

Peroneal Angioplasty as a Single Runoff Vessel in patients with Critical Limb Threatening Ischemia due to infra-popliteal disease

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ABSTRACT

Background: The value of peroneal artery-only runoff (PAOR) revascularization in chronic limb threatening ischemia (CLTI) has been debatable. This study aims to study the efficiency and safety of balloon angioplasty of peroneal artery as single runoff in infrapopliteal disease.

Patients and methods: This is a prospective trial including participants, whom all presented with CLTI due to infrapopliteal disease in the period between 1/5/2018 to 30/4/2020.

Results: The investigation involved 40 participants, with age ranging from 45 to 75 years; 65% were male. On 12 month, primary patency and limb salvage was 60% and 62.5% respectively. Besides, overall mortality rate was 7.5%. The highly significant factor was pedal runoff (foot arteries refilling); as Limb salvage at 12 months in patients with good pedal runoff was 75% compared with 12% in patients with poor pedal runoff ($P = 0.001$). Limb salvage at 12 months in (Rutherford 4) patients was 83.3% compared with 75% and 35.7% in (Rutherford 5) and (Rutherford 6) patients respectively ($P = 0.035$). 12 month LS in DM, vs non-DM was 53.3% vs 90% ($P = 0.038$).

Conclusion: We concluded that the balloon angioplasty of peroneal artery as single runoff, with good collaterals to the foot arterial circuit, in infrapopliteal disease is simple, safe and effective procedure in treatment of critical limb ischemia.

Keywords: CLTI, infrapopliteal disease, limb salvage, Peroneal angioplasty

INTRODUCTION

Critical limb ischaemia (CLI) appears the most acute clinical appearance of peripheral arterial disease (PAD) in which the survival of tissues is intimidated if arterial perfusion to the distal extremities is not well-timed restored[1].

The peroneal artery (PA) has a various collaterals and perfuses the pedal arteries through frontal and rear branches[2].

The significance of peroneal artery (PA) revascularization has always been controversial, mostly in participants with tissue loss. As one of the main essential agents of wound recovery is the establishment of in-line influx to the foot[3].

So we aimed our work at assessment of peroneal artery revascularisation as a single runoff in patients with chronic limb threatening ischemia

Methodology:

This prospective cohort study was conducted on 40 patients, with CLTI (Rutherford 4-5-6) due to atherosclerotic infra-popliteal disease and suitable peroneal artery single vessel runoff for revascularization along the period of May 2018 and April 2020. Patients presenting with

claudication (Rutherford 1-3), acute limb ischemia and those undergoing simultaneous multilevel procedures (including ATA and PTA) were excluded.

For each patient, demographics, symptoms (rest pain minor and major tissue loss), existing comorbid conditions, and risk factors for atherosclerosis (Diabetes Mellitus, Smoking, Hypertension, Cerebrovascular disease and Coronary artery disease) were identified.

Clinical evaluation was carried out for all patients including vital signs, full arterial examination and tissue loss evaluation. Pre-procedural investigations were performed to assess patient fitness in routine laboratory tests and to visualize arterial system in the affected limb by duplex or CTA.

Approval from the ethical committee in Cairo University, Vascular Surgery Division of General Surgery Department, was taken before the beginning of the study.

Technique:

Before the procedure, all patients signed an informed written consent. All interventions were performed in an angiography suite. All patients were admitted one day before. Loading dose of clopidogrel (300 mg) was given the night of the procedure

Angiography was performed through 6 Fr ipsilateral CFA sheath. If crossing lesion transluminal has been failed, subintimal technique was carried out.

A balloon catheter, selected for appropriate diameter (2.5-3 mm) and length (8- 15 mm). The balloon is inflated until any waist on the balloon abolished.

After deflation, a completion angiogram was carried out with a wire across the lesion for access. Re-dilatation was achieved whenever desired. Moreover, one hundred to two hundred micrograms of intra-arterial nitroglycerin had been utilized if arterial spasm were present. Infra-popliteal stents were not used

Procedural outcome:

The process was regarded to be successful depending on the following:

Immediate success, i.e., revascularization warmth, oedema, and passing the rest pain if existent pre-operation.

Angiographic success was known as lower than 30% remaining stenosis recorded at the narrowest point of vascular lumen with foot perfusion and arch revascularization.

