ORIGINAL ARTICLES

UDC: 616.13-007.64-07/-08
DOI: https://doi.org/10.2298/VSP220228073Z

Common surgical practice in the treatment of patients with popliteal artery aneurysm among vascular centers in Serbia

Savremeno lečenje bolesnika sa aneurizmom poplitealne arterije u vaskularnim centrima u Srbiji

Aleksandar Zarić[*], Aleksandar Tomić[*†], Ivan Marjanović[*†], Vladimir Manojlović[‡§], Nebojša Budakov[‡], Anica Ilić[‖], Aleksandra Vujčić[‖], Mihajlo Nešković[¶], Igor Atanasijević[¶], Nemanja Stepanović[**], Jelena Stanković[††], Milan Jovanović[†††‡‡] , Nenad Ilijevski[¶§§], Igor Končar[‖§§], Lazar Davidović[‖§§]

[*]Military Medical Academy, Clinic for Vascular and Endovascular Surgery, Belgrade, Serbia; [†]University of Defence, Faculty of Medicine of the Military Medical Academy, Belgrade, Serbia; [‖]University Clinical Center of Serbia, Clinic for Vascular and Endovascular Surgery, Belgrade, Serbia; [¶]"Dedinje" Cardiovascular Institute, Clinic for Vascular Surgery, Belgrade, Serbia; [§§]University of Belgrade, Faculty of Medicine, Belgrade, Serbia; [‡]University Clinical Center of Vojvodina, Clinic for Vascular Surgery, Novi Sad, Serbia; [§]University of Novi Sad, Faculty of Medicine, Novi Sad, Serbia; [**]University Clinical Center Niš, Clinic for Vascular Surgery, Niš, Serbia; [‡‡]University of Niš, Faculty of Medicine, Niš, Serbia; [††]General Hospital Užice, Užice, Serbia

Abstract

Background/Aim. Popliteal artery aneurysm (PAA) is the most common peripheral artery aneurysm and the second most common aneurysm following abdominal aortic aneurysm (AAA). Still, its incidence is rare, and treatment is non-standardized. The collection of data in a multicenter registry could improve the diagnosis and treatment of PAA. SerbVasc is a newly established data collection collaboration among vascular centers in Serbia. The aim of this study was to present common surgical practices in the diagnosis and treatment of patients with PAA in hospitals in Serbia. **Methods.** Vascular centers in Serbia that accepted the invitation collected data retrospectively concerning patients operated on for PAA from 2012 to 2018. Data regarding symptoms, preoperative diagnostics, vascular and endovascular techniques, and postoperative results were collected. This data set was submitted to the VASCUNET international project of PAA for data analysis between the countries. The same data set was used for a detailed analysis of the contemporary treatment of PAA in six hospitals in Serbia: University Clinical Center of Serbia, "Dedinje" Cardiovascular Institute, Military Medical Academy, University Clinical Center Novi Sad, University Clinical Center Niš, and General Hospital Užice. **Results.** From 2012 to 2018, in six hospitals in Serbia, data for 342 procedures on treating PAA were collected for 329 (96.2%) men and only 13 (3.8%) women. The incidence of PAA repair was 6.8 operations *per* million inhabitants a year. The mean age of patients was 64.34 years (ranging from 29 to 87). A total of 223 (65.8%) elective procedures were performed. Amputation and hospital survival were considered the main outcomes. Thrombosis was recorded in 110 (32.5%) patients as a cause for surgery, and rupture was recorded in 5 patients. The mean diameter of the aneurysm was 35.3 mm, and a slightly larger diameter was recorded in ruptured aneurysms – 43.8 mm on average. Both synthetic and vein grafts were used in elective and urgent procedures equally. Endovascular procedures were performed in 6 (1.8%) cases. **Conclusion.** This study confirms the importance of registry-based collection of data and their analysis. It showed that the national incidence of PAA in Serbia is low and that well-organized, even institution-based, screening algorithms should improve identifying such patients and increase the number of electively treated PAA. Educating vascular surgeons to use the posterior approach could improve vascular healthcare.

Key words:
endovascular procedures; popliteal artery aneurysm; serbia; vascular surgical procedures.

