The importance of the superficial and profunda femoris arteries in limb salvage following endovascular treatment of chronic aortoiliac occlusive disease

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Rafael de Athayde Soares, MD, Marcelo Fernando Matielo, PhD, Francisco Cardoso Brochado Neto, PhD, Marcus Vinícius Martins Cury, PhD, André Câmara Matoso Chacon, MD, Edson Takamitsu Nakamura, MD, *and* Roberto Sacilotto, PhD, *São Paulo, Brazil*

ABSTRACT

Objective: This study aimed to report the long-term limb salvage, survival and patency rates of endovascular treatment for aortoiliac occlusive disease (AIOD) when outflow was achieved through the profunda femoris artery (PFA) only vs both the PFA and superficial femoral artery (SFA).

Methods: From January 2008 to July 2016, patients with AIOD who underwent aortoiliac angioplasty at the Division of Vascular and Endovascular Surgery, Hospital do Servidor Público Estadual, São Paulo, Brazil, were classified into two groups according to whether they had femoral outflow via the PFA only (group 1) or both the PFA and SFA (group 2) in the affected leg. The primary outcome was amputation-free survival. The secondary outcomes were the patency and overall survival rates.

Results: In total, 69 aortoiliac angioplasties were performed in 69 patients: 22 patients (31.8%) in group 1 and 47 (67.2%) in group 2. A total of 12 reinterventions (17.4%) were performed, seven (31.8%) in group 1 and five (10.2%) in group 2, without statistical significance between the groups ($P = .063$). The mean clinical follow-up period was 2500 ± 880.5 days. Both the primary and secondary patency rates analyzed at 1800 days were similar between groups 1 and 2 (80.2% vs 82.3%; $P = .80$ and 84.7% vs 97.6%; $P = .10$, respectively). Furthermore, the limb salvage rates at 1800 days were similar between groups 1 and 2 (91.3% vs 86.1%; $P = .60$), as were the survival rates (74.7% vs 78%; $P = .80$). The Bollinger score was worse in group 1 ($P = .001$), as expected, because of occlusion of the SFA. However, the PFA and popliteal artery scores were similar between the two groups. Occlusion of the SFA did not influence the limb salvage rate according to univariate analysis ($P = .509$) and multivariate Cox regression analysis ($P = .671$).

Conclusions: The patency of the SFA does not interfere with the outcomes of endovascular treatment for chronic AIOD. The PFA in conjunction with the popliteal artery as the sole outflow route for iliac endovascular treatment is associated with similar patency, survival, and limb salvage rates as those for outflow through both the PFA and SFA. (J Vasc Surg 2018;68:1422-9.)

Keywords: Aortoiliac occlusive disease; Critical limb ischemia; Limb salvage; Endovascular treatment; Amputation; Iliac stenting

Endovascular treatment for aortoiliac occlusive disease (AIOD) is well established worldwide. Occlusive disease of the aorta and iliac arteries often leads to incapacitant claudication and critical limb ischemia.[1] Indications for intervention include life-limiting claudication, rest pain, and tissue loss. Less commonly, atheroembolism caused by an aortic or iliac lesion, most often presenting with acute limb ischemia or "blue toe syndrome," is another indication for endovascular treatment. Approximately 45%-65% of patients present with claudication of the buttocks and thighs, which can drastically reduce quality of life.[2]

The profunda femoris artery (PFA) plays important roles in the irrigation of the limbs, especially the thighs, and in extensive collateralization with the popliteal artery to provide an adequate blood supply to the legs and feet. Despite this knowledge, there are few studies in the literature regarding the role of the PFA, especially as the sole outflow artery, in the endovascular treatment of AIOD in patients with superficial femoral artery (SFA) occlusion.

The aim of this study was to determine the long-term rates of limb salvage, survival, and patency after endovascular treatment for AIOD when outflow was achieved via the PFA alone or both the PFA and SFA.

METHODS

This study was approved by our research ethics committee. Patient informed consent was obtained for the study. This was a retrospective consecutive cohort study

From the Division of Vascular and Endovascular Surgery, Hospital do Servidor Público Estadual de São Paulo.

Author conflict of interest: none.

Correspondence: Rafael de Athayde Soares, MD, Division of Vascular and Endovascular Surgery, Hospital do Servidor Público Estadual de São Paulo, Barão de Jaceguai St, 908, Campo Belo, 04606-000 São Paulo, SP, Brazil (e-mail: rafaelsoon@hotmail.com).

