ORIGINAL ARTICLE

ENDOVASCULAR PROCEDURES FOR LOWER LIMB PERIPHERAL ARTERIAL DISEASE IN AN AMBULATORY UNIT

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Abstract

Objectives: *To analyse the safety and outcomes of endovascular procedures in an ambulatory practice.*

Methods: *Data were collected from a cohort of patients admitted in an ambulatory unit for an endovascular procedure for lower limb (LL) arterial occlusive disease during a one year period.*

Results: *A total of 168 procedures were carried out in 134 patients. Patients' mean age was 67 (39-91) years and 78% were male. Most patients presented with lower limb ulcer or gangrene (43%) or disabling claudication (40%). Most frequent comorbidities included hypertension (75.4%), dyslipidemia (72.4%) and diabetes mellitus (57.5%). The preferred vascular access for the procedures was the common femoral artery (52%), superficial femoral artery (24%) and humeral artery (21%). Global complication rate was 19% but only one major, non-fatal complication was identified. The most common complication was arterial dissection (8.3%), none compromising blood flow. One-year amputation rate was 6.7%, and one-year mortality was 3.0%. Factors significantly associated with procedure complications were female sex, hypertension and dyslipidemia.*

Conclusion: *Ambulatory endovascular procedures for PAD are safe and effective in selected patients. Both the low rate and low severity of complications make them an attractive option in the prospect of diminishing the burden of these patients on the health-care system while improving patient comfort.*

INTRODUCTION

Peripheral artery disease (PAD) is a major health problem affecting more than 200 million people globally[1]. PAD affecting the lower limbs leads to symptoms that significantly decrease patients' quality of life (QoL) and increase the risk of local complications and potential limb loss. Rest pain and skin ulceration are markers of limb threatening ischemia with a high risk of amputation unless vascular intervention is pursued. These patients may benefit from early intervention to attain limb salvage[2].

From the beginning of the century, endovascular procedures have overpassed open surgery for lower limb revascularization, even for the most complex anatomical cases[1]. This change in paradigm was boosted by technological and technical improvements and a faster recovery of patients with minimally invasive, low-morbidity procedures. The cost-saving for health systems cannot be overemphasized. Endovascular procedures have been shown to be feasible, even in non-hospital-based settings and that is a major trend in PAD treatment globally[3,4]. Nonetheless, articles that evaluate the safety and efficacy of ambulatory treatment of these patients are lacking[5].

The goal of this work was to analyse the safety and

outcomes of the ambulatory endovascular procedures in a vascular surgery department of a community hospital.

MATERIAL AND METHODS

Data collection

This was an observational study where we retrospectively collected demographic and clinical information of patients submitted to ambulatory endovascular procedures for lower limb PAD. We analysed the procedures done in the period of 01 January 2017 to 31 December 2017.

Statistical analysis

Categorical variables are presented as frequencies and percentages, and continuous variables as means and standard deviations. The Student's t-test was used to compare continuous variables. Categorical variables were compared with the Pearson's chi-square test. Variables found to be statistically significant by a univariate analysis were then entered into a multivariate logistic regression analysis to identify independent risk factors for procedural complications. The results were considered significant at the $P < 0.05$ level. Data analysis was performed using SPSS ®v25.0 (SPSS Inc, Chicago, Illinois, US).

RESULTS

Facilities

All interventions were carried out in a dedicated hybrid angiography suite under local anesthesia by a vascular surgeon. All the patients were admitted to an ambulatory unit. All procedures were performed under local anesthesia at the puncture site (1% lidocaine), with basal analgesia with acetaminophen or opioids in selected cases. An anesthetist was present and would supervise any further sedative or analgesic drugs required only for the non-cooperative patient (e.g. severe pain). Our ambulatory unit runs from Monday morning to Friday afternoon and allows overnight stay. The decision whether to discharge or to stay overnight was made by the operating surgeon on a case by case basis. Unfortunately no reliable data could be collected on this topic since the information on the patients' files was not explicit on the hour of discharge.

