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SALVAGE OF DIABETIC FOOT WITH HIND FOOT ULCERS USING REVERSE SUPERFICIAL SURAL ARTERY FLAP

Dr. Yojitha Sharatha Dalapathy Sankar[1], Dr. Arounkumar.N[2], Dr. Selvakumar K[3]

[1]MS-Post-Graduate, Dept. of General Surgery, Sri Venkateshwaraa Medical College Hospital and Research Centre, Ariyur, Pondicherry.
[2]MS, MCH, Associate Professor, Department of Plastic Surgery, Sri Venkateshwaraa Medical College Hospital and Research Centre, Ariyur, Pondicherry
[3]MS, Professor, Department of General Surgery, Sri Venkateshwaraa Medical College Hospital and Research Centre, Ariyur, Pondicherry

Abstract

Background: Diabetic foot ulcers (DFUs), particularly those on the hindfoot, pose significant challenges due to their poor healing qualities and the high risk of complications, including limb amputation. The Reverse Superficial Sural Artery Flap (RSSA) technique has been proposed as a viable limb-salvage solution, leveraging its robust vascular supply for effective wound coverage.

Objective: To evaluate the efficacy and outcomes of the RSSA flap in the management of diabetic hindfoot ulcers, with an emphasis on its role in limb salvage, healing rates, and the quality of life of the patients.

Methods: This prospective clinical study, conducted from April 2022 to June 2023, involved 18 patients with diabetes-related hindfoot ulcers. Selection criteria focused on those with hindfoot ulcers ranging in size without peripheral arterial disease or osteomyelitis. The study emphasized thorough pre-operative assessments, including imaging and doppler studies, to ensure optimal patient selection and flap planning. Surgical technique, post-operative care, and follow-up protocols were meticulously designed to assess the flap's viability, healing progress, and any complications.

Results: The study demonstrated a high rate of flap viability, with the majority of the RSSA flaps completely viable and only a minority experiencing marginal or partial necrosis requiring additional interventions. All patients showed no recurrence of ulcers during a follow-up period of 2 to 12 months, highlighting the flap's effectiveness in ulcer coverage and its contribution to limb salvage. The RSSA flap's ability to promote rapid healing and facilitate early weight-bearing activities was also noted, significantly impacting patients' recovery and quality of life.

1. Introduction

The pervasive and insidious nature of diabetes mellitus across the globe has led to a significant increase in its myriad of complications, not least among which is the diabetic foot ulcer (DFU). This condition not only signifies a major challenge for healthcare systems worldwide due to its complexity and the multifaceted approach required for management but also represents a profound burden on affected individuals, markedly diminishing their quality of life. Among the spectrum of complications, ulcers located on the hindfoot pose a particularly daunting challenge due to their propensity for poor healing, which is exacerbated by the compromised vascular status often seen in diabetic patients. The dire consequence of non-healing ulcers, including infection, gangrene, and ultimately limb amputation, underscores the critical need for innovative and effective treatment modalities.The integration of heel and other flap options in footwear holds paramount importance in diabetic foot ulcer (DFU) management. These

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE6, 2024

options provide essential structural support and aid in distributing pressure more evenly, thereby reducing the risk of ulcers and promoting healing. Flap designs tailored to accommodate the unique needs of diabetic patients, such as offloading pressure from vulnerable areas, can significantly mitigate the risk of complications like infection and amputation, offering hope for improved outcomes in DFU management.

The evolution of reconstructive surgery has introduced several limb-salvage techniques, with the Reverse Superficial Sural Artery (RSSA) Flap emerging as a particularly promising option. This procedure utilizes a flap based on the sural artery's supply to cover defects, offering a ray of hope for patients with otherwise intractable hindfoot ulcers. The RSSA flap, with its robust blood supply and the flexibility of the skin paddle, provides a viable solution for covering large, complex wounds while ensuring a high degree of tissue viability and promoting rapid healing. This article aims to elucidate the efficacy of the RSSA flap in the salvage of the diabetic foot with a specific focus on hindfoot ulcers. By delving into the anatomical considerations, surgical techniques, and postoperative outcomes associated with this innovative approach, we endeavor to highlight its viability as a limb-salvage technique. Furthermore, this work seeks to explore the multidisciplinary approach required for the management of DFUs, emphasizing the integration of vascular surgery, plastic surgery, endocrinology, and podiatry in achieving optimal outcomes for patients.

Through a detailed case studies, and outcomes analysis, this thesis will contribute to the expanding body of knowledge on the RSSA flap as a vital tool in the armamentarium against the diabetic foot, offering new avenues for treatment and hope for patients facing the grim prospect of limb loss. By addressing the gaps in current research and highlighting areas for future investigation, this work aims to pave the way for advancements in diabetic foot management, ultimately improving patient outcomes and quality of life.

