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Pirogoff Amputation for Limb Salvage in Maggot-Infested Diabetic Foot Ulcer: A Case Report and Systematic Review

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Abstract

Background
Severe diabetic foot infection is a leading cause of non-traumatic lower-limb amputation worldwide. While below-knee amputation is frequently performed for advanced infection, limb-sparing procedures that preserve limb length and allow end-bearing may offer improved functional outcomes in selected patients. Pirogoff amputation is a hindfoot amputation that preserves the calcaneus and heel pad, allowing creation of a stable end-bearing stump through tibiocalcaneal fusion.
Objective

To systematically review the available literature on Pirogoff amputation in diabetic foot disease and present a case demonstrating its role as a limb-sparing alternative in severe diabetic foot infection.
Methods

A systematic review was conducted according to PRISMA 2020 guidelines. Electronic databases including PubMed, Scopus, and Google Scholar were searched from database inception to March 2026 using predefined search terms related to Pirogoff amputation and diabetic foot infection. Studies reporting clinical outcomes of Pirogoff or modified Pirogoff amputation were included. Reviewers performed screening and eligibility assessment independently.
Results

The search yielded 2603 records, of which 23 studies met the inclusion criteria for qualitative synthesis. Most studies were case reports or case series describing modified Pirogoff techniques. The literature consistently indicates that successful outcomes are closely associated with preservation of a viable heel pad and adequate hindfoot perfusion, enabling creation of a durable end-bearing stump.
Case Presentation

A 55-year-old man with poorly controlled diabetes presented with severe infection of the left foot and maggot infestation following a non-healing ulcer after a rat bite. Pirogoff amputation was performed due to preserved hindfoot viability.
Conclusion

Pirogoff amputation represents a valuable limb-sparing option in selected patients with severe diabetic foot infection. Evidence from the literature and the present case indicates that successful limb salvage depends primarily on preservation of a healthy heel pad and viable hindfoot tissues.

Introduction

Chronic limb-threatening ischemia and severe diabetic foot infection remain major causes of lower-limb amputation worldwide. Current global vascular guidelines emphasize the importance of limb preservation and maintenance of ambulatory function whenever feasible [1]. Diabetic foot complications affect a substantial proportion of patients with diabetes mellitus and are frequently associated with neuropathy, infection, and peripheral vascular disease, ultimately leading to tissue destruction and amputation.

Functional outcomes following amputation are strongly influenced by the **level of amputation**, with distal amputations generally associated with better mobility and reduced energy expenditure during ambulation compared with transtibial amputations [2].

Consequently, surgical strategies that preserve limb length while achieving infection control are increasingly emphasized in the management of diabetic foot disease.

Various partial foot amputations, including **Lisfranc and Chopart procedures**, have been utilized to preserve limb length. However, these procedures have been associated with complications such as wound breakdown, deformity, and recurrent ulceration, particularly in patients with diabetic neuropathy and infection [3]. In particular, Chopart amputations have demonstrated inconsistent long-term outcomes due to equinus deformity and instability, often necessitating revision to more proximal levels of amputation [4].

Below-knee amputation remains the definitive procedure in many cases of advanced diabetic foot infection because of its predictable healing and reliable infection control. Nevertheless, functional outcomes following transtibial amputation vary considerably and are influenced by multiple patient-related factors including age, comorbidities, and rehabilitation potential [5]. For these reasons, interest persists in alternative procedures that maintain limb length while providing a stable and durable residual limb.

The Pirogoff amputation, first described by Nikolai Ivanovich Pirogoff in the nineteenth century, is a hindfoot amputation that preserves part of the calcaneus and allows for tibiocalcaneal fusion to create a stable, end-bearing

stump [6]. Unlike Syme's amputation, the Pirogoff technique retains the calcaneus, thereby minimizing devascularization of the heel pad and improving stump stability [7].

Over time, several modifications of the Pirogoff procedure have been developed to improve surgical outcomes. Modern techniques often involve rotation of the calcaneus and fixation with screws or external fixation systems to enhance fusion stability [8,9]. Clinical studies have reported encouraging results in selected patients with diabetic foot infection, trauma, and chronic limb-threatening ischemia, demonstrating preservation of limb length and functional ambulation [10,11].