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of patients with AIOD who underwent aortoiliac angioplasty at the Division of Vascular and Endovascular Surgery, Hospital do Servidor Público Estadual, São Paulo, Brazil, between January 2008 and July 2016. Patient data, including demographic and epidemiologic characteristics and details of the outpatient follow-up program, were collected from the hospital database using Microsoft Access (Microsoft, Seattle, Wash). When necessary, hospital records were also consulted. The details of the surgical procedures were obtained from the database and patient records. All patients had undergone cardiac evaluation by a specialist in our department and were subsequently stratified according to their cardiac risk, based on the guidelines of the American Heart Association pertaining to perioperative cardiovascular evaluation and noncardiovascular surgical care.[3] Based on the data evaluated, heart disease was defined as ischemic heart disease or cardiomyopathy.

The inclusion criteria were patients with a Rutherford classification of 2-6 who had undergone aortoiliac angioplasty.[4] The arteriography procedures performed on the patients were re-evaluated to confirm accurate execution of our departmental protocols. Based on a review of the arteriography procedures that had been performed according to the appropriate protocols, the patients were evaluated according to the TransAtlantic Inter-Society Consensus (TASC) II classifications, diameters and lengths of the catheter balloons and stents used, and other factors associated with the endovascular treatments.[5,6] The required information was obtained from each patient and independently evaluated to assess the Bollinger classification of the femoropopliteal and infrapopliteal segment. The Bollinger Score consists of a vectorial score, which codes the pattern of occlusions, stenosis and plaques, and of an additive score describing the severity of the lesions visualized. Four categories of occlusive lesions were defined in descending order of severity: complete occlusions of the lumen; stenosis more than 50%; stenosis 25%-50%; plaques with stenosis <25%. The occlusion length is also considered to score the angiogram. This score is a suitable means for a semiquantitative description of routine lower limb arteriograms.[7]

Following review of the arteriograms, we classified the patients into two groups according to whether outflow in the affected leg occurred via the PFA only (group 1) or via both the PFA and SFA (group 2). Group 1 was defined as total occlusion or multilevel disease of the SFA, with multiple areas of critical stenosis and segmental occlusions, with a PFA patent and without significant stenosis. Group 2 was defined as a SFA totally patent, without any significant stenosis and with a PFA patent and without significant stenosis. The patency and stenosis of both SFA and PFA was defined using the arteriograms of the procedures performed.

ARTICLE HIGHLIGHTS

- **Type of Research:** Single center retrospective cohort study
- **Take Home Message:** Endovascular aortoiliac intervention in 69 patients resulted in similar limb salvage and survival for patients with a patent diseased superficial femoral artery and patent profunda femoris compared with patients with an occluded superficial femoral artery and patent profunda femoris artery.
- **Recommendation:** This study suggests that a patent profunda femoris artery is critical to limb salvage following endovascular aorta-iliac intervention.

In our department, aortoiliac angioplasty is performed preferentially using bare-metal stents. Patients receive 300 mg clopidogrel as the loading dose immediately after the procedure and continue receiving 75 mg clopidogrel for 6 months and aspirin (100 mg daily) for life. This dose of aspirin is indicated for all patients unless there are contraindications; all patients receive some type of statin. The indications for angioplasty, such as the TASC II classification, are according to those determined in a major trial.[5,6]

Initial technical success of aortoiliac angioplasty was defined as no more than 30% residual stenosis, and prompt restoration of blood flow in the previously stenotic or occluded artery. Procedures such as debridement and minor amputation were also performed if necessary.

All of the patients were scheduled for follow-up at the hospital at intervals of 15 days, 1 month, 3 months, 6 months, and 12 months after discharge. After the first year, the patients were followed up every 6 months, and after the second year, every 12 months, at which time the following clinical criteria were evaluated: pulse palpation, ankle-brachial index, and presence of symptoms. We performed surveillance programs using arterial duplex ultrasound (DUS) at 1, 3, 6, and 12 months after the procedure in all patients of this study. DUS was performed every 6 months after the first year and every 12 months after the second year. If any clinical or sonographic changes were noted, the case was brought up for discussion at a departmental clinical meeting to determine whether reintervention was required. Occlusion after angioplasty was defined (using DUS) as no flow, segmental or complete, in the treated artery. Loss of primary patency was defined as occlusion or stenosis >50%, using DUS, which required reintervention. DUS was also used to differentiate target lesion restenosis from progression of native arterial disease. The profunda femoral artery patency was defined using DUS in the follow-up.

