

# PRIMARY RETROGRADE TIBIAL-PEDAL ACCESS IN PATIENTS WITH CRITICAL LIMB ISCHEMIA

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## Abstract

The most common complications after percutaneous vascular interventions are complications at the site of access. The use of retrograde tibial-pedal access could reduce the risks of significant complications at the puncture site compared to traditional femoral access.

*Purpose:* In this study, we aimed to determine the efficacy and safety of primary tibial-pedal access for revascularization of chronic total occlusion of the femoral-popliteal and infrapopliteal segments in patients with critical lower limb ischemia.

*Materials and Methods:* We conducted a retrospective analysis of 18 patients from January 2022 to August 2024. Patients were selected according to the following criteria: patients with categories 3, 4, 5 according to the Rutherford classification and stages 3,4 according to the Fontaine classification; femoropopliteal (FP) lesion with or without involvement of the infrapopliteal (IP) segment; the presence of blood flow in one or more distal or pedal segments of the main arteries of the leg and foot; informed consent of patients for the intervention.

*Results:* The overall procedural success rate of the intervention was 100%. The average age of patients was  $74 \pm 5$  years. The majority of the subjects were women (66.7%). Comorbidities such as diabetes mellitus (66.7%), arterial hypertension (55.5%), coronary artery disease (38.9%), and hyperlipidemia (77.8%) were diagnosed. The artery of choice in the majority of cases was the anterior tibial artery 13 (72.2%) Balloon angioplasty combined with stent placement was performed in 14 cases (77.8%). Minor bleeding at the puncture site occurred in 1 case (5.5%). There were no signs of major bleeding, hematomas, MALE, MACE, or death in any case. All patients experienced relief of pain of ischemic origin.

*Conclusion:* Retrograde tibial-pedal access is technically easier with a tendency to fewer complications. This technique can be used as a primary procedure or as an alternative to antegrade femoral access in complex patients with a high risk of hematoma formation.

*Keywords:* *primary retrograde tibial-pedal access, primary retrograde distal access, critical lower limb ischemia, CLI, peripheral artery disease, PAD.*

## Introduction

Critical limb ischemia (CLI) is the terminal stage of occlusive peripheral arterial disease and is characterized by chronic pain at rest and loss of tissue and limbs. The annual incidence of CLI is 100 cases per 100,000 population, and mortality reaches more than 20% in the first 6 months after diagnosis [1]. The most common causes of CLI are atherosclerosis and vascular complications of diabetes mellitus [2, 3]. There is a close connection between diabetes mellitus and CLI [4]. Every year, more

than 1 million lower limb amputation operations are performed in the world for diabetes mellitus, more than 600 thousand patients lose their eyesight, approximately 500 thousand patients develop kidney failure [4].

Currently, there are open, endovascular and hybrid methods of vein arterialization with various modifications and technologies. However, there are no large studies in the modern literature comparing the safety and efficacy of these methods in the short and long term [5]. Traditionally, endovascular methods of

revascularization of both the femoral-popliteal and tibial-pedal segments are performed through antegrade ipsilateral femoral or retrograde contralateral femoral access. However, the most common complications after percutaneous vascular interventions are complications at the site of access [6, 7].

Complications at the site of access include hematoma of varying severity, as well as stenosis or occlusion of the site of access. Post-access groin hematomas can be treated expectantly with transfusions and thrombin injections only, but if a pseudoaneurysm is present, re-intervention by open surgery or endovascular means is necessary. The reasons for this may be obesity, calcified artery, stenosis, thickness of the introducer, experience of the surgeon and others [6]. According to various data, complications at the puncture site can reach up to 5%, of which up to 1% require surgical intervention [8].

Hypothetically, the use of retrograde tibio-pedal access could reduce the risks of significant complications at the puncture site compared to traditional femoral access, due to the smaller diameter of the artery and the proximity of the artery to the skin. In addition, the proximal "cap" of chronic total occlusion is often denser and presents difficulties with antegrade intraluminal recanalization even in experienced endovascular surgeons. In this regard, retrograde distal access can be considered as an alternative and safer approach to endovascular revascularization in order to save the limb.

