# RETRO-GRADE TRANS PEDAL AND TIBIAL ARTERY ACCESS FOR REVASCULARIZATION OF INFRA-POPLITEAL ARTERIAL OCCLUSIVE DISEASE

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**KEYWORDS**

chronic lower limb ischemia, peripheral arterial occlusive disease, Infra popliteal angioplasty, Trans pedal/tibial angioplasty.

**ABSTRACT**

**Background:** Peripheral artery disease (PAD) has reached pandemic proportions. Percutaneous recanalization of the affected artery is the most important alternative to surgery and appears equivalent to surgery in the management of patients with critical limb ischemia (CLI).

**Objectives:** to evaluate limb salvage after recanalization of lower extremity arteries using retrograde trans-pedal/tibial access using different modalities (US guided, road mapping and cut down) in patients with CLI.

**Methods:** This prospective study included 50 patients of Beni-Suef university hospital with infra-popliteal atherosclerotic occlusive arterial disease. Diagnosis of the underlying arterial ischemia in each patient will be determined from; patient history records and physical exams and using color Doppler ultrasonograpy (US) or CT angiography.

**Results:** 45 patients suffered from Diabetes (90%), 35 patients were cigarettes smokers (70%), 35 patients had dyslipidemia (70%), 30 patients had hypertension (60%), 15 patients suffered from ischemic heart diseases (30%), while 10 patients had renal impairment (20%), 25 patients with failed antegrade (femoral) angioplasty (50%), 15 patients suffered from tissue loss (30%) and 10 patients suffered from rest pain (20%). we used transpedal access in 50 cases, through anterior tibial artery in 30 limbs (60%), and through dorsalis pedis artery in 11 limbs (22%) and posterior tibial artery in 9 limbs (18%) with technical success rate (66%). 2 case developed hematoma (4%) 1 case developed infection (2%) and Perforation in 1 case, there were no major complications.

**Conclusion:** Retrograde pedal/tibial artery access is a promising alternative for patients in whom conventional endovascular techniques failed to achieve recanalization of the tibial vessels.

# 1. Introduction:

Critical limb ischemia (CLI) occurs when artery stenosis exceeds a critical threshold, preventing blood flow to the distal extremity and reducing basal tissue oxygen levels. Thus, 1% to 2% of peripheral arterial disease (PAD) patients have rest pain and/or non-healing ulcers **[1]**.

Endovascular revascularization for PAD must improve due to the rising number of chronic illness patients and the elderly **[1]**.

Patients with occlusive diseases often undergo endovascular arterial revascularization. Percutaneous recanalization of the injured artery is the main option to surgery for CLI. Arterial occlusions, especially long segment occlusions, may make endovascular therapy difficult, and failure can lead to amputation in CLI patients. The standard antegrade technique cannot manage 20% of complex occlusions because the guide wire fails to re-enter the true lumen distal to the occlusion, especially in infra-popliteal lesions **[2]**.

Healthcare aims to treat patients safely and effectively while reducing costs and hazards. Trans-radial arterial access for coronary revascularization is safer than femoral arterial access, increasing its utilization. Trans-pedal lower extremity revascularization may be superior below and above the knee **[2]**.

To tackle the growing public health threat of PAD and CLI, retrograde tibiopedal access to cross infrainguinal occlusions is essential. Cutdown retrograde crossing of infrainguinal chronic total occlusions (CTOs) was introduced to permit recanalization in 1990 to reduce major limb amputation morbidity, cost, and death **[3]**.

Multilayer arterial occlusion treats chronic limb ischemia wounds. Impending CLI limb loss sometimes requires below-the-knee endovascular intervention. The size and features of lower extremity veins and the fear of limb loss may make traditional peripheral angioplasty equipment more difficult to use in the case of a problem. Tibio-peroneal angioplasty should go beyond limb salvage. If angioplasty fails, surgical options are limited, thus patient selection is crucial **[4]**.