Post-procedural follow up, searching for:

- a) Clinical improvement (assessment of the rest pain or amputation site recovery, cure the infection).
- b) Duplex surveillance program: follow-ups at 3, 6 and 12 months were dedicated as strong guidance for the condition progress (determined the length of influence fragment, grade of patency of stenosis).

Study outcomes

- Limb salvage was defined freedom from major limb amputation above the ankle level.
- Mortality rate was recorded in study's population.

Statistical analysis:

Obtained results were analysed utilizing the statistical package for social sciences, version 16.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative results were calculated as mean \pm standard deviation (SD). Qualitative results were calculated as frequency and percentage. Chi-square (χ^2) test of significance was utilized in order to compare proportions between qualitative parameters. P value below .05 was considered statistically significant.

RESULTS

1. Demographic data:

The age of patients varied from 45 to 75 years with a mean of 62.02 years. The study included 26 males (65%) and 14 females (35%)

2. Risk factors for atherosclerosis:

The study showed that thirty patients (75%) were diabetics, twenty eight (70%) were hypertensive, twenty five patients (62.5%) were smokers, sixteen patients (40%) had ischemic heart disease, four patients (10%) had history of stroke and no patients had end stage renal disease.

3. Operative history:

The study showed that five patients (12.5%) had contralateral major amputation and three patients (7.5%) had previous ipsilateral superficial femoral artery angioplasty.

4. Clinical diagnosis:

According to Rutherford - Baker scale of severity of peripheral arterial disease for chronic lower limb ischemia, 6 (15%) patients had ischemic Rest Pain (grade II, category 4), 20 (50%) patients had minor tissue loss, non-healing ulcer and focal gangrene (grade II, category 5) and 14 (35%) patients had major tissue loss (grade III, category 6).

5. Anatomical characteristics:

- All lesions were infrapopliteal with peroneal artery single runoff amenable for revascularization.
- The peroneal lesions were either multiple stenosis (30%) or occlusion (70%).
- Tibioperoneal trunk was presented in 20% whereas upper peroneal was affected in 60%. Finally middle and lower peroneal lesions were demonstrated in 40% and 10% respectively.

6. Procedural data

Access site:

Ipsilateral antegrade CFA access was used in all cases. Contralateral cross over access was not performed as neither proximal SFA lesions nor pendulous abdomen was founded among our patients.

Wire size

A 0.035 inch guide wire was used in 28 (70%) cases and 0.018 inch wire was used in 12 (30%) cases.

Technique of crossing lesions:

The intraluminal approach was used in 14 (35%) cases while the subintimal approach was used in 26 (65%) cases.

7. Pedal Runoff status:

Thirty two patients (80%) had good pedal runoff (patent pedal arch with a connection to one or two peroneal branches), while eight patients (20%) had poor pedal runoff (incomplete pedal arch with inadequate foot arches refilling).

8. Procedural complications

Major complications:

As a result of myocardial infarction, one patient (2.5%) died during post procedure hospitalization. No other major complications in the form of acute thrombosis, distal embolization, retroperitoneal bleeding was recorded.

Minor complications:

Three patients (7.5%) had groin hematoma that was treated conservatively and minor amputation has been performed in 13 patients (32.5%).

9. Follow up:

During the follow up period, the overall mortality rate was 7.5% (n=3). Apart from 2 cases died from myocardial infarction, one case died from stroke. It is notable in all died cases, that they had CAD and their age was beyond 68 years.

By the end of follow up period, major amputation was done in 15 (37.5%) cases. 11 cases were due to spreading of infection despite of gaining benefits from revascularization, while the other 4 cases were due to failure of revascularization.

Along the period of follow up the limb salvage rate is slightly higher than primary patency as one case developed wound healing despite of steno-occlusive lesions recurrence which was managed conservatively. On 3, 6 and 12 month follow-ups, the primary patency was 70%, 62.5% and 60%, while the limb salvage rate was 72.5%, 65% and 62.5%. Eventually, secondary patency at 12 month was 83.3%.

