ORIGINAL ARTICLE

# Trans Pedal Access for Revascularization of Arterial Occlusive Disease of The Lower Limb

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Abstract

*Background:* ***Peripheral artery disease affects millions worldwide. The trans-pedal approach offers a viable alternative for revascularization in complex cases, with specific advantages and technical challenges.***

*Aim:* ***To assess retrograde trans-pedal/tibial access as an alternative for endovascular treatment in critical limb ischemia. This approach is increasingly used for complex infrainguinal occlusions.***

*Patients and methods:* ***this prospective research involved fifty cases of Faculty of Medicine -Al-Azhar University hospital with atherosclerotic occlusive arterial disease. The diagnosis of underlying arterial ischemia in every case will be determined through case history, physical examinations, and the utilization of color Doppler ultrasonography or computed tomography angiography.***

*Results:* ***At 1-month follow-up, primary patency and limb salvage rates were 100% by duplex scan. At 6 months, primary patency was 90% (conservative treatment), with 100% limb salvage and no re-angioplasty needed. Complications included a 34% failure rate (68% [11/17] due to calcified access failure [7 PTA, 3 ATA, 1 PA]; 32% [6/17] due to lesion crossing failure [5 cases] or tibioperoneal trunk wiring [1 case]), 2 conservatively treated hematomas, 1 conservatively treated infection, and 1 peroneal artery perforation (balloon-controlled). Amputation occurred in 16% (8 above-knee cases): 3 due to access failure (2 prior antegrade, 1 retrograde transpedal) and 5 due to lesion crossing failure (4 prior antegrade, 1 retrograde transpedal).***

*Conclusion:* ***Retrograde trans-pedal access is a promising and safe option for limb salvage in CLI cases, especially when conventional methods fail. It offers high success with low complication rates and growing clinical relevance.***

*Keywords:* TRANS PEDAL; ACCESS; Revascularization

## 1. Introduction

The present trend in health care is to give patients effective, safe care while containing expense and mini-mizing risk. In coronary revascularization, trans-radial arte-rial access was demonstrated to be safer in comparison with the femoral arterial method, leading to its enhanced utilization. Similarly, a trans-pedal method can possibly exemplify similar supe-riority in lower extremity revascularization, both above and below the knee .[1]

Critical limb ischemia requires sufficient revascularization to provide a straight-line flow to the foot. Partial revascularization of iliac or femoro-popliteal arteries alone is typically inadequate to heal advanced gangrene or leg ulcers. Antegrade and retrograde femoral access exhibit a failure rate of fifteen percent to twenty percent when traversing difficult obstructions.[2]

Trans-pedal access necessitates operator experience; nevertheless, the method may have a short learning curve. Employing duplex US may be helpful in achieving access. An alternative method to trans-pedal access involves image overlay, venous cut-down, or road mapping. Nevertheless, this technique may be challenging if the case or the table moves, and it also necessitates the use of additional contrast. This technique needs operator expertise as the puncture should be performed at a ninety-degree angle to the flow. The exposure of fingers to radiation is additionally a concern here. Utilization of handheld duplex US may aid in locating the tibio-pedal vessels, with the dorsalis pedis artery being the most frequently accessed pedal artery, followed by the posterior tibial artery and the peroneal artery.[3]

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The benefits of tibiopedal access include the small diameter of tibial vessels, which may enhance the successful crossing of a wire or a catheter through obstructions. The pedal approach may provide a shorter arterial segment to cross with stents, catheters, and balloons, as compared to conventional ipsilateral or contralateral methods. It is advantageous in patients where vessel size precludes the use of embolic protection devices throughout retrograde or antegrade femoral approaches. Additionally, it can have a safer alternative for cases with obesity for whom a groin approach can't be feasible, or a hostile or infected groin .[4]

Possible disadvantages of tibio-pedal access: Small-diameter vessels are prone to spasm and dissection; they are frequently calcified. Approaching near the ankle can lead to significant challenges in sheath passage due to acute angulations, long method duration, and excessive contrast utilization.[5]

Aim of the study; this study aims to assess limb salvage utilizing retrograde trans-pedal/tibial access utilizing various modalities (cut down, US guided as well as road mapping) in cases had critical limb ischemia as alternative approach for endovascular recanalization. In recent years, the retrograde tibiopedal technique is widely utilized for the revascularization of complex chronic complete obstructions of the infrainguinal region.

## 2. Patients and methods

Study setting: Cases were recruited from Al-Azhar University and El-Hussein Teaching Hospitals under the supervision of the thesis.

Study period: January 2015 to June 2017.

Studied population: This is a prospective research involving fifty cases presented to of Faculty of Medicine-Al-Azhar University hospital (January 2015 to June 2017) with arterial occlusive disease of the lower limb using percutaneous transluminal retrograde trans-pedal/tibial access with various modalities (cut down, US guided as well as road mapping), aims to assess limb salvage following recanalization of lower extremity arteries.

