

# Arterialized Venous Free Flap for Hand Defect Reconstruction Due to Ischemic Steal Syndrome

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**Abstract:** Ischemic steal syndrome (ISS) occurs in hemodialysis patients. Hence, it rarely becomes gangrene or disrupts hand function. We reported a patient with an ISS and radial atherosclerosis that presented with infected ulcer. The patient was treated with arterialized venous free flap from the contralateral forearm. Dialysis access can be used as early as 10 days after the flap. The report also describes the long-term functional follow-up after reconstruction. Although there was superficial flap necrosis, this non-physiologic flap can preserve the patient's hand function.

**Keywords:** Ischemic steal syndrome, hemodialysis access, arterialized venous free flap, hand function

## Introduction

Ischemic steal syndrome (ISS) is a complication following the creation of an arteriovenous fistula used by hemodialysis patients. It is often seen in patients with above-elbow fistula. Manifestations of hand gangrene or digital ischemia are rarely seen. Comprehensive management for ISS with hand gangrene consists of debridement, endovascular intervention, and defect closure.<sup>1,2</sup>

The arterialized venous flap can be utilized in shallow and composite defects. Its nutritional inflow and drainage outflow rely entirely on the subcutaneous venous network. Due to its pliability, this flap has been widely used to cover hand defects. As a flow-through flap, it can also be utilized as vascular conduit.<sup>3,4</sup>

The following case highlights the modality of defect closure following ISS with an arterialized venous flap and the ability to use the AV fistula within 10 days. In the long term, the patient's hand function had a good range of movement and grip strength.

## Case Presentation

A 68-year-old woman came to our clinic with redness and swelling at her dorsal left hand after hemodialysis a day before. Due to the swelling, the patient experienced pain and could not move her fingers or wrist. During her dialysis session, she complained of coolness and a bluish tinge of her fingers, which resolved after the session. As the patient came to the clinic the following week, the swelling had become an ulcer with pus and numbness of fourth and fifth digits (Figure 1). The patient also complained of a high fever. She was known to have end-stage renal disease and had received dialysis twice a week at her brachiocephalic fistula for more than 5 years.

We admitted the patient to the operating room the next day. During thorough debridement, we found that half of her left dorsal hand had become infected to her fourth digit. She was given antibiotics and left with a complex defect with no consent for defect closure. Two days after debridement, we assessed her vascular patency with angiography, and we

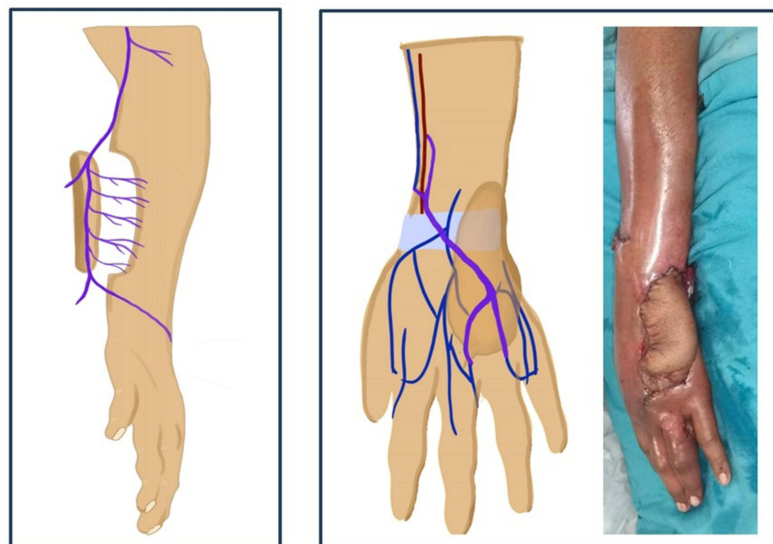


**Figure 1** Left: The ischemic condition at first consultation. Right: Condition when the patient came next week with odorous discharge and high fever.

found a stenotic lesion at her radial artery. A successful angioplasty using a peripheral balloon was performed, and no residual stenosis was noted after the procedure.

