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Comparative Analysis of Surgical Sanation Methods for Pyo-Necrotic Foci in Diabetic Foot Syndrome

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Abstract

The article examines surgical sanation methods used for pyo-necrotic foci in diabetic foot syndrome, with emphasis on the clinical logic of debridement, drainage, staged necrosectomy; negative pressure wound therapy, skin coverage, minor amputation, and selected adjunctive physical modalities. The topic remains clinically relevant because diabetic foot infection often combines tissue necrosis, ischemia, neuropathy, microbial contamination, and delayed repair. The novelty of the article lies in interpreting sanation as a staged surgical pathway, where each technique has a defined indication profile and a clear technical limit. The aim was to compare current methods of local source control and wound-bed preparation without presenting the work as an experimental study. The material base consisted of ten recent peer-reviewed publications and guidelines. Comparative source analysis, typological classification, and conceptual synthesis were applied. The analytical section defines method-specific indications, sequence logic, and closure-readiness criteria for practical surgical planning.

Keywords: Diabetic foot syndrome, Surgical sanation, Debridement, Wound therapy, Autologous skin grafting.

1. Introduction

Pyo-necrotic lesions in diabetic foot syndrome create a difficult surgical field because the visible wound surface rarely reflects the full extent of tissue damage. Necrosis, purulent discharge, tendon exposure, ischemia, neuropathic deformity, bacterial biofilm, and suspected bone involvement may coexist in the same foot. The surgeon therefore deals with a moving lesion, where the first operative step often changes the

diagnosis, the prognosis, and the reconstruction plan (Akter *et al.*, 2025).

The research aim is to compare surgical sanation methods for pyo-necrotic foci in diabetic foot syndrome and to define their indication logic within an analytical review design. Three objectives guide the work. The first objective is to distinguish the place of sharp surgical debridement, staged necrosectomy, drainage, and minor amputation in local source

control. The second objective is to compare wound-bed preparation methods; including negative pressure wound therapy, physical modalities, and local supportive interventions. The third objective is to clarify the conditions under which reconstructive closure, including autologous skin grafting or delayed soft-tissue coverage, becomes clinically justified.

The novelty of the article lies in a comparative model that links each sanitation method with wound-bed status, infection depth, perfusion, exposed anatomical structures, and readiness for closure. The working hypothesis states that surgical treatment of pyo-necrotic diabetic foot lesions becomes safer and more coherent when the surgeon selects methods through a staged matrix: source control, wound-bed conversion, and function-preserving closure (Kamal *et al.*, 2022).

2. Materials and Methods

The material base consisted of ten peer-reviewed English-language publications and guidelines issued between 2021 and 2025. The literature search covered PubMed, Google Scholar, journal platforms, and guideline repositories. The keyword clusters included “diabetic foot infection,” “diabetic foot ulcer,” “surgical debridement,” “pyo-necrotic lesion,” “negative pressure wound therapy,” “skin graft,” “minor amputation,” “osteomyelitis,” “photobio-modulation,” and “limb salvage.” The initial working pool contained 54 records. Screening excluded duplicates, papers centered on non-diabetic chronic wounds, publications without surgical relevance, device-centered reports with weak clinical transferability, studies outside the five-year frame, and materials lacking a direct relation to local sanitation. Ten sources remained for final synthesis. The corpus covered international infection guidelines, wound-healing guidelines, surgical reviews, systematic reviews on debridement and negative pressure wound therapy, reviews of physical modalities, and broad clinical summaries of diabetic foot ulcer management (Armstrong *et al.*, 2023; Chen *et al.*, 2024; Dalmedico *et al.*, 2024; Frykberg *et al.*, 2021; Huang *et al.*, 2023; Maity *et al.*, 2024; Roberts *et al.*, 2024; Sa *et al.*, 2024; Schaper *et al.*, 2024; Senneville *et al.*, 2023).

