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ORIGINAL ARTICLE

Retrograde Pedal Artery Access versus Conventional Common Femoral Artery Access in Isolated Superficial Femoral Artery Lesions

İzole Yüzeyel Femoral Arter Lezyonlarında Retrograd Pedal Arter Erişimi ile Konvansiyonel Ortak Femoral Arter Erişiminin Karşılaştırılması

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ABSTRACT

Aim: The current study compared the efficacy and safety of retrograde pedal artery (PA) access versus conventional common femoral artery (CFA) access in managing isolated superficial femoral artery (SFA) occlusions or severe stenoses.
Method: A retrospective analysis was conducted on 34 patients treated between June 2020 and November 2023. The patients were categorized into two groups: 12 patients with PA access and 22 with CFA access. Technical success, complication rates, stent usage, procedure duration, and radiation doses were analyzed.
Results: Technical success was achieved in 92.8% of the patients in the PA access group and 84% of the CFA access group (p=0.636). Complications at the access site were significantly lower in the PA access group, with no hematomas or pseudoaneurysms observed, while both hematomas (32%) and pseudoaneurysms (16%) were noted in the CFA group (p=0.033). Stent usage was similar between the two groups (21.4% PA vs. 28% CFA, p=0.721). Median procedure durations were 43 minutes interquartile ranges (IQRs) 27.5-59) for PA and 47 minutes (IQR 29-64) for CFA (p=0.446). The median total air kerma dose was 280 mGy (IQR 166.5-326.75) for PA and 225 mGy (IQR 145-489) for CFA (p=0.826).
Conclusion: Retrograde PA access is a viable and safe alternative to CFA access, particularly for patients with complex femoral anatomy, offering similar efficacy with fewer access site complications.

Keywords: Balloon angioplasty, femoral artery, occlusion, pedal access, stenosis

ÖZ

Amaç: Bu çalışma, izole yüzeyel femoral arter (SFA) oklüzyonlarının veya ciddi stenozlarının yönetiminde retrograd yolla pedal arter (PA) erişimi ile konvansiyonel ortak femoral arter (CFA) erişiminin etkinlik ve güvenliğini karşılaştırmaktadır.
Yöntem: Haziran 2020 ile Kasım 2023 arasında tedavi edilen 34 hasta üzerinde retrospektif bir analiz yapıldı. Hastalar, PA erişimi ile tedavi edilen 12 hasta ve CFA erişimi ile tedavi edilen 22 hasta olmak üzere iki gruba ayrıldı. Teknik başarı, komplikasyon oranları, stent kullanımı, işlem süresi ve radyasyon dozları analiz edildi.
Bulgular: PA erişim grubundaki hastaların %92.8'inde, CFA erişim grubundaki hastaların ise %84'ünde teknik başarı elde edilmiştir (p=0.636). Girişim bölgesindeki komplikasyonlar PA akses grubunda anlamlı şekilde daha düşüktü; hematom veya psödoanevrizma gözlemlenmezken, CFA erişim grubunda hematom (%32) ve psödoanevrizma (%16) tespit edildi (p=0.033). Stent kullanımı iki grup arasında benzerdi (%21.4 PA vs. %28 CFA, p=0.721). Ortalama işlem süreleri PA erişim grubu için 43 dakika (IQR 27.5-59), CFA erişim grubu için 47 dakika (IQR 29-64) idi (p=0.446). Ortalama toplam hava kerma dozu PA erişim grubu için 280 mGy (IQR 166.5-326.75), CFA erişim grubu için ise 225 mGy (IQR 145-489) olarak ölçüldü (p=0.826).
Sonuç: Retrograd olarak PA erişimi, özellikle kompleks femoral anatomiye sahip hastalar için, benzer etkinlikle ve daha az komplikasyon oranıyla CFA erişimine göre uygulanabilir ve güvenli bir alternatiftir.