Clinical assessment:

Clinical examination and history taking have been performed for each case involving: 1. Sex and age. 2. Major risk factors for atherosclerosis include Hypertension, Smoking, Diabetes Mellitus, and Ischemic heart disease. 3. Clinical classification of chronic lower limb ischemia has been carried out in line with the categorization of the Society of Vascular Surgery/International Society of Vascular Surgery for chronic lower limb ischemia (categorization of Rutherford).

Inclusion criteria:

Cases had arterial occlusive illness of the lower limb:

-Rest pain.

-Failed antegrade transluminal(femoral) angioplasty (patient with three affected tibial vessels).

-Gangrene, unhealed ulcer, and tissue loss (has one patent tibial vessel- angiosome theory-away from puncture site).

Exclusion criteria:

-Patients with concomitant proximal arterial iliac lesions.

-Non-salvageable limbs (absent distal run off).

-Patient refused to be included in the study.

Pre-procedural investigations:

-Routine laboratory tests: complete blood picture, liver and renal function tests, lipid profile, coagulation profile, and concentration of blood glucose.

-Imaging modality: pre-procedural assessment of the lesion has been performed utilizing: duplex scanning and / or multislice CT angiography to verify the affected vessels (single versus multivessel disease), character of the lesions (stenotic versus occlusion and the length of the lesions) and presence of distal run off and evaluation of the pedal arcades.

Pre-procedural medications:

Clopidogrel was started 2 days before the procedure at a dose of: -75mg/twice/daily. -300mg on the night of intervention.

Procedure:

The retrograde access method involves two steps;

*The 1st step necessitates obtaining percutaneous access into the pedal vessel.

*The 2nd step includes crossing the obstruction in a retrograde fashion.

Preparation for access to the Pedal / Tibial vessel patients should facilitate typical access via either an antegrade or retrograde femoral technique (in case of failure); also, the foot must be prepped for pedal access. Cases must be sedated only sufficiently to relax them so as to diminish foot motion. Each tibial vessel, involving the posterior tibial, anterior tibial, and peroneal arteries, may be accessed in retrograde fashion.

Intervention:

-The use of duplex-guided access for accessing the tibial / pedal vessels.

- Moreover, heavily calcified vessels might induce extensive shadowing, complicating the method. In such cut-down situations, road mapping or straight fluoroscopy techniques provide a better chance for successful access.

-Micropuncture needles 22G.

- The foot's positioning throughout the access

procedure is crucial for plantar flexion when accessing the anterior tibial and dorsalis pedis arteries, as well as for inverting the foot when accessing the distal peroneal artery in the leg, and for eversion and dorsiflexion when accessing the posterior tibial artery in the distal leg.

Artery access wire (0.018 in)

4-Fr vascular sheath

The balloon angioplasty and stent, if needed.

Follow up:

Patients were scheduled for follow-up duplex scanning 1 and 6 months following intervention.

Data collection and Statistical analysis:

Participants who have been found eligible for the research have been asked to sign a written consent to participate in the investigation. Before the intervention, baseline characteristics of cases (age, sex at the period of the management, as well as body mass index) were gathered; the clinical grade was based on the Society of Vascular Surgery/International Society of Vascular Surgery for chronic lower limb ischemia (Rutherford classification). This depends on the assessment of 9 main symptoms of the illness: Pain at rest or claudication, edema, inflammation, skin pigmentation, gangrene, and ulcers. The postoperative complications and failure of revascularization using trans pedal access and amputation (failure of retrograde or antegrade). Recorded information has been examined using the statistical package for the social sciences. Values have been expressed as means ± standard deviation (SD).

Possibility (p-value): *P below 0.05 has been deemed significant, **P below 0.001 has been deemed as highly significant, and P above 0.05 has been deemed insignificant.

## 3. Results

The study includes (sex):

-35 males (70%), -15 females (30%).

The age of the patients: Varied among 48 and 72 years with mean age of 63.5 years old, standard deviation ± 8.5, as shown in graph 1, 2.

*Table 1 . Risk factors:*

| | D.M | SMOKING | DYSLIPIDEMIA | HTN | ISCHEMIC HEART DISEASES | RENAL IMPAIRMENT |
|---|---|---|---|---|---|---|
| PATIENT (50) | 45 | 35 | 35 | 30 | 15 | 10 |

Clinical presentation;

-twenty-five cases with failed antegrade transluminal(femoral) angioplasty (fifty percent).

-fifteen cases had tissue loss (thirty percent).

-ten cases had rest pain (twenty percent).

Patient classification:

A) Lesion nature;

-34 patients with stenotic lesions.