The work used comparative analysis to contrast surgical techniques by indication and wound status. UniversePG | www.universepg.com

Source analysis separated guideline-based positions from review-level interpretation. Conceptual synthesis formed a staged model of sanitation. Typological classification grouped interventions into source-control methods, wound-bed conversion methods, and closure-oriented methods. Analytical generalization supported practical decision logic for a non-experimental surgical review.

3. Results

Recent diabetic foot literature places surgical sanitation inside a wider chain of care. A wound procedure loses clinical value when perfusion, offloading, infection severity, and metabolic risk remain outside the treatment plan. A current clinical review in *JAMA* describes surgical debridement, pressure reduction, ischemia treatment, and infection control as core components of diabetic foot ulcer management (Armstrong *et al.*, 2023). The 2023 practical IWGDF update follows the same clinical architecture by linking prevention, classification, infection control, offloading, vascular assessment, and wound healing (Schaper *et al.*, 2024). For a comparative review of pyo-necrotic foci, this means that every surgical method should be evaluated through the wound state it creates and the next step it permits.

Sharp surgical debridement occupies the first position in most infected necrotic lesions. It removes devitalized tissue, opens contaminated planes, reduces the substrate for bacterial persistence, and exposes the true borders of tissue involvement. A recent review of debridement techniques links method selection to ulcer characteristics, necrotic burden, infection, clinician expertise, and the need for rapid wound-bed correction (Sa *et al.*, 2024). In a diabetic foot lesion with spreading cellulitis, abscess, wet gangrene, malodor, undermining, tendon involvement, or suspected compartmental extension, the main advantage of sharp debridement is speed. Enzymatic, autolytic, biological, and mechanical approaches can support selected wounds, yet they do not replace operative opening and drainage in the presence of pus or systemic risk.

The comparison becomes more nuanced in chronic ulcers with adherent slough, limited infection, and fragile marginal tissue. Sharp debridement remains a reference procedure, although repeated conservative

debridement may reduce avoidable trauma when demarcation is incomplete. The same review separates sharp, mechanical, autolytic, enzymatic, and biological techniques by practical use, wound depth, exudate, pain, ischemia, and infection status (Sa *et al.*, 2024). For pyo-necrotic diabetic foot syndrome, this evidence supports a narrow conclusion. Non-sharp modalities are useful as supportive tissue-management options in selected wounds, while infected necrosis requires rapid source control.

Infection severity changes the threshold for surgery. The IWGDF/IDSA guideline recommends clinical diagnosis of soft-tissue infection, severity grading through the IWGDF/IDSA classification, tissue specimen culture when feasible, and imaging when osteomyelitis remains uncertain after initial evaluation (Senneville *et al.*, 2023). This structure has direct surgical value. The surgeon does not choose debridement in isolation. The operative decision depends on whether the wound represents superficial infection, deep soft-tissue involvement, abscess, necrotizing spread, bone infection, ischemic gangrene, or a mixed lesion. Superficial infected slough may require limited debridement with antimicrobial therapy. A plantar abscess requires incision, drainage, and exploration. Suspected osteomyelitis may require bone sampling, partial bone resection, or staged surgery.

Systematic review evidence on diabetic foot infections adds microbiological weight to this logic. Recent synthesis describes diabetic foot infections as clinically heterogeneous and microbiologically diverse, with antimicrobial resistance and pathogen variation complicating treatment (Maity *et al.*, 2024). The surgical consequence is practical. Debridement provides tissue for microbiological examination and reduces necrotic material that supports persistent bacterial growth. Surgery still does not solve every infectious problem alone. Antibiotic choice, vascular status, renal function, glycemic instability, and local tissue viability influence whether a limited procedure will be enough or whether a staged operative plan carries less risk.

The surgical literature on limb preservation supports staged treatment. An evidence-based overview of amputation prevention describes diabetic foot surgery

through vascular recognition, foot-sparing procedures, minor amputations, reconstruction, and multidisciplinary care (Frykberg *et al.*, 2021). This matters because pyo-necrotic sanation often gets misread as a single radical operation. In many cases, the safer operation is a limited source-control procedure followed by reassessment. In other cases, delayed resection of nonviable toes, metatarsal heads, or infected bone prolongs infection and prevents granulation. The surgical question concerns the remaining tissue: whether it can sustain healing, carry load, and preserve usable foot architecture.

