ORIGINAL ARTICLE

A 5.5 years observational follow-up study of patients with critical limb ischaemia treated efficiently by endovascular approach

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Abstract: Objectives – The aim of this study was to describe our experience with endovascular treatment in critical limb ischaemia and to bring new follow-up data about these patients with initial successfully revascularization. **Methods –** A retrospective study of 181 patients with critical limb ischaemia, with successful endovascular treatment in our institution was performed. We followed death, reintervention and amputation rates during a mean period of 55.1 ± 8.2 months. **Results –** The mean age of the patients was 65.2±11.6 years. Of these patients, 66.3% were males, 38.1% diabetics, 51.4% active smokers, 21% with chronic kidney disease, 32.6% with other clinical forms of peripheral artery diseases. The final treatment was stenting in 31.5% of cases and balloon angioplasty alone in the rest of the cases. Treated arteries were in the femoral-popliteal segment – 55.6%, aorto-iliac segment – 31.4% and infrapopliteal segment – 13%. 27.6% of the patients underwent procedures on more than one arterial segment. During follow up 11 deaths occurred (6.1%), 27 patients (14.9%) underwent reinterventions for revascularization (endovascular or surgical) and 31 patients (17.1%) suffered further amputations. **Conclusions –** Despite a certain rate of death, amputation and reintervention, our results suggest that endovascular approach in critical limb ischaemia can be an efficient and feasible treatment option if its results are optimal at the time of implementation.

Rezumat: Obiective – Scopul prezentului studiu a fost să descrie experiența autorilor în ceea ce privește terapia endovasculară în ischemia critică a membrului inferior și de a duce noi date de follow-up despre acești pacienți revascularizați eficient inițial. **Metodă –** Am efectuat un studiu retrospectiv pe 181 de pacienți cu ischemie critică de membru inferior revascularizați eficient în instituția noastră. Am urmărit ratele de deces, reintervenție și amputație pe o perioadă medie de 55,1 ± 8,2 luni. **Rezultate –** Vârsta medie a pacienților a fost 65,2±11,6 ani. Dintre aceștia, 66,3% sunt bărbați, 38,1% diabetici, 51,4% fumători activi, 21% cu boală cronică renală, 32,6% cu alte forme clinice de boli arteriale periferice. Tratamentul final a fost stentarea în 31,5% dintre cazuri și doar angioplastia cu balon pentru celelalte cazuri. Arterele revascularizate aparțineau segmentului femuro-popliteal – 55,6%, segmentului aorto-iliac – 31,4% și celui infrapopliteal – 13%. La 27,6% dintre pacienți s-au efectuat proceduri pe mai mult de un segment arterial. Pe parcursul urmăririi s-au înregistrat 11 decese (6,1%), 27 de pacienți (14,9%) au necesitat reintervenții pentru revascularizare (endovasculară sau chirurgicală) și 31 de pacienți (17,1%) au suferit amputații ulterioare. **Concluzii –** În ciuda unor anumite rate de deces, amputație și reintervenție, rezultatele noastre sugerează că abordarea endovasculară poate fi o opțiune terapeutică eficientă și fezabilă în ischemia critică a membrului inferior dacă rezultatul final este optim la momentul implementării inițiale.

INTRODUCTION

Recent data in literature demonstrated a continuous increase in atherosclerotic burden which signifies an increased hazard of serious cardiovascular disorders[1]. Although peripheral arterial disease (PAD) affects 10 to 15% of the general population, it has often received less attention than other atherosclerotic diseases[2]. Critical limb ischaemia (CLI) is not a common form of PAD, accounts for just 1 to 3% of all patients with PAD[1,3], but it is very important clinical condition, the most severe, with significant impact on amputation rates, quality of life, cardiovascular morbidity and mortality. Unfortunately, the randomised trials in this field are lacking and there are large discrepancies between

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the reported results of arterial reconstruction, which can influence the management of this patients.