Table I. Clinical characteristics

Variables	Total (N = 69), No. (%)	Group 1 (n = 22; 31.8%), No. (%)	Group 2 (n = 47; 67.2%), No. (%)	*P* value
Age ± SD, years	65.87 ± 8.8	67.82 ± 8.9	64.96 ± 7.2	.21
Male	38 (55.1)	12 (54.5)	26 (55.3)	.57
Hypertension	59 (85.5)	20 (90.9)	39 (82.9)	.31
Diabetes	34 (49.2)	13 (59.1)	21 (44.6)	.19
Heart disease	17 (24.6)	6 (27.3)	11 (23.4)	.49
Chronic renal failure	13 (18.8)	6 (27.3)	7 (14,8)	.18
Active tobacco use	43 (62.3)	14 (63.6)	29 (59.5)	.48

SD, Standard deviation.

Table II. Perioperative and postoperative data

Variables	Total (N = 69), No. (%)	Group 1 (n = 22; 31.8%), No. (%)	Group 2 (n = 47; 67.2%), No. (%)	*P* value
Mean ABI pre	0.35	0.30	0.42	.44
Mean ABI post	0.9	0.75	1	.003
Rutherford class				
2	2 (2.9)	1 (4.5)	1 (2.1)	.11
3	14 (20.2)	3 (13.6)	11 (23.4)	.07
4	13 (18.8)	1 (4.5)	12 (25.5)	.003
5	40 (57.9)	17 (77.3)	23 (48.9)	.39
Operative mortality	3 (4.3)	1 (4.5)	2 (4.3)	.46
High cardiac risk	52 (75.6)	18 (81.8)	34 (72.3)	.39

ABI, Ankle-brachial index.

Statistical analyses were performed using SPSS v 15.0 for Windows (IBM, Armonk, NY). Frequencies and descriptive statistics were analyzed. The χ^2 test and Student *t*-test were used to compare the univariate analysis data. Survival curves to estimate limb salvage, patency, and survival rates were constructed using the Kaplan-Meier method. A *P* value of <.05 was considered statistically significant. The analyses were performed within 1800 days.

RESULTS

A total of 69 aortoiliac angioplasties were performed in 69 patients between January 2008 and July 2016, with initial technical success in 100% of the patients; the mean clinical follow-up period was 2500 ± 880.5 days. Analyses were performed at 1800 days. Of the 69 patients, 22 patients (31.8%) were classified in group 1 and 47 (67.2%) in group 2. A total of 12 reinterventions (17.4%) were performed, seven (31.8%) in group 1 and five (10.2%) in group 2, without statistical significance between the groups (*P* = .063). Of the reinterventions, there were 5 and 2 cases of angioplasty, 1 and 2 cases of iliac femoral bypass, and 1 and 1 case of femorofemoral bypass in groups 1 and 2, respectively. The clinical characteristics of the patients are listed in Table I and the peri- and postoperative data in Table II.

There were 11 patients who needed concomitant femoral or tibial open/endovascular procedures, six patients (27.3%) in group 1 and five patients in group 2 (10.6%); *P* = .083. Of the interventions, there were three and one cases of distal bypass in groups 1 and 2, respectively, three cases of femoropopliteal bypass in group 1, and three cases of femoropopliteal angioplasty and one case of distal angioplasty in group 2. The three cases of femoropopliteal angioplasty in group 2 were done after 1 year of the previous aortoiliac angioplasty.

Regarding the indications for revascularization, most patients presented with critical limb ischemia (76.7%). Group 2 had more patients with rest pain compared with group 1 (*P* = .003). The postoperative ankle-brachial index was higher in group 2 than in group 1 (*P* = .003). The majority of patients had a high cardiac risk (75.6%; Table II).

When we analyzed the endovascular procedures, the common iliac artery was the most prevalent artery (in 62.3% of all patients) subjected to endovascular treatment, with no difference between the groups. When we classified the lesions according to their TASC II classification on the basis of the arteriographic findings, TASC B lesions were predominant among all patients (43.9% of the total patients), and TASC D lesions were predominant in group 2 (*P* = .06; Table III).

Stents were used in approximately 91.3% of patients, with a predominant usage of balloon-expandable stents, in 58% of patients. There were no differences between the two groups in terms of stent usage or the type of stent used (Table III).

Table III. Procedural data

Variables	Total (N = 69), No (%)	Group 1 (n = 22; 31.8%), No (%)	Group 2 (n = 47; 67.2%), No (%)	*P* value
Arteries treated				
Common iliac	43 (62.3)	12 (54.5)	31 (65.9)	.72
External iliac	9 (13)	4 (18.1)	5 (10.6)	.73
Kissing iliac	13 (18.8)	5 (22.7)	8 (17)	.59
Aorta + common iliac				
TASC	4 (5.8)	1 (4.5)	3 (6.3)	.72
A	20 (28.9)	5 (22.7)	15 (31.9)	.56
B	30 (43.9)	11 (50)	19 (40.4)	.08
C	9 (13)	4 (18.1)	5 (10.6)	.06
D	10 (14.4)	2 (9)	8 (17)	.06
Stent usage				
Self-expanding	22 (31.8)	7 (31.8)	14 (29.7)	.27
Balloon-expandable	40 (58)	15 (68.1)	25 (53.1)	.11
Self-expanding + Balloon-expandable	2 (2.9)	0 (0)	2 (4.2)	.27
No stents	5 (7.2)	0 (0)	5 (10.6)	.24

TASC, TransAtlantic Inter-Society Consensus.

