

Dorsal versus Plantar Approaches for Metatarsal Head Resection in Diabetes-Related Neuropathic Forefoot Ulcers: A Retrospective Comparative Cohort Study

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Submitted: 23 August 2025

Accepted: 21 December 2025

Published: 28 December 2025

ABSTRACT

Background: Diabetes-related neuropathic plantar forefoot ulcers result from loss of protective sensation and repetitive mechanical loading. Metatarsal head resection is a surgical offloading option when non-surgical offloading fails, but comparative evidence for dorsal versus plantar access remains limited. **Objective:** To compare healing and early clinical outcomes after dorsal versus plantar metatarsal head resection for neuropathic ulcers beneath the first or fifth metatarsal head in adults with type 2 diabetes without documented osteomyelitis. **Methods:** This single-centre retrospective comparative cohort included 120 patients treated between May 2020 and March 2025. Sixty underwent a dorsal approach with primary closure and 60 a plantar approach with ulcer debridement and secondary-intention healing. The principal outcome was recorded time to complete healing. Secondary outcomes included hospital stay, intraoperative blood loss, recorded time to ambulation, postoperative complications, six-month ulcer recurrence, and major amputation. Analyses were based on aggregate data because patient-level data were unavailable. **Results:** Mean age was 58.4 ± 9.2 years; 100 patients were men. Mean recorded healing time was 6.1 ± 1.2 weeks in the dorsal group versus 10.4 ± 2.1 weeks in the plantar group (mean difference -4.30 weeks, 95% CI -4.92 to -3.68 ; $p < 0.001$). The dorsal group also had shorter hospital stay, lower intraoperative blood loss, and earlier recorded ambulation; all $p < 0.001$. Six-month ulcer recurrence was 5.0% versus 6.7% (risk ratio 0.75, 95% CI 0.18–3.21; Fisher's exact $p = 1.00$). No major amputations were reported. **Conclusions:** Dorsal metatarsal head resection with primary closure was associated with shorter recorded healing time, shorter hospital stay, and earlier recorded ambulation than plantar resection with secondary-intention healing. However, non-random treatment allocation, unavailable baseline patient-level data, and confounding by closure strategy preclude causal inference. Prospective comparative studies with standardised assessment and longer follow-up are required.

Keywords: diabetes-related foot ulcer; peripheral neuropathy; metatarsal head resection; surgical offloading; dorsal approach; plantar approach

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Introduction

Diabetes-related foot ulceration is a major source of infection, hospitalization, disability, amputation, and recurrent morbidity. After healing, the foot is better considered to be in remission than cured because recurrent ulceration is common [1,2]. Contemporary IWGDF terminology defines a diabetes-related foot ulcer as a break in the skin of the foot in a person with diabetes, usually accompanied by peripheral neuropathy and/or peripheral artery disease; a neuropathic ulcer specifically implies neuropathy without peripheral artery disease [3]. Neuropathic plantar forefoot ulcers frequently develop beneath metatarsal heads where loss of protective sensation, deformity, and repetitive mechanical loading create focal tissue stress. Mechanical offloading is therefore a core component of treatment. The IWGDF recommends a non-removable knee-high offloading device as first-choice treatment for a neuropathic plantar forefoot or midfoot ulcer when not contraindicated, and recent systematic review evidence supports the superiority of non-removable devices over removable alternatives for many plantar ulcers [4,5]. When adequate non-surgical offloading fails, surgical offloading may be considered in selected patients. Metatarsal head resection reduces a focal bony prominence and can decrease plantar pressure [6,7]. Systematic reviews and meta-analyses suggest high healing rates after metatarsal head resection in selected neuropathic ulcers, but the evidence base is dominated by observational studies and remains vulnerable to selection bias, heterogeneous case definitions, and variable follow-up [8,9]. Re-ulceration, transfer lesions, infection, and subsequent amputation remain clinically important, particularly because resection can redistribute plantar loading to adjacent metatarsal heads [8–11]. Metatarsal head resection may be undertaken through dorsal or plantar access. Dorsal incision avoids the plantar weight-bearing surface and generally permits primary closure, whereas a plantar approach provides direct access to the ulcer and underlying metatarsal head but may be managed by secondary-intention healing. The most directly relevant comparative study, performed in patients with diabetic foot osteomyelitis, found similar healing times but more postoperative complications after the dorsal approach; importantly, patients selected for dorsal surgery had smaller and shallower ulcers, illustrating the potential for confounding by indication [12]. The present study therefore compared dorsal and plantar metatarsal head resection for neuropathic ulcers beneath the first or fifth metatarsal head in adults with type 2 diabetes and no reported osteomyelitis. The principal hypothesis was that dorsal surgery would be associated with a shorter recorded time to complete healing. Because only aggregate study data remained available, the analysis was necessarily exploring and unadjusted.