Anahtar Kelimeler: Balon anjiyoplasti, femoral arter, oklüzyon, pedal akses, stenoz

Introduction

Peripheral artery disease (PAD) of the lower extremities is a common condition that can lead to critical limb ischemia (CLI) and result in significant morbidity and mortality (1). Among the various arteries affected by PAD, the superficial femoral artery (SFA) is frequently involved, particularly in its proximal segment and within the Hunter's canal (2). Traditional endovascular treatments for SFA occlusions include approaches via the contralateral or ipsilateral common femoral artery (CFA) (3, 4). However, ipsilateral antegrade access can present with technical challenges and complications, especially in patients with anatomical variations such as a high level of CFA bifurcation or comorbid conditions such as obesity. Such conditions may make the procedure difficult and increase the risk of complications such as groin hematomas and bleeding. Additionally, in cases where the SFA ostium is affected, ipsilateral antegrade access becomes even more challenging (5). The contralateral retrograde approach often requires navigation through the

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aortoiliac bifurcation, which can be problematic due to angulation, iliac artery occlusions, or in the presence of bypass grafts or aneurysms. These factors can reduce the technical success rate and increase procedure-related morbidity. An alternative strategy with proven success involves accessing the vessel distal to the lesion and crossing the obstruction in a retrograde fashion. First advocated by Tonnesen et al., ipsilateral retrograde access is considered to be a safe approach for treating femoropopliteal lesions when CFA access fails (6). Retrograde access can be achieved through the distal SFA, popliteal artery, or the tibial or trans pedal arteries (7). Retrograde puncture is typically carried out under ultrasound, fluoroscopy guidance of ultrasound or fluoroscopy to minimize any complications due to bleeding. The most common complications associated with retrograde access are bleeding events, perforation of vessels, or damage to the vascular-nerve bundle (8).

The current study aimed to compare the efficacy and safety of retrograde access via the pedal arteries (PA) with conventional femoral access methods in the management of isolated SFA and CFA stenosis or occlusion. We aimed to provide insights into the potential benefits of the retrograde PA approach in PAD and CLI management by analyzing procedural success rates, complication profiles, and the need for re-intervention. Ultimately, this comparison will help guide future clinical practices by evaluating the advantages and limitations of each strategy.

Material And Methods

Patient Selection

The current retrospective study was approved by the local ethics committee (reference number: 2023-614), and informed consent was obtained from all patients before their participation. The study included all consecutive patients diagnosed with isolated chronic total occlusion (CTO) or severe stenosis of the SFA, who were treated with either retrograde PA access or conventional femoral access between June 2020 and November 2023.

Inclusion criteria were as follows: patients who had undergone pre-procedural computed tomographic angiography confirming chronic total occlusion or severe stenosis in the SFA, exhibited moderate to severe claudication (Fontaine Stage IIb), ischemic rest pain (Fontaine Stage III), and/or ulceration or gangrene (Fontaine Stage IV), and were ineligible for surgical revascularization due to lack of suitable venous conduit, absence of a distal non-diseased artery for anastomosis, or comorbid conditions precluding anesthesia. Patients with significant iliac artery disease and with no significant stenosis in the trifurcation arteries, as well as those eligible for bypass surgery, were excluded from the study.

Procedure

Endovascular revascularization was attempted for all study participants. The endovascular treatments for the patients included in the study were performed using a Philips Azurion Clarity IQ (Philips Medical Systems, Amsterdam, The Netherlands) angiography system. The access routes included ipsilateral common femoral or superficial femoral antegrade access, contralateral common femoral retrograde access, or retrograde access via the anterior or posterior tibial-pedal arteries. The decision regarding the revascularization technique was made by the treating physician and included one or a combination of the following: percutaneous transluminal angioplasty (PTA), drug-coated balloon (DCB) angioplasty, and bare-metal stent (BMS) placement.

An intravascular bolus of 70 U/kg heparin along with 300 µg of nitroglycerin was administered for antispasmodic effect, with nitroglycerin repeated every 30 minutes. If the duration of the procedure exceeded one hour, half of the initial heparin dose was administered again. Following the placement of a 5F sheath, a 4F vertebral catheter with either a 0.018-inch or 0.035-inch wire was used to cross the occlusion or stenosis. Balloon angioplasty was carried out on stenotic or occluded segments. In the event of greater than 30% residual stenosis or the presence of a dissection that prevented adequate flow following angioplasty, bail-out stenting was carried out. In case a 0.035-inch stent delivery system was required during PA access, a sheathless technique was utilized to minimize vessel trauma rather than switching to a 6F sheath. Lack of success in crossing the lesion or reentry into the true lumen entailed a switch to an alternative retrograde or antegrade approach. Examples of cases undergoing endovascular procedures via retrograde PA access are presented in the accompanying figures (Figures 1, 2, 3, and 4). Hemostasis at the pedal or femoral access site was achieved through manual compression. Patients were discharged on the same day after appropriate monitoring and Doppler ultrasound evaluation of the pedal or femoral artery.