Correspondence to: Aleksandar Zarić, Military Medical Academy, Clinic for Vascular and Endovascular Surgery, Crnotravska 17, 11 000 Belgrade, Serbia. E-mail: zaricaleksandar@gmail.com

Apstrakt

Uvod/Cilj. Aneurizma poplitealne arterije (APA) je najčešća aneurizma perifernih arterija i druga po učestalosti posle aneurizme abdominalne aorte (AAA). Međutim, njena učestalost je mala, a lečenje nestandardizovano. Formiranje multicentričnog nacionalnog registra moglo bi unaprediti dijagnostiku i lečenje APA. SerbVasc je novoformirani registar podataka o operisanim bolesnicima u vaskularnim centrima Srbije. Cilj rada bio je da se prikažu podaci iz hirurške prakse o dijagnostici i lečenju bolesnika sa APA u bolnicama u Srbiji. **Metode.** Vaskularni centri u Srbiji koji su prihvatili učešće u istraživanju prikupili su, retrospektivno, podatke o bolesnicima operisanim zbog APA u periodu od 2012. do 2018. godine. Prikupljeni su podaci o simptomatologiji, preoperativnoj dijagnostici, otvorenim i endovaskularnim tehnikama lečenja, kao i o rezultatu postoperativnog lečenja. Prikupljeni podaci su, radi analize između zemalja učesnica, prosleđeni VASCUNET internacionalnom projektu za APA. Isti podaci korišćeni su u analizi savremenog hirurškog lečenja APA u šest bolnica u Srbiji: Univerzitetski klinički centar Srbije, Institut za kardiovaskularne bolesti „Dedinje", Vojnomedicinska akademija, Univerzitetski klinički centar Novi Sad, Univerzitetski klinički centar Niš i Opšta bolnica Užice. **Rezultati.** U periodu od 2012. do 2018, u šest bolnica u Srbiji prikupljeni su podaci o 342 procedure lečenja APA, kod 329 (96,2%) muškaraca i kod samo 13 (3,8%) žena. Učestalost hirurškog lečenja APA iznosila je 6,8 intervencija na million stanovnika godišnje. Prosečna starost bolesnika iznosila je 64,34 godine (od 29 do 87 godina). Izvršeno je ukupno 223 (65,8%) elektivnih intervencija. Amputacija i bolničko preživljavanje su smatrani glavnim ishodima lečenja. Tromboza, kao uzrok operacije, je zabeležena kod 110 (32,5%) bolesnika, a ruptura kod pet. Prosečan dijametar aneurizme iznosio je 35,3 mm, a nešto veći dijametar zabeležen je kod rupturiranih aneurizmi – prosečno 43,8 mm. Sintetski i venski graftovi su jednako korišćeni, kako u elektivnim, tako i u hitnim operacijama. Endovaskularne procedure korišćene su kod 6 (1,8%) bolesnika. **Zaključak.** Sprovedeno istraživanje potvrđuje vrednost postojanja registra podataka i njihove analize. Pokazalo se da je učestalost APA u Srbiji niska i da dobro organizovani *skrining*, čak i u okviru pojedinačnih bolnica, može značajno unaprediti prepoznavanje bolesnika sa APA i povećati broj elektivno operisanih bolesnika. Edukacija vaskularnih hirurga o upotrebi posteriornog pristupa može unaprediti zdravstveni sistem.

Ključne reči:
endovaskularne procedure; a. poplitea, aneurizma; srbija; hirurgija, vaskularna, procedure.

Introduction

Popliteal artery aneurysm (PAA) is the most common peripheral artery aneurysm and the second most common aneurysm besides abdominal aortic aneurysm (AAA) [1]. The incidence of PAA is 7/100,000 in men and 1/100,000 in women. In 50% of cases, it is present bilaterally, and in 30–50%, it is accompanied by AAA [1–4]. Complications of PAA include thrombosis, embolic events, rupture, and compression of adjacent structures. High morbidity and amputation rate caused by PAA can be prevented by surgical treatment, which is advised for all symptomatic PAA and asymptomatic PAA larger than 2 cm [2–7]. Treatment modalities are heterogeneous, and they are mostly diverging between vascular and endovascular solutions. Open surgical treatment differs among centers and countries in terms of approach to PAA and selection of conduit [8–11]. Endovascular techniques used are exclusion with a covered stent, catheter-guided thrombolysis, and hybrid procedures [12–15]. Due to the variety of morphological features of PAA and diverse patient conditions, from young and healthy to old and fragile, there is no consensus for optimal treatment tactics and modality, while the low prevalence of this disease makes experienced data collection of the results rather difficult. Registry-based data may be used to collect experience, analyze common practice and assess the incidence and diagnostic modalities. A recent publication reported data collected in VASCUNET collaborative group showing varieties between countries. VASCUNET is a committee that works under the auspices of the European Society for Vascular Surgery and presents a collaboration of registries of vascular surgery in Europe, Australia, New Zealand, and Brazil. That is the first publication of the VASCUNET group with the Serbian dataset included [2].