-16 patients with occlusive lesions.

b) Anatomic distribution;

-39 limbs (78 %) had 3 diseased tibial vessels (A.T.A, P.T.A. and Peroneal artery)

11 limbs (22%) had 2 diseased femoral and popliteal.

Symptomatic classification;

- twenty-five cases with failed antegrade transluminal(femoral) angioplasty

- fifty percent underwent rest pain with/ without tissue loss.

- fifteen cases underwent tissue loss (thirty percent).

- ten cases underwent rest pain (twenty percent).

Technical success rate:

-66% to achieve at least one patent tibial feeding vessel for every treated limb (twenty-five cases with failed antegrade transluminal(femoral) angioplasty fifty percent).

-80 % to achieve at least one patent tibial feeding vessel for every treated limb (15 patients suffered from tissue loss (30%).

-50 % to achieve at least one patent tibial feeding vessel for every treated limb 10 patients suffered from rest pain (20%).

Failure rate:

-68% was due to failure to gain the access (severely calcified).

-32% was due to failure to pass the lesion or to cross the wire through the lesion or due to procedure complication.

Follow Up:

After one month; Primary patency rate was 100% of the successful angioplastied lesions by duplex scan.

Limb salvage rate was 100%.

After 6 months follow up; Primary patency rate was 90% by duplex scan (continue on conservative treatment). Limb salvage rate was 100%.

There was no need for re-angioplasty of angioplastied cases.

Complications:

Failure rate (34%):

68% (11/17) was due to failure to gain the access (severely calcified); *7 cases of P.T.A *3 cases of A.T.A * 1 case of P.A 32% (6/17 cases) was due to;

* Failure to cross the lesion (5 cases) * Failure to cross the wire through tibioperoneal trunk (1 case).

Access site hematoma:

2 patients suffered from hematoma and were treated conservatively.

Access site infection:

1 patient suffered from infection (cut down) and

was treated conservatively.

Perforation:

1 case, it occurred while wiring peroneal artery. And it was controlled by inflation of the balloon twice 3 minutes for each.

Amputation (16%):

8 cases of above knee amputation;

-3 cases were due to failure to gain the access (severely calcified-occlusive lesion); 2 cases of previous failure of antegrade angioplasty-1 case of retrograde transpedal angioplasty.

-5 cases due to failure to cross the lesion; 4 cases of previous failure of antegrade angioplasty-1 case of retrograde transpedal angioplasty.

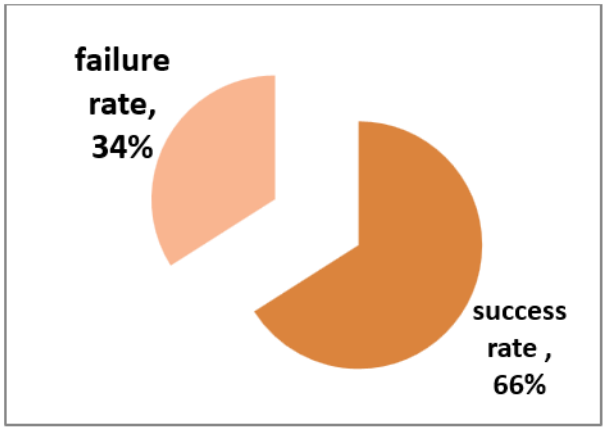
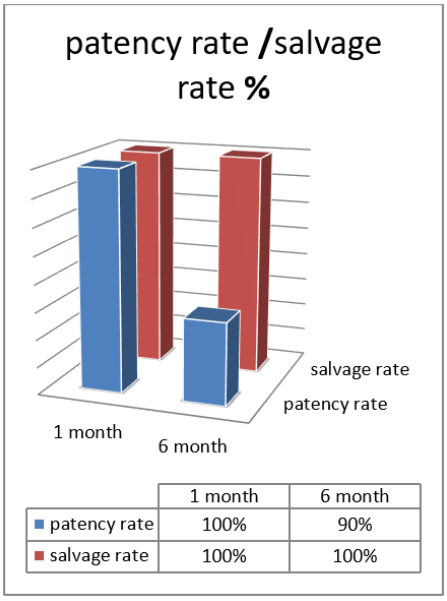



Figure 2. failure rate and success rate.




| | 1 month | 6 month |
|---|---|---|
| patency rate | 100% | 90% |
| salvage rate | 100% | 100% |

Figure 2. Patency rate and salvage rate %.