MATERIALS AND METHODS

Study design and setting

This was a single-center retrospective comparative cohort study conducted in the Department of Vascular Surgery at Tobruk Medical Center, University of Tobruk, Libya, between May 2020 and March 2025. Reporting follows the STROBE recommendations for observational studies where the retained data permit [13].

The original patient-level database was not available during preparation of this manuscript. The analysis was therefore restricted to variables and aggregate outcomes retained in the study records. No unrecorded patient characteristics, outcome definitions, exclusions, or events were imputed or

reconstructed. This limitation should be considered when interpreting all between-group comparisons.

Participants

The retained study records described 120 adults with type 2 diabetes mellitus and a chronic neuropathic plantar ulcer beneath either the first or fifth metatarsal head. Sixty patients underwent metatarsal head resection through a dorsal approach and 60 through a plantar approach.

Documented inclusion criteria were age > 18 years; a clinically diagnosed neuropathic ulcer with loss of protective sensation on 10-g monofilament testing; ulcer location beneath the first or fifth metatarsal head; failure of conservative management for at least 4 weeks; and no clinical or radiological evidence of osteomyelitis.

Documented exclusion criteria were osteomyelitis or deep bone infection; critical limb ischemia, defined in the retained study record as an ankle-brachial index <0.5 requiring revascularization; active infection requiring intravenous antibiotics; and previous foot surgery or amputation. The total number screened, exclusions by reason, first-versus-fifth metatarsal distribution within each treatment group, and completeness of follow-up could not be reconstructed.

Current guidance recommends standardized ulcer characterization, including site, ischemia, infection, area, and depth, and recent consensus work recommends a minimum set of baseline descriptors for comparative diabetes-related foot-ulcer studies [14,15]. These descriptors could not be recovered from the retained aggregate data and were therefore not retrospectively assigned.

Surgical exposure and perioperative care

Dorsal approach: a dorsal incision was made over the affected metatarsophalangeal region. The extensor tendon was identified and retracted, and the metatarsal head was resected using an oscillating saw. The dorsal wound was closed primarily.

Plantar approach: a plantar incision was made through the ulcer, with ulcer debridement followed by metatarsal head resection. The plantar wound was left open to heal by secondary intention.

All procedures were reported to have been performed under spinal anesthesia by the same surgical team. Postoperative management comprised non-weight-bearing for 2 weeks, followed by gradual mobilization in a postoperative shoe. Glycemic management and offloading were described as optimized; however, the specific offloading device, adherence, antibiotic use, dressing regimen, and discharge criteria were not retained.

Treatment allocation was not randomized. The clinical criteria used to select dorsal or plantar access were unavailable; consequently, confounding by indication could not be assessed.

Outcomes

The principal outcome was recorded time to complete healing, measured in weeks. The retained study records did not preserve a formal operational definition of complete healing or the assessment schedule. Secondary continuous outcomes were length of hospital stay, intraoperative blood loss, and recorded time to ambulation. The original variable labelled 'wound size' was excluded because its measurement method and units could not be verified. Return to work was also excluded because preoperative employment status and the denominator contributing to that outcome were unavailable.

