

## Case Report

# Circular external fixation for reverse sural flap protection after partial calcanectomy in a diabetic heel with distal tip necrosis

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## ABSTRACT

Reverse sural artery flaps are susceptible to venous congestion, while posterior heel coverage requires strict protection from pressure. A 48-year-old woman with poorly controlled type 2 diabetes, anaemia and chronic calcaneal osteomyelitis had a persistent 4×5 cm left heel defect. Magnetic resonance imaging showed acute-on-subacute osteomyelitis with an intraosseous abscess. After multidisciplinary preparation, partial calcanectomy and a pedicled reverse sural flap with split-thickness skin grafting were performed. A circular external fixator was configured to suspend the heel, protect the pedicle and permit wound surveillance. The flap remained viable, but repeated supine positioning was followed by congestion and, at one month, 1 cm distal tip necrosis that was debrided and resutured. At 10 weeks, the flap was well settled with a residual 2×4 cm healing distal wound. Circular fixation can provide contact offloading and access, but does not replace positioning, congestion surveillance, metabolic optimisation and structured follow-up.

**Keywords:** Calcaneus, Diabetic foot, External fixators, Heel, Osteomyelitis, Surgical flaps, Sural artery, Wound healing

## INTRODUCTION

Diabetic heel ulcers complicated by calcaneal osteomyelitis combine three difficult problems: eradication of infection, preservation of a mechanically useful calcaneus and durable coverage of a weight-bearing surface. Partial calcanectomy can avert a more proximal amputation, but pooled data still show an osteomyelitis-healing rate of approximately 80% and a secondary below-knee amputation rate of 17.1%.<sup>1</sup>

The reverse sural artery flap offers pedicled coverage without microsurgery and does not sacrifice a major limb artery. In diabetic foot and ankle ulcers, a meta-analysis

reported 93.3% flap healing, but total necrosis, partial necrosis and venous congestion occurred in 6.6%, 12.0% and 6.6%, respectively.<sup>2</sup> A broader pooled analysis found partial and total flap-loss rates of 15.4% and 3.1%.<sup>3</sup> These complications make postoperative pressure avoidance, oedema control and surveillance central to heel reconstruction.

External fixation has been adapted as a surgical offloading platform that can suspend the heel, stabilise the ankle and preserve circumferential access for flap inspection and dressing changes.<sup>4-6</sup> Evidence for this application remains largely technical and case-series based. We present a multidisciplinary salvage of an infected diabetic heel using

partial calcanectomy, a reverse sural flap and an Ilizarov-type circular frame. The instructive feature was limited distal necrosis despite successful contact offloading, illustrating the distinction between preventing external pressure and maintaining venous outflow.

CASE REPORT

A 48-year-old woman with insulin-treated type 2 diabetes, hypertension, dyslipidaemia, glucose-6-phosphate dehydrogenase deficiency and sickle-cell trait was referred to a multidisciplinary limb-salvage service. In 2020, she had undergone multiple debridement's and ray amputations of the left third, fourth and fifth toes for diabetic foot infection. A severe left heel infection in 2024 required further debridement and repeated negative-pressure wound therapy, but two areas of exposed calcaneus persisted. Serial cultures reflected a chronic, previously treated polymicrobial wound. A 2024 swab grew methicillin-resistant *Staphylococcus aureus*, *Eikenella corrodens* and ampicillin-susceptible *Enterococcus faecalis*.

Subsequent cultures in 2025 grew *Proteus mirabilis* and *E. faecalis*; *Candida tropicalis* was reported by the laboratory as probable colonisation. Antimicrobial treatment and wound-bed preparation were coordinated with the referring service. Current guidance supports combining appropriate systemic antibiotics with surgical removal of infected or necrotic bone when diabetic foot osteomyelitis requires operative management.<sup>7</sup>

Magnetic resonance imaging in 2025 showed diffuse calcaneal marrow oedema, greatest posteriorly and inferiorly, with a posterior intraosseous collection communicating with the overlying skin defect, consistent with acute-on-subacute calcaneal osteomyelitis and a Brodie-type abscess (Figure 1). The clinical defect measured approximately 4×5 cm, with adherent heel skin, a draining sinus, palpable bony fragments and exposed necrotic calcaneus. She used a wheelchair and avoided weight bearing on the heel.