Patient Characteristics

Patients' demographic and clinical data are presented in table 1. Female and male populations are compared in table 5.

Endovascular Treatment

All vascular accesses were ultrasound guided. Table 2 summarizes the characteristics of the endovascular procedures. In one quarter of procedures a vascular closing device was used to close the artery entry site (Perclose ProGlide™ (Abbott), and Exoseal™ (Cordis)) (Table 2). For all other cases a standard 15 minutes manual compression was performed by the intervention surgeon at the end of the procedure extending the duration if necessary to obtain full hemostasis. A compressive dressing was left in place and the patient - as well as the attending nurse when the patient wasn't able to fully comply with this - were noticed as to not bend the knee (for femoral punctures) or flex the elbow (for braquial punctures) for 2 hours after the procedure. Patients were then allowed to walk (e.g. go to the toilet) under supervision.

Table 1 **Demographic and clinical characteristics of patients**

	n (%)
Sex	
Male	104 (77.6)
Female	30 (22.4)
Age (years) - Mean ± SD	67 ±10.6
30-39	1 (0.7)
40-49	3 (2.2)
50-59	32 (23.9)
60-69	40 (29.9)
70-79	39 (29.1)
80-89	18 (13.4)
90-99	1 (0.7)
Comorbidities and Risk Factors	
Dyslipidemia	97 (72.4)
Hypertension	101 (75.4)
Diabetes mellitus	77 (57.5)
Obesity	15 (11.2)
Chronic Kidney Disease	14 (10.4)
CPOD	12 (9.0)
Ischaemic Heart Disease	42 (32.3)
Stroke	11 (8.2)
Smoking History	78 (58.2)
Previous Vascular Interventions	59 (44.0)
PTA	46 (78.0)
Open surgery	21 (35.6)
Amputation	3 (5.1)

CPOD – Chronic Pulmonary Obstructive Disease; PTA – Percutaneous Translumi-nal Angioplasty; SD – standard deviation

Complications

Complications are described in table 3. Global complication rate was 19% including minor complications

like pain (n=2) or cutaneous allergic reaction (n=1). Arterial dissection accounted for 14 cases (8.3%), but none was flow limiting. The majority of complications was intraprocedural and all were minor, with none requiring surgical intervention except for one patient that presented 6 days after discharge with pain and a groin and thigh hematoma. A false aneurysm of the femoral artery was diagnosed by ultrasound. The patient required the transfusion of one unit of packed red blood cells and was treated successfully with ultrasound-guided thrombin injection. One patient presented to the emergency department with puncture site bleeding. In this case a compressive bandage was enough to stop the bleeding. We considered ProGlide™ application failure as a procedure complication, although in all cases hemostasis could be achieved by local compression.

Other minor complications included a popliteal arteriovenous fistula without flow implications, one artery perforation and one arterial rupture, all self-limited, and one early stent thrombosis. Two patients presented hypotension and hypertension respectively, and both could be controlled with medical treatment alone. Three patients had intolerance to pain on supine position leading to premature procedure interruption.

Table 2 **Endovascular procedure characteristics**

Characteristic	n (%)
Sheath size (Fr)	
4	86 (52.1)
5	26 (15.8)
6	47 (28.5)
7	1 (0.6)
8	4 (2.4)
Arterial Punctures	
1	143 (85.1)
2	23 (13.7)
3	2 (1.2)
Vascular Access	
Common femoral artery	90 (51.7)
Superficial femoral artery	41 (23.6)
Brachial/Humeral	41 (23.6)
Axillary	1 (0.6)
Common iliac artery	1 (0.6)
Access direction	
Antegrade	52 (32.3)
Retrograde	109 (67.7)
Contrast	
Iodine-based	146 (90.7)
CO2	15 (9.3)
Segment treated	
Aorto-iliac	63 (37.5)
Femoral-popliteal	113 (67.3)
Infra-popliteal	37 (22.0)
Multiple sites	55 (32.7)
Hemostasis of puncture site	
Manual compression only	124 (74.7)
Closure Device	42 (25.3)
ProGlide™	31 (18.7)
EXOSEAL™	11 (6.6)