Table1: Outcome results

	3 months	6 months	12 months
PP (primary patency)	(n: 28) 70%	(n: 25) 62.5%	(n: 24) 60%
SP (secondary patency)	83.3%		
LS (limb salvage)	(n: 29) 72.5%	(n: 26) 65%	(n: 25) 62.5%
Major amputation	(n: 11) 27.5%	(n: 14) 35%	(n: 15) 37.5%
Mortality Rate	(n: 3) 7.5%		

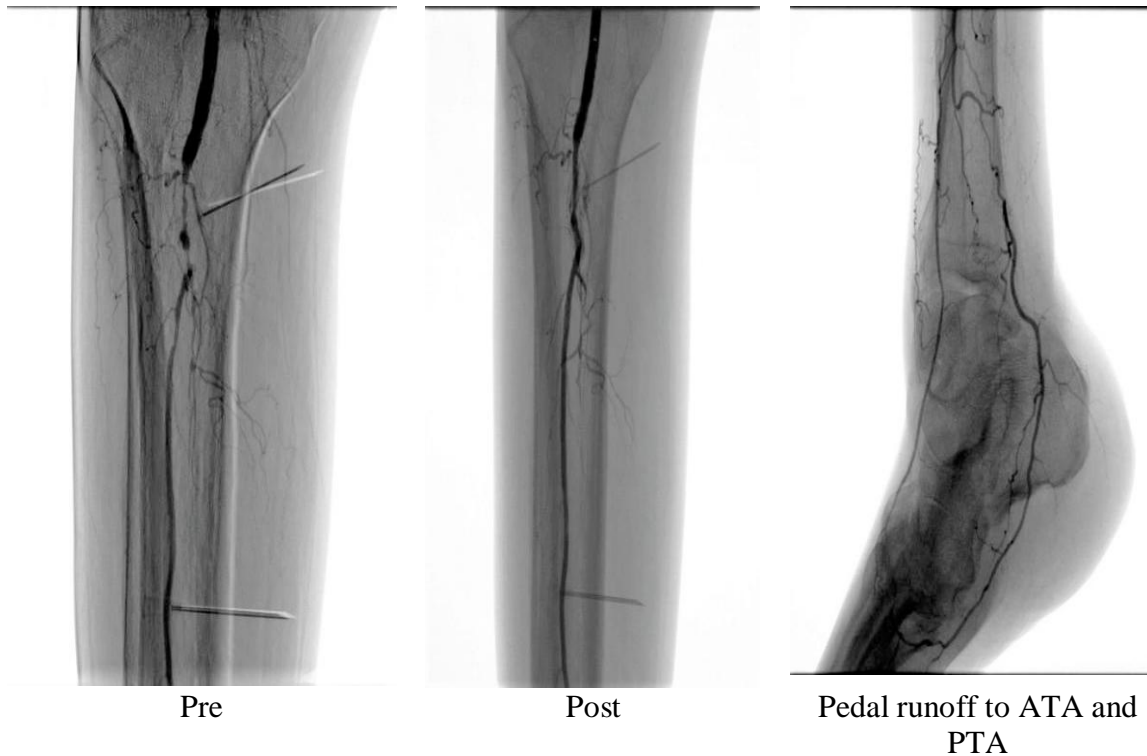
10. Significant factors of Limb salvage.

Chi-square (x2) test and Probability (P-value) showed the significance of various factors on limb salvage as demonstrated in table (2).

Table2: Statistical analysis for significant factors of limb salvage with peroneal angioplasty as single vessel runoff.

	Limb salvage	
	x2	P- value
Age	3.5644	0.168
Gender	0.7326	0.392
DM	4.3022	0.038 *
HTN	1.1429	0.285
Smoking	1.2018	0.273
CAD	0.4444	0.505

CVD	0.2963	0.586
Clinical presentation stage	6.7302	0.035 *
Pedal runoff	10.6667	0.001 *

