proximally ligated. After a few days, the second procedure, with a definite excision of the left SAA, was performed. After endotracheal intubation with a double lumen bronchi-



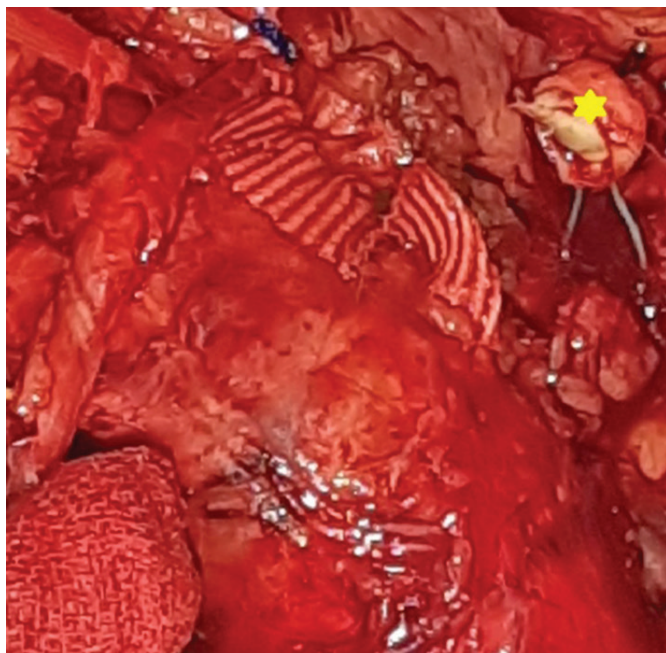
Slika 3. Intraoperativna fotografija koja prikazuje sve anatomske elemente distalnog luka aorte. Obeleženi su sledeći elementi: plavom zvezdicom zona 2 i 3 luka aorte; žutom zvezdicom aneurizma leve potključne arterije; zelenom zvezdicom levi vagalni živac; belom strelicom označeno je mesto na luku aorte između leve zajedničke karotidne i leve potključne arterije, zauzdano trakom

Figure 3. Intraoperative photo showing all the anatomical elements of the distal aortic arch. The following elements are marked: with a blue asterisk - zone 2 and zone 3 of the aortic arch; with a yellow asterisk - the left subclavian artery aneurysm; with a green asterisk - the left vagal nerve; the white arrow marks the site on the aortic arch which lies between the left common carotid artery and the left subclavian artery.



Slika 4. Intraoperativna fotografija nakon otvaranja aneurizmatске kese: pre vađenja tromba – levo, i nakon uklanjanja tromba – desno

Figure 4. Intraoperative photo after the opening of the aneurysm sac with its thrombus - on the left; the aneurysm sac after thrombus removal - on the right



Slika 5. Intraoperativna fotografija nakon završene rekonstrukcije; žutom zvezdicom označena je leva potključna arterija koja je podvezana distalno od aneurizme i proksimalno od ishodišta LIMA (engl. *left internal mammary artery*)

Figure 5. Intraoperative photo after completed reconstruction; the yellow asterisk marks the left subclavian artery which has been ligated distally to the aneurysm and proximally to the origin of the left internal mammary artery

operacija, uz definitivnu eksciziju leve AnPA. Nakon endotrahealne intubacije bronhijalnim tubusom sa dvostrukim lumenom i deflacija levog plućnog krila, sprovedena je levostrana posterolateralna torakotomija kroz peti međurebarni prostor. Identifikovani su svi elementi distalnog luka aorte (Slika 3). Nakon sistemske primene heparina (100 IU/kg), leva potključna arterija (PA) je ligirana distalno od AnPA i proksimalno od ishodišta LIMA, pa je LIMA-LAD bajpas ostao prohodan. Distalni luk aorte na mestu leve AnPA je parcijalno klemovan, a aneurizma otvorena (Slika 4). Defekt na luku aorte je ušiven i ojačan filcom (Slika 5). Nakon završetka procedure, aplikovan je protamin sulfat i levi hemitorakas je dreniran pomoću dva drena. Pacijent je imao uredan postoperativni tok, bez znakova povrede miokarda ili drugih hirurških komplikacija. Kontrolna angiografija pre otpusta iz bolnice pokazala je prohodan LIMA-LAD bajpas sa potpunom ekskluzijom leve AnPA i prohodnim C-S bajpasom (Slika 6).

