

Revision using distal inflow effectively addresses arteriovenous fistula-induced upper limb ischemia without compromising access

Zaur Guseinov , Merve Topcu , Fatih Bayraktar , Kocaaslan Cemal , Ebuzer Aydın 

Department of Cardiovascular Surgery, Medeniyet University Faculty of Medicine, İstanbul, Türkiye

Received: June 27, 2025 Accepted: August 10, 2025 Published online: August 29, 2025

ABSTRACT

Arteriovenous fistulas (AVFs) are the preferred vascular access for hemodialysis patients; however, they may lead to ischemic complications such as steal syndrome. A 72-year-old woman with chronic kidney disease developed hand ulcers and coldness following the creation of a left brachiobasilic AVF. The patient underwent a revision using distal inflow (RUDI) procedure. The postoperative fistula was functional with a positive thrill, and the patient was discharged the same day. At the two-week follow-up, increased hand temperature and marked healing of ulcerative lesions were observed. In conclusion, RUDI may offer an effective treatment option in moderate ischemia cases.

Keywords: Revision using distal inflow, upper extremity ischemia, brachiobasilic arteriovenous fistulas.

Arteriovenous fistulas (AVFs) are the preferred first choice for vascular access (VA) in hemodialysis patients. However, they can lead to serious complications.^[1] In high-risk patients, various techniques have been adopted to prevent steal syndrome and to treat moderate ischemia which cannot be managed conservatively. Ischemia related to VA is a serious complication of AVF, potentially resulting in limb or even life-threatening outcomes, with an incidence reported to be as high as 30%.^[1] This condition is characterized by inadequate blood flow to distal tissues. A key factor guiding treatment is the access flow volume. The management of ischemia differs depending on whether it is associated with high or normal access flow. In the absence of ischemia, some of these techniques may also be used to reduce high access flow volumes and protect cardiac function. Several surgical options have been developed to manage ischemic complications. These include AVF ligation, AVF banding, distal revascularization with interval ligation (DRIL), proximalization of arterial inflow (PAI), and revision using distal inflow (RUDI).^[2]

In this article, we present a patient who developed hand ischemia following the creation of a left brachiobasilic AVF and subsequently underwent

a RUDI procedure, resulting in significant improvement of the ischemic symptoms.

CASE REPORT

A 72-year-old female patient with a known history of hypertension, diabetes mellitus (DM), and chronic kidney disease undergoing hemodialysis three times per week, previously underwent left brachiobasilic AVF (BB AVF) surgery approximately six months earlier at another center. One month postoperatively, the patient presented to our clinic with widespread ulcerations, primarily on the dorsal surfaces of the second and third fingertips, along with coldness of the hand (Figure 1). On physical examination, the radial artery pulse was not palpable, and the patient reported resting pain. color Doppler ultrasound revealed an AVF flow of approximately

Corresponding author: Zaur Guseinov, MD. Department of Cardiovascular Surgery, Medeniyet University Faculty of Medicine, 34720 Kadıköy, İstanbul, Türkiye.

E-mail: guseynovzaur4@gmail.com

Citation:

Revision using distal inflow effectively addresses arteriovenous fistula-induced upper limb ischemia without compromising access. *Cardiovasc Surg Int* 2025;12(3):239-242. doi: 10.5606/e-cvsi.2025.1959.

1600 mL/min. The radial and ulnar arteries were of normal caliber, with no significant stenosis detected; however, flow velocity in the radial artery was reduced.

Manual compression of the AVF improved capillary refill, raised hand temperature, and relieved pain. After evaluation, the patient was diagnosed with VA-related ischemia. Under ultrasound guidance, the BB AVF, as well as the brachial, radial, and ulnar arteries, were evaluated. Given the patient's clinical condition, a RUDI procedure was planned.