Outcomes

Ankle-Brachial Index (ABI) was significantly improved in post-angioplasty patients. This difference was valid for in the male and female patient population (Figure 1). The one-year amputation rate was 6.7% (n=9/134). During this period 2 patients were submitted to transfemoral amputation, 3 patients to transmetatarsal amputation and 6 patients to toe amputations. The crude one-year, and two-year mortality rate was 3.0% (4/134) and 6.7% (9/134) respectively. No procedure related mortality was observed.

Univariate and multivariate analysis of risk factors and complications

The association between risk factors and complications of the endovascular procedures is presented in table 4. Independent predictors of complications were female sex (odds ratio [OR] 2.54; 95% CI:1.04-6.2; P=0.036), hypertension (OR 2.5; 95% CI: 1.05-6.0; P=0.034) and dyslipidemia (OR 2.02; 95% CI:1.00-5.52; P=0.047). Older age (>70 years old) did not reach statistical significance (OR 2.16; 95% CI:0.92-5.03; P=0.071). In the multivariate logistic regression analysis female sex was the only variable having statistical significant association with higher complication rates (OR 2.12; 95% CI:1.07-6.71; P=0.045) (Table 4).

DISCUSSION

This work results support our practice experience that endovascular treatment for PAD can be safely adopted as an ambulatory procedure. The first studies reporting the safety of endovascular angioplasty treatments were published in the 80's of last century[6]. Since then data has accumulated for the safety, clinical and financial advantages of these procedures. Clinical outcomes have steadily improved since then, not only because of the technical evolution but also because of the growing experience and training of the vascular teams (nurses, doctors and tech-

nicians) involved in periprocedural care of these patients[7].

In our cohort, patients that were submitted to angioplasty had a significant increase in the mean values of ABI from 0.52 to 0.71 ($p<0.001$) (Figure 1). A recent study identified increases in ABI>0.15 after endovascular procedure as an independent predictor for freedom from major amputation after 1 year[8]. We did not find this correlation in our cohort. Nonetheless, hypertension and previous stroke were significantly associated with failure to achieve increase of ABI>0.1 (data not published). The one-year amputation rate was 6.7% and the all-cause mortality rate was 3.0% (4/134). After two-years the all-cause mortality rate was 6.7% (9/134) in accordance with the severity of the arterial disease and its impact on survival.

Global complication rate was 19% with a very low incidence of major complications (1/168 interventions, 0.6%). In a systematic review that included 3883 procedures for PAD, Hauguel H. and colleagues found complication rates that varied from 1.5 to 33%, including minor complications such as mild pain and bruising[9]. Our rates were even lower than what has been reported by other authors although the definition of what constitutes a complication can be very heterogeneous. We have considered failure of percutaneous closure devices as a complication, although there was no consequence for the patients. Furthermore, non-compromising flow dissection may be considered as a "normal" consequence of most balloon angioplasties and not a complication by itself. We choose to consider them as long as they were considered important enough to be reported.

At the end of every procedure, hemostasis was achieved by a minimum of 15 minutes of manual compression by the attending surgeon. This was done if needed also after the application of a closure device. Some studies pointed to lower hematoma formation when vascular closure devices were used[10]. Nonetheless, more recent meta-analysis and systematic reviews seem to indicate comparable efficacy, safety and complication rates between vascular closure devices and manual compression. Moreover closure devices seem to be associated with increased rates of wound infection and thrombosis[10]. In our hospital, closure devices are usually applied for sheath diameter equal or greater than 5Fr, but the majority (64%) were used in 6Fr sheaths.