Trans-pedal artery access for revascularization of complicated tibio-pedal lesions in CLI patients has grown in popularity. Trans-pedal access is necessary for limb preservation when retrograde and antegrade femoral access fails. Creating direct foot flow in chronic limb ischemia needs enough revascularization. Advanced leg ulcers or gangrene frequently need more than partial iliac or femoro-popliteal artery revascularization. When crossing difficult tibio-pedal occlusions, antegrade and retrograde femoral access failed 15% to 20% **[5]**.

Retrograde femoral artery access is simple and common, however it has limitations when crossing tibio-pedal lesions. Only a few balloons and catheters can reach distant tibio-pedal lesions. Pushability decreases when the crossing wire loses torque, increasing the chance of vessel dissection and revascularization failure. Because catheters, wires, and support are available antegrade femoral access may improve tibio-pedal lesion traversal. Antegrade femoral access requires operator skill because to the risk of multiple punctures and hematomas. Antegrade puncture may complicate access control, especially in obese people **[6]**.

Trans-pedal access requires operator skill, although it may be easy to master. Access may be easier with duplex ultrasound. For trans-pedal access, use road mapping, image overlay, or venous cutdown. This method requires supplemental contrast and might be difficult if the patient or table moves. Popping the flow at a 90º angle, needs operator skill. Radiation exposure to fingertips is a hazard. Portable duplex ultrasound can identify the tibio-pedal vessels, with the dorsalis pedis artery being the most accessible, followed by the posterior tibial and peroneal arteries **[3]**.

Our goal of the current study was to evaluate the preservation of limbs in patients suffering from CLI after recanalization of lower extremity arteries using retrograde trans-pedal/tibial access with the use of three different techniques: cut down, road mapping, and US guiding.

## 2. Patients and methods:

This is a prospective study including **50** patients presented to the vascular unit of Beni-Suef University Hospital (January 2015 to June 2017) with infra popliteal arterial occlusive disease, for whom percutaneous transluminal retrograde trans-pedal/tibial access using different modalities (US guided, road mapping and cut down was done). Diagnosis of the underlying arterial ischemia in each patient was determined from; patient history records, physical exams and using, color Doppler ultrasonograpy (US) or CT angiography.

**Inclusion criteria**

*Patients with infra popliteal arterial occlusive disease:* Rest pain, failed antegrade transluminal(femoral) angioplasty (patient with affected three 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 lesion
- Non-salvageable limbs (absent distal run off)
- Patient refused to be included in the study.

**Ethical considerations:**

The potential benefits and risks of the endovascular treatment of this approach were explained to each patient, and were written (consent). Each patient was also informed for a possible second artery puncture from the femoral artery if the attempt from the pedal vessels failed. The study was approved by ethical committee of Faculty of medicine at Beni-Suef University.

**Clinical assessment:**

History taking and clinical examination was done for all patients including: Age and gender, Major risk factors for atherosclerosis including; Diabetes Mellitus, Smoking, Hypertension and Ischemic heart disease, Clinical categorization of chronic lower limb ischemia was done in accordance to the categorization of the Society of Vascular Surgery / International Society of Vascular Surgery for chronic lower limb ischemia (Rutherford classification).

**Pre-procedural investigations:** -

- Routine laboratory tests: complete blood picture, kidney and liver function tests, coagulation profile, lipid profile and blood glucose level.
- Imaging modality: pre-procedural assessment of the lesion was done using: 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 at the night of intervention.

**Procedure:**

The retrograde access technique comprises two steps; the first step requires gaining percutaneous access into the pedal vessel. The *second step* involves crossing the occlusion in a retrograde fashion.

Access into the Pedal/Tibial Vessel patients should be prepared in a way to allow the usual access through either a retrograde or antegrade femoral approach (in case of failure); additionally, the foot should be prepared for the pedal access. Patients should be sedated only enough to relax them in order to minimize foot movement. All tibial vessels, including the anterior tibial, posterior tibial, and peroneal arteries, can be accessed in retrograde fashion.