2. Methodology

Study Design and Patient Selection

This study was a prospective clinical investigation conducted between April 2022 and June 2023. It focused on patients presenting with diabetes-related hindfoot ulcers. A total of 18 patients, comprising 10 males and 8 females with a mean age of 50 years were enrolled in the study. The ulcers treated were of varying etiologies, predominantly infective (14 cases) and neuropathic (4 cases) were enrolled.

Inclusion Criteria :

- Diagnosis of diabetes mellitus with a hindfoot ulcer.
- Ulcers ranging from 5x4 cm^2 to 15x10 cm^2 in size.
- Patients who consented to participate in the study.

Exclusion Criteria :

- Presence of peripheral arterial disease.
- Diagnosis of osteomyelitis.
- Patients under the age of 18.

Pre-operative Evaluation

Pre-operative assessment included a thorough medical and surgical history, physical examination focusing on the ulcer and potential donor sites, and imaging studies. Two primary diagnostic tools were used:

1. **X-Ray of the Foot:** To assess bone involvement and exclude osteomyelitis.

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE6, 2024

2. **Arterial Doppler Ultrasound:** To rule out any peripheral vascular occlusive disease. If PAD is present, it may impact surgical decisions and outcomes, making it important to identify beforehand.

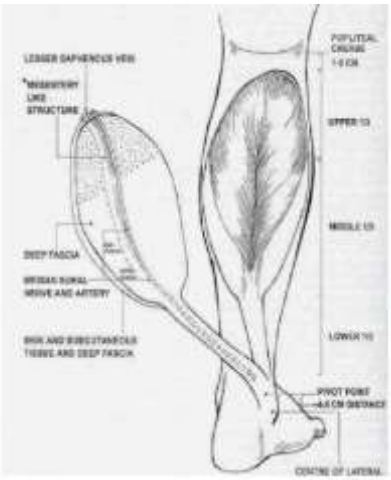
Additionally, donor site evaluation ensured:

- Infection-free skin and subcutaneous tissue.
- Skin surface without any scars due to previous trauma and infection.

Surgical Technique

The reverse superficial sural artery flap procedure was executed in two stages:

1. **Flap Harvest and Insert:**
   Under appropriate anaesthesia, all patients were operated in prone position. Using hand held doppler, perforator which is around 5-8cms above lateral malleolus was marked. Then flap was marked by planning in reverse, based on the defect.
   Incision was made around the flap, flap is raised in subfascial plane along with sural nerve, median sural artery & short saphenous vein. Flap was raised until pivot point i.e, marked perforator. Flap was transposed onto the defect and insert given. Donor area was covered by split skin graft.



2. **Flap Division:** Approximately 3-4 weeks post-initial surgery, once flap was settled in recipient site, flap was divided from pedicle and complete insert of flap is given. donor area was completely closed.

Post-operative protocol:

- Regular dressing was done.
- After the 1st stage, Foot was completely offloaded and elevated to avoid pressure over the flap.
- Suture removal was typically performed 2-3 weeks post-operatively.
- Weight-bearing activities were gradually introduced 3-4 weeks after flap division, depending on patient recovery.
- All patients were given silicone insole socks with proper footwear.

After the 2nd stage, Patients were followed up for at least six-twelve months post-operatively to monitor for any recurrence of the ulcer or other complications.

Data Collection and Analysis

Data collected included demographic details (age, gender), etiology of the ulcer (infective or neuropathic), size of the ulcer, surgical outcomes, complication rates, and time to suture removal and weight-bearing. Descriptive statistics were used to summarize the data.

3. Results

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE6, 2024

Out of the 18 RSSAF procedures performed, the majority (14 flaps) demonstrated complete viability with no complications, effectively covering the ulcerated area and promoting healing. However, 2 flaps developed marginal necrosis, characterized by superficial necrosis along the flap margins. These instances of marginal necrosis were managed conservatively through local wound care and did not necessitate further surgical intervention.

An additional 2 flaps exhibited partial necrosis, presenting a more significant challenge. These cases required a secondary intervention, specifically the application of a skin graft to salvage the affected area and ensure wound closure.