Reported safety outcomes were extensor tendon injury, toe instability, superficial wound infection, delayed healing requiring secondary suturing, ulcer recurrence at 6 months, and major amputation. Complete cross-group ascertainment was available only for recurrence and reported major amputation; therefore, other complication categories are presented descriptively without comparative hypothesis testing. This outcome predates recent consensus work. A 2024 core outcome set for diabetes-related foot-ulcer intervention studies identified wound healing, time to heal, new/recurrent ulceration, infection, major amputation, minor amputation, health-related quality of life, and mortality as core outcomes [16]. The retained dataset did not contain all of these outcomes.

Statistical analysis

Continuous outcomes are presented as mean $\pm$ standard deviation. Unadjusted mean differences were calculated as dorsal minus plantar and are reported with 95% confidence intervals. Welch independent-samples t tests were calculated from the reported summary statistics because patient-level distributions and equality of variance could not be assessed. Six-month recurrence was compared using Fisher's exact test because event counts were small; an unadjusted risk ratio with a 95% confidence interval was also calculated. All tests were two-sided with $\alpha=0.05$. No adjustment was made for multiple secondary outcomes, and these comparisons should be considered exploratory. No multivariable modelling, survival analysis, subgroup analysis, or missing-data analysis was possible without patient-level data.

RESULTS

Study population

The retained cohort contained 120 patients: 60 in the dorsal group and 60 in the plantar group. Overall, 100/120 (83.3%) were men and 20/120 (16.7%) were women; mean age was 58.4 ± 9.2 years. Sixty ulcers were reported beneath the first metatarsal head and 60 beneath the fifth metatarsal head. Group-specific distributions of age, sex, HbA1c, diabetes duration, ulcer site, ulcer duration, ulcer dimensions/depth, vascular measurements, smoking, renal disease, and other comorbidities were not available. Baseline comparability between groups therefore cannot be established.

Healing and perioperative outcomes

Mean recorded healing time was 6.1 ± 1.2 weeks in the dorsal group and 10.4 ± 2.1 weeks in the plantar group, corresponding to an unadjusted mean difference of -4.30 weeks (95% CI -4.92 to -3.68 ; $p < 0.001$). Hospital stays and recorded time to ambulation were also shorter in the dorsal group. Reported intraoperative blood loss was lower by approximately 20 mL, although the clinical importance of this absolute difference is uncertain (Table 1). These estimates are unadjusted and should not be interpreted as causal effects of surgical approach.

Table 1. Unadjusted healing and perioperative outcomes by surgical approach

Outcome	Dorsal (n=60)	Plantar (n=60)	Mean difference*	95% CI	p value
Healing time, weeks	6.1 ± 1.2	10.4 ± 2.1	-4.30	-4.92 to -3.68	< 0.001
Hospital stay, days	3.2 ± 0.8	6.5 ± 1.4	-3.30	-3.71 to -2.89	< 0.001
Intraoperative blood loss, mL	25 ± 8	45 ± 12	-20.0	-23.69 to -16.31	< 0.001
Recorded time to ambulation, weeks†	2.1 ± 0.6	4.3 ± 1.0	-2.20	-2.50 to -1.90	< 0.001

Note. *Mean difference = dorsal minus plantar. †The retained study did not preserve a formal definition of “time to ambulation”. Values are mean ± SD. Confidence intervals and Welch tests were calculated from the reported aggregate summary statistics.

Complications and recurrence

The retained study records documented extensor tendon injury in 4/60 (6.7%) and postoperative toe instability in 3/60 (5.0%) patients after dorsal surgery. In the plantar group, superficial wound infection was recorded in 5/60 (8.3%) and delayed healing requiring secondary suturing in 2/60 (3.3%). Corresponding event counts for the opposite treatment group were not retained; therefore, these complication rates cannot be validly compared (Table 2).