A later surgical review narrows this reasoning by connecting diabetic foot surgery with neuropathy, ischemia, infection, deformity, and reconstruction (Roberts *et al.*, 2024). This source directly supports the comparison of method-specific indications. Two wounds with similar surface area may require different operations. A forefoot ulcer with localized osteomyelitis may require bone resection or minor amputation with soft-tissue preservation. A plantar ulcer over a deformity may require removal of the pressure-producing structure, since the same pressure point will reopen the wound after closure. A necrotic focus in an ischemic foot may require vascular intervention before definitive coverage. Surgical sanation therefore has anatomical, infectious, vascular, and biomechanical components.

Negative pressure wound therapy occupies another stage. It is not the first method for necrosis removal and it should not cover uncontrolled infection, untreated necrotic tissue, active bleeding, or uncorrected ischemia. Its clinical value begins after adequate debridement, when the wound bed contains viable tissue but still produces exudate, contains dead space, or requires granulation before closure. A systematic review and meta-analysis of randomized controlled trials reports that negative pressure wound therapy has been studied as an adjunct in diabetic foot ulcers and may improve wound-related outcomes compared with standard care in selected settings (Dalmedico *et al.*, 2024). For surgical sanation, this places vacuum therapy in the interval between source control and closure. It stabilizes the wound environment after the surgeon has removed the pyo-necrotic substrate.

The IWGDF wound-healing guideline gives this point a cautious frame. It supports consideration of negative pressure wound therapy for postoperative wounds and evaluates adjunctive interventions for diabetic foot ulcers with restraint (Chen *et al.*, 2024). That restraint protects the clinician from device-centered decision-making. Negative pressure requires a prepared wound, protection of exposed structures, bleeding control, and scheduled reassessment. Persistent slough under the dressing or untreated ischemia can conceal deterioration. In a comparative model, negative pressure therapy belongs to wound-bed conversion. It is not primary sanitation.

Autologous skin grafting and other closure methods belong to a later phase. Their indication depends on absence of uncontrolled infection, sufficient perfusion, stable granulation, manageable exudate, and reduction of mechanical pressure. The 2023 IWGDF wound-healing guideline uses a conservative approach to skin substitute products and separates standard care from selected adjunctive options (Chen *et al.*, 2024). For the narrow focus of this article, the implication is clear. Autologous skin coverage continues sanitation after wound-bed preparation. It does not compensate for residual pus, bone sequestra, or plantar overload.

Physical modalities require restrained interpretation. Pyo-necrotic diabetic foot syndrome often motivates adjunctive treatment when inflammation, microcirculatory dysfunction, pain, and delayed epithelialization complicate repair. A review of physical therapy in diabetic foot ulcer care describes energy-based techniques such as shockwave therapy, electrical stimulation, magnetic stimulation, ultrasound, and photobiomodulation, with emphasis on wound condition and evidence quality (Huang *et al.*, 2023). The IWGDF wound-healing guideline gives a more conservative evaluation of physical therapies, which limits their placement in the sanitation sequence (Chen *et al.*, 2024). For surgical sanitation, polychromatic or photobiomodulation-type exposure can be discussed as an adjunct after debridement and infection control, especially during the transition to repair. It should not be described as a method for removing necrotic tissue.

A comparison of four sources clarifies the decision path. The IWGDF/IDSA infection guideline prioritizes

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diagnosis, severity grading, tissue culture, imaging, antimicrobial strategy, and surgery when indicated (Senneville *et al.*, 2023). A surgical evidence review places source control within limb salvage and multidisciplinary surgery (Roberts *et al.*, 2024). A debridement review separates tissue-removal techniques by wound characteristics and practical use (Sa *et al.*, 2024). The negative pressure meta-analysis deals with an adjunctive technology that supports healing after wound preparation (Dalmedico *et al.*, 2024). Together, these positions support a staged hierarchy. Infected necrosis first requires opening, drainage, and debridement. The residual defect then needs conversion into a clean granulating surface. Closure becomes justified when the wound bed, perfusion, and load conditions can sustain repair.