Figure 1. (a) Computed tomography angiography revealing calcifications and steno-occlusive lesions within the left common femoral artery and superficial femoral artery. (b, c) Initial digital subtraction angiography images, following retrograde placement of a 5F sheath in the anterior tibial artery, demonstrating patency of the trifurcation arteries and the popliteal artery. (d, e) Digital subtraction angiography images acquired after retrograde catheterization of the left external iliac artery using a diagnostic catheter and guidewire showing steno-occlusive lesions in the superficial femoral artery. (f) Balloon angioplasty was carried out on the stenotic and occluded segments within the superficial femoral artery. (g, h) Final angiographic images illustrating a complete revascularization of the superficial femoral artery.

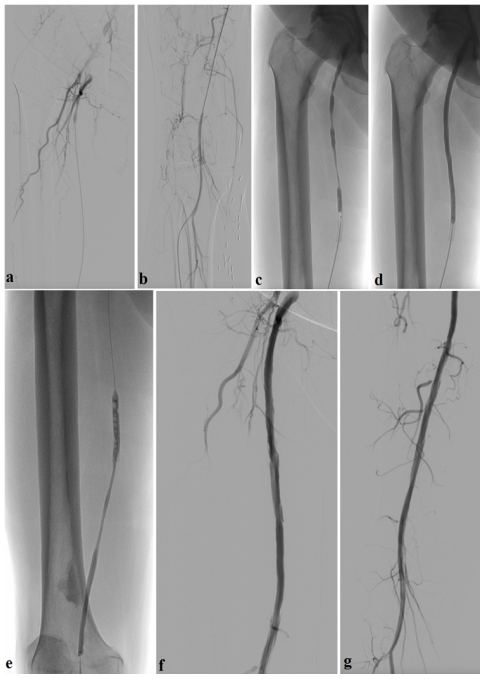

Figure 2. (a, b) Digital subtraction angiography images obtained from the right external iliac artery via retrograde access through the anterior tibial artery demonstrating a long-segment occlusion within the superficial femoral artery, including a previously deployed stent. (c, d, e) Sequential images of balloon angioplasty performed on the proximal segment of the SFA occlusion, followed by in-stent angioplasty and balloon dilation of the distal segment of the occluded superficial femoral artery. (f, g) Final angiographic images post-balloon dilation depicting successful recanalization of the superficial femoral artery.

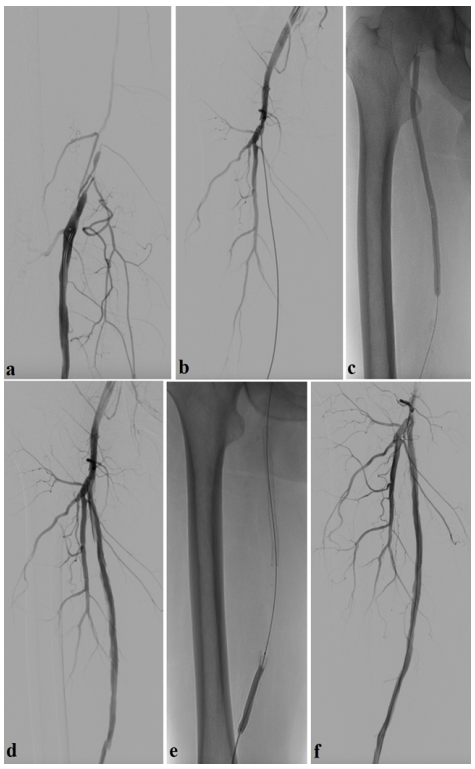

Figure 3: (a, b) Baseline angiography of the right superficial femoral artery via retrograde access through the posterior tibial artery revealing extensive occlusion of the superficial femoral artery with a patent popliteal artery. (c) Balloon angioplasty carried out on the occluded segment of the superficial femoral artery. (d) Post-percutaneous transluminal angioplasty angiogram showing flow-limiting dissections (indicated by arrows) in the proximal and distal segments of the superficial femoral artery. (e) Fluoroscopic image displaying stents placed to cover the dissected segments in the proximal and distal superficial femoral artery, followed by in-stent balloon angioplasty. (f) Final angiogram confirming a complete revascularization of the superficial femoral artery.