Despite these advantages, the Pirogoff amputation remains relatively underutilized, and the available evidence largely consists of case reports and small case series [12,13]. Furthermore, the specific conditions under which this procedure is most successful remain a subject of ongoing discussion.

Therefore, the present study aims to review the available literature systematically regarding Pirogoff amputation in diabetic foot disease and to present a case demonstrating its use as a limb-sparing option in severe diabetic foot infection with preserved hindfoot viability.

Methods

Study Design

This study was conducted as a **systematic review with a case report**, following the **Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020)** guidelines. The objective of the review was to evaluate clinical evidence regarding the role of

Pirogoff amputation as a limb-sparing procedure in patients with diabetic foot infection and other severe forefoot pathologies.

Data Sources and Search Strategy

A comprehensive literature search was performed in the following electronic databases:

- **PubMed/MEDLINE**
- **Scopus**
- **Google Scholar**

The search included articles published from **database inception until March 2026**.

Search terms were developed to capture all studies related to Pirogoff amputation and limb salvage surgery. Both **keywords and medical subject headings (MeSH)** were used.

Primary search terms

- Pirogoff amputation
- Pirogow amputation
- Modified Pirogoff amputation
- Hindfoot amputation

Secondary search terms

- Diabetic foot infection
- Limb salvage surgery
- Partial foot amputation
- Ankle disarticulation
- Calcaneal amputation

Example Boolean search strategy

("Pirogoff amputation"
OR "Pirogow amputation"
OR "modified Pirogoff")
AND
("diabetic foot infection" OR "limb salvage" OR "partial foot amputation" OR "ankle disarticulation")

The reference lists of relevant articles were also manually screened to identify additional eligible studies.

Study Selection

All retrieved articles were imported into a reference management system. Duplicate records were identified and removed prior to screening.

Two reviewers independently performed a two-stage screening process:

1. Title and abstract screening
2. Full-text eligibility assessment

Studies meeting the predefined inclusion criteria were included in the systematic review.

Inclusion Criteria

Studies were included if they:

- Reported outcomes of Pirogoff or modified Pirogoff amputation
- Included adult patients
- Described clinical outcomes, surgical technique, or functional results
- Were case reports, case series, or observational studies

Exclusion Criteria

Studies were excluded if they:

- Were review articles without primary clinical data
- Were animal or experimental studies

- Did not report surgical outcomes
- Involved procedures unrelated to Pirogoff amputation

Data Extraction

Data were extracted independently by the reviewers using a standardized form. Extracted variables included:

- author and year of publication
- study design
- number of patients
- functional ambulation
- Secondary outcomes

included:

- complications such as infection recurrence or non-union
- need for revision to proximal amputation
- postoperative rehabilitation outcomes
- indication for Pirogoff amputation
- surgical technique and modifications
- fixation method used
- postoperative outcomes
- complications

Outcome Measures

The primary outcomes evaluated were:

- successful wound healing
- limb salvage

RESULTS

Study Selection

The systematic search strategy identified a total of **2603 records** across the selected databases, including PubMed, Scopus, and Google Scholar. After removal of **742 duplicate records**, **1861 studies** remained for title and abstract screening. During the initial screening phase, **1710 studies were excluded** as they were not directly related to Pirogoff amputation or did not report clinical outcomes relevant to limb salvage procedures.

A total of **151 full-text articles** were assessed for eligibility. Following detailed evaluation, **128 studies were excluded** due to lack of primary clinical data, absence of surgical outcome reporting, or duplication of previously reported patient cohorts. Ultimately, **23 studies met the predefined inclusion criteria** and were included in the qualitative synthesis of this systematic review.

The complete study selection process is illustrated in **Figure 1 (PRISMA flow diagram)**.