Ultrasound guided arterial puncture was routinely performed. The use of ultrasound allows real time evaluation of femoral artery atheromatosis increasing the accuracy of single puncture of the artery anterior wall and avoiding unnecessary failed punctures and hematomas[12,13]. Eighty-five percent of procedures were done with only one access site. Only one case of significant bleeding and/or hematoma was reported in our series with a very late presentation: an 89 years old female patient was brought to the emergency department 6 days after the index procedure because of leg pain and extensive bruising of the thigh. The patient was admitted and ultrasound confirmed the diagnosis of a pseudoaneurysm of the superficial femoral artery. The patient eventually needed a transfusion of packed red blood cells and the pseudoaneurysm was treated through ultrasound-guided thrombin injection.

A 65 years old male patient returned to the emergency department the day after the procedure with moderate bleeding from the puncture site. He was treated by manual compression and compression bandage. The low rate of patients that returned to the hospital (2/134 patients, 1.4%) does not support the idea that overnight stay might be a safer choice for all the patients. In fact, the majority of complications occurred during the procedure or in the next few hours afterwards.

Femoral artery is commonly the prefered access for

Table 3 **Endovascular procedures complications**

	n (%)
Global Complications	32 (19)
Arterial dissection	14 (8.3)
Arterial perforation/rupture	2 (1.8)
Patient intolerance to pain	2 (1.8)
Bleeding	1 (0.6)
Early stent thrombosis	1 (0.6)
Arteriovenous fistula	1 (0.6)
Other	8 (4.8)
ProGlide™ failure	5 (15.2)*
Hypertension	1 (0.6)
Hypotension	1 (0.6)
Allergy to contrast	1 (0.6)

** % of total ProGlide™ systems used.*

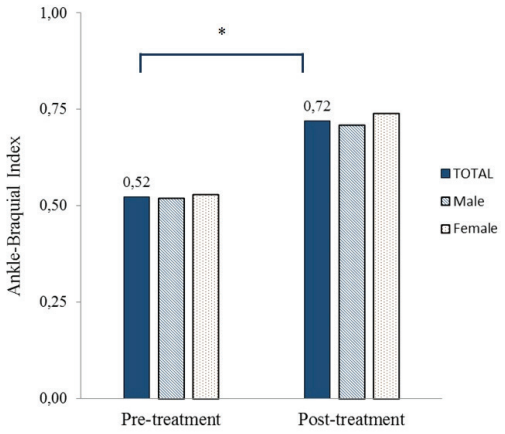

Figure 1 *Variation in Ankle-Brachial Index of patients submitted to angioplasty for the whole population, and for the subgrups of male and female patients. * p<0.001*

endovascular procedures, mainly because of technical ease and patient tolerance[13,14]. The use of alternative accesses is related to the need for multiple access points in complex procedures[15]. In our series the use of brachial accesses represented 23.6% of punctures. No complications were found related to this access point.

Risk factors associated with complication in the univariate analysis were sex (odds ratio [OR] 2.54; P= 0.036), hypertension (OR 2.5; P=0.034) and dislipidemia (OR 2.02; P=0.047). Being over 70 years old had no noticeable impact despite a trend towards statistical significance. No association was found between the severity of disease and complications. Other vascular risk factors like diabetes did not show correlation with procedural complications. Other studies showed similar dissociation between diabetes and complications and concluded that diabetes should not be a contraindication for same day endovascular procedures[16]. Nonetheless, it is well known that diabetes increases the odds of amputation and mortality by several fold[1]. One year amputation rates and all-cause mortality didn't differ between sex.

Female sex was the only variable that remained significantly associated with complications in the multivariate logistic regression analysis (OR 2.12; P=0.045). The significance of these results is not completly understood but sex disparities have been discribed in previous retrospective studies[17,18,19]. Factors pointed as responsible, have been older age at presentation, delayed diagnosis and atypical presentations of disease. In fact, in our study, the female population is on average 10 years older than the male population and has more advanced disease as evaluated by the Leriche-Fountaine classification, and has a higher burden of diabetes. On the other hand, women are less likely to be smokers or ex-smokers (Table 5). More studies are needed on this subject to better clarify the significance of these results.

