



## ORIGINAL ARTICLE

# INFRAGENICULAR ENDOVASCULAR INTERVENTION IN CRITICAL LOWER LIMB ISCHEMIA

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### Abstract

**Purpose:** To determine the effectiveness of percutaneous transluminal angioplasty (PTA) for treatment of patients with the infragenicular arterial lesions as a primary choice for management of critical lower limb ischemia due to infragenicular arterial disease. We present the technical success, early- and medium-term outcomes, and limb salvage rate.

**Methods:** The records of 57 patients undergoing infragenicular popliteal artery (IGPA) and tibial vessels PTA presented to vascular unit at Mansoura university hospital over a period between January 2010 and April 2012 was reviewed. Patients underwent follow-up with clinical examinations, ABI, Duplex, and Arteriography. Demographic variables and cardiovascular risk factors, primary patency and limb salvage were analyzed.

**Results:** Mean follow-up was 11.08 + 3.2 ranging from 3 to 13 month With Kaplan Mayer analysis, primary patency was 94.7%, 83.8%, and 69.3% at 3, 6, and 12 month, respectively. And limb salvage was 96.5%, 92.9%, and 82.4% at 3, 6, and 12 month, respectively.

**Conclusions:** Infragenicular angioplasty can be used as a primary intervention for CLI and it may be the only choice for some cases. It could be also used as a second step after correction of a proximal lesion (either by open surgery or endovascular) the low complication rate and relatively noninvasive nature of PTA made it first recommendation in infragenicular vessels.

**Keywords:** Ischemia, infragenicular, angioplasty.

## INTRODUCTION

Percutaneous treatment of infrainguinal peripheral vascular disease was pioneered almost four decades ago by Dotter and Judkins.<sup>(1)</sup> Percutaneous transluminal angioplasty (PTA) of the infrapopliteal arteries was limited until the advent of low profile balloon catheters and steerable guide wires in the 1980s. Since then, there has been tremendous growth in the use of endovascular interventions to treat infrapopliteal peripheral vascular disease.<sup>(2)</sup> Although the precise proportion of patients

with infrapopliteal involvement is unclear, it is estimated that multi-segment arterial involvement is present in 20% of patients with intermittent claudication.<sup>(3)</sup> The major risk factors associated with PAD are advanced age, smoking, and diabetes.<sup>(4)</sup> Other risk factors include hypertension, hyperlipidemia, male sex, homocysteinemia, elevated plasma fibrinogen levels, elevated glucose level, prior myocardial infarction (MI), heart failure, history of stroke, and history of transient ischemic attack.<sup>(5,6)</sup> Of all the risk factors, diabetes deserves particular attention for its role

in infrapopliteal atherosclerosis.<sup>(7)</sup> According to the Transatlantic Intersociety Consensus (TASC) document on Management of Peripheral Arterial Disease (PAD) tibial arterial lesions are classified into four groups: A, B, C and D. Endovascular treatment is recommended for groups A and B. However, due to the improvements in equipment and technique, endovascular therapy is now considered a feasible option in groups C–D.<sup>(8)</sup> Below the knee angioplasty is feasible. It provides good medium term clinical outcome in a group of patients with limited treatment options. It is used as an adjunct to proximal angioplasty to increase the limb salvage rate.<sup>(9)</sup> Further experience of infrapopliteal PTA using tapered catheters led to a lower incidence of complications, but a poor long-term patency the advent of coronary artery PTA triggered a number of technological advances that facilitated infrapopliteal angioplasty. These advances included small strong low profile balloons, steerable hydrophilic guidewires, road mapping facilities and the use of vasodilators to overcome arterial spasm.<sup>(10)</sup> Certainly, the potential advantages of percutaneous therapy as compared to surgical reconstruction are significant; no general anesthesia or lengthy incisions, shorter hospitalizations, lower morbidity and mortality, earlier intervention in the course of the disease, and less complicated reapplication in the course of the disease recurrence.<sup>(11)</sup>

## PATIENTS AND METHODS

We conducted a prospective study of 57 patients who were subjected for infragenicular angioplasty from 254 patients who were presented to vascular surgery unit at Mansoura university hospital with critical lower limb ischemia during the period between January 2010 and April 2012.

Patients included in this study were those with critical lower limb ischemia Rutherford categories 4, 5 and 6 who have infragenicular popliteal artery (IGPA) and/or tibial vessels lesions. Patients who had co-existing proximal lesions treated on the same occasion were also included. Exclusion criteria were patients who had acute on top of chronic ischemia, non-salvageable foot and those with TASC (D) lesion (occlusion >2cm and/or diffuse disease).