Six-month ulcer recurrence was recorded in 3/60 (5.0%) patients in the dorsal group and 4/60 (6.7%) in the plantar group (risk ratio 0.75, 95% CI 0.18–3.21; Fisher's exact p = 1.00). The wide confidence interval is compatible with both clinically meaningful benefit and harm and does not establish equivalence. No major amputations were reported in either group.

Table 2. Reported postoperative complications, recurrence, and major amputation

Reported event	Dorsal (n=60)	Plantar (n=60)
Extensor tendon injury	4 (6.7%)	Not ascertainable
Toe instability	3 (5.0%)	Not ascertainable
Superficial wound infection	Not ascertainable	5 (8.3%)
Delayed healing requiring secondary suturing	Not ascertainable	2 (3.3%)
Ulcer recurrence at 6 months	3 (5.0%)	4 (6.7%)
Major amputation	0 reported	0 reported

Representative clinical sequences from the study are shown in Figures 1 and 2. They illustrate short-term wound progression after dorsal surgery but are descriptive examples and do not independently validate the cohort-level healing estimates.



Figure 1. Clinical sequence of a neuropathic ulcer in the fifth metatarsal head region. (A, B) Preoperative appearances of an ulcer reported to have failed to heal for more than 6 months. (C) Postoperative appearance following dorsal metatarsal head resection. (D) Near-complete wound healing at 14 days postoperatively. Images reproduced from the original study manuscript.



Figure 2. Clinical sequence of a neuropathic plantar ulcer beneath the first metatarsal head. (A) Preoperative ulcer reported to have failed to heal for more than 5 months. (B) Postoperative dorsal appearance after metatarsal head resection. (C) Near-complete healing of the plantar ulcer at 14 days postoperatively.

Discussion

Principal findings and interpretation

In this retrospective cohort, dorsal metatarsal head resection with primary closure was associated with a 4.3-week shorter recorded healing time than plantar resection with secondary-intention healing (Table 1). Hospital stays and recorded time to ambulation were also shorter. The magnitude of the healing-time difference may be clinically important; however, the analysis is unadjusted and should not be interpreted as a causal treatment effect. The difference in blood loss was statistically precise but small in absolute terms and, in isolation, is unlikely to determine surgical choice.

A biologically plausible explanation for faster recorded healing after dorsal surgery is avoidance of a plantar incision combined with primary skin closure. This is also the principal threat to causal interpretation: surgical route and wound-closure strategy were perfectly linked in the retained protocol. The study therefore compares treatment packages—dorsal access plus primary closure versus plantar access plus secondary-intention healing—rather than isolating the independent effect of incision location. Healing time may also have been influenced by baseline ulcer depth, area, duration, callus burden, vascular status, infection history, and clinician selection of the operative route, none of which could be adjusted for. The representative photographs (Figures 1 and 2) are consistent with short-term wound progression after dorsal surgery, but they are illustrative case images and should not be interpreted as comparative outcome evidence.