**Instruments:**

- RIVAL balloon/BARD peripheral vascular- D 6 mm, L 15 cm
- Artery access wire (0.018 in)
- 4-Fr vascular sheath -4-Fr vascular sheath French vascular sheath 5.5cm 0.35(402-604P)-16102649-2017-02; AVANTI/Cordis.
- Vascular catheter (angiodynamics, SOFT-VU Berenstein) 5F (1.8 mm)* 100 cm on maximum wire 0.38 in. REF(category number); 10722702.
- Micropuncture needles 22G.

**Methods:**

Initial angiography (Assessment)
Angioplasty
Final angiography/duplex (Evaluation of adequate angioplasty), **as shown in Figures (1-7).**

**Follow up:**

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

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

-Also, heavily calcified vessels can cause extensive shadowing that will make the technique difficult. In these situations, straight fluoroscopy or road mapping or cut down offer a better chance for successful access.

- -The position of the foot during the access procedure is important in plantar flexion when accessing the dorsalis pedis and anterior tibial artery and inverting the foot when accessing the distal peroneal artery in the leg and eversion and dorsiflexion when accessing the posterior tibial artery in the distal leg.

Figure (1a): puncture needle duplex guided into P.T.A.

Figure 1(b): Artery access wire (0.018 in) into P.T.A.

Figure 1(c): 4Fr sheath introduction

Figure 1(d): 4Fr sheath into P.T.A.

Figure 1(e): 4F sheath into P.T.A. after removal of the wire.

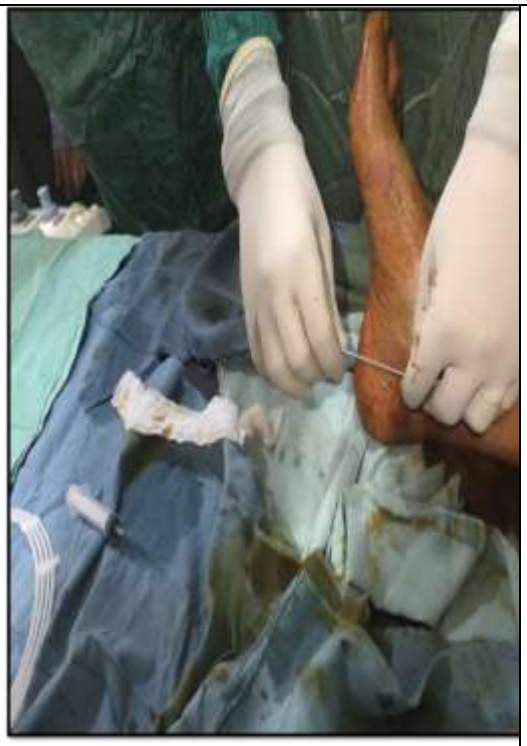


Figure 1(f): entry of vascular catheter into the sheath.

Figure (1): Case 1 in retrograde access technique

Figure 2(a): Puncture needle duplex guided entry into the end of D.P.A.

Figure 2(b): 4F vascular sheath into D.P.A. with catheter.

Figure 2(c): 4F vascular sheath with catheter entry into D.P.A. with catheter.

Figure 3: 4F vascular sheath and catheter into D.P.A with trail to cross the lesion.