A second comparison concerns osteomyelitis and bone-linked pyo-necrotic foci. Infection guidelines recommend imaging when bone involvement remains uncertain and surgical treatment in selected cases of diabetes-related foot osteomyelitis (Senneville *et al.*, 2023). Reviews of diabetic foot surgery describe conservative bone resection, ray amputation, exostectomy, and deformity correction as function-preserving options when anatomy and viability allow their use (Frykberg *et al.*, 2021, Roberts *et al.*, 2024). A broad diabetic foot ulcer review reinforces that infection treatment must remain linked with offloading and ischemia correction (Armstrong *et al.*, 2023). Bone sanitation therefore addresses a distinct surgical problem: persistent infected structure, sequestrum, deformity-driven recurrence, or mechanically exposed bone. **Fig. 1** presents the staged placement of the main sanitation methods within the surgical pathway.

The figure separates methods by their operative timing. Negative pressure therapy before source control may seal an infected cavity. Skin grafting before stable granulation increases the risk of failed coverage. Repeated superficial cleaning without opening a deep abscess delays infection control. Wide resection without perfusion assessment may create a larger nonhealing defect. The reviewed sources support a final typology. Primary sanitation methods include sharp debridement, necrosectomy, incision and drainage, bone sampling, and minor amputation when tissue or bone cannot be preserved.