DISKUSIJA

Prema nekim podacima iz literature, AnPA aneurizme predstavljaju svega 1% svih operisanih aneurizmi perifernih arterija [2]. Najčešći uzrok ovih aneurizmi je ateroskleroza. Ostala etiologija uključuje posttraumatsko proširenje, poststenotsko proširenje - uzrokovano sindromom gornjeg torakalnog otvora [3], urođenu arteriopatiju (*Kommerell diverticulum* - aneurizma inici-



Slika 6. Postoperativna aortografija na kojoj se vidi prohodan levostrani karotidno-subklavijalni bajpas, odsustvo aneurizme leve potključne arterije nakon njene ekscizije i suture spoljašnje krivine luka aorte na mestu aneurizme

Figure 6. Postoperative scan showing a patent left carotid-subclavian bypass, the absence of the left subclavian artery aneurysm, after its excision, and aortic arch suture

al tube and deflation of the left lung, left posterolateral thoracotomy was performed through the fifth intercostal space. All the elements of the distal aortic arch were identified (Figure 3). After systemic heparin administration (100 IU/kg), the left SA was ligated distally to the SAA and proximally to the origin of the LIMA, thus the LIMA-LAD bypass remained patent. The distal aortic arch was partially clamped at the site of the SAA and the aneurysm was opened (Figure 4). The defect of the aortic arch was sutured, and it was reinforced with a felt patch (Figure 5). After the procedure was completed, protamine-sulfate was administered and the left hemithorax was drained with the use of two drains. Postoperatively, the patient had a good recovery, without any signs of myocardial injury or any surgery-related issues. A follow-up angiography was performed before discharge, showing a patent LIMA-LAD bypass with a completely excluded left SAA and a patent left C-S bypass (Figure 6).

DISCUSSION

According to some data from literature, the SAAs represent only 1% of all repaired peripheral artery aneurysms [2]. The most common etiology of SAA is atherosclerosis. Other causes include posttraumatic dilatation, poststenotic dilatation - due to thoracic outlet syndrome [3], congenital arteriopathy (*Kommerell diverticulum* - aneurysm of the initial segment of the aberrant left SA) [4], and genetic arteriopathies (such as Marfan, Turner, Loeys-Dietz and vascular Ehlers-Danlos syndromes) [5,6].

jalnog segmenta aberantne leve PA) [4] i genetske arteriopatrije (kao što su Marfanov, Turnerov, Luiz-Dicov [Loeys-Dietz], i vaskularni Ehlers-Danlosov sindrom) [5,6].

Kod ovog pacijenta aneurizma je bila uzrokovana aterosklerozom. Prethodno dvanaestogodišnje iskustvo na našoj klinici, koje je uključivalo 25 pacijenata, pokazalo je da samo 20% svih AnPA aneurizmi ima etiologiju ateroskleroze, te da je isti procenat aneurizmi imao intratorakalnu lokalizaciju [1]. U seriji pacijenata sa intratorakalnim AnPA aneurizmama, bilo je 3 levostrane i 2 desnostrane AnPA aneurizme. Kod prve tri primenjen je hibridni tretman (implantacija stent-grafta + ekstraanatomska rekonstrukcija supraaortnih grana), a druge dve su tretirane otvorenom hirurgijom, uz primenu sternotomije.

Lokalizacija AnPA aneurizme diktira hirurški pristup. Zlatni standard za ekstratorakalnu hirurgiju AnPA jeste otvorena hirurgija, posebno kod genetskih arteriopatrija ili u slučajevima sindroma gornjeg torakalnog otvora, gde je istovremena rebarna/mišićna resekcija/embolektomija često neophodna. Međutim, kada su u pitanju intratorakalne AnPA aneurizme, hirurški pristup zavisi od strane na kojoj se nalazi aneurizma (desna ili leva). Na desnoj strani, preferirana opcija jeste otvorena hirurgija putem medijalne sternotomije. Međutim, hibridni tretman implantacijom stent-grafta u desnu PA uz pokrivanje zajedničke karotidne arterije i desnog subklavijalno-karotidnog bajpasa, može biti opcija kod pacijenata sa visokim rizikom.

Tretman prvog izbora za levu intratorakalnu AnPA jeste hibridni pristup (implantacija stent-grafta + ekstraanatomska rekonstrukcija supraaortnih grana), zbog manjeg perioperativnog rizika. Otvorena hirurgija obično zahteva primenu parcijalnog vantelesnog krvotoka, privremeno postavljanje klemne na levu PA i rekonstrukciju distalnog luka aorte uz pomoć interpozicije grafta. Nažalost, kod ovog pacijenta, hibridni tretman nije bio moguć usled kratke i neadekvatne zone naleganja stent-grafta i anomalije luka aorte (bovin tipa). Uobičajena dovoljna dužina zone naleganja stent-grafta jeste 15-20 mm bez bilo kakvog oštrog ugla manje krivine luka aorte, kako bi se obezbedila adekvatna proksimalna zona fiksacije i sprečio endolik tip IA, što se smatra neuspehom u proceduri koji se mora korigovati kako bi se izbegao pulsatilni krvni tok u aneurizmatsku kesu [7].