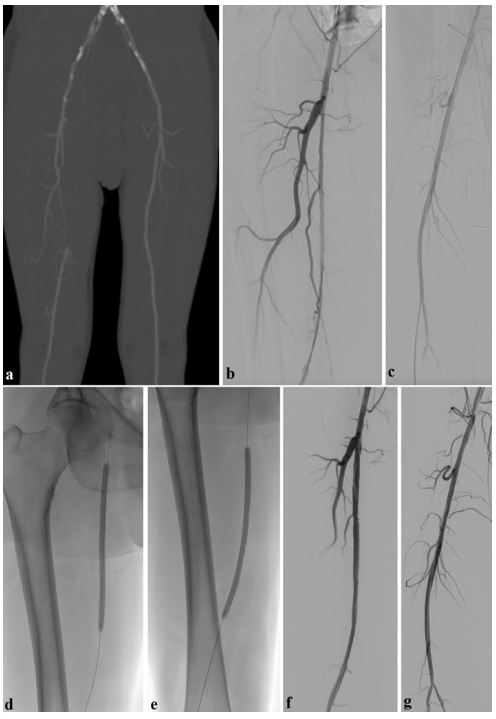

Figure 4: (a) CT angiography showing extensive calcifications in the bilateral iliac arteries, with an occlusion in the right superficial femoral artery. The bilateral common femoral arteries (CFA), left superficial femoral artery, and both popliteal arteries remained patent. (b, c) Following retrograde access through the right anterior tibial artery at the ankle level, a diagnostic catheter and guidewire were advanced to the right external iliac artery. Digital subtraction angiography images revealed areas of steno-occlusions within the superficial femoral artery. (d, e) Balloon angioplasty was carried out at the sites of steno-occlusions in the superficial femoral artery. (f, g) Final Digital subtraction angiography images post-balloon angioplasty indicating full patency of superficial femoral artery.

Outcome Measures

Technical success was defined as achieving revascularization with less than 30% residual stenosis, without the need for additional access. Any of the following events at the treated vessel or access site were considered as complications: arteriovenous fistula, thrombus formation, aneurysm, pseudoaneurysm, hematoma, infection, retroperitoneal bleeding, compartment syndrome, need for postprocedural blood transfusion, unplanned above-the-ankle amputation, embolization, dissection, and persistent vasospasm. In addition, the procedure duration and total radiation dose were compared between the patients undergoing retrograde PA access and those undergoing conventional femoral access.

Statistical Analysis

Data processing and analysis were carried out with SPSS Statistics, Version 25.0 (SPSS, Chicago, IL, USA). The normality of the distribution of the numerical variables was assessed quantitatively with the Kolmogorov-Smirnov test and visually via Q-Q plots. Descriptive statistics are presented as medians with interquartile ranges (IQRs). Due to a non-normal distribution, non-parametric tests were applied for comparative analyses. The Mann-Whitney U test was used to compare procedure duration and total air kerma dose between the two groups (retrograde PA access and CFA access), while Fisher's exact test was employed to analyze complication and technical success rates. A p-value of less than 0.05 was considered statistically significant for all tests.

Results

A total of 12 patients underwent retrograde access through the PA, including 10 males (83.3%) and two females (16.6%). Among the 12 cases, 12 (85.7%) had SFA occlusion, and two (14.3%) had severe SFA stenosis. Bilateral SFA intervention was conducted in two patients. The median age of the patients was 59 years (IQR, 55-62 years). Hypertension was present in nine patients (75%), diabetes mellitus (DM) in seven (58.3%), coronary artery disease in seven (58.3%), chronic renal failure (CRF) in three (25%), congestive heart failure (CHF) in one (8.3%), and a smoking history in eight patients (66.6%). The Fontaine stages were as follows: Stage IIb in two cases (14.3%), Stage III in three cases (21.4%), and Stage IV in nine cases (64.3%). Trans-Atlantic Inter-Society Consensus (TASC) II lesion classifications were as follows: TASC II B in five cases (35.7%), TASC II C in six cases (42.9%), and TASC II D in three cases (21.4%). Demographic data for the patients are presented in Table 1. Access via the anterior PA was used in eight procedures (57.1%), and access via the posterior tibial artery was used in six procedures (42.9%).