Table IV. Bollinger classification

Femoropopliteal and infrapopliteal arteries	Total, mean ± SD	Group 1, mean ± SD	Group 2, mean ± SD	*P* value
Proximal supfem	6.22 ± 4.6	14.22 ± 5.0	1.86 ± 2.7	.000
Distal supfem	7.39 ± 4.6	15.00 ± 5,0	3.24 ± 4.0	.000
Prof fem	.88 ± 1.4	1.00 ± 1.8	.82 ± 1.13	.667
Proximal POP	5.26 ± 4.6	6.6 ± 4.5	4.9 ± 4.7	.906
Distal POP	4.42 ± 4.6	7.2 ± 4.5	5.6 ± 4.7	.102
Tib-per	3.57 ± 1.29	9.00 ± 2.38	2.00 ± 1.19	.093
Proximal PT	5.17 ± 1.40	5.29 ± 2.57	5.13 ± 1.73	.960
Distal PT	6.82 ± 1,52	8.29 ± 2.46	6.13 ± 1.13	.523
Proximal AT	8.23 ± 1.50	10.29 ± 2.26	7.27 ± 1.94	.364
Distal AT	8.86 ± 1.48	10.29 ± 2.26	8.20 ± 1.97	.529
Proximal PER	4.86 ± 1.39	7.29 ± 2.77	3.37 ± 1.56	.244
Distal PER	5.30 ± 1.49	3.67 ± 2.37	6.00 ± 1.90	.490

Distal AT, Distal anterior tibial; *Distal PER,* distal peroneal; *Distal POP,* distal popliteal artery; *distal PT,* Distal posterior tibial; *Distal supfem,* distal superficial femoral artery; *Prof fem,* profunda femoris artery; *Proximal AT,* proximal anterior tibial; *Proximal PER,* proximal peroneal; *Proximal POP,* proximal popliteal artery; *Proximal PT,* proximal posterior tibial; *Proximal supfem,* proximal superficial femoral artery; *SD,* standard deviation; *Tib-per,* tibioperoneal trunk.

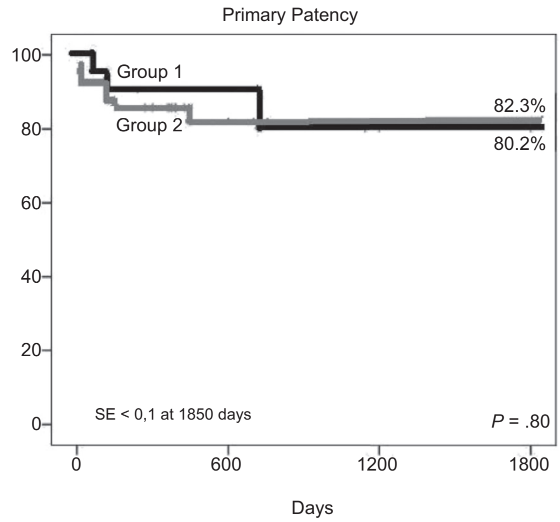
Regarding the Bollinger classification, group 1 had a worse score (P = .001), as expected considering the occlusion of the SFA. However, the PFA and popliteal artery scores were similar between the groups. Indeed there were no differences in infrapopliteal scores among the groups (Table IV).

The primary and secondary patency rates at 1800 days were similar between groups 1 and 2 (80.2% vs 82.3%; P = .80 and 84.7% vs 97.6%; P = .10, respectively; Figs 1 and 2). Furthermore, the limb salvage rates at 1800 days were similar between groups 1 and 2 (91.3% vs 86.1%; P = .60; Fig 3). The survival rates were also similar between groups 1 and 2 (74.7% vs 78%; P = .80; Fig 4).

We performed a Cox regression analysis to identify any other factors related to the limb salvage rate in our study (Table V). Occlusion of the SFA did not influence the limb salvage rate according to the univariate (P = .509) and multivariate analyses (P = .671).