**Figure 1. Preoperative assessment. (A) Chronic left posterior-plantar heel defect with exposed calcaneus. (B) Sagittal magnetic resonance image showing posterior and inferior calcaneal marrow abnormality with an intraosseous collection communicating with the overlying defect.**

**Table 1. Relative clinical timeline.**

| Interval                   | Clinical event                                                                                                                                                               |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2020                       | Multiple debridements and ray amputations of the left third to fifth toes for diabetic foot infection.                                                                       |
| 2024                       | Severe heel infection; debridement and cycles of negative-pressure wound therapy. Persistent exposed calcaneus.                                                              |
| Early 2025                 | MRI confirmed acute-on-subacute calcaneal osteomyelitis with intraosseous abscess; serial polymicrobial cultures and wound preparation.                                      |
| Definitive surgery in 2025 | Partial calcanectomy, reverse sural artery flap, donor-site split-thickness skin graft and Ilizarov-type circular external fixation for heel suspension and flap protection. |
| Postoperative days 5–6     | Congestion and patchy blistering during repeated supine positioning; flap remained warm and perfused.                                                                        |
| Approximately 1 month      | One-centimetre medial distal tip necrosis debrided and resutured; remainder of flap viable.                                                                                  |
| Approximately 10 weeks     | Flap well settled; residual 2 × 4 cm distal wound healing with dressings. Definitive frame-removal and weight-bearing with aircast.                                          |

The vascular team judged perfusion adequate for healing and advised avoidance of a tourniquet. Metabolic preparation was challenging: a preoperative glycated hemoglobin value was 10 %; random glucose was 15 mmol/L and microcytic anaemia was present (hemoglobin 8.9 g/dL; mean corpuscular volume 71.3 fL). Serum albumin was 35.4 g/L. The patient and family were counselled about the reconstructive plan and risks. The relative clinical course is summarised in Table 1.

In 2025, combined orthopaedic, vascular and plastic surgery was performed under general anesthesia without a tourniquet. After debridement, the definitive defect measured 6 × 5 cm and the exposed calcaneus was brittle and unhealthy. The abnormal calcaneal bone was excised as a partial calcanectomy. A pedicled reverse sural artery

fasciocutaneous flap was elevated and inset over the heel; a drain was placed beneath the flap. A meshed split-thickness skin graft harvested from the ipsilateral thigh covered the flap donor site.

After flap inset, an Ilizarov-type circular external fixator was applied using two proximal rings secured by four wires and a foot half-ring. The construct held the ankle in protective equinus and created a noncontact zone around the heel and flap pedicle (Figure 2). The open frame permitted direct examination and dressing changes. A biphasic pedal Doppler signal was recorded in theatre; later examination demonstrated triphasic anterior tibial and dorsalis pedis signals, a warm limb and capillary refill below two seconds.