OBJECTIVES

The aim of this study was to describe our experience with endovascular treatment in CLI and to bring new follow-up data about these patients with initial successfully revascularization.

METHODS

We performed a retrospective study on patients with CLI, admitted in our institution between February 2012 and February 2020, which have been invasively explored by angiography and then underwent successful endovascular treatment (balloon angioplasty alone or stenting). Initial characteristics of patients were obtained from hospital's observation files and other medical documents attached there (medical letters, ultrasound bulletins, data from hospital's computer system). Technical data about the invasive diagnosis and endovascular management were obtained from Cath Lab's files and by reviewing the angiographic films. An arterial revascularization has been considered successful if the residual stenosis was bellow 50%, the distal flow was improved, the symptomatology was improved and the patients were discharged without amputations or procedural complications that could jeopardize the limb's integrity or patients life. We followed death, reintervention and amputation rates. Follow up was made collaborating with referring physicians, general practitioners, by phone call directly to patients or by reviewing the hospital's computer system. Recording deaths, we also try to identify if the cause was related with the evolution of critical limb ischaemia or other events occurred. Reintervention was considered every arterial revascularization made for new symptoms of CLI. We considered both endovascular and surgical reintervention, in index limb and in contralateral limb, same arterial segment that was revascularized first time and other arterial segments that needed subsequent revascularization. Amputation, irrespective of the limb, has been considered minor if it was performed bellow the ankle and major if performed above this level. In this study's data base we included only patients with complete information, regarding both initial revascularization and follow up moment.

RESULTS

The study embedded 181 patients with CLI treated efficiently by endovascular approach, with mean follow up period: 53.4 ± 8.2 months. Patients initial characteristics are figured in Table 1. We also mention that at discharge all patients have received dual antiplatelet therapy (between one month and one year depending on the endovascular procedure), maximum tolerated statin dose and treatment of associated diseases according to specialized recommendations.

In our institution we treated a number of 223 arteries, distributed as follows: 65 (29.1%) arteries in aortoiliac segment, 121 (54,2%) arteries in femoropopliteal segment and 37 (16.7%) infrapopliteal arteries. The lesions were type A, B and C (TASC II classification[4]), but simply they can be divided in stenoses (55.6%) and occlusions (44.4%). The final therapy was balloon angioplasty alone in 155 (69.5%) arteries and stenting in 68 (30.5%) arteries. Thirty-eight (21%) patients underwent procedures on 2 or more arteries in different segments of the same limb and 12 (6.6%) patients underwent procedures on 2 or more arteries on both inferior limbs. Procedural issues are detailed in Table 2. In the aortoiliac segment 63 of 65 lesions were stented and the remaining 2 underwent balloon angioplasty alone. In the femoropopliteal segment 109 lesions underwent balloon angioplasty alone and the remaining 13 were stented. The whole 37 infrapopliteal arteries were treated with balloon angioplasty.

The arterial approach used for the revascularization procedures was as follows: antegrade femoral – 106 (56.1%) punctures (usually used for revascularization of superficial femoral artery, popliteal artery and infrapopliteal segment), left brachial – 42 (22.2%) punctures and retrograde femoral – 28 (14.8%) punctures (usually used for revascularization of aortoiliac segment), femoral contralateral – 11 (5.8%) punctures and popliteal – 2 (1%) punctures.

Table 1. Patients characteristics at the moment of revascularization – whole group and divided by sex

Patients characteristics	Group	Males	Females
Number	181	120 (66.3%)	61 (33.7%)
Age (years)	65.2±11.6	63.5±10.7	67.4±9.3
Diabetics	69 (38.1%)	41 (34.2%)	28 (45.9%)
Smokers	93 (51.4%)	55 (45.8)	38 (66.3%)
Chronic kidney disease	38 (21%)	25 (20.8%)	13 (21.3%)
Hypertension	149 (82.3%)	101 (84.2%)	48 (78.7%)
Other PAD	59 (32.6)	38 (31.6%)	21 (34.4%)
Bilateral involvement	54 (29.8%)	36 (30%)	18 (29.5%)
Multilevel involvement of the same limb	84 (46.4%)	50 (41.7%)	34 (55.7%)
Trophic lesions at presentation	53 (29.3%)	34 (28.3%)	19 (31.1%)