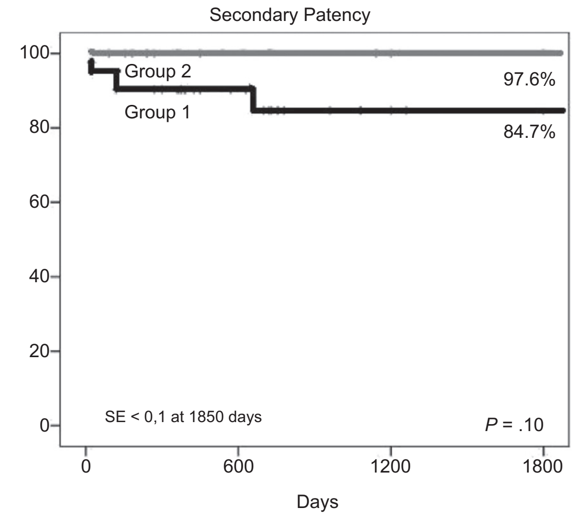
DISCUSSION

There are few reports on the influence of the PFA on the outcomes of endovascular treatment for AIOD. Kudo et al[8] analyzed the long-term outcomes and predictors of 151 iliac angioplasties and reported 1-, 3-, and 5-year cumulative primary patency rates of 76%, 59%, and 49%, respectively. The cumulative assisted primary



At risk Days	0	600	1200	1800
Group 1	22	15	14	7
Group 2	47	27	12	11

Fig 1. Kaplan-Meier plot of primary patency rates. The primary patency rate at 1800 days was 80.2% in group 1 and 82.3% in group 2 with a standard error (*SE*) <10% (SE < 0.1) at 1850 days.

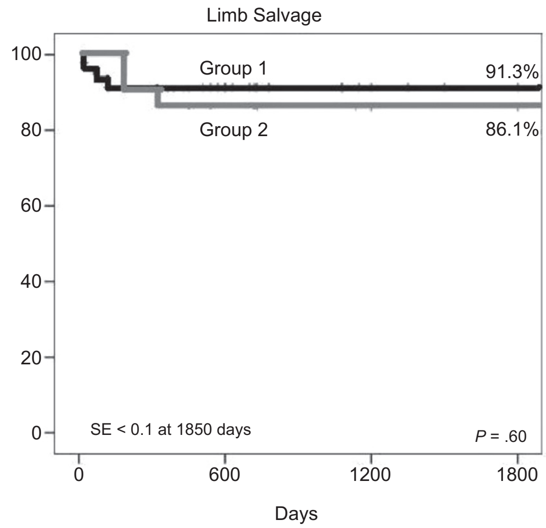


At risk Days	0	600	1200	1800
Group 1	22	15	14	7
Group 2	47	26	12	11

Fig 2. Kaplan-Meier plot of secondary patency rates. The second patency rate at 1800 days was 84.7% in group 1 and 97.6% in group 2 with a standard error (*SE*) <10% (SE < 0.1) at 1850 days.

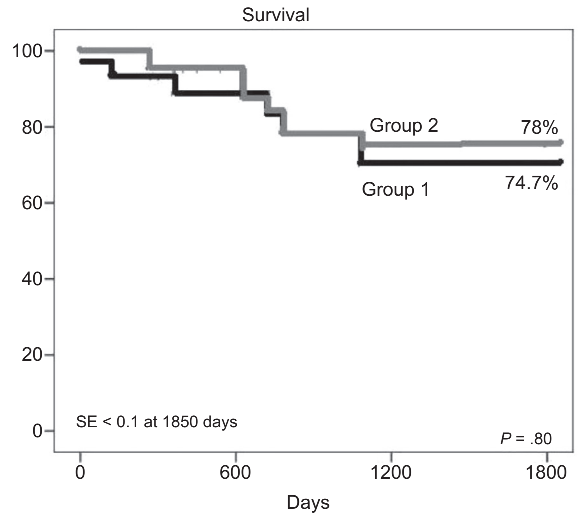
patency, secondary patency, and limb salvage rates at 7 years were 98%, 99%, and 93%, respectively. They found that a history of smoking ($P = .0074$), TASC C/D lesions ($P = .0001$), and stenotic ipsilateral SFAs ($P = .0002$) were significant independent predictors of adverse outcomes in terms of the primary patency rate. They did not analyze the role of the PFA; however, a stenotic ipsilateral SFA was associated with worse outcomes. The data of that study are in contrast to those found in the present study, in which we did not find a relationship between the clinical outcomes and number of patent femoral arteries, as outflow through the PFA was sufficient to achieve good patency and limb salvage rates, particularly in the presence of a patent popliteal artery.