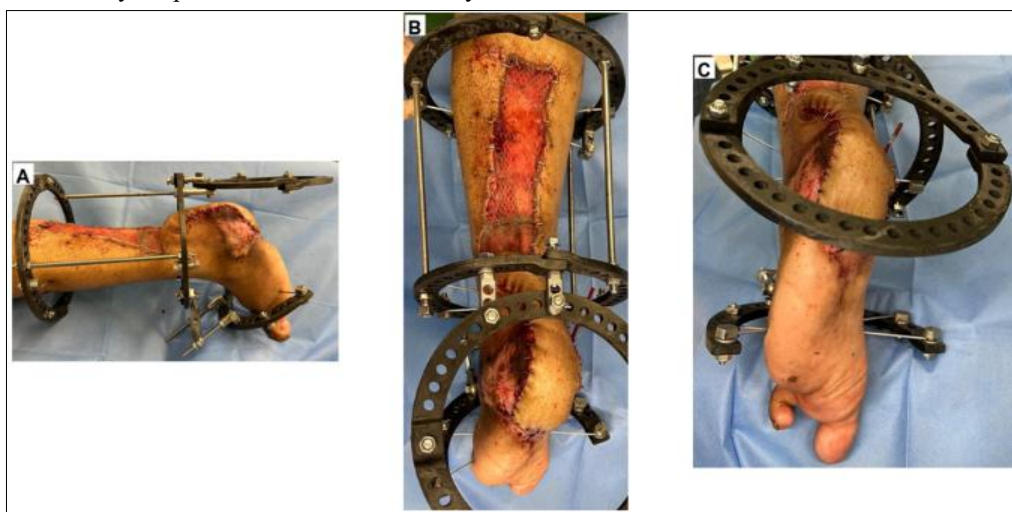


**Figure 2: Immediate postoperative construct. (A) Reverse sural flap inset over the heel with the circular external fixator creating a noncontact zone. (B) Donor site resurfaced with a meshed split-thickness skin graft and heel flap within the open frame. (C) Foot half-ring and proximal circular rings permitting circumferential inspection while maintaining protective equinus.**

Postoperatively, the limb was elevated and kept non-weight-bearing. The patient was instructed to remain prone or semi-lateral, avoid supine heel dependency and avoid dressing shear. The flap was inspected through the open construct. Cefazolin was administered for five days and thromboprophylaxis was provided. Operative tissue culture grew *Staphylococcus pettenkoferi*, susceptible to clindamycin, linezolid, trimethoprim-sulfamethoxazole and vancomycin but resistant to oxacillin and penicillin.

During postoperative days 5–6, repeated supine positioning was documented despite counselling. The flap remained warm with capillary refill below two seconds and bleeding on pinprick, but patchy blistering and venous congestion were observed. These changes settled sufficiently for discharge on postoperative day 10; the skin graft had taken and the flap was clinically perfused. Glycaemic therapy was adjusted during admission. A postoperative glycated hemoglobin value of 8.31% was reported with a laboratory caution that

haemoglobinopathy, anemia, altered red-cell turnover or recent transfusion could affect interpretation.

At approximately one month, the circular frame remained in situ and a 1 cm area of medial distal flap-tip necrosis was identified. The non-viable margin was debrided and resutured; a swab grew only skin commensal flora. At subsequent reviews, the flap was described as well settled, while a 2 × 4 cm distal wound continued to heal with alternate-day non-adherent dressings. At the latest documented wound examination, approximately 10 weeks after reconstruction, there was no major flap loss. A later superficial culture grew *Corynebacterium amycolatum*. The frame was removed, and the patient transitioned to mobilizing in an air cast at the subsequent follow-up. Written informed consent was obtained from the patient for publication of the clinical details and images.

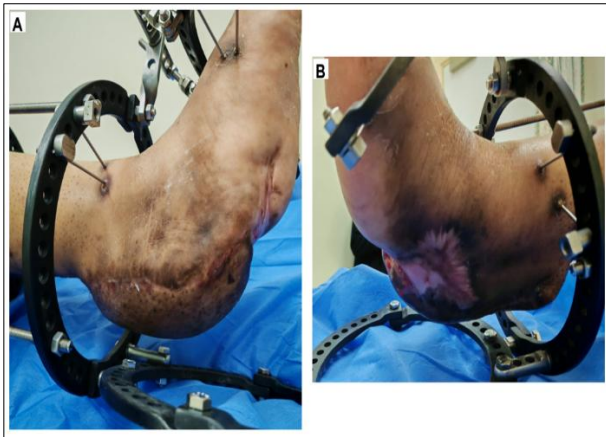


**Figure 3: Follow-up appearance with the circular frame in situ. (A) Medial view showing the settled flap and healed donor-site graft. (B) Posterior view showing viable coverage with a limited distal healing margin; this was managed with local debridement, resuturing and dressings.**

## DISCUSSION

This case demonstrates a useful but bounded role for circular external fixation after reverse sural flap coverage of the heel. The frame reliably separated the reconstruction from the bed, protected the pedicle from direct compression and allowed circumferential access. It did not abolish the physiological consequences of dependency. Congestion appeared during repeated supine positioning and was followed by limited distal tip necrosis, although the remaining flap survived. The temporal sequence does not prove causation; infection history, diabetes, anemia and the intrinsic venous vulnerability of a reverse-flow flap were plausible co-contributors.