A retrograde approach to endovascular recanalization of femoral-popliteal lesions was first described more than 30 years ago [9]. Most often, the target artery for puncture with retrograde access is the artery of the back of the foot and the anterior tibial artery, but it is also possible to puncture the posterior tibial or peroneal artery. Notably, there are limited data regarding the success rate and safety of chronic total occlusion (CTO) intervention via retrograde access, as published studies have included only a few patients with femoro-popliteal CTO [10].

### **Purpose.**

In this study, we aimed to determine the efficacy and safety of primary tibial-pedal access

for revascularization of chronic total occlusion of the femoral-popliteal and infrapopliteal segments in patients with critical lower limb ischemia.

### **Materials and Methods**

We conducted a retrospective analysis of 18 patients at the Limb Salvage Center of the Private Clinic Almaty clinic from January 2022 to August 2024. All patients underwent ultrasound duplex scanning and CT angiography of the lower extremity arteries for diagnostics and planning of procedure.

Patients were selected according to the following criteria: patients with categories 3, 4, 5 according to the Rutherford classification and stages 3, 4 according to the Fontaine classification; femoropopliteal (FP) lesion with or without involvement of the infrapopliteal (IP) segment; the presence of blood flow in one or more distal or pedal segments of the main arteries of the leg and foot; informed consent of patients for the intervention. Relative indications were the obesity, flush- occlusion of the superficial femoral artery, calcified common femoral artery, severe comorbid background, rigid scars after previously open surgery in the groin on the ipsilateral side. Patients with secondary (auxiliary) retrograde distal access were excluded from the study. The target artery for access were a. tibialis anterior, a. dorsalis pedis, a. tibialis posterior, a. peronea.

In all cases, access was performed under duplex ultrasound navigation, a linear sensor was installed transversely or longitudinally to the access artery, a hydrophilic radial introducer 5F, 6F with a 22G needle was used. Access was performed under local anesthesia with Novokain 0.5%. To relieve arterial spasm, Verampamil, Nitroglycerin, or Papaverine were used. A TR Band pressure bandage was installed at the puncture site for 3 hours under ultrasound duplex navigation in all patients. Further observation of patients was carried out for 30 days.

The study complies with the Declaration of Helsinki and was approved by the Institutional Review Board. The authors and co-authors of the article have no conflicts of interest.

### **Results**

According to the analysis the average age of patients was 74±5 years. Risk factors closely

associated with the development of CLI include advanced age, diabetes mellitus (DM), smoking, and female gender. The majority of the subjects were women (66.7%) with comorbidities such as diabetes mellitus (66.7%), arterial hypertension (55.5%), coronary artery disease (38.9%), and

hyperlipidemia (77.8%). A significant number of patients had a high BMI of  $32 \pm 5.8$ . The majority of patients (83.3%) underwent primary intervention, while the remaining three patients had previously undergone interventions in the lesion area (Table 1).

**Table 1.** Baseline characteristics of patients.

Features	N (%)
Age (years)	$74 \pm 4,7$
Male/Female	6 (33,3%)/12 (66,7%)
Hypertension	10 (55,5%)
DM	12 (66,7%)
CAD	7 (38,9%)
Smoking	4 (22,2%)
CKD3 and above	2 (11,1%)
Hyperlipidemia	14 (77,8%)
BMI (kg/m <sup>2</sup> )	$32 \pm 5,8$
Prior intervention	3 (16,7%)
Hemoglobin (g/l)	$112 \pm 21$

DM=Diabetes Mellitus; CAD=Coronary Artery Disease;

CKD=Chronic kidney disease;

BMI=Body Mass Index.

*Source: Made by authors*

The overall procedural success rate of the intervention was 100%. The artery of choice in the majority of cases was the anterior tibial artery 13 (72.2%), while the peroneal artery was not used in any case. With one patient, after dissection of the anterior tibial artery, the approach was changed to the posterior tibial artery. In more than half of the cases, the femoropopliteal and ipsilateral tibial segment

were revascularized (55.5%). Balloon angioplasty combined with stent placement was performed in 14 cases (77.8%). Drug eluting balloons (DEB) or drug coated balloons (DCB) were used only in 5 patients (27.8%), where the main indications for their use were previous interventions in this lesion area. (Table 2).

