

Limb Salvage through Sequential Local Drug and Agent Delivery in a Wagner Grade 5 Diabetic Foot Ulcer with Multidrug Resistant Infection: A Case Report

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ABSTRACT

Case presentation: A 51 year old woman with poorly controlled type 2 diabetes mellitus, hypertension, and dyslipidemia presented with an extensive, malodorous Wagner grade 5 neuropathic ulcer of the retrocalcaneal region, with necrotic tissue, purulent exudate, exposed bone, and systemic signs of infection, together with severe hyperglycemia (450 mg/dL) and mild diabetic ketosis. Laboratory work-up showed marked systemic inflammation (leukocytosis with neutrophilia, neutrophil to lymphocyte ratio 12.77, platelet-to-lymphocyte ratio 357, systemic immune inflammation index 5263, C-reactive protein 327 mg/L) and hypoalbuminemia. A coordinated, multidisciplinary strategy diabetology, wound care, culture-guided antimicrobial therapy, and rehabilitation combined volume expansion, empirical broad-spectrum antibiotics later adjusted to culture guided meropenem for multidrug-resistant *Klebsiella pneumoniae*, minimally invasive debridement, structured metabolic control (insulin degludec, empagliflozin/metformin), and staged wound bed preparation with enzymatic debridement, hydrocolloid and foam dressings, adjunctive ozone therapy, and therapeutic ultrasound. At approximately three months, the wound showed close to 92% closure, the limb was fully preserved without amputation, and the patient regained functional strength (Oxford grade 4/5).

Discussion: This case illustrates how a coordinated, multidisciplinary limb salvage strategy integrating metabolic control, culture-guided infection management, sequential wound-bed preparation, and planned biomechanical offloading and rehabilitation can achieve limb preservation even in an advanced (Wagner grade 5), infected neuropathic diabetic foot ulcer traditionally associated with a high risk of major amputation. Blood count derived systemic inflammatory indices appear to be inexpensive, readily available adjuncts for stratifying infection severity and for guiding the intensity and urgency of multidisciplinary intervention.

Conclusion: These findings support the growing evidence that structured, team based diabetic foot programs substantially reduce amputation rates compared with fragmented, single specialty care.

Keywords: diabetic foot ulcer; limb salvage; multidisciplinary team; wound healing; debridement; amputation prevention

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INTRODUCTION

Diabetic foot ulcers (DFUs) remain among the most burdensome complications of diabetes mellitus, with an estimated global prevalence of 6.3% among people with diabetes and marked variation across regions and levels of access to structured multidisciplinary foot care¹. Approximately one in six people with diabetes will develop a foot ulcer during their lifetime, and up to 85% of major lower-limb amputations are preceded by an ulcer that could plausibly have been prevented or treated earlier¹. Ulcer severity is commonly graded using the Wagner classification, a six-tier system (grades 0–5) based on wound depth, tissue involvement, and the presence of gangrene; grade 5 denotes extensive gangrene of the entire

foot and has traditionally been associated with a high risk of major amputation².

Current international guidance emphasizes that outcomes depend on the simultaneous correction of infection, mechanical off-loading, and metabolic control, delivered through a coordinated multidisciplinary team rather than through local wound care alone. The 2023 update of the International Working Group on the Diabetic Foot (IWGDF) and Infectious Diseases Society of America (IDSA) guideline recommends prompt clinical diagnosis of infection, targeted microbiological sampling, and antibiotic therapy adjusted to culture and antibiogram results, together with surgical debridement when deep or

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bone infection is suspected³. Complementary IWGDF guidance on wound-bed preparation supports sharp debridement as the standard of care, reserving adjunctive technologies for situations in which standard care alone has failed to achieve healing⁴, while off-loading of mechanical tissue stress is regarded as one of the most important, and most frequently neglected, components of ulcer healing⁵.