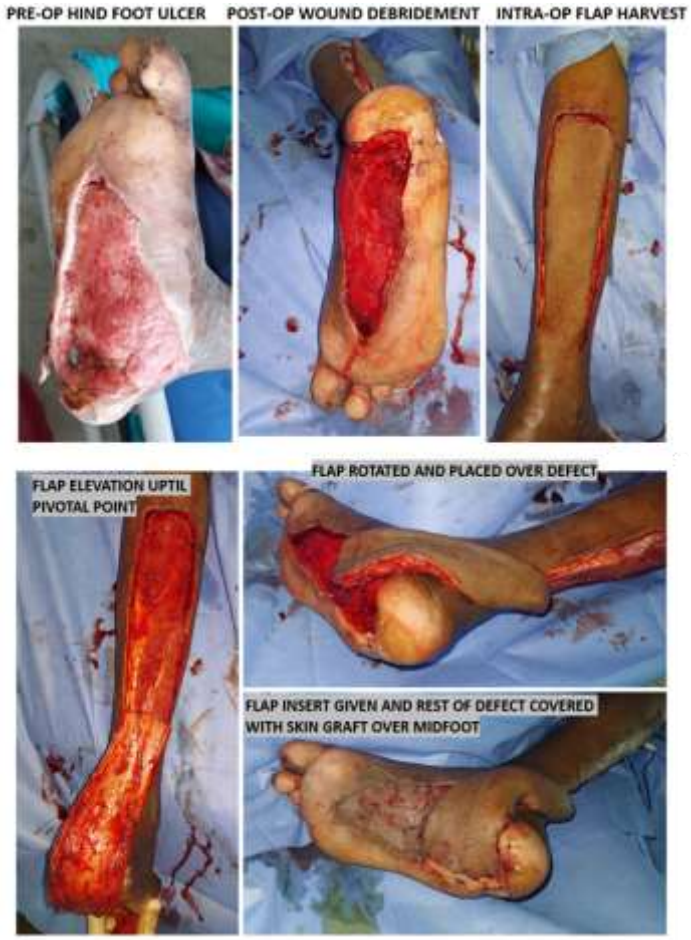


Figure 1 – Case 1

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE6, 2024

Figure 2 – Case 2

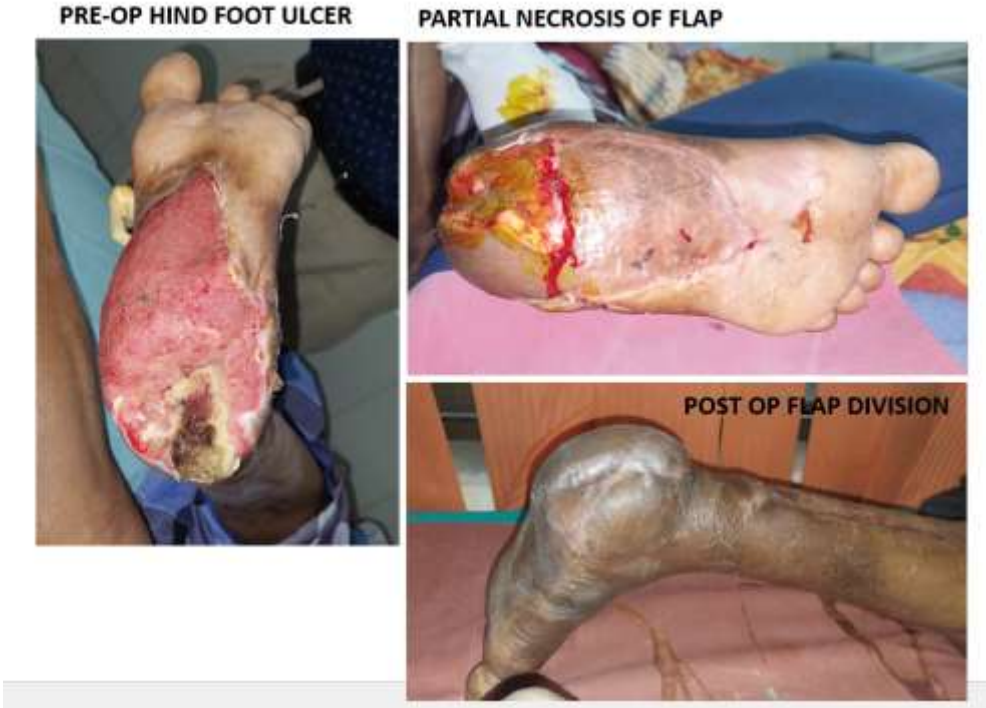


Figure 3 – Case 3

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE6, 2024

Figure 4 – Case 4

Healing and Recovery

All patients in this study were subjected to a follow-up period ranging from 2 to 12 months to monitor wound healing, flap integrity, and functional outcomes. The follow-up results were uniformly positive, with all wounds settling well over time. The successful integration of the flap and subsequent wound healing allowed patients to progress to weight-bearing activities. The introduction of proper footwear was a critical component of the recovery process, enabling patients to resume ambulation without discomfort or recurrence of ulcers.