On the day of surgery, preoperative vascular mapping of the upper and lower extremity vessels was performed under sterile operating room conditions. Under local anesthesia, a left antecubital incision was made to identify the radial artery and BB AVF, which was isolated using a vessel loop. Simultaneously, an autologous graft measuring approximately 4 to 5 cm in length and 5 mm in diameter was harvested from the left saphenous vein. The segment of the basilic vein near the anastomosis of the existing BB AVF was ligated. The harvested saphenous vein graft was interposed between the proximal radial artery and the basilic vein using end-to-side anastomoses

(Figure 2). Functionality of the newly created fistula was confirmed by a positive thrill test. Following hemostasis, anatomical closure of the layers was performed. Two hours postoperatively, the patient



Figure 2. Perioperative image. The saphenous vein graft was interposed between the proximal radial artery and the basilic vein using end-to-side anastomoses.



Figure 1. Widespread ulceration and coldness, particularly on the dorsal surfaces of the second and third fingertips.

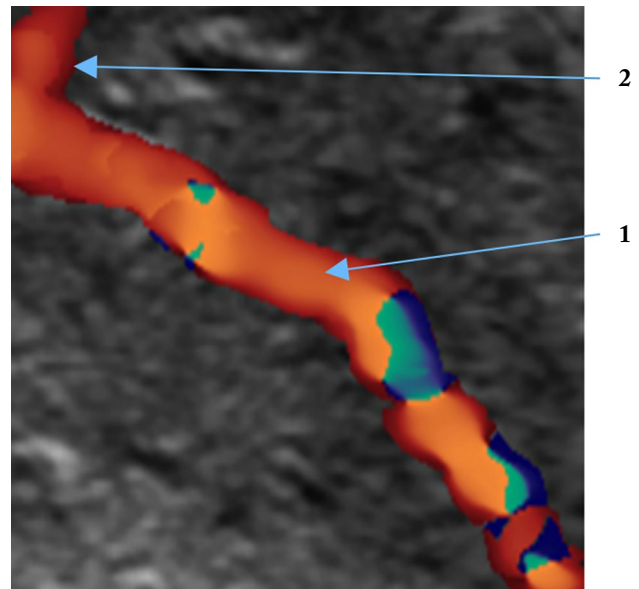


Figure 3. The patient on postoperative Day 10. Significant improvement in ischemic findings was observed, including resolution of ulcer tension.



Figure 4. Postoperative ultrasonographic evaluation confirmed maintained patency of the saphenous vein.

was evaluated in the cardiovascular surgery ward and reported improvement in fingertip pain. Her general condition and vital signs remained stable, and the patient was discharged the same day. At the two-week postoperative follow-up in the cardiovascular surgery outpatient clinic, hand warming was noted, and ischemic symptoms, particularly the ulcers, resolved. In the early postoperative period, at one-month follow-up, the graft was evaluated by our team using Doppler ultrasound and was found to be patent (Figure 3). The patient was subsequently followed by our team for approximately six months after the procedure. During this follow-up period, the ischemic symptoms had completely resolved (Figure 4). Written informed consent was obtained from the patient.

DISCUSSION

For every patient considered for VA creation, a stepwise preoperative evaluation algorithm is essential to minimize the risk of upper extremity ischemia. The initial phase involves a thorough assessment of comorbidities such as DM, atherosclerosis, and any history of central venous catheterization or pacemaker implantation. This is followed by a detailed physical examination, including bilateral upper extremity blood pressure measurements and palpation of radial pulses, supplemented by Duplex ultrasound.

Ischemia related to AVF formation is a significant complication which can lead to limb loss, if not promptly managed. Various surgical strategies have been developed to address this issue, including AVF ligation, banding, DRIL, PAI, and RUDI.^[3] While banding and ligation are effective in relieving symptoms, their primary limitation lies in the sacrifice of VA. Some authors propose that multiple moderate stenoses created by sequential banding may be preferable to a single tight band; however, this still remains controversial.^[3]

The DRIL procedure, involving ligation of the artery distal to the AVF anastomosis and creation of a bypass from a more proximal arterial source, preserves access while restoring distal perfusion. Despite a reported secondary patency rate of up to 80%, DRIL is technically complex, typically requires general anesthesia, and carries a 10 to 20% risk of incision-related complications.^[4] Additionally, limb perfusion becomes entirely dependent on bypass graft patency, potentially compromising limb viability.