Prior to PTA, all patients had a full vascular assessment including: clinical history, history of DM its type and duration, Smoking, Hypertension, cardiovascular, cerebrovascular diseases and any previous vascular medication including its type and duration. Previous endovascular intervention and vascular surgery were also documented. All of patients were subjected to thorough general and local physical examination, with special attention to the pulse, Skin lesions, ulceration, tissue necrosis, infection and ABI measurement. All patients had undergone full Laboratory investigations including: CBC, Blood sugar curve, Kidney functions, Liver functions, Coagulation and Lipid profile.

Duplex and CTA were performed for diagnosis and

characterization of the lesions, before PTA. Initial MRA was not standard practice in our department and restricted only to cases where CTA is contraindicated. Hospital medical notes including inpatient and outpatient clinic/office visits, procedure details, clinical outcomes including improvement in rest pain and ulcer healing/resolution were documented prior to discharge and at subsequent outpatient visits. Appropriate medical management was commenced, along with risk factor modification.

Procedure details: Angiographic information regarding diseased segment location and degree of stenoses or occlusion, and extent of distal run-off was available on all patients prior to angioplasty. All patient received Peri-procedural medications with oral antiplatelet in form of salicylic acid 150 mg bid and cilastazole 100mg twice daily and good hydration by normal saline for 6 hrs before and after the procedure.

Informed written consent was obtained in all cases. The procedure was done under local anesthesia in most of the cases and in few cases with irritable non cooperative patient spinal anesthesia was the choice. Ipsilateral antegrade femoral arterial puncture was used in most of the cases while crossover contralateral femoral access was done in occasional cases with associated proximal SFA lesion or iliac arteries lesions. All patients received 5000 IU heparin IV after sheath insertion. Selective angiography of the infrainguinal and infrapopliteal arteries was performed with a 4F multipurpose diagnostic catheter. After obtaining the preinterventional angiography hemodynamically relevant lesions of the femoral and popliteal artery-if present-were treated to establish good inflow to the calf either by angioplasty alone or with stenting.

Afterwards a 0.018 guidewire with a steerable soft atraumatic tip was then used to pass the infrapopliteal lesion in an antegrade direction.

After crossing the lesion, dilation using low-profile balloons with a diameter of 2.5–3mm for tibial arteries and 4mm for infragenicular popliteal artery and a length of 40–150mm with 6–10 atm for 30–60 s was performed with an inflator device.

Following deflation, routine angiography was performed with the guide-wire remaining across the lesion and procedure outcome was recorded.

Post interventional medication consisted of PGE1 (Alprostadil) 60 ug once per day for two or three days, 150mg acetylsalicylate (ASA) indefinitely on a lifetime basis plus 75mg clopidogrel for 1 month and cilostazole for one year. Following a definition made by our vascular center

Success, failure, complications and short-term patency were analyzed according to the guidelines provided by the Society of Vascular Surgery and the International Society for Cardiovascular Surgery<sup>(12)</sup> Technical success

considered when it was possible to restore straight-line flow down to the foot circle in at least one crural artery with no significant residual stenosis (>30%). Major complications were defined as those that altered the patient's clinical state, whereas minor complications did not. Haemodynamic patency required that the ankle brachial pressure index (ABPI), measured in the angioplastied artery, rose by > 0.10 within 24 h or that the angioplastied segment was patent on repeat arteriography. Symptomatic patency (clinical success) required that the resolution of rest pain or healing of ulcers and minor amputations. Primary patency required that the affected limb had been treated at a single angioplasty session; no secondary patency was estimated in our study.

The follow up period ranged from 3 to 13 month with the mean follow up period 11.08±3.2 month. Follow up was conducted in vascular surgery outpatient clinic at 1, 3, 6 and 12 months regarding the followings points: a- Sustained clinical improvement based on Rutherford upward categorical shift with absence of rest pain and/or progressive tissue healing during the follow up

period of our study. B- Hemodynamic state (ABI, and pulse wave recordings). C- Limb salvage rate. (Absence of major amputation). Toe and transmetatarsal amputation were classified as minor amputations.

Short-term clinical success of PTA was evaluated based on ulcer size and appearance. Clinical success of PTA was defined as disappearance of necrotic and inflammatory symptoms and partial (at least 30% decrease in ulcer size) or total healing of the ulcer without bypass grafting or major amputation.

**Statistical analyses:** The statistical analysis of data done by using excels program and SPSS (SPSS, Inc., Chicago, IL) program statistical package for social science version 16.

The analysis of the data was done to test statistical significant. Chi-square test was used for qualitative data. Kaplan –Meier test was used for patency and limb salvage.