Table 2. Procedural issues

	Group	Males	Females
Profile of target lesions (n=223)			
Occlusions	**99 (44.5%)**	**61 (27.3%)**	**38 (17%)**
• aortoiliac	5 (2.2%)	4 (1.8%)	1 (0.4%)
• femoropopliteal	72 (32.4%)	45 (20.2%)	27 (12.1%)
• infrapopliteal	22 (9.9%)	12 (5.4%)	10 (4.5%)
Stenoses	**124 (55.6%)**	**83 (37.3%)**	**41 (18.4%)**
• aortoiliac	60 (26.9%)	43 (19.3%)	17 (7.6%)
• femoropopliteal	49 (22%)	31 (13.9%)	18 (8.1%)
• infrapopliteal	15 (6.7%)	9 (4%)	6 (2.7%)
Final therapy (n=223)			
• balloon angioplasty alone	155 (69.5%)	98 (43,9%)	57 (25,6%)
• stenting	68 (30.5%)	49 (22%)	19 (8,5%)
Multilevel approach (pat. no.)			
• ≥2 arteries same limb	38 (21%)	21 (11.6%)	17 (7.6%)
• ≥2 arteries different limb	12 (6.6%)	8 (4.4%)	4 (2.2%)

Results of the endpoints were: deaths – 11 patients (6.1%), reinterventions – 27 patients (14.9%), amputations – 31 patients (17.1%). Details are presented in Table 3.

Of the recorded 11 deaths only 2 (1.1%) were due to CLI. Both patients (1 male and 1 female), after optimal endovascular revascularization of a superficial femoral artery occlusion, refused segmental amputation of the necrotic forefoot, which led to septic shock and death in the end. The other deaths were due to causes unrelated to CLI, like neoplasia, enteromesenteric infarction, sudden cardiac death, car crash.

Endovascular reinterventions were performed in the majority of cases for „*de novo*" lesions, but we had 1 procedure performed for an intra bare metal stent restenosis at the level of superficial femoral artery and 2 endovascular reinterventions performed after restenosis post balloon angioplasty alone in femoropopliteal segments. Surgical revascularizations were performed for three categories of patients: "*de novo*" lesions, restenosis after initial endovascular revascularization and hybrid approach. In the first two categories, surgery was performed for TASC D lesions or for failed angioplasty attempt. In the hybrid approach scenario, we had 5 patients (2.8%) with multilevel involvement, in which after optimal endovascular revascularization of the aortoiliac segment, due to persistent ischemia surgery was performed for type D lesions in the fe-

Table 3. Endpoints results

Endpoints	Group	Males	Females
Deaths	**11 (6.1%)**	**6 (5%)**	**5 (8.2%)**
Reinterventions	**27 (14.9%)**	**20 (16.7%)**	**7 (11.5%)**
• **Redo-PTA**	**9**	**5**	**4**
- Stenting	3	2	1
- Balloon angioplasty	6	3	3
• **Surgery**	**18**	**15**	**3**
- Ipsilateral limb	11	10	1
same segment	5	5	0
different segment	6	5	1
- Contralateral limb	7	5	2
Amputations	**31 (17.1%)**	**23 (19.2%)**	**8 (13.1%)**
• **Ipsilateral limb**	22	14	8
- Major	7	5	2
- Minor	15	9	6
• **Contralateral limb**	7	7	0
- Major	3	3	0
- Minor	4	4	0
• **Both limbs**	2	2	0
- Major	1	1	0
- Minor	1	1	0

moropopliteal segment (usually long, very calcified superficial femoral artery occlusions) with subsequent good results.