The aim of this study was to present common surgical practices in the diagnosis and treatment of patients with PAA in hospitals in Serbia.

Methods

In order to participate in the VASCUNET report of 10,764 PAA cases published by Grip et al. [2] in 2020, main vascular centers in Serbia collected data retrospectively on patients operated on due to PAA from 2012 to 2018. All centers were invited, and those who accepted the invitation contributed to the study. This data set was used for detailed analysis of the contemporary treatment of PAA in six hospitals in Serbia: University Clinical Center of Serbia (UCCS), "Dedinje" Cardiovascular Institute (DCI), Military Medical Academy (MMA), University Clinical Center Novi Sad (UCCNS), University Clinical Center Niš (UCCN), and General Hospital Užice (GHU). All variables included in the dataset were determined by the VASCUNET group and were previously agreed upon between 14 countries participating in the Delphi consensus processes on chronic lower limb ischemia [16], acute limb ischemia [17], and previous VASCUNET reports on PAA [18].

Variables collected were the following: country, hospital, patient age, patient ID, gender, admission date, admission mode (indications for operative treatment were defined as elective and emergency due to thrombosis, ischemia, or rupture of PAA), diabetes mellitus, cardiac history (ischemic heart disease or congestive heart disease), current smoker

status, pulmonary history, cerebrovascular event history (history of a transient ischemic attack or stroke), hypertension history, indication, side of operation, ankle-brachial index (ABI), the diameter of the aneurysm, thrombosis, run-off (one, two, or three vessels), operation date, procedure (open, endovascular, hybrid), access route (medial, posterior, other, endovascular), proximal anastomosis site (iliac, femoral, popliteal), distal anastomosis site (popliteal above the knee, popliteal below the knee, crural), graft type (vein, synthetic, composite), additional open procedure, additional endovascular procedure, preoperative thrombolysis, perioperative thrombolysis, discharge date, wound complication, hemorrhage, fasciotomy, graft patent at discharge, graft patent at 30 days, amputation, acute kidney injury postoperatively, acute coronary event, major stroke, renal replacement therapy, died within 30 days of surgery, date of death, symptoms, amputation, graft patent at one year, symptoms remaining after one year.

All vascular clinics based at four national university clinical centers were invited, as well as all vascular departments in general hospitals. Data from the clinics that accepted to participate and those that sent the database by the due date were included. Data collected enabled analysis of incidence, demographics, indications, comorbidities, diameter, operative procedures and strategies, postoperative complications, and follow-up characteristics. Since this was a retrospective collection of data, some of the data were missing in every center. UCCS did not report symptoms at follow-up, MMA and UCCN did not report postoperative ABI, and no center reported previous cerebrovascular events. All postoperative data for UCCS and UCCN were collected on discharge. UCCNS used 30-day data for all the records, and other hospitals used both. Postoperative data were obtained on discharge in 242 cases, and in 95 cases, postoperative data were obtained at 30 days. Data for five cases were missing.

A population of 7.11 million was used for analysis, and it was calculated as the mean of the population in the first and last year of the time period.

The SPSS software package version 20.0 (IBM, Armonk, New York, USA) was used for statistical analysis. Statistical comparisons were performed with cross tabulation and comparison of mean values.

Results

From 2012 to 2018, a total of 342 procedures due to PAA were collected in six hospitals in Serbia. The incidence of PAA repair was 6.8 operations *per* million inhabitants a year. The mean age of patients during the period was 64.34 years, ranging from 29 to 87 years. Operated patients were predominantly men, 329 (96.2%); only 13 (3.8%) were women.

The overall incidence from 2012 to 2018 was 6.8 operations *per* million inhabitants a year. Incidence for the Novi Sad region was 28.1 operations *per* million inhabitants a year, Niš 6.6 operations *per* million inhabitants a year, and Užice 29.3 operations *per* million inhabitants a year.

Preoperative cardiac disease and hypertension history, including smoking habits, differed between the hospitals. Incidences of diabetes mellitus, cardiac, pulmonary, hypertension history, and smoking were analyzed for 339 procedures; data for three procedures were missing. Cerebrovascular disease history data was not provided. Data are presented in Table 1.