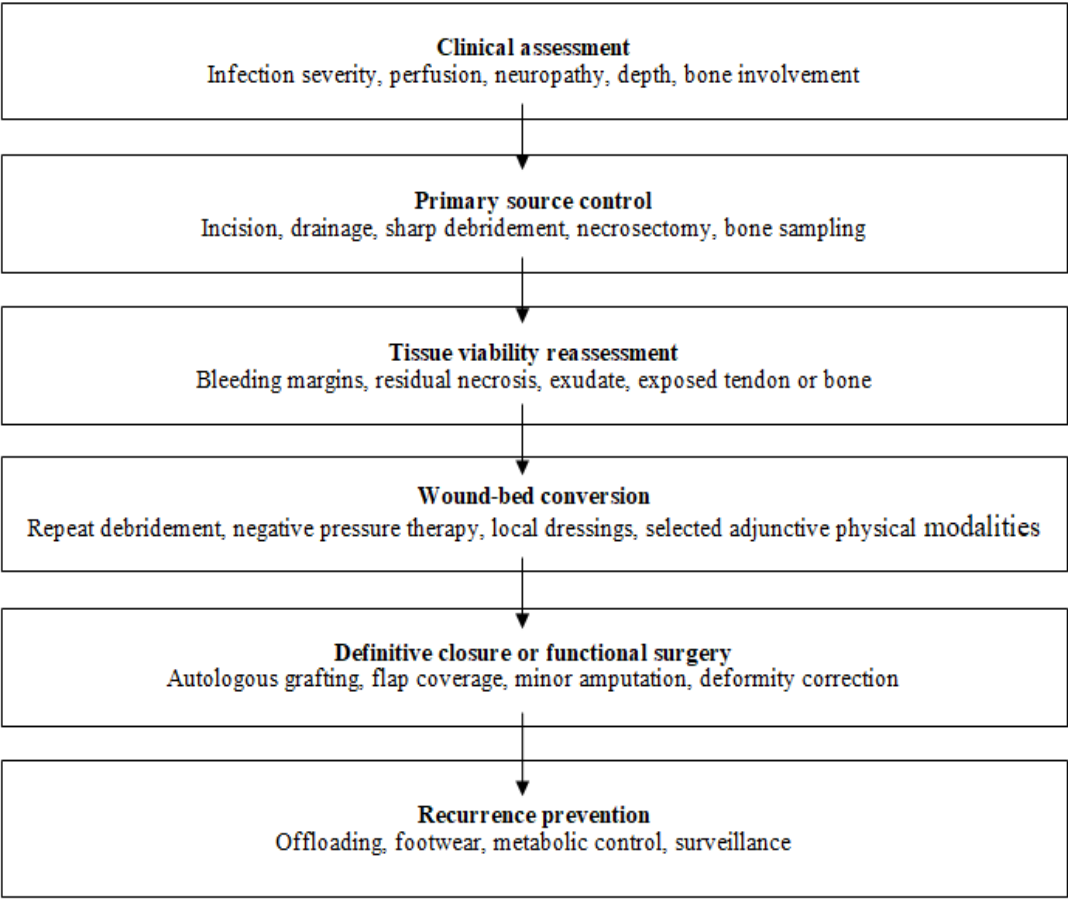


Fig. 1: Staged placement of surgical sanitation methods in pyo-necrotic diabetic foot lesions (compiled by the author based on Senneville *et al.*, 2023; Chen *et al.*, 2024; Roberts *et al.*, 2024).

Wound-bed conversion methods include repeated selective debridement; negative pressure wound therapy, moisture-balanced dressings, and selected adjunctive physical modalities. Closure methods include autologous grafting, flap procedures, delayed primary closure, and functional resection. This typology separates source control, wound preparation, and reconstructive readiness without claiming universal superiority of one method across all diabetic foot lesions.

4. Discussion

Surgical sanitation of pyo-necrotic diabetic foot lesions works best as a sequence of decisions. Debridement, vacuum therapy, light exposure, grafting, and minor amputation solve different problems. Debridement removes dead tissue and gives the surgeon access to viable margins. Drainage eliminates closed purulent spaces. Bone resection removes infected or mechanically destructive structures. Negative pressure therapy

manages a prepared wound. Skin grafting or flap coverage completes repair when infection, perfusion, and pressure conditions have reached a stable state.

Premature transition to the next stage creates predictable complications. A graft over a contaminated surface fails because the wound bed cannot support integration. Vacuum therapy over an unrecognized abscess delays reoperation. Conservative dressings in the presence of wet gangrene give infection time to extend along tissue planes. Excessive radicality carries its own harm. Removal of more tissue than the infectious and ischemic pattern requires enlarges the defect and may damage foot mechanics. The safest strategy uses staged judgment, anatomical precision, and repeated reassessment. **Table 1** compares the methods by surgical purpose, indication, limitation, and trigger for transition. It is designed for clinical reasoning in an analytical review, not for direct protocolization.

Table 1: Comparative indication profile of surgical sanitation methods for pyo-necrotic diabetic foot lesions (compiled by the author based on Armstrong *et al.*, 2023; Sa *et al.*, 2024; Senneville *et al.*, 2023; Roberts *et al.*, 2024).

Method	Main surgical purpose	Typical indication	Boundary of use	Decision trigger for next step
Sharp surgical debridement	Rapid removal of devitalized tissue and exposure of viable margins	Slough, necrosis, infected ulcer base, undermining, contaminated wound bed	Severe ischemia and unclear tissue viability require caution	Clean bleeding margins, reduced necrotic load, visible depth of lesion
Incision and drainage	Elimination of closed purulent spaces	Abscess, phlegmon, deep plantar or interdigital infection, tense swelling	Drainage alone leaves risk when necrotic tissue remains	Collapse of cavity, microbiological sampling, reassessment of spread
Staged necrosectomy	Controlled removal of necrosis over repeated procedures	Mixed viable and nonviable tissue, ischemia risk, uncertain demarcation	Prolonged staging delays control if infection progresses	Stable demarcation, granulation, absence of new necrosis
Bone resection or minor amputation	Removal of infected or nonviable skeletal structures	Osteomyelitis, gangrenous toe, exposed infected bone, nonfunctional segment	Excessive resection may impair biomechanics and future offloading	Stable stump, controlled infection, closure feasibility
Negative pressure wound therapy	Wound-bed conversion after source control	Prepared postoperative wound, exudate, dead space, need for granulation	Uncontrolled necrosis, untreated abscess, active bleeding, and critical ischemia limit use	Granulation coverage, reduced exudate, readiness for graft or closure
Autologous skin grafting	Surface closure of a prepared defect	Clean granulating wound, adequate perfusion, controlled infection, manageable load	Exudate, shear, residual infection, and ischemia increase failure risk	Epithelial integration, stable coverage, transition to offloading plan
Adjunctive physical modalities	Supportive modulation of repair phase	Delayed repair after source control, selected clean ulcers, pain or inflammatory persistence	These modalities do not replace debridement, drainage, revascularization, or antibiotics	Objective wound progression under standard monitoring