Considering that 29.3% of patients presented with tissue loss, fortunately, of the 31 amputations recorded, 20 were minor (11%), usually a toe with trophic lesion at presentation and good delimitation of the necrosis after revascularization. Major amputations (6.1%) were performed due to extensive progression of the disease, when the lesions had no endovascular or surgical solution, or limb's viability was lost due to late presentation.

DISCUSSIONS

As the 2017 *ESC Guidelines on the Diagnosis and Treatment of Peripheral Artery Diseases* outlines, early recognition of CLI's signs and referral to a vascular multidisciplinary team are mandatory for limb salvage[4]. The same guideline clearly highlights that revascularization is indicated whenever feasible[4]. So, in our time we can consider that arterial revascularization is the cornerstone of treatment to prevent extremity loss[1]. Options for revascularization include endovascular, surgical and hybrid revascularization (as a combination of endovascular and surgical interventions). The BASIL trial (Bypass versus Angioplasty in Severe Ischaemia of the Leg) is, at the moment, the only randomized trial published that directly compared endovascular revascularization to open surgery in CLI patients[5]. At 2 years there was no significant difference between endovascular therapy and surgery regarding amputation-free survival[5]. BASIL-2 and BEST-CLI, other trials on the same topic, are still on going[6,7]. Due to significant technological advances in endovascular area and considering the more invasiveness, the risks of morbidity and mortality associated with surgery, nowadays, there is a significant trend toward „endovascular first" approach in the treatment of CLI[8].

Faglia et al. performed a prospective study on 993 diabetic patients with CLI treated by successfully peripheral angioplasty (PTA) with a mean follow-up of 26 ± 15 months[9]. During follow-up 119 (12%) patients died, 17 (1.7%) major amputations were carried, clinical restenosis was observed in 87 (8.8%) patients and the 5 years primary patency was 88%[9]. Our data resembles with this study's conclusions allowing us to consider that PTA as first choice revascularization technique is feasible, with low mortality, infrequent restenosis and potential of repetition when needed.

We reported a rate of limb salvage of 82,9% (amputation free) for our surveillance time. The study of Dosluoglu et al compared the outcome of endovascular revascularization, open surgery and hybrid revascularization on 654 patients, 770 limbs with symptomatic lower extremity occlusive disease (67% CLI)[10]. Limb salvage rates in patients with critical limb ischemia were similar in the endovascular (12- and 36-month; 86% ± 2% and 80% ± 3%), hybrid (94% ± 4% and 80% ± 7%), and open groups (80% ± 3% and 74% ± 4%) 10. Almost identical survival rates were reported in this cohort. The 12-, 36-, and 60-month survival in the open group was 80% ± 3%, 65% ± 4%, and 45% ± 4%, in endovascular group was 83% ± 2%, 63% ± 3%, and 43% ± 5%, and in the hybrid group was 80% ± 4%, 64% ± 5%, and 49% ± 7% (P= .963)[10]. During a mean follow up period of 53.4 ± 8.2 months we encountered a survival rate of 93.9%, much favourable in the male's group.

A meta-analysis of infrapopliteal angioplasty for CLI, based on data retrieved from 30 articles, published for 1 and 36 months a survival rate of 98.3% ± 0.7% and 68.4% ± 5.5%, and limbs salvage rates of 93.4% ± 2.3% and 82.4% ± 3.4%, respectively[11].

CONCLUSIONS

Despite a certain rate of death, amputation and reintervention, our results suggest that endovascular approach in CLI can be an efficient and feasible treatment option if its results are optimal at the time of implementation. Multidisciplinary teams should have the treatment decision of CLI patients: endovascular, surgical or hybrid revascularization on individualized approach. Although it is well known that arterial revascularization is the most important item of CLI treatment, further studies are needed to clarify witch procedure is superior and to identify the factors that influence the management of these patients.

Conflict of interest: none declared.

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