Zbog svega navedenog, kao manje invazivni pristup, izabran je hirurški tretman u dva akta. Imajući u vidu moguću okluziju LIMA-LAD bajpasa tokom operacije leve AnPA, izvršili smo PCI sa rekanalizacijom LAD, iz bojazni da bi okluzija LIMA-LAD bajpasa mogla da izazove težak i potencijalno smrtonosan infarkt miokarda.

Hirurška procedura je sprovedena u dva akta. U prvom smo omogućili adekvatnu perfuziju leve ruke i leve

The aneurysm in this patient had an atherosclerotic etiology. The experience from the previous twelve years at our clinic, which includes 25 patients, shows that only 20% of all SAAs had an atherosclerotic etiology and that the same percentage had an intrathoracic localization [1]. In this series of patients with intrathoracic SAAs, there were 3 left SAAs and 2 right SAAs. The first three were treated with hybrid surgery (stent-graft implantation + extra-anatomic supra-aortic branch reconstruction) and the second two were treated with open surgery, with the application of the sternotomy approach.

The localization of the SAA dictates the surgical approach. The gold standard for extrathoracic SAA is open surgery, especially in genetic arteriopathies or in cases of thoracic outlet syndrome, where a simultaneous rib/muscle resection/embolectomy is often necessary. However, when it comes to intrathoracic SAAs, the surgical approach depends on the side where the aneurysm is located (right/left). On the right side, the preferred option is open surgery by means of median sternotomy. However, hybrid treatment with stent-graft implantation in the right SA with coverage of the common carotid artery and right subclavian-carotid bypass may be an option in high-risk patients.

The preferred treatment option for intrathoracic left SAA is the hybrid approach (stent-graft implantation + extra-anatomic supra-aortic branch reconstruction) due to a lower associated perioperative risk. Open surgery usually necessitates the use of partial extracorporeal circulation, temporary clamping of the left SA and reconstruction of the distal aortic arch with graft interposition. Unfortunately, in this patient, hybrid treatment was not possible due to a short and inadequate landing zone and a bovine aortic arch anomaly. The customary length of the landing zone that is considered sufficient is 15-20 mm, without any sharp angles in the lesser curvature of the aortic arch - this being necessary to provide an adequate proximal sealing zone and prevent type IA endoleak, which is considered to be procedure failure and needs to be corrected in order to prevent pulsatile flow into the aneurysm sac [7].

Consequently, a less invasive two-stage approach was chosen as a treatment option. Bearing in mind possible occlusion of the LIMA-LAD bypass during left SAA surgery, we performed PCI with recanalization of the LAD, fearing that the occlusion of the LIMA-LAD may produce severe and potentially fatal myocardial infarction.

The surgical procedure was performed in two stages. In the first stage we enabled adequate perfusion of the left arm and the left ventricle through a LIMA-LAD bypass with the help of a C-S conduit, while in the second one we performed the exclusion of the aneurysm with preservation of the flow through the LIMA-LAD

komore putem *LIMA-LAD* bajpasa uz pomoć *C-S* bajpasa, dok smo u drugom aktu izveli ekskluziju aneurizme uz očuvanje protoka kroz *LIMA-LAD* bajpas pomoću minuciozne tehnike ušivanja spoljašnje krivine distalnog dela luka aorte. Nije bilo potrebe za vantelesnim krvotokom i višim dozama intravenskog heparina, te su stoga izbegnute potencijalne komplikacije, kao što su respiratorne (pulmonarno krvarenje, akutni respiratorni distres sindrom), koagulopatija, hlađenje pacijenta, itd. [8].

Prikazani slučaj pokazuje značaj izbora pravog pristupa lečenju kod svakog pacijenta, posebno u slučaju prethodnih operacija i kardiovaskularnog komorbiditeta.

ZAKLJUČAK

Pažljivo planiranje i otvorena hirurgija leve AnPA u dva akta, najpre levostranim karotidno-subklavijalnim bajpasom, a zatim ekskluzijom i suturom aneurizme na spoljašnjoj krivini luka aorte može biti jedna od opcija lečenja za pacijente kod kojih nije izvodljiv hibridni tretman.

Sukob interesa: Nije prijavljen.

with meticulous suture of the outer curvature of the distal aortic arch. There was no need for extracorporeal circulation and higher doses of intravenous heparin, whereby potential complications such as pulmonary (pulmonary hemorrhage, acute respiratory distress syndrome), coagulopathy, cooling of the patient, etc., were avoided [8].

Our case demonstrates the importance of selecting the right treatment option for each patient, especially in the presence of previous operations and cardiovascular comorbidity.

CONCLUSION

Careful planning and two-stage open surgical treatment of the left SAA, first with left carotid-subclavian bypass, followed by aneurysm exclusion and suture of the outer curvature of the aortic arch, in the second stage, may be a treatment option for patients not amenable to hybrid treatment.

Conflict of interest: None declared.

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