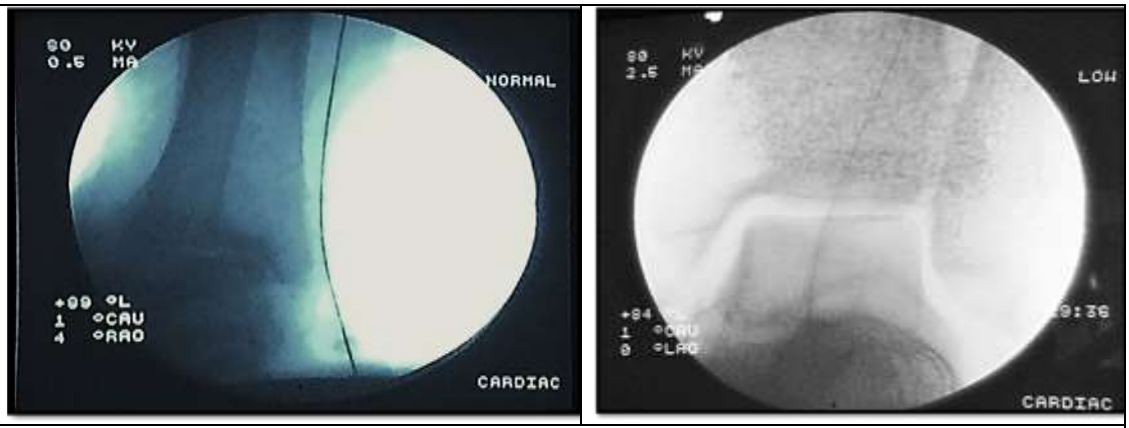



Figure 4: the wire into P.T.A and A.T.A.

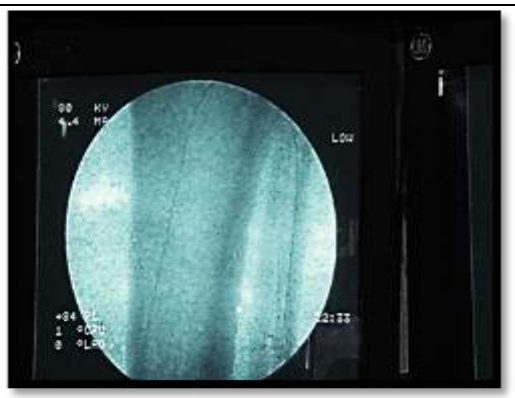


Figure 5a: The passage of the wire into A.T.A and Tibio-peroneal trunk(passage of lesion)

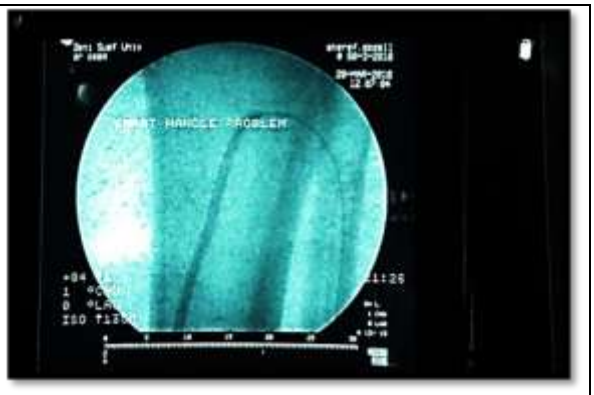


Figure 5b: balloon inflation of A.T.A lesion.

Figure 6: Case of our study using fluoroscopy to gain the access in P.T.A.

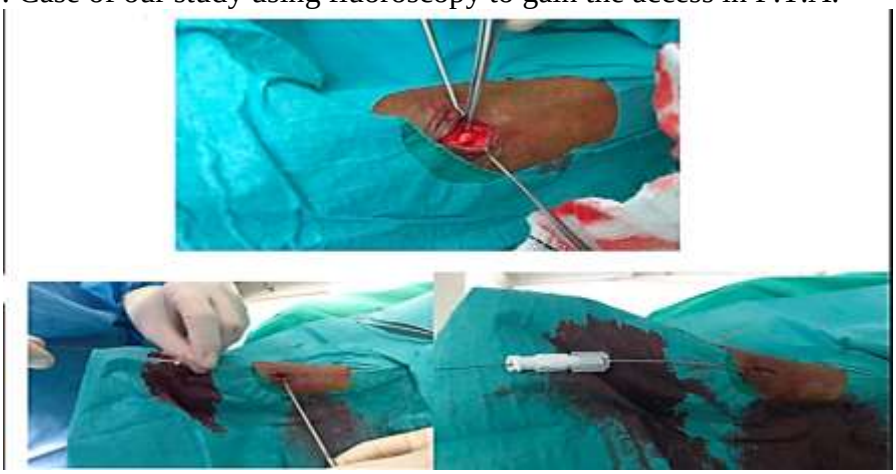


Figure 7: Case of the study with wire and catheter into end of A.T.A through cutdown.