Comparison with direct comparative literature

The most directly comparable published cohort is that of Tardáguila-García et al., who studied 108 patients undergoing metatarsal head resection for diabetic foot osteomyelitis [12]. In contrast to the present study, they reported similar healing times between dorsal and plantar access and more postoperative complications in the dorsal group. Their dorsal cohort also had smaller and shallower ulcers, demonstrating that operative approach may be strongly related to baseline case characteristics. The difference between studies may therefore reflect dissimilar populations, the presence versus absence of osteomyelitis, wound severity, surgical technique, postoperative care, or residual confounding rather than a true reversal of treatment effect. That distinction is clinically important because osteomyelitis changes both surgical goals and wound biology. Current IWGDF/IDSA guidance recommends a structured diagnostic pathway when diabetic foot osteomyelitis is suspected, incorporating clinical assessment, plain radiography and inflammatory markers initially, with MRI when diagnostic uncertainty persists; bone sampling may be required in selected cases [17]. The retained study record only states that clinical and radiological evidence of osteomyelitis was absent, so the exact diagnostic pathway cannot be verified. Metatarsal head resection within the broader surgical-offloading evidence Foundational studies showed that metatarsal head resection can lower local plantar pressure and achieve healing in selected non-ischemic neuropathic ulcers [6,7]. More recent evidence syntheses support its potential effectiveness but also expose the limitations of the evidence base. Sanz-Corbalán et al. identified substantial rates of re-ulceration and amputation across heterogeneous studies [8], while Yammine and Assi found favorable healing outcomes compared with standard care but noted that the comparative evidence consisted largely of retrospective studies and case series [9]. A prospective case series also reported high initial healing but clinically relevant long-term complications, reinforcing that technical healing does not end the patient's ulcer risk [18].

The present six-month recurrence estimate should therefore not be overinterpreted. As shown in Table 2, only seven recurrence events were reported, producing a wide confidence interval that cannot establish equivalence between approaches. Transfer re-ulceration is a specific biomechanical concern after metatarsal head resection. In a prospective cohort, Molines-Barroso et al. reported substantial re-ulceration after metatarsal head resection and found that risk varied by the metatarsal respected, with the first metatarsal carrying a higher risk and the fifth a lower risk [10]. Because the current retained data do not preserve the first-versus-fifth metatarsal distribution within each surgical group, ulcer location is a potentially important uncontrolled confounder. Six months is also too short to characterize the full burden of transfer lesions and recurrent ulceration. Surgical offloading should also be considered as a family of biomechanical interventions rather than a single operation. Meta-analysis of metatarsal osteotomies has reported high healing rates in recalcitrant neuropathic ulcers [19]. A 2026 systematic review of minimally invasive floating metatarsal osteotomy similarly reported high pooled healing but identified transfer lesions and non-union as meaningful adverse outcomes [20]. These procedures are not directly interchangeable with metatarsal head resection, but the broader literature supports the same principle: reducing focal plantar stress can facilitate healing while simultaneously redistributing load and creating new biomechanical risks.

Offloading, vascular status, and multidisciplinary care

The clinical sequence leading to surgery is insufficiently characterized in the retained dataset. Contemporary IWGDF guidance places high-quality mechanical offloading at the center of treatment and recommends considering metatarsal head resection only when appropriate non-surgical treatment has failed [4]. The current report documents at least 4 weeks of conservative management but does not identify the device used or adherence. This matters because non-removable knee-high devices are supported by stronger evidence than removable devices for many neuropathic plantar forefoot ulcers [4,5], and failure of a poorly adhered-to removable device is not equivalent to failure of guideline-concordant offloading. Perfusion is another major determinant of healing. The retained threshold of $ABI < 0.5$ identifies severe ischemia but is not sufficient to exclude peripheral artery disease in diabetes. Current intersocietal IWGDF/ESVS/SVS guidance recommends interpreting pedal Doppler waveforms together with ABI and toe-brachial index where feasible, because no single bedside test reliably excludes peripheral artery disease in a person with diabetes and a foot ulcer [21]. The absence of group-specific vascular data is therefore a major limitation, especially when healing time is the principal endpoint. Similarly, prevention of recurrent ulceration after healing requires continued pressure management. IWGDF prevention guidance supports integrated foot care and therapeutic footwear with demonstrated pressure-relieving effect for people at high risk of recurrence [22]. Randomized evidence has also shown that footwear benefit depends substantially on actual use [23]. Contemporary wound-healing guidance emphasises that adjunctive wound therapies should be considered within, rather than instead of, established multidisciplinary care [24], and a recent expert consensus likewise stresses coordinated management of perfusion, infection, pressure, metabolic factors, wound bed preparation, and recurrence prevention [25]. The retained study record does not contain information on long-term footwear, plantar-pressure assessment, adherence, adjunctive wound therapies, or multidisciplinary follow-up, so the six-month recurrence results cannot be separated from post-healing preventive care.