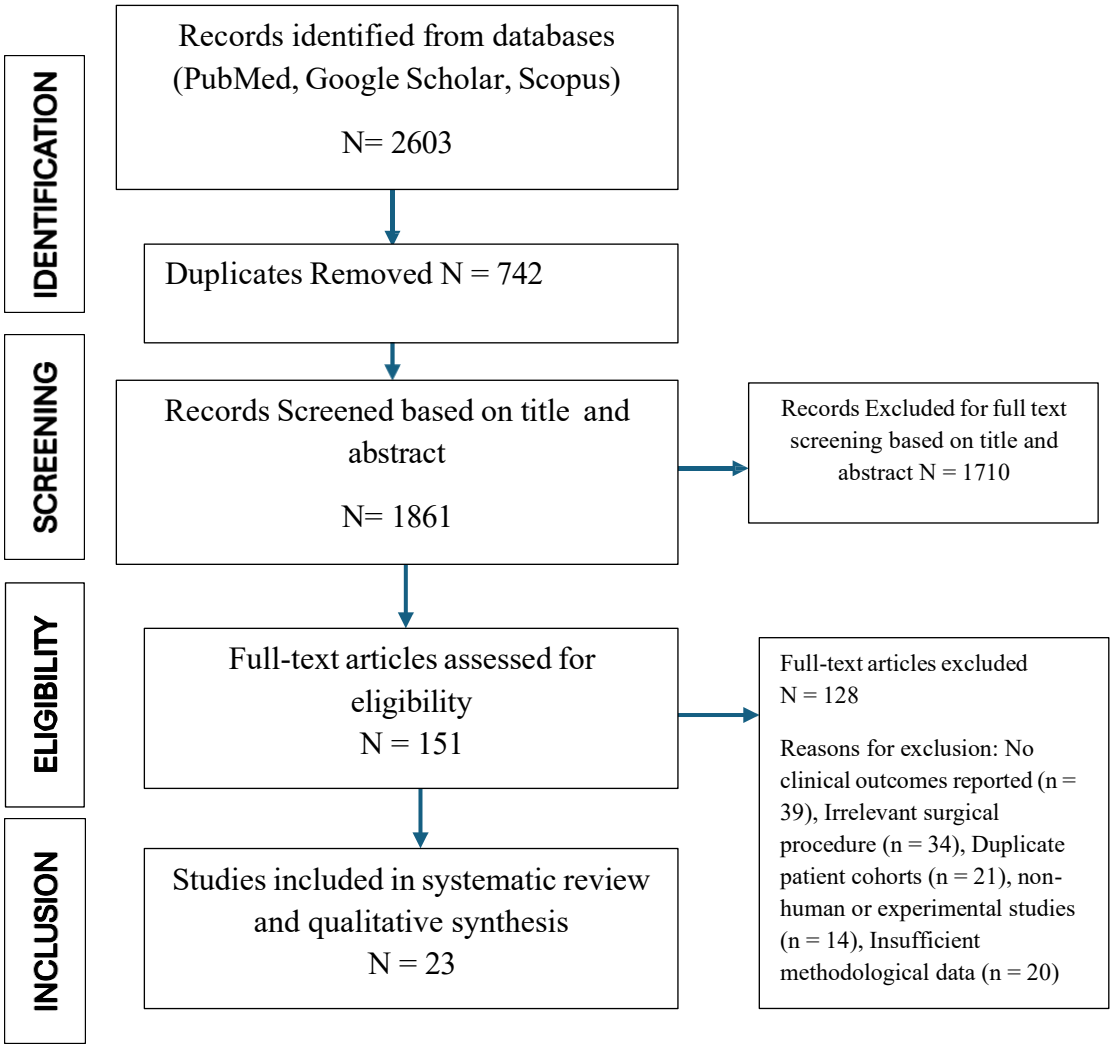

Figure 1. PRISMA 2020 flow diagram illustrating the study selection process for the systematic review

Study Characteristics

The characteristics of the included studies are summarised in **Table 1**. The included literature comprised a heterogeneous group of publications consisting primarily of **retrospective observational studies, case series, and individual case reports**. No randomised controlled trials evaluating Pirogoff amputation were identified.