A total of 223 (65.8%) elective procedures were performed. Out of 115 (34%) emergency procedures, the indication for the treatment was thrombosis in 110 (32.5%) and rupture in 5 (1.5%) cases. Procedures for left-sided PAA were performed in 226 (66.1%) and for right-sided in 116 (33.9%) cases. Imaging methods were used to record aneurysm size and run-off vessels. The mean diameter of the aneurysm was 35.3 mm, ranging from 13 mm to 90 mm. For ruptured aneurysms, the diameter is larger, 43.8 mm on average, ranging from 28 to 60 mm. Run-off vessel data, defined as one, two, or three vessels present, were eligible for 159 (46.5%) patients.

More than half of all the procedures, 177 (51.7%), were performed in UCCS, and the other half was divided among the other hospitals. The majority of emergency patients were treated in the same hospital – 78/177 (44.1%), mostly due to thrombosis. Out of 336 open procedures, the medial approach was used in 237 (69.3%), the posterior approach in 98 (28.7%), and the extended medial in 1 (0.3%). The proximal anastomotic site was iliac, femoral, and popliteal artery in 1 (0.3%), 140 (42%), and 192 (57.7%) procedures, respectively, while for nine proce-

Table 1

Distribution of patients by sex, age, and preoperative history among hospitals in Serbia

Variable	Total	UCCS	DCI	MMA	UCCNS	UCCN	GHU	*p*-value
Male	329 (96.2)	173(97.7)	37 (90.2)	28 (96.5)	64 (95.5)	12(100)	15 (93.7)	0.311
Female	13 (3.8)	4 (2.3)	4 (8.8)	1 (3.5)	3 (4.5)	0 (0)	1 (6.3)	0.311
Age	64.34	64.12	63.20	64.59	66.06	59.92	65.38	0.344
Diabetes	55 (16.2)	34 (19.2)	6 (15.8)	3 (10.3)	6 (8.95)	2 (20)	4 (33.3)	0.367
Cardiac history	90 (26.6)	37 (20.9)	14 (36.84)	6 (20.7)	22 (32.8)	1 (9.1)	10 (62.5)	**0.002**
Pulmonary history	42 (12.4)	17 (9.6)	5 (13.2)	2 (6.9)	13 (19.4)	1 (8.3)	4 (25)	0.176
Hypertension	264 (77.9)	129(72.9)	38 (100)	22 (75.9)	51 (76.1)	10(83.3)	14 (87.5)	**0.012**
Current smoker	117 (34.5)	63 (35.6)	11 (28.9)	5 (17.2)	19 (28.4)	7 (58.3)	12 (75)	**0.001**

UCCS – University Clinical Center of Serbia; DCI – Cardiovascular Institute "Dedinje"; MMA – Military Medical Academy; UCCNS – University Clinical Center Novi Sad; UCCN – University Clinical Center Niš; GHU – General Hospital Užice.

All values are expressed as numbers (percentages). Bolded values are statistically significant.

dures, there were no data on the proximal anastomotic location. The distal anastomosis was performed above the knee in the popliteal artery, below the knee in the popliteal artery, and in the crural arteries in 48 (14.4%), 260 (78.8%), and 25 (7.5%) procedures, respectively. The synthetic graft was used in 172 (51.8%), the vein graft in 154 (46.4%), and the composite graft in 6 (1.8%) procedures, while there were no data for ten procedures. Both synthetic and vein grafts were used in elective and urgent procedures equally. In emergency cases, the synthetic graft was used more often than the vein graft for thrombosis and rupture in all cases eligible. Additional open or endo procedures were needed in 14.1%. Thrombolysis was performed preoperatively in 1 and perioperative in 11 cases. Endovascular procedures were performed only in 6 (1.8%) cases, all for elective admissions in DCI. The distribution of the number of procedures in six centers, as well as other preoperative and intraoperative parameters, is presented in Table 2.