The reverse sural flap remains attractive where free tissue transfer is unavailable, disproportionately burdensome or unsuitable. Its distal blood supply depends on reverse flow through peroneal perforator connections, while venous return must also proceed against the usual direction of valvular flow. Technical refinements wide pedicles, avoidance of tight tunnelling, adipofascial extensions and staged delay in selected patients aim to improve reliability.<sup>8</sup> Nonetheless, high-risk cohorts are less forgiving than pooled series: a 70-flap analysis reported 36% necrosis and identified diabetes, peripheral arterial disease and venous insufficiency as strong risk factors.<sup>9</sup> The modest necrosis in our patient should therefore be reported as an expected reconstructive hazard, not obscured as an uncomplicated result.

Calcaneal source control and soft-tissue restoration are inseparable. Systematic review data on adult calcaneal osteomyelitis show wide variation in reinfection and amputation rates and support coordinated orthopaedic, plastic and infection management.<sup>10</sup> In the present case, partial calcanectomy removed brittle exposed bone, the flap supplied durable tissue over the residual heel and

serial microbiology informed the infectious assessment. The normal white-cell count did not exclude chronic osteomyelitis; the diagnosis rested on the sinus, exposed necrotic bone and magnetic resonance findings.

The external-fixation literature supports the mechanics of the construct but not a guaranteed biological effect. The SALSastand was described to elevate, offload and protect reconstructed diabetic feet while preserving wound access.<sup>4</sup> A kickstand modification prevented heel pressure injury in 10 trauma patients with 11 fractures, and a three-patient series used similar fixation after free-flap plantar calcaneal reconstruction, with all four flaps surviving.<sup>5,6</sup> These small, heterogeneous reports cannot establish superiority over splints, casts or positioning protocols. Our patient adds a pedicled reverse sural flap example and shows that even a well-designed frame must be paired with nursing instructions, patient education and frequent venous-congestion checks.

Protective equinus may increase heel clearance and reduce immediate traction across a posterior reconstruction, but it should be purposeful and time-limited. Prolonged plantarflexion risks stiffness and equinus contracture, and the frame itself introduces pin-tract infection, wire loosening, neurovascular injury, discomfort and follow-up burdens. The present construct was used for flap protection and offloading; the operative record did not document Achilles tendon lengthening or subsequent gradual correction. Those procedures should not be inferred from a planned operation or from frame appearance alone.

Long-term success at a weight-bearing heel is not synonymous with early flap survival. Reverse sural flaps can provide stable weight-bearing coverage, but recurrent superficial ulceration has been reported even after apparently successful reconstruction.<sup>11</sup> Current diabetic-foot guidance emphasises sustained mechanical offloading and appropriately fitted footwear as part of ulcer healing and recurrence prevention.<sup>12</sup> This is particularly important for a patient with prior lateral ray amputations and altered plantar load. The available record ended before frame removal and protected weight-bearing, so the definitive functional outcome remains unknown.

Reassuring pedal Doppler signals should not be conflated with comprehensive perfusion staging. Intersocietal guidance recommends combining clinical examination with objective haemodynamic testing when peripheral arterial disease may affect a diabetic foot ulcer.<sup>13</sup> Likewise, negative-pressure wound therapy should remain an adjunct to source control and reconstruction; current wound-healing guidance provides conditional support for its use in postoperative diabetic foot wounds.<sup>14</sup>

Several limitations temper interpretation. This is a single case; wound measurements and descriptions varied between visits; no toe pressure, transcutaneous oxygen measurement, full angiographic report or objective flap-perfusion study was available; and adherence was

documented clinically rather than measured. The follow-up record did not contain a validated functional score, complete epithelialisation date, frame-removal date or long-term re-ulceration assessment. Accordingly, the case supports feasibility and a physiological lesson, not comparative effectiveness.

## CONCLUSION

An Ilizarov-type circular frame can create dependable contact-free heel suspension, protect a reverse sural flap and preserve access after partial calcaneotomy. It remains an adjunct rather than a substitute for venous-aware positioning, flap monitoring, infection control, metabolic and hematological optimisation, and a documented transition to durable footwear and weight bearing. Limited distal necrosis in this case reinforces that honest appraisal of both benefit and failure modes is essential when selecting surgical offloading for a high-risk diabetic heel.

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