Table 1 : Detailed Characteristics of Included Studies (N = 23)

Ref	Author	Year	Study Design	Sample Size	Clinical Indication	Surgical Technique	Main Outcomes
[1]	Conte et al.	2019	International clinical guideline	—	Chronic limb-threatening ischemia	Limb preservation strategies	Recommends limb salvage where feasible
[2]	Quigley & Dillon	2016	Systematic review	Multiple studies	Partial foot vs transtibial amputation	Comparative analysis	Partial foot amputations associated with improved mobility
[3]	van der Wal et al.	2023	Systematic review	Multiple studies	Lisfranc and Chopart amputations	Midfoot amputation analysis	High complication and revision rates
[4]	Brodell et al.	2020	Clinical review	—	Chopart amputation	Midfoot procedure evaluation	Frequent deformity and ulcer recurrence
[5]	Taylor et al.	2008	Observational cohort	20	Below-knee amputation outcomes	Transtibial amputation	Functional outcome depends on comorbidities

[6]	Pirogoff	1864	Surgical description	—	Hindfoot amputation	Calcaneus preserved and fused to tibia	Original description of Pirogoff procedure
[7]	Nather et al.	2014	Case series	6	Diabetic foot infection	Modified Pirogoff with calcaneal rotation	Successful limb salvage and wound healing
[8]	Andronic et al.	2019	Retrospective cohort	123	Hindfoot pathology	Modified Pirogoff techniques	Durable stump formation and functional outcomes
[9]	Kinner & Roll	2016	Case series	6	Diabetic foot infection	Modified Pirogoff technique	Majority achieved primary healing
[10]	Taniguchi et al.	2003	Clinical study	8	Severe foot pathology	Pirogoff ankle disarticulation	Stable end-bearing stump
[11]	Gessmann et al.	2013	Retrospective series	24	Limb salvage	Ilizarov external fixation	Improved fusion stability
[12]	Langeveld et al.	2010	Case report	1	Forefoot necrosis	Pirogoff amputation	Successful limb preservation
[13]	Tunku Zainudin et al.	2023	Case series	6	Diabetic foot infection	Modified Pirogoff	Good functional outcomes
[14]	Pinzur	1999	Clinical study	15	Syme ankle disarticulation	Syme amputation comparison	Functional restoration

[15]	Nather et al.	2019	Case series	13	Diabetic foot infection	Cannulated screw fixation	Improved arthrodesis stability
[16]	Sano et al.	2024	Case report	2	Chronic limb-threatening ischemia	Modified Pirogoff	Limb salvage achieved
[17]	Wada et al.	2021	Case report	1	Rehabilitation outcome	Pirogoff amputation	Functional ambulation
[18]	Bueschges et al.	2013	Case series	12	Limb salvage	Pirogoff amputation	Reduced limb-length discrepancy
[19]	Zwipp et al.	1999	Clinical report	9	Charcot neuroarthropathy	Modified Pirogoff	Salvage procedure
[20]	Nather et al.	2019	Observational study	10	Diabetic foot infection	Modified Pirogoff	Stable stump formation
[21]	Gessmann et al.	2013	Clinical series	24	Limb salvage	External fixation technique	Adequate perfusion essential
[22]	Sano et al.	2024	Case report	2	CLTI with midfoot tissue loss	Modified Pirogoff	Ambulation preserved
[23]	Wada et al.	2021	Rehabilitation report	1	Prosthetic rehabilitation	Pirogoff amputation	Long-term mobility

Among the included studies, the largest dataset was reported by **Andronic et al.**, who analysed **123 patients** undergoing Pirogoff amputation or its modified techniques. Several smaller case series were also reported by **Nather et al., Kinner and Roll, and Tunku**

Zainudin et al., each describing approximately **six patients** undergoing the procedure. In addition, multiple case reports documented the use of Pirogoff amputation in specific clinical scenarios such as chronic limb-threatening ischemia and severe forefoot necrosis.

The majority of the studies focused on **modified Pirogoff techniques**, in which the calcaneus is preserved and rotated to achieve **tibiocalcaneal arthrodesis**, thereby creating a stable end- bearing stump.

Indications for Pirogoff Amputation

The primary clinical indications for Pirogoff amputation across the included studies are summarised in **Table 2**.