Regarding the influence of the femoral arteries in iliac stenting, Kudo et al[9] evaluated the impact of the ipsilateral SFA on percutaneous transluminal angioplasty of the iliac arteries. They found that 77 limbs (42%) had patent SFAs (pSFA group; 66 intact or with <50% stenosis and 11 previously bypassed), 28 (15%) had stenotic (50%-99%) SFAs (sSFA group), 51 (28%) had occluded SFAs (oSFA group), and 27 (15%) had concomitant SFA angioplasty (aSFA group). The TASC iliac lesion type and status of the ipsilateral PFA were not significantly different among the four groups. They showed a significantly decreased primary patency rate in the sSFA group (29% at 3 years, Kaplan-Meier method and log-rank test; $P < .0001$) compared with the other three groups; however, there were no significant differences among the pSFA, oSFA, and aSFA groups (67%, 67%, and 86% at 3 years, respectively; $P = .92$). The continued clinical improvement rates were significantly decreased in the sSFA group (36% at 3 years, $P = .0043$) compared with the other three groups; however, there were no significant differences among the pSFA, oSFA, and aSFA groups (81%, 84%, and 75% at 3 years, respectively; $P = .088$). The assisted primary and secondary patency rates and limb salvage rates were not significantly different among the four groups ($P > .40$). Therefore, the authors concluded that the primary patency and continued clinical improvement rates are significantly decreased in patients with stenotic SFAs, suggesting that concomitant SFA angioplasty might improve iliac patency after iliac angioplasty in patients with stenotic SFAs. The presence of an occluded SFA did not adversely affect the outcome of iliac angioplasty. Similarly, in our study, we showed similar primary patency, secondary patency, and limb salvage rates between groups 1 and 2 (ie, single and double artery outflow after iliac stenting, respectively). In this present study, there was over three times more reinterventions in group 1, despite the *P* value of .06. Perhaps, with a higher number of patients this value would be statistically significant. Otherwise, the number of concomitant femoral or tibial endovascular/open surgery interventions was statistically similar in



At risk Days	0	600	1200	1800
Group 1	22	15	14	11
Group 2	47	27	14	13

Fig 3. Kaplan-Meier plot of limb salvage rates. The limb salvage rate at 1800 days was 91.3% in group 1 and 86.1% in group 2 with a standard error (*SE*) <10% (SE < 0.1) at 1850 days.



At risk Days	0	600	1200	1800
Group 1	22	14	13	10
Group 2	47	30	16	15

Fig 4. Kaplan-Meier plot of survival rates. The survival rates at 1800 days were 74.7% in group 1 and 78% in group 2 with a standard error (*SE*) <10% (SE < 0.1) at 1850 days.

both groups. This may be explained by the collateralization among the PFA and the popliteal arteries, which will be explained further. However, the main focus of our study was the influence of the PFA, rather than the SFA.

We found a worse Bollinger classification in group 1 mainly because of occlusion of the SFA. However, Bollinger classification of the popliteal artery and the infrapopliteal arteries was similar in both groups, and this may have played a fundamental role in the similar patency and limb salvage rates between the two groups. Gray[10] was the first to describe arterial anastomoses between the PFA and popliteal arteries. These anastomoses are not usually visible on clinical imaging, including direct angiography, computed tomography angiography, or magnetic resonance angiography. Gray provided a description of the collateral circulation after ligation of the femoral artery, which he attributed to Cooper.[11] In his original report, Cooper argues that most patients have sufficient collateral flow, via anastomoses of smaller vessels, to allow surgeons to ligate any major arteries to control aneurysm or hemorrhage. At first, these studies aimed to evaluate whether the PFA provides adequate blood flow to the legs in the case of acute trauma or occlusion of the SFA, thus, avoiding the need for SFA reconstruction. However, it has been confirmed that this collateral circulation plays an important role in chronic occlusions, when there has been sufficient time to allow their development. In the same way, Davies et al[12] compared the outcomes of endovascular PFA revascularization (ePFR) with ePFR and concurrent endovascular femoropopliteal revascularization. They reported 12-month amputation-free survival and reintervention rates of 78% and 72% following isolated ePFR, and 96% and 81% following ePFR and concurrent endovascular femoropopliteal revascularization, respectively. There was no significant difference in amputation-free survival ($P = .4$) or the reintervention rate ($P = .91$) between the two groups.