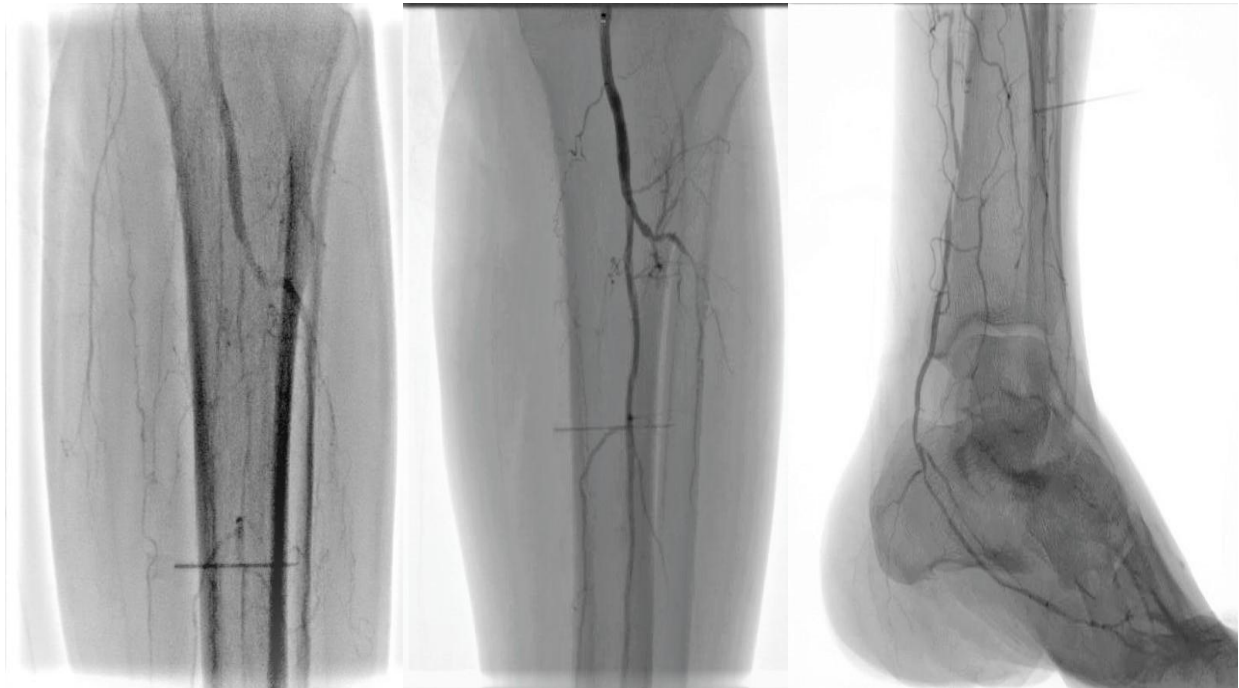


Case 1

The highly significant factor was pedal runoff. as Limb salvage at 12 months in 32 patients with good pedal runoff (patent pedal arch with a connection to one or two peroneal branches) was 75% compared with 12% in 8 patients with poor pedal runoff (P = 0.001).

Based on P-value, clinical staging was significant factor on rate of limb salvage. Limb salvage at 12 months in 6 patients (Rutherford 4) was 83.3% compared with 75% and 35.7% in 20 patients (Rutherford 5) and 14 patients (Rutherford 6) (P = 0.035).

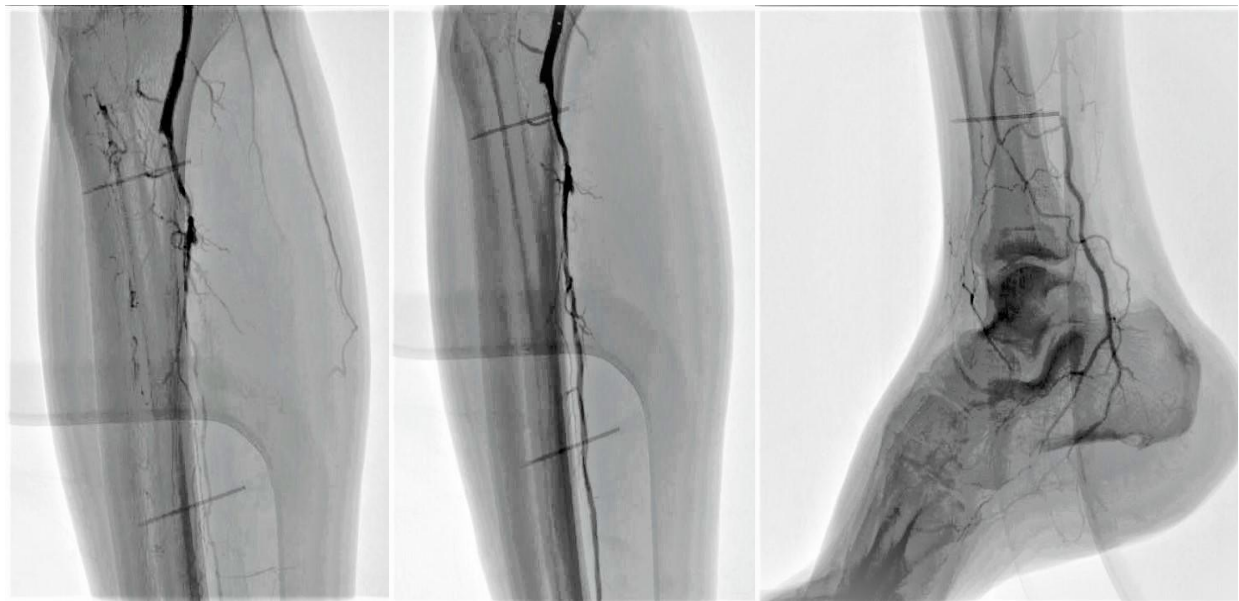
Limb salvage was significantly worse in cases with DM (12 month LS in DM, vs non-DM, 53.3% vs 90%. P = 0.038).