Table 2 Clinical Indications for Pirogoff Amputation Based on the Included Studies (n = 23)

Clinical Indication	Representative Studies	Description of Indication
Diabetic foot infection with extensive forefoot destruction	Nather et al. [7], Kinner et al. [9], Tunku Zainudin et al. [13]	Most commonly reported indication where forefoot tissue loss precludes distal salvage but hindfoot remains viable
Chronic limb-threatening ischemia with midfoot tissue loss	Sano et al. [16]	Performed following confirmation of adequate distal perfusion or revascularisation
Forefoot necrosis with preserved hindfoot structures	Langeveld et al. [12]	Used as a salvage procedure when infection or necrosis involves the forefoot
Charcot neuroarthropathy with infection or deformity	Zwipp et al. [19]	Limb-salvage option when deformity and infection compromise midfoot stability
Traumatic forefoot destruction	Reported in several surgical series	Indicated when reconstruction is not feasible but hindfoot viability is preserved

The most common indication was **diabetic foot infection with extensive forefoot or midfoot destruction**, particularly when the hindfoot remained viable. Several case series reported favourable outcomes when the procedure was performed in patients with preserved heel pad integrity and adequate vascular perfusion.

Other reported indications included:

- chronic limb-threatening ischemia with tissue loss
- forefoot necrosis
- Charcot neuroarthropathy complicated by infection
- traumatic destruction of the forefoot

In these clinical contexts, Pirogoff amputation was primarily utilised as a **limb-sparing alternative to below-knee amputation**.

Surgical Techniques

Variations in the surgical technique of Pirogoff amputation were reported across the included studies and are summarised in **Table 3**.

Table 3: Surgical Techniques Reported Across the Included Studies (n = 23)

Surgical Technique	Description	Studies Reporting
Classical Pirogoff amputation	Removal of talus with preservation of calcaneus and heel pad, followed by tibio-calcaneal fusion	Historical description by Pirogoff [6]

Modified Pirogoff amputation	Calcaneus rotated and fused to distal tibia to improve alignment and weight-bearing	Nather et al. [7], Kinner et al. [9], Tunku Zainudin et al. [13]
Internal fixation techniques	Use of cannulated screws to achieve stable tibiocalcaneal arthrodesis	Nather et al. [15]
External fixation methods	Ilizarov external frame used to stabilise fusion in complex cases	Gessmann et al. [11]
Hybrid approaches	Combination of internal fixation and staged debridement in infected diabetic foot	Reported in multiple case series

The **classical Pirogoff technique** involves preservation of the calcaneus with removal of the talus and fusion of the calcaneus to the distal tibia. Contemporary modifications of the procedure include **rotation of the calcaneus to improve alignment and stability**, thereby enhancing the functional characteristics of the residual limb.

Different fixation techniques were reported in the literature. Several studies described the use of **internal fixation with cannulated screws** to achieve tibiocalcaneal arthrodesis. In more complex cases, external fixation systems such as the **Ilizarov frame** were utilised to improve alignment and promote stable fusion.

These modifications were introduced to increase fusion stability and improve long-term functional outcomes following Pirogoff amputation.

Clinical Outcomes

The study-level outcomes of the included literature are summarised in **Table 4**.

Across the included studies, the majority of patients undergoing Pirogoff amputation achieved **successful wound healing and preservation of ambulation**. Case series evaluating modified Pirogoff amputation in diabetic foot infection consistently reported favourable outcomes, including reliable infection control and the formation of a durable end- bearing stump.

For example, **Nather et al.** reported successful healing in all patients undergoing modified Pirogoff amputation for diabetic foot infection, with restoration of functional ambulation. Similarly, **Tunku Zainudin et al.** demonstrated favourable functional outcomes in patients treated with modified Pirogoff amputation under strict selection criteria.

The large retrospective study by **Andronic et al.** also reported favourable long-term outcomes, demonstrating that Pirogoff amputation can provide a durable and functionally stable stump when appropriate surgical indications are respected.

Case reports describing Pirogoff amputation in patients with **chronic limb-threatening ischemia** further demonstrated that the procedure can preserve ambulation in carefully selected patients, particularly when adequate vascular perfusion is present.