Surgical wound complications demanding surgical treatment were present in less than 1% – 23 patients, hemorrhage occurred in 9 (2.7%) cases, and fasciotomy was indicated in 14 (4%) patients; all of this was more frequent in emergency cases. Amputation was performed in 10 (2.8%) patients, 5 (2.2%) in elective and 5 (4.7%) in urgent patients, 3 (2.7%) in thrombosed, and 2 (1.7%) in ruptured PAA. No major strokes were recorded, and 4 (1.2%) patients had an acute coronary event (acute coronary syndrome, myocardial infarction, serious arrhythmia, cardiac failure). One patient (0.3%) had a renal impairment that needed renal replacement therapy. Four patients (1.2%) died at 30 days: two in elective and two in the emergency group. Moreover, there were 11 (3.2%) graft occlusions recorded. Data for amputation were missing in 25 cases and also for graft patency at 30 days in 37 patients. Follow-up at one year recorded amputation, graft patency at one year, and persistence of the symptoms. Amputation rate data were eligible for 272 cases, graft patency

Table 2

Indications, preoperative imaging, and type of surgical procedure

Variable	Total	UCCS	DCI	MMA	UCCNS	UCCN	GHU
Number of procedures	342 (100)	177 (51.77)	41 (12.0)	29 (8.5)	67 (19.6)	12 (3.5)	16 (4.7)
Indication							
elective	223(65.8)	98 (55.4)	35 (92.1)	22 (75.9)	46 (68.7)	10 (83.3)	12 (75)
thrombosis	110 (32.5)	78 (44.1)	3 (7.9)	5 (17.2)	19 (28.4)	1 (8.3)	4 (25)
rupture	5 (1.5)	0	0	2 (6.9)	2 (2.9)	1 (8.33)	0
diameter	35.4	33.5	33.9	37.6	39.3	35.3	35.3
right	116 (33.9)	31 (17.5)	22 (53.6)	12 (41.4)	35 (52.2)	6 (50)	10 (62.5)
left	226 (66.1)	146 (82.5)	19 (46.3)	17 (58.6)	32 (47.8)	6 (50)	6 (37.5)
Run-off							
one vessel	43(26.9)	5 (13.9)	5 (13.9)	15 (51.7)	11 (16.4)	10 (83.3)	2 (12.5)
two vessels	46 (28.8)	7 (19.4)	7 (19.4)	6 (20.7)	26 (38.8)	1 (8.3)	6 (37.5)
three vessels	70 (43.8)	23 (63.9)	23 (63.9)	8 (27.6)	30 (44.8)	1 (8.3)	8 (50)
Procedure							
open	336 (98.3)	177 (100)	35 (85.4)	29 (100)	67 (100)	12 (100)	16 (100)
endovascular	6 (1.8)	0	6 (14.6)	0	0	0	0
Access route							
medial	237 (69.3)	88 (49.7)	35 (85.4)	26 (89.7)	65 (97)	11 (91.7)	11 (68.8)
posterior	98 (28.7)	89 (49.3)	0	3 (10.4)	2 (3)	0	5 (31.3)
other	1 (0.3)	0	0	0	0	1 (8.3)	0
endovascular	6 (1.8)	0	6 (14.6)	0	0	0	0
Proximal anastomosis							
iliac	1 (0.3)	0	0	1 (3.5)	0	0	0
femoral	140 (42)	72 (40.9)	16 (45.7)	12 (41.4)	25 (37.3)	10 (100)	5 (31.3)
popliteal	192 (57.7)	104 (59.1)	19 (54.3)	16 (55.2)	42 (62.7)	0	11 (68.8)
Distal anastomosis							
popliteal above knee	48 (14.4)	16 (9.1)	6 (17.1)	7 (24.1)	19 (28.4)	0	0
popliteal below knee	260 (78.8)	152 (86.4)	29 (82.9)	15 (51.7)	42(62.7)	8 (80)	14 (87.5)
crural	25 (7.5)	8 (4.6)	0	7 (24.1)	6 (8.9)	2 (20)	2 (12.5)
Graft type							
vein	154 (46.4)	80 (45.7)	14 (0.4)	7 (24.14)	36 (53.7)	8 (80)	9 (56.2)
synthetic	172 (51.8)	94 (53.7)	21 (0.6)	17 (58.6)	31 (46.2)	2 (20)	7 (43.7)
composite	6 (1.8)	1 (0.5)	0	5 (17.2)	0	0	0
additional open procedure	41 (12)	18 (10.2)	4 (9.8)	9 (31)	6 (8.9)	2 (16.7)	2 (12.5)
additional endo procedures	7 (2.1)	6 (3.4)	0	0	1 (1.5)	0	0
preoperative thrombolysis	1 (0.3)	0	0	0	0	0	1 (6.3)
perioperative thrombolysis	11 (3.2)	11 (6.2)	0	0	0	0	0

For abbreviations see Table 1. All results are shown as numbers (percentages) except diameter, which is shown in millimeters.