The PFA is the main vessel supplying arterial blood to the thigh muscles. In patients with critical limb ischemia and severely diseased or occluded SFAs, the PFA is the main collateral pathway maintaining arterial flow to the distal extremity. Donas et al[13] evaluated the therapeutic value of endovascular technique for the treatment of profunda femoris arterial obstructive disease in critical limb ischemia patients with technically demanding open profunda repair. All patients had adequate flow via the common femoral artery, long occlusion of the superficial femoral and popliteal arteries, and impaired crural arteries. The endovascular approach was technically successful in all cases, and the procedure-related morbidity and mortality rates were 0% over the entire follow-up period. The 3-year primary and secondary patency rates of the treated segment were 80% and 86.7%, respectively. The limb

Table V. Cox regression analysis of factors associated with the limb salvage rate

	Univariate analysis				Multivariate analysis			
Variables	β	HR	95% CI	*P*	β	HR	95% CI	*P*
Occlusion of SFA	0.517	6.00	0.128-2.767	.509	.597	7.00	0.226-10.060	.671
Active tobacco use	0.299	0.830	0.262-2.297	.589	1.249	1.03	0.820-4.681	.642
Chronic kidney disease	13.759	10.42	0.680-2.051	.981	8.11	3.71	0.538-4.567	.831
Diabetes	0.984	0.869	0.221-1.501	.257	.885	0.906	0.411-14.294	.831
Hypertension	13.230	0.913	0.331-1.429	.453	1.032	0.571	0.331-4.234	.552
TASC AB + CD	0.686	0.913	0.542-1.543	.172	0.711	0.915	0.339-12.230	.437

CI, Confidence interval; *HR,* hazard ratio; *SFA,* superficial femoral artery; *TASC,* TransAtlantic Inter-Society Consensus.

salvage rate was 93.3%. The authors concluded that endovascular treatment of lesions of the PFA, as the only femoral artery for outflow, showed excellent results in terms of patency and limb salvage rates. Similarly, our results support that outflow through the PFA alone yields good patency and limb salvage rates, particularly in the presence of a patent popliteal artery, despite the focus of our study being aortoiliac endovascular procedures.

The overall operative mortality was 4.3%, with no difference between the two groups, which can be considered satisfactory despite the high prevalence of patients with an elevated cardiac risk (75.6%) in this study. However, the survival rate at 1800 days was approximately 78%. Our survival and operative mortality rates are similar to those found in the literature. For example, in an analysis of 136 iliac endovascular procedures, Timaran et al[14] reported an operative mortality rate of 0.7% and a survival rate of 78% at 5 years. Similarly, in a study of the evolution of AIOD endovascular treatment approaches over a 7-year period, Kasemi et al[15] also reported a perioperative mortality rate of 4.5% among 22 patients with TASC D lesions.

Few studies in the literature have investigated femoral artery outflow in iliac endovascular treatment, with a focus on the role of the PFA in patency and limb salvage rates. Despite the retrospective nature of the present study, the lack of statistically significant differences between the groups indicates the importance of our findings regarding a poorly explored subject in endovascular surgery. However, prospective studies involving more participants are needed to improve the validity of these findings.

CONCLUSIONS

In this study, we found that SFA patency does not affect the outcomes of endovascular treatment for chronic AIOD. In iliac endovascular treatment, outflow via the PFA alone (in conjunction with collateralization with the popliteal artery) results in similar patency, survival, and limb salvage rates compared with outflow via both the PFA and SFA.

AUTHOR CONTRIBUTIONS

Conception and design: RAS
Analysis and interpretation: RAS, MM, MMC, FBN, RS
Data collection: AMC, EN
Writing the article: RAS
Critical revision of the article: RAS, MM, MMC, FBN, AMC, EN, RS
Final approval of the article: RAS, MM, MMC, FBN, AMC, EN, RS
Statistical analysis: RAS, MMC
Obtained funding: Not applicable
Overall responsibility: RS