A



B

Fig 1a. Pre PTA, b. post PTA.



A



B

Fig 2a. Pre angioplasty, b. Post Angioplasty: after restoration of blood supply to the ankle.

## RESULTS

In our study 34 (59.6%) were males, and 23 (40.4%) were females. their ages ranged between (42–81) year and the mean age was 62.26 + 9.22 years.

Forty eight (84.2%) of our patients were diabetics, 23 (40.4%) of them were smokers, dyslipidemia was evident in 18 patients and 40 patients were hypertensive. There were associated co- morbidities in the form of ischemic heart in 15 patients and renal failure in 4 patients.

Most of our patients 44(77.2%) were having minor tissue loss (Rutherford category 5), 5 cases (8.7 %) presented with rest pain (Rutherford category 4), while the remaining 8 patients (14%) presented with major tissue loss (Rutherford category 6).

The fifty seven patients included in this study had 111 lesions and associated proximal lesion in 13 cases, all patients had successful revascularization of at least one tibial artery. Majority of the lesions corresponded to TASC C 66 (59.4%), followed by TASC B 29(26%), TASC A 16 (14.4%), there were no TASC D lesions treated in our series. Their distribution was as follow in Table 1

**Table 1.**

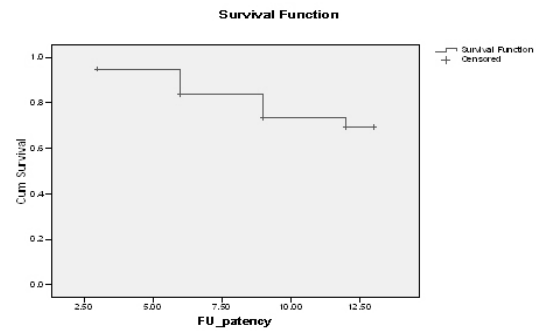
	No.	%
Popliteal below knee	9	8.1
Tibio peroneal	15	13.5
Posterior tibial	37	33.3
Anterior tibial artery	34	30.6
Peroneal artery	16	14.4

PTA and Stenting for common iliac artery (CIA), external iliac artery was done in one, two cases respectively. Eight cases required PTA of superficial femoral artery (SFA) while it necessitated stenting of (SFA) in four cases.

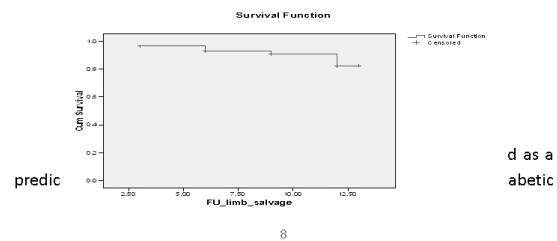
The mean pre-PTA ABI was 0.54 + 0.196 and the mean post-PTA ABI was 0.83+ 0.211.

Reported complications were Pseudoaneurysm in 2 cases, Puncture site hematoma in 2 cases and Perforation of the target vessel in 3 cases and they had no effect on clinical outcome.

Patency of angioplastied vessels was evaluated by Duplex and ABI and in some cases by CTA and it was 94.7% at 3month and 83.8% at 6 month and drop to 69.3% at 12 month.



In our study the limb salvage rate was 96.5% at 3 month and 92.9% at 6 month and reach 82.4 % at 12 month.



Predictor of outcome prognosis; the mean value of patency in diabetic was 10.37 and 9.57in non diabetic (p = 0.46), also the mean value of limb salvage in diabetic was 11.28 and 10.5 in non-diabetic (p=0.44).

On statistical analysis of isolated tibial lesions versus cases with associated proximal lesions; the mean value of patency in cases with associated proximal lesions was 7.31, while in isolated infragenicular lesions were 11.02 (p = 0.001) and the mean value of limb salvage in cases with associated proximal lesions was 8.46, while in isolated infragenicular lesions were 11.86 (p=0.017).

## DISCUSSION

Revascularization by means of (PTA) has become the first line of management for patients with PAD. In patients with CLI, the aim of revascularization is to provide sufficient blood flow to relieve rest pain and/or allow healing of the ischemic foot lesion.<sup>(13-15)</sup>

Kudo, et al 2006, mentioned that they have been considering (PTA) as a first line procedure in patients with CLI whenever possible and have not limited the indication for PTA to patients who cannot undergo an operation.<sup>(16)</sup>

Our study was concentrating on the outstanding role of Infragenicular angioplasty as a primary choice for the management of critical lower limb ischemia due to

infragenicular arterial disease for all patients even those young and generally fit for anesthesia.