The table shows that the main distinction between methods lies in the type of wound transformation they produce. Sharp debridement and drainage change the infectious state. Negative pressure therapy changes the postoperative wound environment. Grafting changes the closure status.

Adjunctive modalities influence repair after the main surgical problem has been controlled. This order protects the article from inflated claims about supportive methods.

A practical implementation model can rely on four checkpoints. The first checkpoint is infection depth. Local redness and superficial slough require a limited response, while abscess, wet necrosis, systemic signs, or suspected fascial extension require urgent source control. The second checkpoint is perfusion. Poor bleeding after debridement gives the surgeon a different risk profile from a wound with viable margins. The third checkpoint is structural involvement. Exposed tendon, joint capsule, metatarsal head, or phalanx changes the procedure from soft-tissue

sanitation to anatomical reconstruction or resection. The fourth checkpoint is closure readiness. A clean surface alone cannot sustain repair if pressure, exudate, or tissue tension remain uncontrolled. This model reduces two recurrent surgical errors. Under-treatment appears when clinicians repeat dressing changes while a hidden purulent space continues to destroy tissue. Overtreatment appears when surgeons remove tissue that limited resection, staged debridement, vascular correction, and delayed closure might have preserved. The boundary between these errors cannot be drawn from the wound photograph. It requires probing, imaging when indicated, vascular assessment, microbiology, pain pattern, systemic status, and direct evaluation of tissue planes. Negative pressure wound therapy needs careful positioning. Surgeons often choose it because it reduces exudate and supports granulation. In pyo-necrotic diabetic foot

lesions, those effects help only after the dirty phase has been controlled. The surgeon should start vacuum therapy only after documenting what has been removed, which structures remain exposed, whether the wound bleeds adequately, and why no closed abscess persists. Without these answers, the device can hide deterioration under a clean dressing. Autodermoplasty or split-thickness grafting requires an even stricter threshold. In diabetic foot syndrome, closure and healing are not the same event. A graft may take on a clean surface, yet recurrence follows if plantar pressure, footwear, deformity, or ischemia remains active. Grafting fits broad superficial defects with stable granulation, adequate perfusion, controlled drainage, and mechanical protection. It fits poorly in wet, infected, undermined, ischemic, or load-bearing cavities.

Table 2: Monitoring criteria for staged surgical sanitation and readiness for wound closure (compiled by the author based on Schaper *et al.*, 2024; Chen *et al.*, 2024; Dalmedico *et al.*, 2024; Frykberg *et al.*, 2021).