**Table 2.** Procedural characteristics.

Features	N(%)
Success rate	18 (100%)
<b>Primary access to the target artery</b>	
ATA/a.dorsalis pedis	13 (72,2%)
PTA	5 (27,8%)
PA	0 (0%)
<b>Revascularized segment</b>	
Femoro-popliteal (FP)	8 (44,4%)
Tibial	0 (0%)
FP+Tibial	10 (55,5%)

Type of intervention	
Balloon angioplasty (POBA)	13 (72,2%)
Balloon angioplasty (DEB, DCB)	5 (27,8%)
Stent placement	14 (77,8%)
Time of fluoroscopy (min)	128 ± 46
Contrast volume (ml)	52 ± 18
Heparin volume (units)	6112 ± 1388

ATA=anterior tibial artery; PTA=posterior tibial artery; PA=peroneal artery; POBA=plain old balloon angioplasty; DEB=drug eluting balloon; DCB=drug coated balloon.

*Source: Made by authors*

Of all the interventions, there was minor bleeding at the puncture site in 1 case (5.5%), which did not require hemotransfusion and was resolved by using an additional pressure bandage. In one case, after insertion of the sheath, arterial dissection was observed, in connection with which it was decided

to use access through the other ipsilateral tibial artery with subsequent exposure with a balloon at the site of the first puncture. There were no signs of major bleeding, hematomas, MALE, MACE, or death in any case. All patients experienced relief of pain of ischemic origin. (Table 3).

**Table 3.** Complications and 30-day follow-up.

Features	N(%)
Immediate complications	
Bleeding	1(5,5%) (minor)
Hematoma	0(0%)
Access artery occlusion	0(0%)
Access artery dissection	1(5,5%)
MALE	0(0%)
MACE	0(0%)
Death	0(0%)
30-day follow-up	
Worsening kidney function	2(11,1%)
MALE	0(0%)
Access artery occlusion	0(0%)
MACE	0(0%)
Death	0(0%)
AV-fistula	0(0%)

MALE=major adverse limb events; MACE=major adverse cardiovascular events; AV-fistula=arterio-venous fistula.

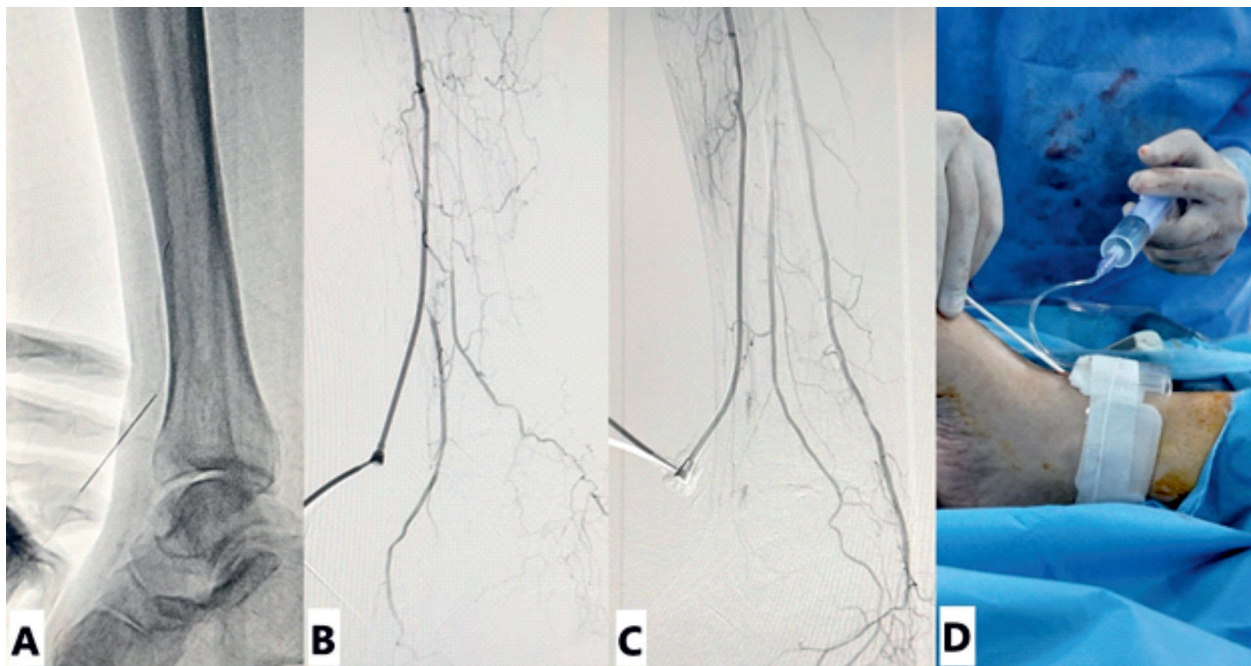
*Source: Made by authors*



### Case report

87-year-old woman with critical limb ischemia and gangrene of 2nd and 3rd fingers. In past medical history she had CAD, DM and obesity (BMI=42 kg/m<sup>2</sup>). Prolonged chronic total occlusion of superficial femoral artery, posterior