Pre

Post
Case 2

Pedal runoff to PTA



Pre

Post
Case 3

Pedal runoff to PTA

DISCUSSION

Critical limb ischemia (CLI) illustrates symptoms associated with end-stage atherosclerotic peripheral arterial disease presented with rest pain and tissue loss. It is related to increase risk of limb amputation and cardiovascular-related death rate [3].

The peroneal artery is distinctive in that it is frequently spared of atherosclerosis in comparison to the anterior and posterior tibial arteries but terminates at the ankle and supplies the foot obliquely throughout the lateral branches [5].

From that concept, we did this prospective study, which included 40 patients with critical chronic lower limb ischemia due to infra-popliteal disease, for whom percutaneous

transluminal angioplasty of peroneal artery as single vessel runoff was done. Meanwhile detecting predictors of limb salvage (age, sex, DM, smoking, HTN, clinical presentation and status of pedal arch runoff) in previously mentioned patients.

The age of our patients varied between 45 and 75 years with a mean of 62.02 which is lower than other studies by Dosluoglu et al. [6] and Abularrage et al. [7] as the mean age was 77.3 years and 77.36 years respectively and these can be accounted for better health care systems which lead to control of risk factors.

On view on demographic of patient in our cohort, the majority of them were male (65%). In addition to that, high prevalence of diabetes (75%) in our patients and associated other comorbidities like smoking (62.5%), hypertension (70%) and coronary artery disease (40%) were observed in our records which coincided with other studies in Ghoneim et al. [3], Dosluoglu et al. [6], Abularrage et al.[7].

Indications of intervention in our study according to Rutherford - Baker scale of severity of peripheral arterial disease for chronic lower limb ischemia were ischemic rest pain (Rutherford 4) in 15% of patients, whereas the remaining 85% of patients had tissue loss either minor tissue loss (Rutherford 5) in 50% of patients or major tissue loss (Rutherford 6) in 35% of patients while that by Dosluoglu et al.[6] the patients presented with gangrene were 52% and Ghoneimet al. [3] recorded 16.6% as Rutherford IV, 45% as Rutherford V and 38.3% as Rutherford VI.

All lesions included within this study were infra-popliteal; however, in Abularrage et al.[7] 44%, 16%, 39% and 67% of lesions were isolated femoro-popliteal, isolated tibial, multilevel and multivessel respectively. While in Dosluoglu et al. [6], the most distal territory of interference was infrapopliteal (tibioperoneal or peroneal artery) in 42%.

According to Mohapatra et al. [5] records, the peroneal artery was the only treated tibial artery in 75.4% which managed by balloon angioplasty in all cases, along with atherectomy in 5.8% and adjunctive stenting in 6.5%.

Besides in another study, In the Peroneal Artery-Only Runoff (PAOR) group, patients had infrapopliteal PTA (three with adjunctive employ of Excimer laser atherectomy), and one patients had infrapopliteal stent (Cypher, Cordis, Johnson and Johnson, Miami, Fla) following considerable recoil after PTA [6].

In this study 12 months primary patency (PP) rates were 60% which is comparable to Abularrage et al [7] records with 61% PP and it is exceeded by Dosluoglu et al.[6] who had 73% PP rate at 12 months.

Twelve months limb salvage rate in our study (62.5%) was similar with Ghoneim et al.[3] (68.8%). On the other hand, it is considered less than quoted by Dosluoglu et al.[6] of 81% at 12 months and also less than limb salvage rate of 91% at 12 months showed by Abularrage et al.[7] and 95.7% limb salvage rate recorded by Ipemaet al. [8]. This is may be due to 85% of our patients presented with tissue loss as result of late presentation.

Regarding causes of major amputation, Dosluoglu et al. [6] stated that there were six major amputations in the PAOR group (18%). All amputations occurred in spite of a patent treated arterial fragment in the PAOR group. All were associated with extensive tissue loss secondary to the primary infection, or recurrent infection, and all were diabetics.