## 3. Results:

This prospective study included 50 patients with infrapopliteal arterial occlusive disease; unilateral lower limb was planned for angioplasty. Other limb of each patient is investigated to exclude angiopathy (non-significant lesion with luminal reduction less than 50%, history of previous angioplasty or surgery in 8 cases).

In table (1): 35 (70%) were males and 15 (30%) were females. The age of the patients ranged between 48 and 72 years with mean age of 63.5 ± 8.5 years. Concerning Risk factors: 45/50 patients suffered from Diabetes (90%), 35/50 patients were cigarettes

smokers (70%), 35/50 patients had dyslipidemia (70%), 30/50 patients had hypertension (60%), 15/50 patients suffered from ischaemic heart diseases (30%), and 10/50 patients had renal impairment (20%). Concerning clinical presentation; 25 patients presented with failed antegrade transluminal(femoral) angioplasty (50%), 15 patients suffered from tissue loss (30%) and 10 patients suffered from rest pain (20%).

**Table (1): Demographic and basic clinical data of the patients:**

| | | **All patients (n=50)** |
|---|---|---|
| **Sex** (n, %) | **Male** | 35 (70%) |
| | **Female** | 15 (30%). |
| **Age** (Y) (mean±SD) | | 63.5 ± 8.5 |
| **Risk factors** (n, %) | **Diabetes** | 45 (90%) |
| | **Smoking** | 35 (70%) |
| | **dyslipidemia** | 35 (70%) |
| | **hypertension** | 30 (60%) |
| | **ischaemic heart diseases** | 15 (30%) |
| | **renal impairment** | 10 (20%) |
| **Clinical presentation** (n, %) | **Failed antegrade transluminal (femoral) angioplasty** | 25 (50%) |
| | **Tissue loss** | 15 (30%) |
| | **Rest pain** | 10 (20%) |

In table (2): 34 patients had stenotic lesions, and 16 patients with occlusive lesions. 39 limbs (78 %) had 3 diseased tibial vessels (A.T.A, P.T.A. and Peroneal artery), 11 limbs (22%) had 2 diseased tibial vessels, A.T.Ain 49 limbs (upper/middle/lower part= 20/11/18), P.T.A in 48 limbs (14/22/12), and P.A→42 limbs (10/9/23).

**Table (2): Procedure data of the patients:**

| | | **All patients (n=50)** |
|---|---|---|
| **Procedure** | **The length of the stenotic lesions** (mm) (mean ± SD) | 9.45±2.33 |
| | **Lengths of the occlusive lesions** (mm) (range) | 10mm to 50 mm |
| **Lesion nature** (n, %) | **stenotic lesions** | 34 (68%) |
| | **occlusive lesions** | 16 (32%) |
| **Anatomic distribution per limb** (n, %) | **3 diseased tibial vessels** | 39 (78 %) |
| | **2 diseased tibial vessels** | 11 (22%) |
| | **A.T.A upper/middle/lower part** | 49 (20/11/18) |
| | **P.T.A** | 48 (14/22/12) |
| | **P.A** (Peroneal artery) | 42 (10/9/23) |

In figure (8): Success rate was 33 (66%) of cases while failure rate was 17 (34%) of cases


**Figure (8): Technical success of retrograde approach in comparison with failure rate percent**

In table (3): total Failure rate was in 17 patients (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 cases were due to; failure to cross the lesion (5 cases), failure to cross the wire through tibioperoneal trunk (1 case).

**Table (3): Failure rate of the procedure among the study participants:**

| | | **Failed cases (n=17)** |
|---|---|---|
| **Failure rate** (n, %) | Total failure rate | 17 (34%) |
| | failure to gain the access (severely calcified) | 11 (68%) |
| | Failure to cross the lesion | 5 (29.4%) |
| | Failure to cross the wire through tibioperoneal trunk | 1 (5.9%) |

In table (4): 2 patients suffered from hematoma and were treated conservatively. 1 patient suffered from infection (cut down) and was treated conservatively. 1 case, it occurred while wiring peroneal artery and it was controlled by inflation of the balloon twice 3 minutes for each.