Structured, multidisciplinary diabetic foot programs typically anchored by a wound care specialist or podiatrist working together with a vascular surgeon (the so-called “toe and flow” model), diabetologist, infectious-disease specialist, and rehabilitation team have been associated with substantial reductions in major lower-extremity amputation rates compared with fragmented, single specialty care⁶. Implementation of a dedicated multidisciplinary diabetic-foot unit has been shown to lower the incidence of lower-extremity amputation compared with standard, noncoordinated care⁷, and regional implementation of toe and flow programs has reported decreases in amputation incidence of approximately 39% to 56%, together with fewer diabetes-related hospitalizations⁸. We report the case of a patient with a Wagner grade 5 neuropathic diabetic foot ulcer, complicated by multidrug-resistant infection and severe metabolic decompensation, managed through a coordinated multidisciplinary limb-salvage strategy, to illustrate how the integration of infection control, metabolic optimization, wound bed preparation, and planned rehabilitation can prevent amputation even in an advanced, high-risk presentation.

CASE REPORT

A 51 year old woman with an approximately ten-year history of type 2 diabetes mellitus, arterial hypertension, and dyslipidemia was evaluated for an extensive ulcer of the retrocalcaneal region with deep compromise of the calcaneal–talar area and ankle. On examination, the wound bed showed necrotic tissue, purulent and malodorous exudate, and undermined edges, with loss of epidermis, dermis, subcutaneous tissue, and muscle plane, and exposed calcaneal bone. The patient reported unmeasured fever, chills, and general malaise. Neurological assessment with a 10-g monofilament and 128-Hz tuning fork documented grade 3 sensory and grade 2 motor diabetic neuropathy; peripheral pulses were weak but palpable, capillary refill was normal, and there were no clinical signs of critical limb ischemia. Biomechanical examination revealed claw deformity of the second toe, onychogryphosis, onychocryptosis, onychomycosis, and plantar forefoot hyperkeratosis. The ulcer was classified as Wagner grade 5.

Prior outpatient diabetes treatment consisted of NPH insulin (20 IU before breakfast, 30 IU before the evening meal) and metformin 850 mg twice daily, with losartan 100 mg once daily for hypertension. On admission, capillary glucose was 450 mg/dL with HbA1c 13%, consistent with long-standing poor metabolic control and mild diabetic ketosis. Laboratory findings relevant to infection severity and systemic inflammatory burden, obtained on a subsequent control sample, are summarized in Table 1.

Table 1. Summary of key clinical, laboratory, and systemic inflammatory index findings.

Variable	Result	Interpretation
Wagner classification	Grade 5	Deep, infected ulcer with bone exposure
Hemoglobin	9.40 g/dL	Anemia
Leukocytes	16,910 /mm ³	Leukocytosis
Segmented neutrophils	87.2%	Neutrophilia
Lymphocytes	7.0%	Lymphopenia
Neutrophil-to-lymphocyte ratio (NLR)	12.77	High risk of endothelial dysfunction
Platelet-to-lymphocyte ratio (PLR)	357	Systemic inflammation, prothrombotic state
Systemic immune-inflammation index (SII)	5,263	Significant systemic inflammatory activation
C-reactive protein	327.06 mg/L	Marked acute-phase response
D-dimer	364.00 ng/mL	Elevated
Serum albumin	2.89 g/dL	Hypoalbuminemia
Urine glucose	1000 mg/dL	Severe glycosuria
Urine ketone bodies	80 mg/dL	Ketosis
Wound culture	Multidrug-resistant	Susceptible to meropenem on

Variable	Result	Interpretation
	Klebsiella pneumoniae	antibiogram

Note. Admission glycemia (450 mg/dL) and HbA1c (13%) were recorded at initial presentation; the remaining laboratory

Values correspond to a subsequent control sample

Care was coordinated from the outset by a multidisciplinary team comprising diabetology, wound care, and infectious-disease-guided antimicrobial management. Initial management combined intravenous 0.9% saline for volume expansion and minimally invasive surgical debridement with removal of necrotic, infected, and compromised bony tissue and alignment of wound edges. Tissue culture isolated multidrug-resistant *Klebsiella pneumoniae*, with an antibiogram susceptibility to meropenem, for a total of 10 days; a follow up culture after completion of therapy showed no isolation of *Klebsiella pneumoniae*, and the patient subsequently completed a 5-day course of levofloxacin 500 mg once daily before discontinuing antibiotics.

Metabolic management was intensified with insulin degludec 40 IU administered 30 minutes before lunch and empagliflozin/metformin 12.5 mg/850 mg once daily before breakfast, together with a structured nutritional plan (five meals per day with carbohydrate counting and planned protein and fiber intake). Blood pressure was controlled with valsartan 160 mg plus hydrochlorothiazide 12.5 mg once daily. Within three days, capillary glucose values remained below 150 mg/dL.