On the same point, Das et al. [9] reported that the major amputation rate following successful isolated below-the-knee endovascular intervention in patients with ischemic foot ulcers varied considerably among infected and non-infected wounds (21.5% vs 9.7%, respectively), and the wound cure rate was also considerably different among the two groups (46.2% vs 86.1%, respectively).

Our analysis agreed with all previous analysis as there were 15 (37.5%) cases that had major amputation, out of them 11 cases were due to spreading of infection despite of gaining

benefits from revascularization, while the other 4 cases were due to failure of revascularization.

Fridhet al. [10] investigated how comorbidities and medications influence the outcomes after revascularization for Chronic Limb Threatening Ischemia (CLTI). They reported that diabetes (HR 1.45 [95% CI, 1.32-1.60], $p < 0.001$) was independently associated with an increased amputation rate.

Regarding our statistical analysis, we found 12-month limb salvage (LS) in DM, vs non-DM was 53.3% vs 90% ($P = 0.038$). Interestingly, Dosluogluet al. [6] clarified in (PAOR), the 24-month LS for patients with DM was $75\% \pm 9\%$, while it was 100% in patients without DM ($P = 0.159$).

Furthermore, Das et al. [9] showed that insulin-dependent diabetes mellitus was predictor of wound nonhealing after initial Endovascular Therapy (EVT). With 59.5% of patients in the non-healing group obtaining insulin treatment in comparison to only 25.9% in the healing group ($P = 0.001$).

Mohapatra et al.[5]noted that smoking ($P = 0.036$) was associated with decreased wound healing. Whereas, our cohort records showed that smoking was not dependent factor on limb salvage ($P = 0.273$) and this is similar to other studies done by Abularrage et al.[7] who showed that smoking ($P = 0.23$) was not significant factor on LS.

Dosluogluet al. [6] reported that LS had been notably decreased inpatients presented with gangrene than non-healing ulcers (24-month LS $73\% \pm 6\%$ vs $96\% \pm 4\%$, $P = 0.012$).

Our records shared the same opinion; as 12-month limb salvage for patients with major tissue loss (Rutherford 6) was 35.7%, whereas this was 75% in patients with minor tissue loss (Rutherford 5) and 83.3% in patients with rest pain (Rutherford 4) ($P = 0.035$).

All together with, Mohapatraet al. [5] stated that extensive tissue loss (HR, 0.25; 95% CI, 0.09-0.75; $P = 0.013$) had been associated with decreased wound healing. And Das et al. [9] analysis showed major tissue loss (HR, 2.1; 95% CI, 1.3-3.4; $P = 0.003$) was independent predictor of wound non-healing after initial successful EVT in isolated below-the-knee interventions.

In our cohort, limb salvage rate was significantly worse in poor pedal runoff than good pedal runoff (12-month LS 12.5% vs 75%, $P = 0.001$). On the same way, Ricco et al. [11] interpreted that Amputation-free viability at 3 years in patients with a patent pedal arch (Rutherford 0-1) was $73.0\% \pm 7.0\%$ vs $45.7\% \pm 6.0\%$ in patients with incomplete pedal arch (Rutherford 2-3; $P = 0.0002$).

In this study, the overall survival rate was 92.5% which is almost similar with Ipema et al.[8] (89.8%) and considered higher than reported by Abularrage et al.[7] of 81% and Kawarada et al.[12] of 73.8 % at one year. However, our survival rate is slightly higher because lower mean age of our patients and less co-morbidity related factors compared to other studies).

Study limitations could be summarized as low number of cases and relatively short period of follow up. Conventional balloon angioplasty was the only process applied in the current trial so it could not compare results of this procedure with other infrapopliteal procedures. Data on time for wound healing and angiosome directed revascularization were not collected. Information on medical therapy used regarding DM and the effect of glycated haemoglobin (HbA1c) level on study outcomes was not collected.

CONCLUSION

- Endovascular approach is considered safe and effective in management of infra-popliteal atherosclerotic occlusive disease.
- Limb salvage is significantly decreased in any patient who have either one or combination of these factors; poor pedal runoff, major tissue loss and diabetes mellitus.

- Balloon angioplasty of peroneal artery as single runoff, with good collaterals to the foot arterial circuit, in infrapopliteal disease is simple, safe and effective procedure in treatment of chronic limb threatening ischemia.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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