**Table (4): Complications of the procedure among the study participants:**

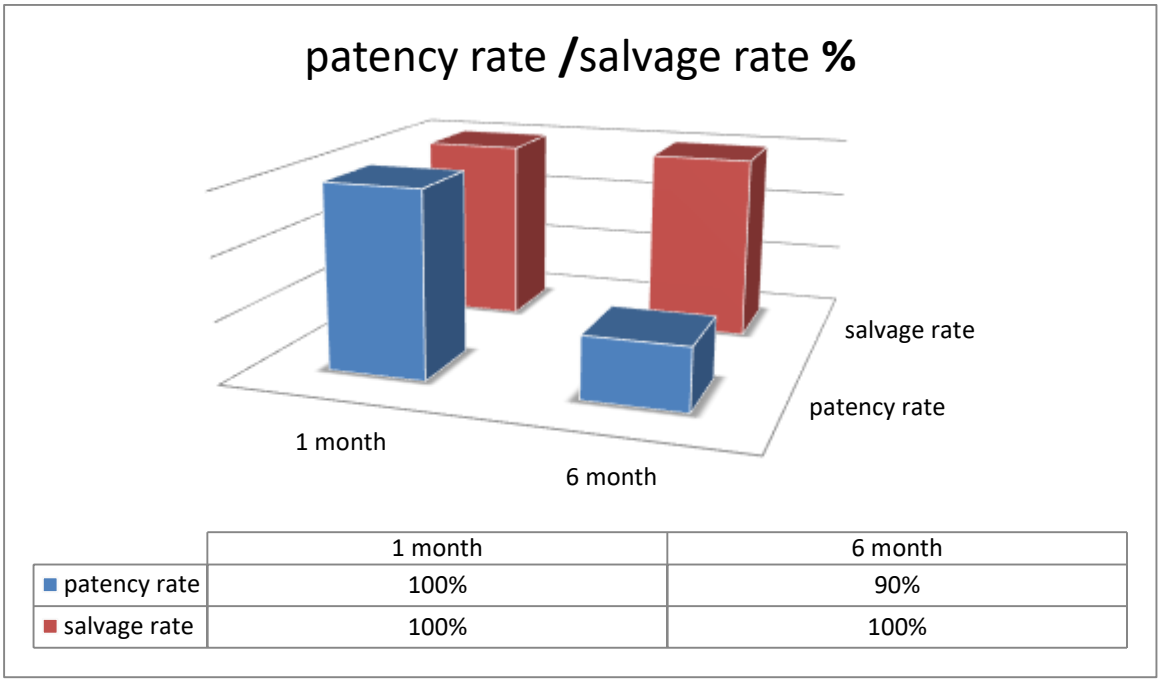
| **Complications** | **All patients (n=50)** |
|---|---|
| **Access site hematoma** | 2 (4%) |
| **Access site infection** | 1 (2%) |
| **Perforation** | 1 (2%) |

In table (5): Total Amputation rate above knee was in 16% of cases of; 3 cases were due to failure to gain the access (severely calcified-occlusive lesion); 2 cases of previous failure of antegrade angioplasty, and 1 case of retrograde transpedal angioplasty. 5 cases were due to failure to cross the lesion; 4 cases of previous, failure of antegrade angioplasty, and 1 case of retrograde transpedal angioplasty.

**Table (5): Above knee amputation rate of the procedure among the study participants:**

| | | **Amputation cases (n=8)** |
|---|---|---|
| **Amputation rate** (n, %) | Total Amputation rate | 8 (16%) |
| | failure to gain the access (severely calcified) | 3 (37.5%) |
| | failure to cross the lesion | 5 (62.5%) |

In figure (9): Patency rate reached 100% after 1 month with no change after 3 months but 90 % after 6 months.