We acknowledge there are several limitations of this study, such as its retrospective nature and potential patient selection bias. Patients were selected and proposed for endovascular intervention at the outpatient clinic appointment - meaning that the attending surgeon could consider predetermined characteristics known to minimize complications (e.g. avoiding uncooperating or extremely frail patients). Nevertheless our results seem to support individual criteria that were used. We cannot exclude that other minor complications like small hematomas or limited bleeding went unnoticed after the procedure. Same day discharge or overnight stay might be different in terms of approach leading to a more broad selection of patients that could in some cases need to be admitted on ward. In our group of patients none had to be admitted to the ward after intervention.

Many patients need close surveillance of their wounds with frequent surgical debridement. There is a close articulation with the diabetic foot clinic, so that the ward' beds are available for the more complex cases that may need additional IV antibiotics, large debridements or negative pressure therapy for instance.

CONCLUSION

Endovascular procedures for PAD carried out in ambulatory units are feasible and safe. Complications are

Table 4 **Demographic and clinical factors associated with endovascular procedures complications: univariate and multivariate regression analysis.**

	Complications	Complications (univariate regression analysis)		Complications (multivariate regression analysis)	
	n (%)	OR (95% CI)	p	OR (95% CI)	p
Sex: Female	10 (26.3)	2.54 (1.04-6.2)	0.036	2.12 (1.07-5.21)	0.045
Age >70	15 (21.4)	2.16 (0.92-5.03)	0.071		
Dyslipidemia	14 (11.9)	2.02 (1.00-5.52)	0.047	2.08 (0.84-0.52)	0.116
Hypertension	15 (12.0)	2.50 (1.05-6.0)	0.034	2.42 (0.96-6.13)	0.062
Diabetes mellitus	15 (14.7)	1.16 (0.5-2.78)	0.73	2.08 (0.82-5.26)	0.121
Obesity	1 (5.6)	3.40 (0.43-27.0)	0.11		
CKD	1 (6.7)	2.73 (0.34-21.7)	0.32		
CPOD	1 (5.9)	3.17 (0.40-7.14)	0.25		
IHD	7 (13.2)	1.30 (0.51-3.31)	0.58		
Stroke	2 (11.7)	1.43 (0.31-6.67)	0.65		
Smoking History	11 (11.6)	1.97 (0.85-4.6)	0.11		

CKD – Chronic Kidney Disease; CPOD – Chronic Pulmonary Obstructive Disease; IHD – Ischaemic Heart Disease; OR – Odds ratio;

usually mild and detected early after the procedure. In our cohort of patients, only female sex was associated with procedural complications. Further research is needed to establish quality benchmarks that should be implemented and followed in order to improve results and patient safety.

Table 5 **Demographic and clinical factors of male and female patients**

Factor	Male (n%)	Female (n%)	p
Age (years) Mean ± SD	65.3 ± 9.6	74.0 ± 10.8	<0.01
Severity of PAD (Leriche-Fontaine)			
Stage I	3 (2.4)	0 (0.0)	<0.01
Stage II	73 (58.4)	7 (20.6)	
Stage III	6 (4.8)	1 (3.0)	
Stage IV	43 (34.4)	26 (76.5)	
Dyslipidemia	76 (72.4)	21 (70.0)	0.798
Hypertension	79 (75.2)	22 (73.3)	0.832
Diabetes mellitus	54 (51.4)	23 (76.7)	0.014
Obesity	12 (11.4)	3 (10.0)	0.826
CKD	10 (9.52)	4 (13.3)	0.546
CPOD	13 (12.4)	0 (0)	0.043
IHD	32 (30.5)	10 (33.3)	0.766
Stroke	9 (8.57)	2 (6.67)	0.737
Smoking History	77 (73.3)	2 (6.67)	<0.01

PAD – Peripheral Artry Disease; CKD – Chronic Kidney Disease; CPOD – Chronic Pulmonary Obstructive Disease; IHD – Ischaemic Heart Disease; OR – Odds ratio.

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