Table 3

Follow-up data

Variable	Total	UCCS	DCI	MMA	UCCNS	UCCN	GHU
Wound complication	23(0.9)	9 (5.1)	0	3 (10.3)	9 (13.4)	1 (8.3)	1 (6.3)
Hemorrhage	9 (2.7)	4 (2.3)	0	0	4 (6)	1(8.3)	0
Fasciotomy	14 (4.1)	6 (3.4)	0	1 (3.5)	3 (4.5)	1 (8.3)	3 (18.8)
Discharge patency	317 (96.3)	173 (98.3)	31 (96.9)	26 (89.7)	64 (95.5)	9 (100)	14 (87.5)
One-month patency	293 (96.1)	155 (98.7)	26 (96.3)	26 (89.7)	63 (94.0)	9 (100)	14 (87.8)
Amputation	10 (2.8)	2 (1.3)	1 (2.8)	2 (6.9)	3 (4.5)	2 (18.2)	0
Coronary event	4 (1.2)	0	0	1 (3.5)	1 (1.5)	1 (8.3)	1 (6.3)
Cerebrovascular event	0	0	0	0	0	0	0
Renal replacement therapy	1 (0.3)	0	0	1 (3.5)	0	0	0
Died in 30 days	4 (1.2)	1 (0.6)	0	0	0	1 (8.3)	2 (12.5)
Occlusion at 30 days	11 (100)	2 (18.2)	1 (9.1)	3 (27.3)	4 (36.3)	0 (0)	1 (9.1)
Symptoms remaining at 30 days							
no symptoms	305 (96.2)	157 (99.4)	32 (88.9)	28 (96.6)	67 (100)	8 (66.7)	13 (86.7)
claudication	11 (3.5)	1 (0.6)	4 (11.1)	1 (3.5)	0	4 (33.3)	1 (6.7)
gangrene	1 (0.3)	0	0	0	0	0	1 (6.7)
One year follow-up							
amputation in one year	15 (5.5)	2 (1.6)	3 (8.3)	0	7 (12.3)	2 (16.7)	1 (6.7)
one year patency	247 (91.8%)	119 (97.6%)	33 (91.7)	25 (89.3)	46 (82.1)	10 (100)	14 (93.3)
symptoms at one year	20 (15.3)		9 (27.3)	1 (3.6)	9 (16.1)	0	1 (6.7)

For abbreviations see Table 1. All values are expressed as numbers (percentages).

for 269, and persistence of the symptoms for 132 cases. Postoperative complications and follow-up are presented in Table 3.

Discussion

To participate in the VASCUNET report on PAA, the Serbian vascular service joined the database reports of PAA for seven years. Six hospitals in Serbia participated, and 342 cases were collected. Analysis among vascular centers in Serbia and departments has been performed assessing incidence, demographics, indications, comorbidities, diameters, operative procedures and strategies, postoperative complications, and follow-up characteristics of common surgical practice for PAA treatment.

For centuries surgeons have been dealing with PAA. From the Antyllus proximal and distal ligation in the 3rd century AD, Hunters proximal ligation in 1785, Matas endoaneurysmorrhaphy to revascularization after exclusion of aneurysm with the popliteal vein (Goyanes,1905), end to end anastomosis (Enderlen, 1907), saphenous vein (Pringle, 1913), and synthetic graft (Crawford, 1957), surgical treatment has evolved [19, 20]. Accessibility of modern diagnostic tools, especially Doppler ultrasound and multidetector computed tomography present in every major hospital, makes the detection of PAA easy. Extension of the disease, inflow and run-off vessels, and the quality of the great saphenous vein as a conduit can be easily obtained, and operative tactics can be managed accordingly [21, 22]. However, the incidence of PAA detection is not as expected, and the results of surgical treatment are still troublesome.

There were 342 procedures for PAA for seven years in six vascular departments. The overall incidence from 2012 to 2018 is 6.8 operations *per* million inhabitants a year. That is far behind the incidence reported in Sweden, where a screening program for AAA exists and considers routine examination of popliteal arteries [2]. Only Malta, New Zealand, and Iceland have a lower incidence of PAA operation *per* million inhabitants. Information about the number of amputations performed due to prolonged acute ischemia would also be very informative for vascular healthcare in Serbia. Only the Užice County could be calculated for incidence due to the existence of the same group of patients coming from the same area. Užice has 28 cases of PAA *per* million inhabitants a year which is far more than the country's average. Low incidence is either a manifestation of good primary prevention or a low incidence of early primary detected PAA.