Monitoring domain	What is assessed	Clinical meaning	Decision supported
Infection control	Local warmth, edema, drainage character, odor, systemic response, culture adequacy	Shows whether source control and antimicrobial strategy match the lesion	Repeat debridement, drainage, antibiotic revision, imaging
Tissue viability	Bleeding margins, color, demarcation, residual slough, pain pattern when present	Separates tissue able to support repair from tissue likely to fail	Staged necrosectomy, vascular reassessment, delayed closure
Perfusion status	Pulse examination, vascular testing, wound-edge viability, ischemic signs	Determines whether local surgery can progress safely	Revascularization consultation, limited surgery, delayed reconstruction
Structural involvement	Bone exposure, tendon exposure, joint communication, deformity, plantar pressure point	Defines whether the lesion is soft-tissue, osteoarticular, or biomechanical	Bone sampling, minor amputation, exostectomy, pressure correction
Wound-bed conversion	Granulation quality, exudate volume, dead space, undermining, dressing tolerance	Indicates readiness for continuation of vacuum therapy or closure	Continue negative pressure therapy, change dressing strategy, prepare graft
Closure readiness	Clean surface, controlled drainage, stable load protection, absence of progressive necrosis	Shows whether coverage has a realistic chance of durability	Autologous grafting, flap coverage, delayed primary closure
Recurrence prevention	Offloading adherence, footwear plan, glycemic risk, patient mobility, follow-up access	Reduces the risk that a technically successful operation becomes a recurrent ulcer	Long-term surveillance, orthotic plan, education, multidisciplinary care

Adjunctive polychromatic or photobiomodulation-type exposure should appear in the article as a supportive method with limited claims. Its most coherent place is the reparative interval after debridement and infection control. The justification concerns local repair conditions, pain, inflammation, and epithelialization in selected wounds. Light-based methods do not remove necrosis, drain pus, resect infected bone, or correct ischemia. The article should keep that boundary visible. **Table 2** proposes monitoring criteria for staged sanation and closure readiness. It avoids numerical thresholds because the review has no original dataset.

The second table moves the discussion from selection of procedures to control of transitions. A review article on sanation gains practical value when it explains how the surgeon decides that the wound has moved from one phase to another. This distinction matters in diabetic foot syndrome because local improvement can coexist with unresolved risk. Clean granulation without offloading remains fragile. Infection control without perfusion remains incomplete. A technically adequate graft without surveillance remains vulnerable. The proposed operative sequence can be expressed through three clinical questions. The first operation should determine whether pus, necrosis, infected bone, or nonviable tissue remains. The interval phase should determine whether the wound moves from contamination to repair. The closure step should determine whether the foot can tolerate coverage under real loading conditions. This sequence allows different methods to coexist without overstating their capabilities.

The article should avoid universal ranking of surgical methods. Current literature does not support a single hierarchy across all diabetic foot lesions. Conditional superiority gives a more accurate position. Sharp debridement works best for urgent removal of infected necrosis. Negative pressure therapy fits selected prepared postoperative wounds with exudate and dead space. Grafting fits clean granulating surfaces that require coverage. Adjunctive physical modalities support repair after the surgeon has completed primary source control. The practical recommendation is to present surgical sanation as an indication matrix. Each

method should answer the wound's dominant problem: infection, necrosis, ischemia, exudate, exposed structures, tissue deficit, or recurrence risk. Such a matrix suits an analytical review because it avoids invented numerical outcomes and gives the reader a reproducible clinical framework.

5. Conclusion

Surgical sanation of pyo-necrotic foci in diabetic foot syndrome requires a staged selection of interventions according to infection depth, tissue viability, perfusion, structural involvement, and wound-bed condition. Primary source control relies on sharp debridement, necrosectomy, incision and drainage, bone sampling, and minor amputation when infected or nonviable structures cannot be preserved. After source control, repeated selective debridement, negative pressure wound therapy, appropriate dressings, and selected physical modalities support wound-bed conversion by controlling exudate and promoting conditions suitable for granulation. Reconstructive closure, including autologous skin grafting and other coverage techniques, becomes appropriate when infection is controlled, perfusion is sufficient, the wound bed is stable, and mechanical protection can be maintained. The comparison indicates that the reviewed methods address different stages of the same surgical pathway and therefore require selection according to their specific indications and limits of use. The proposed hypothesis is supported at the conceptual level: linking source control, wound-bed conversion, and closure readiness within a staged decision matrix provides a coherent framework for choosing surgical sanation methods while preserving tissue and preparing the foot for durable wound closure.

6. Acknowledgment

The author has no acknowledgments to declare.

7. Conflicts of Interest

The author declares no conflicts of interest.

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