Table 1. Demographic Data of Patients

	Pedal Artery Access Group n=14	CFA Access Group n=25
Number of Patients	12	22
Male, n (%)	10 (83.3)	17 (77.3)
Female, n (%)	2 (16.6)	5 (22.7)
Age median (IQR)	59 (55–62)	62 (54–70)
SFA occlusion, n (%)	12 (85.7)	17 (68)
SFA severe stenosis, n (%)	2 (14.3)	8 (32)
Hypertension, n (%)	9 (75)	18 (81.8)
DM, n (%)	7 (58.3)	16 (72.7)
CAD, n (%)	7 (58.3)	16 (72.7)
CRF, n (%)	3 (25)	6 (27.7)
CHF, n (%)	1 (8.3)	2 (9)
Smoking History, n (%)	8 (66.6)	17 (77.3)
Fontaine Stage IIb, n (%)	2 (14.3)	5 (20)
Fontaine Stage III, n (%)	3 (21.4)	6 (24)
Fontaine Stage IV, n (%)	9 (64.3)	14 (56)
TASC II B, n (%)	5 (35.7)	9 (36)
TASC II C, n (%)	6 (42.9)	11 (44)
TASC II D, n (%)	3 (21.4)	5 (20)

CAD: Coronary artery disease, CHF: Congestive heart failure, CRF: Chronic renal failure, DM: Diabetes mellitus, SFA: Superficial femoral artery, TASC: Trans-Atlantic Inter-Society Consensus.

A total of 22 patients underwent CFA access, including 17 males (77.3%) and five females (22.7%). Among the 22 cases, 17 (68%) had SFA occlusion, and eight (32%) had severe SFA stenosis. Bilateral SFA intervention was performed in three patients. The median age was 62 years (IQR, 54-70 years). Hypertension was present in 18 patients (81.8%), DM in 16 (72.7%), coronary artery disease in 16 (72.7%), CRF in six (27.7%), CHF in two (9%), and a smoking history in 17 patients (77.3%). The Fontaine stages were as follows: Stage IIb in five cases (20%), Stage III in six cases (24%), and Stage IV in 14 cases (56%). TASC II lesion classifications were as follows: TASC II B in nine cases (36%), TASC II C in 11 cases (44%), and TASC II D in five cases (20%). Demographic data for the patients are presented in

Table 1.

Five procedures in the CFA access group (20%) were carried out via contralateral CFA retrograde access due to involvement of the SFA ostium or obesity, 17 procedures (68%) via ipsilateral CFA antegrade access, and three procedures (12%) via SFA antegrade access due to high CFA bifurcation.

Technical success was achieved in 13 procedures (92.8%) in the PA access group. In one case, the antegrade intervention was required after the failure of the retrograde recanalization, after which revascularization was successfully achieved. Technical success was achieved in 21 procedures (84%) in the CFA access group. Retrograde intervention was required in four cases following the failure of antegrade recanalization, and revascularization was successfully achieved. No significant difference in technical success rate was identified between the two groups (p=0.636) (Table 2). No hematomas or pseudoaneurysms were observed at the PA access sites. At the one-month follow-up, the pedal access artery remained patent in all patients, while eight patients (32%) in the CFA access group developed hematomas, and among these, four (16%) had pseudoaneurysms. A significant difference in access site complications was observed between the two groups (p=0.033).

Table 2. Comparison of procedural outcomes and complications between pedal artery and common femoral artery access groups.

	Pedal Artery Access Group n=14	CFA Access Group n=25	*p*-value
Technical Success, n (%)	13 (92.8)	21 (84)	0.636
Complications, n (%)	0 (0)	8 (32)	0.033
Stent Usage, n (%)	3 (21.4)	7 (28)	0.721
Procedure Duration time, minute, median (IQR)	43 (27.5-59)	47 (29-64)	0.446
Total Air Kerma Dose, mGy, median (IQR)	280 (166.5-326.75)	225 (145-489)	0.826

IQR: Interquartile range

Stents were used following balloon angioplasty in three procedures (21.4%) in the PA access group, and seven procedures (28%) in the CFA access group. The difference in stent usage between the two groups did not reach statistical significance (p=0.721).