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

**Figure (9): Patency rate percent in comparison with salvage rate percent following intervention**

**4. Case presentation:**

Case 1: figure (10)

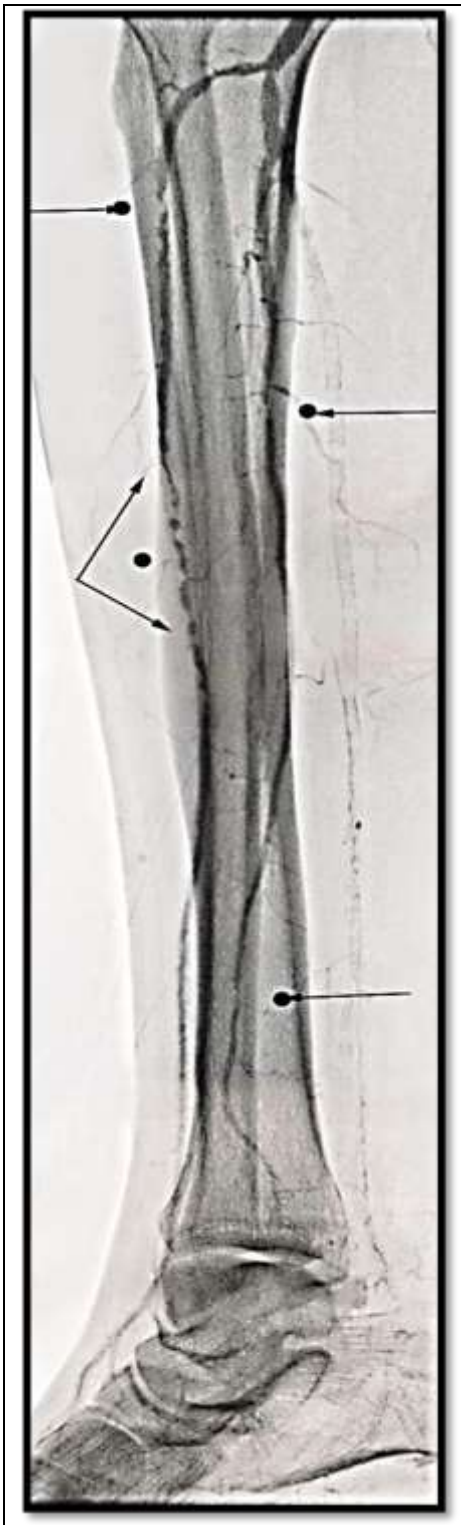


Figure (10a): Pre procedure ATA: Near total occlusion lesion in proximal 1/3 and near total occlusion segment in middle 1/3. PR: 2 stenotic lesions;one in the proximal 1/2and the other in distal 1/3.

Figure (10b): The right showing successful percutaneous angioplasty of the ATA and PR.

**Case (2): figure (11)**

Figure (11a): Pre procedure PA, stenotic lesion in proximal 1/3 and another one in distal 1/3. TPT: stenotic lesion.

Figure (11b): successful percutaneous angioplasty of the PA and TPT

## 5. Discussion:

One sign of systemic atherosclerosis is peripheral artery disease (PAD). Cerebrovascular disease is the leading cause of death and morbidity in the PAD population, and its association with coronary artery disease is evident in the fact that PAD incidence increases with age **[7]**.

Innovative vascular therapies have recently included transpedal access. When the usual antegrade approach to overcome the blockage is not possible, it is critical to treat patients with severe limb ischemia caused by femoropopliteal or tibial occlusive disease. According to **Hany et al. [7]**, the transpedal retrograde technique is a reliable way to bypass blockages since it seldom causes access point occlusion in the pedal/tibial vasculature.

Researchers found that endovascular treatment of CLI patients using the retrograde approach was very successful, had few complications at the access site, and was minimally invasive. With an antegrade approach achieving a success rate of up to 80% (unpublished data from our institution) and a retrograde attempt succeeding in 80% to 90% of cases (80% to 90% of the time), we estimate that only 5% to 7% of patients with infrapopliteal occlusions would not have a successful endovascular intervention **[1]**.