Consequently, 115 (34%) procedures were established overall for emergency cases. Thrombosis was indicated in 32.5% of all cases, and 5 (1.5%) patients had a rupture. UCCS had the highest number of operations for thrombosis, 44.1% of all cases, and DCI had the lowest number of operations, less than 8%. That comes as a consequence of the organization of the national healthcare system, where UCCS is open 24/7 for vascular emergencies. A more profound analysis of health care service is necessary to define whether such a concept is beneficial to the patients. Women had smaller aneurysm diameters than the average of 30.45 mm and fewer (15%) urgent operations, all for thrombosis. Emergency-treated ruptured aneurysms, all recorded in men, were larger than the average (43.8 mm). The diameter of ruptured PAA ranged from 28 to 59 mm. All ruptured PAA were operated on using a medial approach.

The medial approach was used in 237 (69.3%) cases and posterior in 98 (28.7%) cases. Surgeons in UCCS used both methods evenly, while the other five hospitals relied on medial exposure predominantly. All centers used both vein and synthetic grafts for arterial reconstruction. The composite graft was used in six cases – five in MMA and one in UCCS. Each approach has advantages and limitations; how-

ever, both provide options for every particular patient. Organized institutional screening might increase the number of diagnosed patients and increase the volume of procedures in all centers, which might contribute to education and training in the dorsal approach.

Endovascular treatment was used in 1.8% of cases compared to New Zealand's 58% [2]. Vascular surgeons in Serbia used the endovascular technique the least compared to other countries [2]. There are obvious reasons like financing, accessibility, experience in stenting, as well as the mindset of surgeons in Serbia. On the other side, endovascular treatment of PAA has not been proven to be superior to open repair. The high incidence of complications prevents surgeons in Serbia from spending limited resources on such a procedure. A stepwise increase in the number of these procedures in highly selected patients may be accepted. Considering the age and comorbidities of patients presented, endovascular treatment should be used more routinely in common surgical practice.

Our study has some limitations. Not all hospitals with vascular surgery services participated. Still, these are mostly low-volume hospitals with very few potential cases of PAA, and most of the patients from these hospitals were already referred to those hospitals that were a part of this study. This study is a retrospective collection of data collected prospectively, which explains some of the missing data in our database. Data needed for such analysis of diagnostic methods, surgical techniques, and basic outcomes were not missing. This study was unable to address the number of primary amputations performed due to thrombosed PAA and prolonged leg ischemia. Considering the low incidence of PAA compared to other countries, such a number might be substantial and should be evaluated.

We were unable to include in the paper the severity of limb ischemia (acute, subacute, and chronic) due to thrombosed PAA, as this information is missing in the data set. As this is our first report of Serbian VASCUNET data, we will be stricter in quality control of included data in the data set.

Conclusion

This study confirms the importance of registry-based collection of data and their analysis. It showed that the national incidence of PAA in Serbia is low and that well-organized, even institution-based, screening algorithms should improve such findings and increase the number of electively treated patients. Education of vascular surgeons to use the posterior approach could improve vascular healthcare.

Acknowledgement

The presented article is a part of the Serbian collaboration registry "SerbVasc" part of VASCUNET.