## 4. Discussion

Peripheral Arterial Disease is one of the manifestations of systemic atherosclerosis. The incidence of peripheral arterial disease rises with advancing age, making it crucial to remember the major and high significant correlation among cerebrovascular disease and coronary artery disease in these cases, because it represents the major cause of death and morbidity in the peripheral arterial disease population Hany et al. [6]

Transpedal access represents a novel advancement in vascular interventions. The management of cases with critical limb ischemia due to femoropopliteal or tibial occlusive disease is crucial when the regular antegrade method to crossing the obstruction isn't probable. The transpedal retrograde method is very successful method for crossing obstructions, demonstrating and it has a very low rate of obstruction at the access point of the tibial / pedal vessels .[6]

We determined that the retrograde method for endovascular treatment of CLI cases is minimally invasive, highly effective, and correlated with minimal access site complications. Since that the success rate for an antegrade method is stated to be as high as eighty percent, as observed in our institution, and that eighty percent of the remaining limbs are suitable to a retrograde attempt, which subsequently succeeds in eighty percent to ninety percent of cases, we estimate that only five to seven percent of cases with infrapopliteal obstructions should remain without a successful endovascular intervention .[7]

In study done by Noory et al., fifty-six case cases (thirteen females and forty-three males, mean age sixty-eight range forty-three to eighty-seven) with stable chronic peripheral artery disease (Rutherford category two to five) have been managed with antegrade subintimal angioplasty that might not be completed due to re-entry failure then retrograde access using transpedal access was used for completing the procedure .[8]

In study done by Tay in 2012, 24 patients with critical limb ischemia underwent endovascular intervention. The median patient age was 72 years. The majority (70.8%) were male. 75% were in Rutherford category 6, 20.8% in category 5 and 4.2% in category 4 after antegrade access failure, retrograde transpedal access was used for recanalization .[6]

This study included 35 males (70%) and 15 females (30%) and the patient's age 48 and 72 years with mean age of 63.5 years old, standard deviation ± 8.5, forty five cases had Diabetes (ninety percent), thirty fife cases were cigarettes smokers (seventy percent), thirty five cases had dyslipidemia (seventy percent), thirty cases had hypertension (sixty percent), fifteen cases had ischemic heart diseases (thirty percent), whereas ten cases had renal impairment (twenty percent), twenty five cases with failed antegrade (femoral) angioplasty (fifty percent), fifteen cases had tissue loss (thirty percent) as well as ten cases had rest pain (twenty percent).

In a study done by Botti et al. in 2013, a series of 6 patients in which the retrograde pedal

approach had been tried for critical limb ischemia with ulceration following failed antegrade recanalization of at least one tibial vessel run off to the foot. Access had been gained via the posterior tibial artery in four cases and via the dorsalis pedis artery in 2 cases. Every case illustrated full recovery utilizing the method with no major complications .[9]

In the study done by Roger et al. in 2011, 13 patients with failed conventional antegrade recanalization of the tibial vessels were involved. Indication for intervention was gangrene in 10 patients and severe claudication in 3 patients. 11 patients had elevated blood pressure via the posterior tibial artery, and 2 cases via the dorsalis pedis artery. In 11 patients, the method was successful in recanalizing the elevated tibial vessels with restoration of in-line flow. The two failed patients illustrated no deterioration in the condition of the limb, and there were no access-site complications in any .[10]

Montero et al., stated utilizing the Transpedal approach in fifty-one patients. The indication for intervention has been failed antegrade recanalization of at least one tibial vessel; forty-four cases had successful recanalization of the anterior tibial artery, and seven cases via the posterior tibial artery. There was a single instance of dorsalis pedis artery obstruction at the access site following a failed attempt to recanalize the anterior tibial artery .[11]

In the present research, we utilized transpedal access in five patients, via anterior tibial artery in thirty limbs (sixty percent), via dorsalis pedis artery in eleven limbs (twenty-two percent), as well as posterior tibial artery in nine limbs (eighteen percent), with a technical success rate of sixty-six percent.

Research done by Botti et al., illustrated that 8 patients have been successfully recanalized by utilizing transpedal technique with no major complications. [9]

As regard to study done by Roger et al., which presented a series of 13 cases with critical limb ischemia treated by transpedal approach, there were no access-site complications .[10]

In this study, two patients developed advanced hematoma (4%), and 1 case developed infection (2%) at the site of arterial cut down, which were resolved by conservative management and antibiotics, and completely resolved after one week of hospital stay. Perforation: 1 case, it occurred while wiring the peroneal artery, and it was controlled by inflation of the balloon twice, 3 minutes for each (2%). Failure to gain access to the site: 2 patients as a result of heavily calcified arteries (4%). There were no major complications.

*4. Conclusion*

Retrograde trans-pedal access is a unique, limb-preserving method for revascularization in critical limb ischemia (CLI) when conventional endovascular approaches fail.

It offers high technical success and low complication rates, making it a safe and promising alternative. Its growing importance highlights the need for interventionists to master this technique for CLI treatment.

## Disclosure

The authors have no financial interest to declare in relation to the content of this article.

## Authorship

All authors have a substantial contribution to the article

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## Conflicts of interest

There are no conflicts of interest.

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