The research by **Noory et al. [8]** included 56 individuals with stable chronic peripheral artery disease (Rutherford classifications 2 to 5), with a mean age of 68 and a range of 43-87 years. The participants included 43 men and 13 females. **Noory et al. [8]** reported that when antegrade subintimal angioplasty failed owing to re-entry, the patients received retrograde access by transpedal access to finish the treatment. **Tay** et al. [9] performed endovascular intervention on 24 patients who had CLI. The patients' median age was 72 years. There were 70% men that took part. According to **Hany et al. [7]**, recanalization was performed via retrograde transpedal access in 75% of cases when antegrade access failed, 20.8% in category 5, and 4.2% in category 4.

With ages ranging from 48 to 72 years, this study included 35 males (70%) and 15 females (30%), resulting in an average age of 63.5 years and a standard deviation of ± 8.5. In this study, forty-five patients had diabetes, thirty-five smoked cigarettes, thirty-five had dyslipidemia, thirty had hypertension, fifteen had ischemic heart disease, ten had renal impairment, twenty-five had failed antegrade (femoral) angioplasty, fifteen showed tissue loss, and ten reported rest pain. The overall diabetes diagnosis rate was 90%.

After six cases of severe limb ischemia with ulceration and failed antegrade recanalization of at least one tibial artery supplying the foot, **Botti et al. [10]** investigated the use of the retrograde pedal technique. Two patients and four persons were able to get access via the dorsalis pedis artery and the posterior tibial artery, respectively. Without major complications, every single patient showed complete healing after using the method.

**Roger et al. [11]** looked at thirteen cases of conventional antegrade recanalization of the tibial arteries that failed. Ten of those cases had gangrene, and three had severe claudication as their indication for intervention. Two cases used the dorsalis pedis artery for access, and eleven cases used the posterior tibial artery. The procedure restored inline flow in eleven cases by recanalizing the accessible tibial arteries. In both cases when the procedure was unsuccessful, the limb's health remained stable, and the access site remained unaffected.

**Montero-Baker et al. [12]** observed 51 cases of the Transpedal method in action. Intervention was considered necessary if at least one tibial arterial had previously failed antegrade recanalization; 44 patients met this need for the anterior

tibial artery, and 7 patients met this requirement for the posterior tibial artery. The access location saw a single case of dorsalis pedis artery obstruction after a failed attempt to recanalize the anterior tibial artery.

The technical success rate was 66% in this experiment including 50 patients who had transpedal access. Fifty percent of these patients had their procedures done via the anterior tibial artery, twenty-two percent via the dorsalis pedis artery, and eighteen percent through the posterior tibial artery.

**Botti et al. [10]** recorded eight successful cases of transpedal recanalization with no major complications.

In their **study, Roger et al. [11]** documented thirteen cases of transpedal treatment for critical limb ischemia; they found no access-site complications. Using antibiotics conservatively, two patients in this study developed hematomas (4% of the total) and one patient developed an infection at the site of the vascular cutdown (2% of the total), both of which resolved completely after one week in the hospital. Inflating the balloon twice for three minutes each (2% of the total time) prevented a perforation that happened during peroneal artery wiring. Two people, or 4% of the total, experienced access site failure as a result of severely calcified arteries. We did not encounter any major problems.

## 6. Conclusion:

Retrograde trans-pedal operations offer a novel and perhaps limb-preserving recanalization and revascularization approach for patients with severe limb ischemia and advanced tibial occlusive disease. This procedure has a substantial technical success rate and a comparably low frequency of procedural problems. Comprehending the anatomy, techniques, and technologies accessible may boost operation success rates. The angiosome concept in below-knee revascularization procedures may be advantageous, although additional comparative and prospective data are necessary for thorough assessment of this notion.

## 7. Conflict of interest:

None

## 8. References:

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