REFERENCES

1. Bosch JL, Hunink MG. Meta-analysis of the results of percutaneous transluminal angioplasty and stent placement for aortoiliac occlusive disease. Radiology 1997;204:87-96.
2. Clair DG, Beach JM. Strategies for managing aortoiliac occlusions: access, treatment and outcomes. Expert Rev Cardiovasc Ther 2015;13:551-63.
3. Fleisher LA, Beckman JA, Brown KA, Calkins H, Chaikof EL, Fleischmann KE, et al. ACC/AHA 2007 guidelines on perioperative cardiovascular evaluation and care for non-cardiac surgery. J Am Coll Cardiol 2007;50:E159-241.
4. Rutherford RB, Flanigan PD, Gupta SK. Suggested standards for reports dealing with lower extremity ischemia. J Vasc Surg 1986;4:80.
5. Norgren L, Hiatt W, Dormandy J, Nehler M, Harris K, Fowkes F; on behalf of the TASC II Working Group. Inter-society consensus for the management of peripheral arterial disease (TASC II). Eur J Vasc Endovasc Surg 2007;33(Suppl 1):S5-75.
6. Norgren L, Hiatt WR, Dormandy JA, Nehler MR, Harris KA, Fowkes FG, et al. TASC II working group. Inter-society consensus for the management of peripheral arterial disease (TASC II). J Vasc Surg 2007;43:S1-67.
7. Bollinger A, Breddin K, Hess H, Heystraten FM, Kollath J, Konttila A, et al. Semi-quantitative assessment of lower limb atherosclerosis from routine angiographic images. Atherosclerosis 1981;38:339-46.
8. Kudo T, Chandra FA, Ahn SS. Long-term outcomes and predictors of iliac angioplasty with selective stenting. J Vasc Surg 2005;42:466-75.
9. Kudo T, Rigberg DA, Reil TD, Chandra FA, Ahn SS. The influence of the ipsilateral superficial femoral artery on iliac angioplasty. Ann Vas Surg 2006;20:502-11.
10. Gray H. Anatomy: Descriptive and Surgical. London: John W Parker and Son; 1860. p. 422.

11. Cooper A. Dissection of a limb on which the operation for popliteal aneurism had been performed. Med Chir Trans 1811;2:251-61.
12. Davies RS, Rashid SH, Adair W, Bolia A, Fishwick G, McCarthy MJ, et al. Isolated percutaneous transluminal angioplasty of the profunda femoris artery for limb ischemia. Vasc Endovas Surg 2013;47:423-8.
13. Donas PK, Pitoulias GA, Schwindt A, Schulte S, Camci M, Schlabach R, et al. Endovascular treatment of profunda femoris artery obstructive disease: nonsense or useful tool in selected cases? Eur J Vasc Endovasc Surg 2010;39:308-13.
14. Timaran CH, Prault TL, Stevens SL, Freeman MB, Goldman MH. Iliac artery stenting versus surgical reconstruction for TASC (Transatlantic Inter-Society Consensus) type B and C iliac lesions. J Vasc Surg 2003;38:272-8.
15. Kasemi H, Marino M, Dionisi CP, Di Angelo CL, Fadda GF. Seven-year approach evolution of the aortoiliac occlusive disease endovascular treatment. Ann Vas Surg 2016;30:277-85.

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INVITED COMMENTARY

Stephen W. K. Cheng, MBBS, MS, FRCS, *Hong Kong*

The authors from Brazil reported the results of a retrospective review of a single-center experience over 8 years in 69 patients suffering from lower limb arterial disease treated by iliac angioplasty (with or without stenting) alone. Based on the patency of the superficial femoral artery (SFA) the patients were classified into two groups, namely, those with and without a patent SFA. Almost 80% of patients had critical limb ischemia. The groups had similar outcomes in terms of iliac patency, limb salvage, and overall survival analyzed at 1800 days. They concluded that the patency of the SFA does not interfere with the outcomes of endovascular treatment for aortoiliac occlusive disease.

The two groups were not randomized, and the number of patients was relatively small. Because all the profunda femoris artery in the study cohort were patent, the findings seemed to confirm that a patent profunda femoris artery is essential to the success of inflow procedures and that SFA patency was probably of secondary importance. Notably a higher percentage of TASC D lesions in group 2 (17% vs 9%) may bias the results against group 1, especially with the small number of patients. Also, patients in group 2 (with patent SFAs) had more resting pain and tissue loss.

The majority of patients (76%) had critical limb ischemia. The authors should be congratulated of achieving a high limb salvage rate in these patients. Their results suggest that treating the inflow (iliac) lesions was sufficient in patients with multisegment disease. Further clarification on the rationale, patient selection, and indication to choosing to treat only the iliac segment in the presence of distal disease in these patients would be welcome. There were still a good number of patients in Rutherford classes 2 and 3, and in these patients the primary outcome of amputation-free survival may not be relevant. It would be interesting to know if symptoms actually improve in these and also patients with resting pain.

A significant number of patients (16%) had concomitant femoropopliteal or distal interventions in addition to the iliac angioplasty. In fact, 27% of patient in group 1 received either a femoral angioplasty or a femoropopliteal bypass, so the outflow in this group was not in fact dependent on the profunda femoris artery only. Although group 2 was defined as patients with a totally patent SFA without disease, there was evidence of SFA disease progression within 1 year. The truth was that particularly in patients with critical ischemia, disease is often multilevel and it is not easy to attribute success based on any arterial segment alone.

The opinions or views expressed in this commentary are those of the authors and do not necessarily reflect the opinions or recommendations of the Journal of Vascular Surgery or the Society for Vascular Surgery.