Outcome measurement and reporting

The study also highlights why standardized outcome definitions are important. The retained study summary does not define complete healing or time to ambulation, and it does not include minor amputation, mortality, quality of life, or complete infection ascertainment. The 2024 international core outcome set for diabetes-related foot-ulcer intervention studies identifies wound healing, time to heal, new/recurrent ulceration, infection, major and minor amputation, health-related quality of life, and mortality as core outcomes [16]. In 2026, an international core descriptor further recommended a standard minimum set of baseline participants, ulcer, limb, treatment, biochemical, and quality-of-life descriptors for comparative studies [15]. Future studies of dorsal versus plantar access should prospectively incorporate both frameworks.

Strengths and limitations

The strength of the study is the clinically focused comparison of two operative approaches in 120 patients treated by one surgical team, with quantitative reporting of healing time, hospital stay, ambulation, recurrence, and major amputation. The observed effect sizes are large enough to justify further prospective evaluation. Studying has important limitations. It was retrospective and non-randomized; the rationale for approach selection is unknown; patient-level data are unavailable; and baseline comparability cannot be established. Ulcer area, depth, duration, classification, vascular status, glycemic control by group, first-versus-fifth metatarsal distribution, smoking, renal disease, and other clinically relevant confounders could not be adjusted for. Dorsal access was inseparable from primary closure and plantar access from secondary-intention healing. Formal definitions of healing, ambulation, infection, delayed healing, and instability were not preserved. The method used to exclude osteomyelitis and fully assess perfusion was incompletely documented. Complete cross-group complication ascertainment was unavailable. Healing-time distributions and censoring could not be evaluated, and all statistical comparisons are based on aggregate summary data. Finally, six-month follow-up is inadequate for robust assessment of recurrent or transfer ulceration. These limitations mean that the numerical differences are best regarded as hypothesis-generating associations rather than estimates of causal efficacy.

Implications for future research

A prospective multicenter comparative cohort or randomized study is required before one surgical approach can be preferred. Such a study should use explicit criteria for approach selection; standardized ulcer descriptors and classification [14,15]; objective perfusion assessment [21]; a documented osteomyelitis pathway [17]; standardized pre- and postoperative offloading [4,5]; a prespecified healing definition; time-to-event analysis where censoring occurs; and at least 12 months of follow-up for recurrence and transfer lesions. If randomization is not feasible, the analysis should prespecify clinically justified confounders and use multivariable or propensity-based methods. Core patient-important outcomes should follow the recent international consensus set [16].

Conclusion

In this retrospective comparative cohort, dorsal metatarsal head resection with primary closure was associated with shorter recorded healing time, shorter hospital stay, and earlier recorded ambulation than plantar resection with secondary-intention healing in patients with neuropathic ulcers beneath the first or fifth metatarsal head and without documented osteomyelitis. These findings do not establish that dorsal access is intrinsically superior because treatment allocation was non-randomised, baseline ulcer and vascular severity could not be adjusted for, and surgical access was confounded by closure strategy. Six-month recurrence estimates were too imprecise and follow-up too short to demonstrate equivalence. Prospective comparative studies using standardised patient selection, offloading, perfusion assessment, outcome definitions, and longer follow-up are warranted.

Declarations

Ethics approval and consent

This retrospective study was approved by the Ethics Committee of Tobruk Medical Center, Tobruk, Libya. The study involved retrospective review of existing clinical records. All patient data were handled confidentially and analysed in anonymised form.

Consent for publication

Written informed consent for publication of the clinical photographs and associated anonymised clinical information was obtained from all patients whose images are included in this manuscript.

Conflicts of interest and Funding

The author declares no conflicts of interest. No specific funding was received for this study.

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