R E F E R E N C E S

1. *Serrano Hernando FJ, Martínez López I, Hernández Mateo MM, Hernando Rydings M, Sánchez Hervás L, Rial Horcajo R*, et al. Comparison of popliteal artery aneurysm therapies. J Vasc Surg 2015; 61(3): 655–61.
2. *Grip O, Mani K, Altreuther M, Bastos Gonçalves F, Beiles B, Cassar K,* et al. Contemporary Treatment of Popliteal Artery Aneurysms in 14 Countries: A Vascunet Report. Eur J Vasc Endovasc Surg 2020; 60(5): 721–9.
3. *Ghotbi R, Deilmann K.* Popliteal artery aneurysm: surgical and endovascular therapy. Chirurg 2013; 84(3): 243–54. (German)
4. *Björck M, Earnshaw JJ, Acosta S, Bastos Gonçalves F, Cochennec F, Debus ES,* et al. Editor's Choice - European Society for Vascular Surgery (ESVS) 2020 Clinical Practice Guidelines on the Management of Acute Limb Ischaemia. Eur J Vasc Endovasc Surg 2020; 59(2): 173–218.
5. *Cervin A, Ravn H, Björck M.* Ruptured popliteal artery aneurysm. Br J Surg 2018; 105(13): 1753–8.
6. *Akman J, Katsogridakis E, Antoniou GA.* Ruptured popliteal artery aneurysms. Vascular 2019; 27(4): 430–47.
7. *Tomić A.* Kompartment sindrom. Belgrade: Pharmanova; 2010. (Serbian)
8. *Davidovic L, Jakovljevic N, Radak D, Dragas M, Ilic N, Koncar I*, et al. Dacron or ePTFE graft for above-knee femoropopliteal bypass reconstruction. A bi-centre randomised study. Vasa 2010; 39(1): 77–84.
9. *Kainth A, Smeds MR.* Popliteal Aneurysm Repair. Treasure Island (FL): StatPearls Publishing; 2022.
10. *Kropman RH, van Santvoort HC, Teijink J, van de Pavoordt HD, Belgers HJ, Moll FL*, et al. The medial versus the posterior approach in the repair of popliteal artery aneurysms: a multicenter case-matched study. J Vasc Surg 2007; 46(1): 24–30.
11. *Dragas M, Zlatanovic P, Koncar I, Ilic N, Radmili O, Savic N,* et al. Effect of Intra-operative Intra-arterial Thrombolysis on Long Term Clinical Outcomes in Patients with Acute Popliteal Artery Aneurysm Thrombosis. Eur J Vasc Endovasc Surg 2020; 59(2): 255–64.
12. *Joshi D, Gupta Y, Ganai B, Mortensen C.* Endovascular versus open repair of asymptomatic popliteal artery aneurysm. Cochrane Database Syst Rev 2019; 12(12): CD010149.
13. *Zamboni M, Scrivere P, Silvestri A, Vit A, Pellegrin A, Sponza M,* et al. Hybrid Approach to Popliteal Artery Aneurysm with Thromboembolic Symptoms. A Pilot Study. Ann Vasc Surg 2021; 72: 270–5.
14. *Dorigo W, Pulli R, Turini F, Pratesi G, Credi G, Innocenti AA,* et al. Acute leg ischaemia from thrombosed popliteal artery aneurysms: role of preoperative thrombolysis. Eur J Vasc Endovasc Surg 2002; 23(3): 251–4.
15. *Ohrlander T, Holst J, Malina M.* Emergency intervention for thrombosed popliteal artery aneurysm: can the limb be salvaged? J Cardiovasc Surg (Torino) 2007; 48(3): 289–97.
16. *Behrendt CA, Bertges D, Eldrup N, Beck AW, Mani K, Venermo M,* et al. International Consortium of Vascular Registries Consensus Recommendations for Peripheral Revascularisation Registry Data Collection. Eur J Vasc Endovasc Surg 2018; 56(2): 217–37.
17. *Behrendt CA, Björck M, Schwaneberg T, Debus ES, Cronenwett J, Sigvant B.* Acute Limb Ischaemia Collaborators. Editor's Choice - Recommendations for Registry Data Collection for Revascularisations of Acute Limb Ischaemia: A Delphi Consensus from the International Consortium of Vascular Registries. Eur J Vasc Endovasc Surg 2019; 57(6): 816–21.
18. *Björck M, Beiles B, Menyhei G, Thomson I, Wigger P, Venermo M,* et al. Editor's Choice: Contemporary treatment of popliteal artery

aneurysm in eight countries: A Report from the Vascunet collaboration of registries. Eur J Vasc Endovasc Surg 2014; 47(2): 164–71.

19. *Earnshaw JJ*. Where We Have Come From: A Short History of Surgery for Acute Limb Ischaemia. Eur J Vasc Endovasc Surg 2020; 59(2): 169–70.
20. *Galland RB*. Popliteal aneurysms: from John Hunter to the 21st century. Ann R Coll Surg Engl 2007; 89(5): 466–71.
21. *Schwarze V, Marschner C, de Figueiredo GN, Rübenthaler J, Clevert DA*. Contrast-enhanced ultrasound (CEUS) in the diagnostic evaluation of popliteal artery aneurysms, a single-center study. Clin Hemorheol Microcirc 2020; 76(2): 191–7.
22. *Piccoli G, Gasparini D, Smania S, Sponza M, Marzio A, Vit A,* et al. Multislice CT angiography in the assessment of peripheral aneurysms. Radiol Med 2003; 106(5–6): 504–11. (English, Italian)

Received on February 28, 2022
Revised on June 24, 2022
Accepted on July 5, 2022
Online First July 2022