The PAI involves redirecting arterial inflow to the AVF from the axillary artery, which offers higher flow and pressure. This technique reduces the steal phenomenon and preserves distal perfusion through collateral branches. However, its reliance on prosthetic grafts increases infection risk and lowers long-term patency rates.^[5]

The RUDI, a relatively novel technique, involves relocating the AVF inflow to a more distal artery, most often the proximal radial artery, using an interposed graft. This approach is particularly suited for high-flow, proximally located AVFs. Autologous vein grafts (e.g., saphenous, cephalic, or basilic) are preferred over prosthetic materials due to superior patency, reduced infection risk, and cost-effectiveness.

In the present case, considering the patient's advanced age and proximal AVF anatomy, the RUDI procedure was selected. In this patient, the AVF flow rate was high (1600 mL/min), and, therefore, the banding technique was deemed inappropriate. In patients with high-flow AVFs, the degree of stenosis created by ligature during the banding procedure may be difficult to titrate accurately. In some cases, the AVF may become non-functional, while in others, insufficient tightening of the ligature may fail to resolve the ischemic symptoms. Therefore, the RUDI procedure was considered a more suitable

option for this patient. Compared to DRIL, RUDI offers several advantages, including higher AVF flow rates and lower risk of postoperative bleeding, while maintaining similar patency and symptom resolution outcomes. A recent review reported that RUDI resulted in ischemic symptom resolution in approximately 82% of cases, with AVF function preserved for a median of one year.

In conclusion, upper extremity ischemia is a rare but clinically significant complication following the creation of an arteriovenous fistula (AVF) in hemodialysis patients. Early diagnosis and timely intervention are crucial for optimal outcomes. In clinical practice, several surgical techniques are available to manage AVF-related hand ischemia, including RUDI, PAI, DRIL, and banding. Each of these methods has its own advantages and limitations. Therefore, the choice of surgical approach should be individualized based on the patient's overall condition, the anatomical characteristics of the fistula (as assessed by ultrasonography), and the severity of ischemia.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: All authors contributed equally to this article.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. Rivero M, Harris L. Nonthrombotic complications of hemodialysis access. In: Sidawy AN, Perler BA, editors. Rutherford's vascular surgery and endovascular therapy. 10th ed. Amsterdam: Elsevier; 2022. p. 1234-45.
2. Henriksson AE, Bergqvist D. Steal syndrome after brachiocephalic fistula for vascular access: Correction with a new simple surgical technique. *J Vasc Access* 2004;5:13-5. doi: 10.1177/112972980400500103.
3. Lee H, Thomas SD, Paravastu S, Barber T, Varcoe RL. Dynamic Banding (DYBAND) technique for symptomatic high-flow fistulae. *Vasc Endovascular Surg* 2020;54:5-11. doi: 10.1177/1538574419874934.
4. Weaver ML, Holscher CM, Graham A, Reifsnyder T. Diyaliz erişimiyle ilişkili iskemi için distal revaskülarizasyon ve aralık ligasyonu en iyi şekilde kol damar kanalı kullanılarak gerçekleştirilir. *J Vasc Surg* 2021;73:1368-75.
5. Shaikh FA, Siddiqui N, Shahzad N, Riaz A, Sophie Z. Hemodiyaliz erişimi için ameliyata alınan yüksek riskli hastalarda diyaliz erişimiyle ilişkili çalma sendromunu önlemek için cerrahi teknikler: Sistematik bir inceleme. *Cureus* 2019;11:e6086.