tibial artery and peroneal artery was revealed in CT-angiography. Using primary retrograde access to a single ATA, blood flow to all segments was restored. After the procedure 2,3,4 fingers were amputated with fast healing of wounds. (Figure 1, Figure 2).



**Figure 1.** Technical features of retrograde tibial-pedal access. (A) Fluoroscopy showing the wire through the distal anterior tibial artery. (B) Introducer inserted percutaneously into the anterior tibial artery. (C) View after the successful revascularization of femoro-popliteal and infrapopliteal segments. (D) TR band placement and Introducer removing.

*Source: Made by authors*



**Figure 2.** Follow-up of wound healing after the procedure. (A) Gangrene of 2nd and 3rd fingers. (B) Second day after the amputation of fingers. (C) View after plastic surgery of the wound with local tissues of the 4th finger. (D) 2 weeks after the surgery.

*Source: Made by authors*

## Discussion

CLI patients are prone to higher risk of limb loss (amputation) and cardiovascular complications. The main aim of CLI management is to decrease the limb amputation [11]. Retrograde transpedal or tibial access has been used as an alternative approach since 2005, along with the specialized CTO crossing and reentry devices. With improved equipment combined with antegrade and/or retrograde techniques, the success rate of endovascular therapy in the femoropopliteal (FP) CTO has significantly improved from 75% in 2001 to 81%–94% in 2014 [12, 13]. In many instances, retrograde access with tibio-pedal access (TPA) can facilitate procedural success. Recently, to prevent femoral access-related complications, transradial approach (TRA) and/or TPA may also be an acceptable treatment strategy for FP CTO.

Interestingly, in our cases, at 30-day follow up, all patients reported having symptomatic improvement, while there were no cases of acute limb ischemia, death, or worsening kidney dysfunction.

## Conclusion

Retrograde tibial-pedal access is technically easier and tends to have fewer complications. This technique can be used as a first step or as an alternative to antegrade femoral access in complex patients with a high risk of hematoma formation. Since this is a new technology, further research and understanding of its ideal use cases is needed.

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## АЯҚТЫҢ АУЫР ИШЕМИЯСЫ КЕЗІНДЕ БАСТАПҚЫ РЕТРОГРАДТЫҚ ТИБИО-ПЕДАЛЬДЫ ХИРУРГИЯЛЫҚ ЖОЛЫН ҚОЛДАНУ

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### Андатпа

Тері арқылы қан тамырларының араласуынан кейінгі ең жиі кездесетін асқынулар кіру орнындағы асқынулар болып табылады. Ретроградтық дистальды қол жеткізуді пайдалану дәстүрлі феморальды қол жеткізумен салыстырғанда пункция орнында елеулі асқынулардың қаупін азайтады.

**Мақсаты.** Бұл зерттеудің мақсаты төменгі аяқтың сыни ишемиясы бар емделушілерде феморо-поплитальды және инфрапоплитеальды сегменттерінің созылмалы окклюзияларын реваскуляризациялау үшін бастапқы ретроградтық дистальды тәсілдің тиімділігі мен қауіпсіздігін анықтау болды.

**Материалдар мен әдістер.** Алматы Private Clinic Аяқ сақтау орталығында 2022 жылдың қаңтарынан 2024 жылдың тамызына дейін 18 науқасқа ретроспективті талдау жасалды. Пациенттер келесі критерийлер бойынша таңдалды: Рудерфорд классификациясы бойынша 3,4,5 санаттары және Фонтейн классификациясы бойынша 3,4 кезеңдері бар науқастар; инфрапоплитеальды сегментінің қатысуымен немесе онсыз феморопоплитальды зақымдану; аяқтың бір немесе бірнеше белтыр сегментінің артерияларында қан ағымының болуы; пациенттердің ақпараттандырылған келісімі.