Wound bed preparation followed a staged protocol. The wound was irrigated with 0.9% saline, 4% chlorhexidine, and hypochlorite solution. During the infective phase, a size 14 urinary catheter was placed within the wound as an irrigation conduit, delivering hypochlorite solution at 10 mL/hour for 48 hours (a wick/irrigation technique). Once infection was controlled, granulation was promoted with continued lavage, enzymatic debriding agents, and hydrocolloid dressings, complemented by adjunctive ozone therapy and therapeutic ultrasound; 10% urea was applied to intact periwound skin to maintain hydration. During epithelialization, epithelializing creams and foam dressings were used, and closing areas were treated with vitamin E and urea, with ozone therapy and ultrasound continued as adjuncts.

The clinical course was documented photographically. Figure 1 shows the wound at initial presentation, with extensive necrotic and purulent tissue and exposed bone (Wagner grade 5). Figure 2 shows the wound bed after debridement and progressive granulation, with a smaller, cleaner defect. Figure 3 shows the wound at approximately three months, with advanced epithelialization and an estimated 92% reduction of the original wound area.



Figure 1. Initial presentation: extensive Wagner grade 5 retrocalcaneal ulcer with necrotic tissue, purulent exudate, and exposed bone



Figure 2. Wound bed after debridement, showing a smaller defect with progressive granulation tissue.



Figure 3. Advanced healing at approximately three months, with epithelialization and an estimated 92% reduction of wound area.

At the most recent evaluation, approximately three months after presentation, the wound showed close to 92% closure with small residual open areas. Insulin was discontinued, and the patient continued empagliflozin/metformin with dietary management and a stable antihypertensive regimen. The limb was preserved in its entirety, without amputation. Functional rehabilitation with phase-1 kinesiotherapy was initiated, with muscle strength of 4/5 on the Oxford scale, and the patient was scheduled for personalized offloading and a podiatric/biomechanical insole assessment to reduce the risk of recurrence.

DISCUSSION

Management followed the sequence emphasized by current IWGDF/IDSA guidance: prompt clinical diagnosis of infection, empirical broad-spectrum antibiotic therapy pending culture, surgical debridement of necrotic and infected tissue, and escalation once susceptibility results were available³. In this case, effective limb salvage required the coordinated input of several specialties functioning as a single team: diabetology for glycemic and metabolic stabilization, wound care for sequential

debridement and dressing selection, microbiology guided infectious disease management, and rehabilitation medicine for functional recovery the core composition described for effective diabetic foot limb salvage teams⁶. Sharp debridement combined with basic moisture-balanced dressings remains the recommended standard of wound-bed preparation, with adjunctive modalities enzymatic debridement, ozone therapy, and therapeutic ultrasound considered complementary once standard care alone has not achieved the desired progress⁴. Off-loading of mechanical stress, although not the central focus of this report, remains an essential and often under prioritized component of healing and recurrence prevention, and was planned for this patient through a personalized insole once wound closure allowed for biomechanical assessment⁵.

Comparable favorable outcomes have been reported in other published case reports of severe, infected diabetic foot ulcers with bone or tendon exposure managed through coordinated, staged multidisciplinary protocols similar to the one applied here. Table 2 summarizes these cases alongside the present one.

Table 2. Comparison with other published case reports of severe diabetic foot ulcers managed with multidisciplinary limb-salvage protocols.

Study (year)	Wagner grade / key feature	Core intervention	Reported outcome
Present case (2026)	Grade 5, retrocalcaneal ulcer, MDR <i>Klebsiella pneumoniae</i> , bone exposure	Culture-guided meropenem, staged debridement, catheter-based hypochlorite irrigation, ozone therapy, ultrasound	~92% wound closure, full limb preserved, Oxford 4/5 at 3 months
Godoy-Santos et al., 2017	Infected ulcer with calcaneal bone	Staged debridement, bone allograft, free muscle flap	Full limb salvage with reconstructed,

Study (year)	Wagner grade / key feature	Core intervention	Reported outcome
	exposure	reconstruction	functional foot
Chai et al., 2020	Grade 4, MDR <i>Pseudomonas aeruginosa</i>	Debridement, culture-guided meropenem, glycemic control	Complete wound healing without amputation in ~40 days
Chen & Chang, 2026	Grade 4, ischemic, necrotizing fasciitis	NPWT with instillation/dwell time, dermal substitute, multidisciplinary comorbidity management	>70% granulation coverage of exposed bone/tendon, limb salvage, no amputation

Note. MDR = multidrug-resistant; NPWT = negative-pressure wound therapy.