A month later, the patient agreed to have another surgery for the defect and was re-admitted to the operation room for soft tissue coverage. An arterialized venous free flap in a flow-through manner was thought to be the most beneficial option. Donor flap was harvested from the contralateral forearm to cover the 10×5 cm defect. An end-to-side anastomosis was attached to her radial artery as afferent flow. Three efferents were created: two end-to-end anastomoses at dorsal hand veins and one end-to-end anastomosis to the cephalic vein. We could palpate the thrill at the site of arteriovenous anastomosis (Figure 2). On day 10, the patient was discharged, and the flap was less congested. The same brachiocephalic AV fistula was able to be used in her routine dialysis.

After six weeks, the patient came to the clinic with an eschar at the flap. We decided to do angiography for evaluation following debridement. From the angiography, the radial artery and all of our anastomoses were patent. We decided to



**Figure 2** Postoperative after AVF with end-to-side anastomosis to radial artery and end-to-side venous drainage.



**Figure 3** Left:, After removing eschar, we found healthy subcutaneous tissue and thrill along the vein. Right:, Coverage with split thickness skin graft.

debride all the eschar. The subcutaneous tissue was vital. The thrill was palpated at the afferent anastomosis. Two efferent anastomoses were patent. The anastomosis with the 4th digit vein was occluded. A split-thickness skin graft was put on top of the tissue (Figure 3). After two weeks, the graft was successfully integrated, and the flap had completely healed. The patient still uses the same AV fistula for her routine dialysis during that period.

One year later, the patient came to the outpatient clinic. She had no complaint regarding the flap. The patient has normal range of movement of the wrist and all digits and good grip power, as before the syndrome appeared. She is still receiving hemodialysis twice a week from her old left brachiocephalic arteriovenous fistula (Figure 4).

## Discussion

Ischemic steal syndrome (ISS) is a complication following the creation of an arteriovenous fistula. Its clinical manifestations range from coolness and mild paresthesia to ulceration, tissue necrosis, or gangrene of the entire hand. The diagnosis is primarily clinical, along with the decreased flow in the distal area of fistula creation. Risk factors for ISS are end-stage renal disease, diabetes mellitus, peripheral artery disease, age over 60 years, being female, upper arm versus lower arm arteriovenous fistula, multiple operations in the same limb, and PTFE grafts. ISS occurs in 5–10% of patients with brachiocephalic fistula and 1–2% with radiocephalic fistula.<sup>1</sup> Our patient had a history of diabetes, had stenosis of the radial artery in her angiography, and for more than 5 years received dialysis from a brachiocephalic fistula, which are risk factors for ISS.

A flow-through radial artery-based forearm flap is an ideal option for this kind of defect following the replacement of tissue with a tissue-like principle.<sup>5</sup> Another option is if the patient has no artery donor available or refuses to do so, as in our case, an arterialized venous flap can be considered.<sup>6</sup> Its thickness and length of pedicle are the main reasons that we chose the flap.<sup>3,7</sup> Due to weekly brachiocephalic fistula use in her left arm, the patient decided to have the same option in her contralateral arm. Therefore, our donor flap was harvested from the contralateral forearm.

As this was a flow-through flap, we performed 3 end-vein anastomoses in an effort to improve palmar circulation and function. Congestion and necrosis, which are common problems in the first week, also occurred in our patient and were



**Figure 4** One-year follow-up: Flap is vital with palpable thrill. Hand function was returned to normal to support her daily life.

resolved prior to discharge. As per the findings by Wharton et al, an arterialized venous flap has a significant incidence of partial necrosis, reaching as high as 10%.<sup>8</sup> We designed our flap 1 cm wider than the defect size as Giesen et al suggested.<sup>9</sup> The patient came back 6 weeks later with a non-vital dermis which is uncommon for this flap. The problem was solved by applying a skin graft onto its vital subcutaneous tissue and patent flap.

Woo et al did not recommend using this flap in patients with a chronic wound.<sup>4</sup> However, proper debridement was performed, and we believe that a venous free flap can be a beneficial choice to cover an ulcer defect in steal syndrome. In long-term evaluation, we improved her hand function to normal and also her quality of life as a dialysis patient.

## Conclusion

Arterialized venous free flap is an effective treatment for patients with a history of ischemic steal syndrome due to the probability of global atherosclerosis. Surgeons may need to perform angiography to gather baseline data to choose the recipient vessels for the flap transfer.

## Ethical Approval and Patient Consent

In our institution, ethical approval is not required for case reports. However, informed written consent was obtained from the patient for publication of this case report and the accompanying images.

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## Disclosure

The authors declare that they have no competing interests in this work.

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