Recurrence of Ulcers

A key indicator of the long-term success of RSSAF in managing diabetic hindfoot ulcers is the absence of ulcer recurrence. In this cohort, no evidence of recurrence was observed in any of the patients during the follow-up period. This outcome underscores the efficacy of the RSSAF in not only addressing the immediate concern of wound coverage but also in contributing to **the overall limb salvage and improvement in patients' quality of life.**

4. Discussion

The management of diabetic hindfoot ulcers presents a significant reconstructive challenge, particularly due to the inherent limitations of soft tissue availability in the distal lower limb and foot. These ulcers are fraught with a higher predisposition towards infection and critical ischemia, often leading to a trajectory that culminates in limb amputation. The crux of salvaging limbs afflicted by diabetic hindfoot ulcers lies in achieving robust and durable soft tissue coverage. Various methodologies have been explored in pursuit of this goal, each with its own set of advantages and limitations, including split skin grafting, free flap reconstructions, and pedicled flaps, among which the Reverse Superficial Sural Artery Flap (RSSAF) has emerged as a noteworthy option.

Split skin grafting, while a staple in the repertoire of reconstructive options, is notably less suitable for weight-bearing areas such as the hindfoot. This inadequacy stems from the method's predisposition towards complications like hyperkeratosis, contracture, and the recurrent nature of ulceration in such grafts. These drawbacks significantly diminish its feasibility as a viable solution for the diabetic hindfoot. In contrast, local flap techniques such as the medial plantar artery flap, adductor hallucis flap, and rotational flaps offer promising alternatives. These flaps provide robust vascularized tissue coverage, reducing the risk of

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hyperkeratosis and contracture while promoting better wound healing and long-term outcomes for patients with diabetic hindfoot ulcers.

Conversely, the free flap approach is distinguished by its capacity to provide extensive coverage, making it an attractive option for large defect reconstructions. However, its application is circumscribed by several critical constraints. The necessity for an adequate vascular supply, which is often compromised in diabetic patients, poses a significant hurdle. Additionally, the requirement for specialized resources and expertise limits this approach's accessibility, particularly in resource-limited settings. Moreover, the free flap technique is both cost-intensive and time-consuming, with a comparably higher risk of failure. Examples of free flaps, such as the gracilis, latissimus dorsi, and various fasciocutaneous flaps, underscore the technique's potential yet also highlight its limitations. But these flaps are limited to smaller size soft tissue defects.

The pedicled flap, and more specifically, the RSSAF, presents a simpler and more pragmatic alternative for the reconstruction of the diabetic foot. This method capitalizes on local flap utilization, thereby minimizing donor site morbidity and preserving the natural aesthetic contour of the foot. The durability and resilience of the coverage offered by the RSSAF, alongside its relatively straightforward and rapid procedural execution, mark significant advantages. The consistent blood supply inherent to the pedicled flap approach facilitates surgery even in patients with microangiopathy, enhancing the viability of the flap. Moreover, the RSSAF is associated with minimal postoperative discomfort, promoting an expedited and more comfortable recovery process. Importantly, the approach supports early mobilization and weight-bearing, which are crucial for the rehabilitation of diabetic patients.

Despite its merits, the RSSAF is not devoid of challenges. The insensitivity of the flap can result in hyposensitivity at the lateral border of the foot, potentially affecting proprioception and the patient's ability to navigate their environment safely. Furthermore, the viability of larger flaps is compromised by unreliable perfusion, necessitating judicious preoperative planning to circumvent this limitation. The risk of venous congestion also necessitates a meticulous surgical technique to ensure optimal outcomes. Additionally, the inapplicability of the RSSAF in patients with significant peripheral arterial disease underscores the need for a comprehensive preoperative vascular assessment. The demand for meticulous postoperative care, particularly in terms of immobilization and positioning, further underscores the complexity of ensuring successful outcomes with the RSSAF.

5. Conclusion

In conclusion, the landscape of diabetic hindfoot ulcer management is notably complex, demanding a multifaceted approach that meticulously considers the unique challenges and needs presented by each case. Among the available reconstructive options, the RSSAF stands out for its balance of simplicity, effectiveness, and patient-centric outcomes. Despite its inherent limitations, this method offers a practical solution for achieving durable soft tissue coverage, thus playing a pivotal role in limb salvage efforts for diabetic patients. The continued evolution of surgical techniques and flap designs promises to further enhance the outcomes for this challenging patient population, underscoring the importance of innovation and tailored care in the field of reconstructive surgery.