The median procedure duration was 43 minutes (IQR 27.5-59) in the PA access group, with a median total air kerma dose of 280 mGy (IQR 166.5-326.75). The median procedure duration was 47 minutes (IQR 29-64) in the CFA access group and the median total air kerma dose was 225 mGy (IQR 145-489). The procedure duration and total air kerma dose were similar between the two groups (p=0.446 and p=0.826, respectively).

Discussion

The findings from the current study offer insights into the comparative effectiveness and safety of retrograde PA access versus conventional CFA access for treating isolated SFA occlusions or severe stenoses. Our study highlights the potential for PA access to be an effective alternative procedure, especially in patients with high CFA bifurcation, SFA ostium involvement, or obesity, where antegrade CFA access poses technical challenges. By exploring alternative access strategies, the current study contributes to the ongoing efforts to refine endovascular techniques for PAD, particularly in scenarios of challenging anatomical variations.

Our data demonstrated a comparable and high technical success rate in both PA and CFA access groups. Of note, PA access showed a lower incidence of access site complications, with no hematomas or pseudoaneurysms observed. This contrasted with the CFA group, where 32% of patients developed hematomas and 16% had pseudoaneurysms with a statistically significant difference from the PA access group. These findings suggest that retrograde PA access may be a safer option for minimizing access site complications, particularly in patients at high risk for such complications. These outcomes align well with prior studies that underscore the value of minimizing groin access in cases of complex SFA anatomy or increased bleeding risk.

A comparison of the current findings with existing literature suggests that retrograde pedal and tibial approaches may offer advantages over the traditional trans popliteal approach for accessing SFA lesions. Historically, the retrograde trans popliteal approach, as described by Leachman et al., required patients to be positioned prone, which can be challenging both technically and in terms of patient comfort (9). The close anatomical proximity of the popliteal artery to the vein in many cases increases the risk of complications, including fistula and hematoma formation, especially due to difficulties in achieving post-procedure compression. Studies have reported a higher rate of complications with this approach, with the overall complications dropping significantly when popliteal access in the prone position was excluded in favor of

pedal or tibial approaches. Additionally, the popliteal approach has been associated with a relatively high technical failure rate (10%-26%), often due to difficulties in re-entering the true lumen near the SFA origin, which can lead to excessive stenting and potential occlusion of the profunda femoris artery (6, 10). The outcomes of the current study are in good agreement with these findings, as PA access not only provided a safer alternative with fewer access site complications but also allowed successful revascularization without the need for extensive stenting in most cases. Furthermore, previously published studies suggest that lesion morphology and disease severity can influence technical success and outcomes, with complex lesions often requiring bidirectional access to improve the chances of intraluminal recanalization. Retrograde access is beneficial in crossing softer distal caps of CTO, which may enhance the technical success rate (11, 12). Consistent with these insights, our study demonstrated high technical success with retrograde PA access, particularly in patients with challenging lesion characteristics. Retrograde access supports better long-term patency by preserving a healthy distal landing zone and minimizing collateral damage which may improve outcomes if future surgical interventions are required (13).

The current study has some limitations that should be considered. As a retrospective analysis, it is inherently subject to selection bias, and the sample size was relatively small. Additionally, the study was conducted at a single institution, which may limit the generalizability of the findings. Prospective, multicenter studies with larger patient populations will provide a more comprehensive assessment of the effectiveness and safety of PA access compared to CFA access.

Retrograde PA access appears to be a safe and effective alternative to conventional CFA access, particularly for patients with challenging femoral anatomy. The retrograde PA access approach was associated with significantly fewer access site complications and therefore may improve procedural outcomes and expand treatment options for PAD patients with high-risk anatomical features.

Highlights

PA access achieved a high technical success rate (92.8%), comparable to CFA access (84%), for treating isolated SFA lesions.

Access site complications were significantly lower with PA access, with no hematomas or pseudoaneurysms, compared to higher rates in the CFA group (32% hematomas, 16% pseudoaneurysms).

PA access is particularly beneficial for patients with complex femoral anatomy, offering a safer alternative with fewer complications.

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