**Нәтижелері.** Процедураның сәттілігі 100% болды. Науқастардың орташа жасы  $74 \pm 5$  жасты құрады. Пациенттердің көпшілігі әйелдер болды (66,7%). Қант диабеті (66,7%), артериялық гипертензия (55,5%), жүректің ишемиялық ауруы (38,9%) және гиперлипидемия (77,8%) сияқты қатар жүретін аурулар анықталды. Көп жағдайда таңдау a.tibialis anterior 13 (72,2%) болды. 14 жағдайда (77,8%) стент қоюмен біріктірілген баллонды ангиопластика жасалды. Барлық араласулардың ішінде пункция орнында аздаған қан кету 1 жағдайда (5,5%) байқалды. Ешбір жағдайда елеулі қан кетулер, гематомалар, жүрек-тамыр жүйесі тарапынан жағымсыз құбылыстар немесе өлім белгілері болған жоқ. Барлық пациенттер ишемиялық себептермен қатысты ауырсынулары жеңілденді.

**Қорытынды.** Ретроградты біріншілік дистальды әдіс техникалық тұрғыдан қарапайым және асқынулары азырақ болады. Бұл әдісті гематоманың пайда болу қаупі жоғары күрделі емделушілерде негізгі әдіс ретінде немесе антеградтық феморальды әдіске балама ретінде пайдалануға болады.

**Түйін сөздер:** бастапқы ретроградтық тиббио-педальды хирургиялық жолы, бастапқы ретроградтық дистальды хирургиялық жолы, аяқтың артерияларының критикалық ишемиясы, АКИ.

## ПРИМЕНЕНИЕ ПЕРВИЧНОГО РЕТРОГРАДНОГО ТИБИО-ПЕДАЛЬНОГО ДОСТУПА У ПАЦИЕНТОВ С КРИТИЧЕСКОЙ ИШЕМИЕЙ НИЖНИХ КОНЕЧНОСТЕЙ

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### Аннотация

Наиболее частыми осложнениями после чрескожных сосудистых вмешательств являются осложнения в месте доступа. Использование ретроградного дистального доступа позволяет снизить риски значимых осложнений в месте пункции по сравнению с традиционным бедренным доступом.

**Целью** данного исследования было определение эффективности и безопасности первичного ретроградного дистального доступа для реваскуляризации хронических окклюзий бедренно-подколенного и берцового сегментов у пациентов с критической ишемией нижних конечностей.



*Материалы и Методы.* Проведен ретроспективный анализ 18 пациентов в Центре спасения конечностей клиники Private Clinic Almaty с января 2022 года по август 2024 года. Пациенты отбирались по следующим критериям: пациенты с 3,4,5 категориями по классификации Рудерфорда и 3,4 стадиями по классификации Фонтейна; поражение бедренно-подколенного с вовлечением или без вовлечения берцового сегмента; наличие кровотока в одном или нескольких мегстральных артерий голени и стопы; информированное согласие пациентов на вмешательство.

*Результаты.* Успешность процедуры составил 100%. Средний возраст пациентов составил  $74 \pm 5$  лет. Большинство пациентов были женщинами (66,7%). Диагностированы такие сопутствующие заболевания, как сахарный диабет (66,7%), артериальная гипертензия (55,5%), ишемическая болезнь сердца (38,9%) и гиперлипидемия (77,8%). Артерией выбора в большинстве случаев была передняя большеберцовая артерия 13 (72,2%). Из всех вмешательств малое кровотечение в месте пункции наблюдалось в 1 случае (5,5%). Ни в одном случае не было признаков значимого кровотечения, гематомы, нежелательных сердечно-сосудистых событий или смерти. У всех пациентов наблюдалось купирование болевого синдрома ишемического характера.

*Выводы.* Ретроградный первичный дистальный доступ технически проще и имеет тенденцию к меньшему количеству осложнений. Этот метод может быть применен в качестве основного доступа или как альтернатива антеграднему бедренному доступу у сложных пациентов с высоким риском образования гематомы.

*Ключевые слова:* первичный ретроградный тиббио-педальный доступ, первичный ретроградный дистальный доступ, критическая ишемия нижних конечностей, КИНК, заболевания периферических артерий, ЗПА.

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