As summarized in Table 2, these reports share the core features of the present case an advanced, infected diabetic foot ulcer with bone or tendon exposure, managed by a coordinated multidisciplinary team while differing in the specific technologies used to achieve wound-bed control and closure. Two of the four cases, including the present one, involved multidrug-resistant organisms: *Klebsiella pneumoniae* in the present case, and *Pseudomonas aeruginosa* in the case reported by Chai et al.⁹. In both instances, targeted antibiotic therapy guided by culture and antibiogram, combined with debridement and metabolic control, was sufficient to achieve healing without requiring free tissue transfer or bone reconstruction. By contrast, the case reported by Godoy-Santos et al. required complex microsurgical reconstruction with a bone allograft and a free muscle flap to achieve limb salvage¹¹, likely reflecting a greater degree of structural bone loss at presentation than in the present case, where staged debridement alone allowed the calcaneal defect to granulate and close. The case reported by Chen and Chang achieved substantial granulation coverage of exposed bone and tendon using negative-pressure wound therapy with instillation and dwell time as the central adjunctive technology¹⁰, whereas ozone therapy, enzymatic debridement, and a catheter-based irrigation technique served an analogous role in the present case; the two approaches achieved a similar degree of granulation coverage (>70% and an estimated 92% wound closure, respectively) despite relying on different adjunctive technologies, suggesting that the underlying principle of sequential infection control followed by structured wound-bed preparation may matter more than the specific adjunctive modality chosen. Despite these methodological differences, all four cases converge on a common finding: when infection, perfusion, and metabolic status are addressed early and simultaneously by a coordinated team, limb salvage remains achievable even in ulcers with Wagner grade 4–5 severity and exposed bone, a presentation that would conventionally be regarded as carrying a very high a priori risk of major amputation.

Adjunctive ozone therapy, used during the granulation and epithelialization phases in this patient, has been reported in several randomized and non-randomized trials to

accelerate granulation, reduce bacterial load, and improve wound closure when combined with conventional wound care¹⁰, which is consistent with the favorable evolution observed once infection control and metabolic stabilization had been achieved within the multidisciplinary protocol. This report has the inherent limitations of a single case: findings cannot be generalized, several clinical thresholds and classifications were applied according to the treating team's own criteria, and the sequence of adjunctive therapies (ozone, ultrasound, enzymatic debridement) does not allow the individual contribution of each intervention to be isolated. Nonetheless, the case adds a real-world, photographically and biochemically documented example of how a structured multidisciplinary limb-salvage protocol, informed by objective inflammatory risk markers, can achieve amputation-free healing in an advanced neuropathic diabetic foot ulcer.

CONCLUSION

In a patient with a Wagner grade 5 neuropathic diabetic foot ulcer complicated by multidrug-resistant infection and severe metabolic decompensation, a coordinated multidisciplinary limb-salvage strategy combining culture-guided infection control, correction of glycemic and blood-pressure control, sequential wound-bed preparation with adjunctive ozone therapy and ultrasound, and planned biomechanical offloading and rehabilitation achieved close to 92% wound closure, full limb preservation, and functional recovery at three months. Systemic inflammatory indices derived from the routine complete blood count (NLR, PLR, SII) may be useful, low cost adjuncts for risk-stratifying diabetic foot infection severity and for triggering timely activation of a multidisciplinary team. These findings reinforce the value of structured, team-based diabetic-foot programs consistent with the treating team's own guiding principle of “we salvage, we do not amputate” as an effective strategy for amputation prevention, even in advanced and high-risk presentations.

Declarations

Informed consent: Written informed consent was obtained from the patient for the publication of this case report and the accompanying clinical images.

Conflicts of interest: The authors declare no conflicts of interest.

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