The majority of the patients were males (60%) and the mean age was 62 years in our study. In comparison to more similar studies the male patients are the majority which reflects that male gender is a risk factor for CLI, in our study the main risk factors were diabetes mellitus 84%, smoking 40%, Hyperlipidemia 31% and Hypertension 70%. The most common co-morbidities were Cardiac disease 26% and renal disease on regular haemodialysis 7%. It is clear from comparing other studies<sup>(17)</sup> and our analysis of the risk factors and associated co-morbidities that Diabetes is the most common risk factor and it takes the upper hand in predisposition of CLI, the other risk factors and co-morbidities are different in the similar studies which may be due to the different geographic distribution and the variable habits among the populations.

Follow up of 12 months revealed overall patency rate of 69%, while the overall limb salvage rate was 82%. This discrepancy between patency and limb salvage probably reflects the fact that patency of the treated vessel is less important in such patients than in those with coronary, carotid or renal arterial disease, the re-canalization temporarily increases blood flow to the foot and has a positive effect in eradicating infection and healing ulcers and surgical wounds. As foot tissue healing reduces oxygen demand, less blood flow is generally required to maintain tissue integrity and keep the limb asymptomatic.

There was an overall significant improvement in ABIs following below knee PTA, with mean pre-ABI being  $0.54 + 0.196$  and improvement to a mean post-PTA ABI of  $0.83 + 0.211$  ( $p < 0.001$ ).

Other large single center study of 993 patients over a five year period after tibioperoneal angioplasty reported a limb salvage rate of 88% with a re-intervention rate of 13%<sup>(18)</sup> and it was 82% in short term follow up in other one.<sup>(19)</sup> And this cope with our result in short term follow up.

Reported complications in our study include two Pseudoaneurysm which were treated surgically, two Punctures site hematoma managed conservatively while three Perforations of the target vessel was managed by sustained balloon inflation across the perforation for three minutes. And all of them didn't affect the outcome

Establishing the continuity of blood flow to at least one foot artery is essential for healing of ischemic foot lesions.<sup>(20)</sup> We adopt this concept to revascularize the foot, many other reports adopt this concept and they reporting similar technique and clinical success rate even in the peroneal artery. Ballotta, et al 2008<sup>(21)</sup> and Dosluoglu, et al 2008<sup>(22)</sup> reported that Revascularization to the terminal peroneal artery (PA) affords adequate tissue perfusion and that the lack of any direct

communication between the PA and the major pedal vessels is no reason to reject the PA as the last choice outflow vessel for distal revascularization. The peroneal artery-only runoff is equivalent to other vessel runoff for patency, limb salvage and wound healing rates in patients presenting with ischemic tissue loss.

Although diabetes is generally considered a bad prognostic indicator in peripheral revascularization, recent studies have shown this may not always be the case<sup>(23,24)</sup> in our study however DM was the major risk factor it was also statistically insignificant as regard patency and limb salvage, p value 0.46, 0.44 respectively. However In other recent study, diabetic patients presenting with isolated tibial artery occlusive disease are more likely to have more advanced tissue loss, and a worse prognosis.<sup>(25)</sup>

In selected populations who have pure isolated below the knee vessel disease, successful angioplasty led to a very high rate of limb salvage and good long-term prognosis (26). Also In our study cases associated with proximal lesions have lower patency rate in comparison with cases that have isolated below the knee.

End stage renal disease on dialysis was 4 cases, two of them had a poor outcome regarding patency and limb salvage, the few number was non valuable for statistical analysis, Lida, et al 2012<sup>(27)</sup> adopt in recent study that CLI patients, especially those ESRD on dialysis, commonly present with long, diffuse arteriosclerotic disease in the infrapopliteal region; lesion length consequently was an anatomical predictor for Major Adverse Limb Events (MALE).

Limitation do exist within this study, the primary one being the small sample size along with the small number of major adverse clinical events. Also no routine angiographic follow-up of treated lesions was obtained. Perhaps a multicenter prospective cohort study model could be conceived to combat these issues. However, despite the low numbers, significance was still reached for the predictors of major Adverse Clinical Outcome (MACO).

In conclusion our study indicates that high short-term primary patency can be achieved with infragenicular angioplasty. And it should be considered as the first line of treatment especially with high surgical risk patients. The high technical success rate and low incidence of complications in this study confirms the findings of previous reports of infragenicular PTA. These data clearly demonstrate that lesions in the crural vessels can be reached, crossed and dilated successfully and safely with modern endovascular technology and it doesn't preclude the possibility of future surgical intervention.

**Conflict of interest/ funding:** None.

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