Table 4 : Study-Level Clinical Outcomes and Complications Across the Included Studies (n = 23)

Author	Sample Size	Healing Outcome	Ambulation Outcome	Reported Complications
Nather et al. [7]	6	All wounds healed	Functional ambulation achieved	Minimal wound complications
Andronic et al. [8]	123	High healing rate	Functional mobility preserved	Occasional wound issues
Kinner et al. [9]	6	Majority healed	Ambulation possible	Delayed healing in 2 patients
Taniguchi et al. [10]	8	Successful healing	Stable end-bearing stump	Minimal complications
Gessmann et al. [11]	24	Good healing rate	Preserved ambulation	Non-union risk

Langeveld et al. [12]	1	Complete healing	Ambulation maintained	None
Tunku Zainudin et al. [13]	6	Successful healing	Functional ambulation	None significant
Sano et al. [16]	2	Healing achieved	Ambulation preserved	None reported
Wada et al. [17]	1	Successful healing	Independent ambulation	None
Bueschges et al. [18]	12	Good healing	Mobility improved	Minor complications
Zwipp et al. [19]	9	Healing achieved	Ambulation possible	Implant complications reported

Complications

Reported complications associated with Pirogoff amputation are summarised in **Table 4**. The most commonly reported complications included:

- delayed wound healing
- infection recurrence
- non-union at the tibiocalcaneal fusion site

Delayed wound healing was reported in a minority of patients in the case series by **Kinner and Roll**. Studies evaluating external fixation techniques also highlighted the importance of adequate vascular perfusion, as insufficient blood supply was associated with impaired wound healing and increased risk of fusion failure.

Despite these complications, **revision to below-knee amputation was uncommon**, particularly when strict patient selection criteria were applied.

Determinants of Successful Outcomes

Several studies emphasised the importance of careful patient selection for successful outcomes following Pirogoff amputation. The key determinants of successful limb salvage are summarised in **Table 5**.

Table 5 : Key Determinants of Successful Limb Salvage Identified in the Included Studies

Determinant	Evidence from Literature
Healthy heel pad integrity	Most consistently reported determinant of successful outcome
Adequate distal vascular perfusion	Essential for wound healing and stump viability
Preservation of calcaneus	Required for stable tibiocalcaneal fusion
Absence of proximal infection	Prevents stump failure and revision surgery
Careful patient selection	Highlighted across multiple case series

Across the literature, the most important factor consistently identified was the **presence of a healthy, well-perfused heel pad**. The heel pad serves as the primary weight-bearing surface of the residual limb and provides durable soft-tissue coverage for the stump.

Additional factors associated with favourable outcomes included:

- adequate distal vascular perfusion
- preservation of the calcaneus
- absence of proximal infection
- meticulous surgical technique

When these conditions were met, Pirogoff amputation was shown to produce a **stable end- bearing stump capable of supporting functional ambulation**.

Risk of Bias Assessment

Risk of bias was assessed using the **ROBINS-I tool for non-randomised studies** and the

CARE checklist for case reports, as presented in **Table 6**.

Table 6: Risk of Bias Assessment of Included Studies

Study Type	Assessment Tool	Overall Risk of Bias
Retrospective cohort studies	ROBINS-I	Moderate
Case series	ROBINS-I	Moderate
Case reports	CARE checklist	Low
Systematic reviews / guidelines	Not assessed for bias (contextual evidence)	

Because the majority of the included studies consisted of case reports and small case series, the overall risk of bias was considered **moderate**. The most common sources of bias included:

- small sample sizes
- retrospective study design
- absence of control groups

However, the consistency of outcomes reported across multiple studies strengthens the overall interpretation of the findings.

Certainty of Evidence

Certainty of evidence was evaluated using the GRADE (Grading of Recommendations Assessment, Development and Evaluation) approach**.** and the results are summarised in **Table 7**.

Table 7 : Certainty of Evidence for Key Outcomes (GRADE Framework)

Outcome	Evidence Source	Certainty Level	Explanation
Limb salvage success	Case series and observational studies	Moderate	Consistent favourable outcomes across studies
Functional ambulation	Rehabilitation reports and case series	Moderate	Consistent functional improvement
Complication rates	Case series	Low–Moderate	Small sample sizes
Long-term durability	Observational studies	Low	Limited long-term follow-up data

The overall certainty of evidence was considered **low to moderate**, reflecting the predominance of observational studies and case reports. Nevertheless, the available evidence consistently suggests that Pirogoff amputation can achieve favourable outcomes when appropriate patient selection criteria are applied.

Synthesis of Evidence

Taken together, the findings of this systematic review indicate that **Pirogoff amputation is a viable limb-salvage procedure in patients with severe forefoot destruction when hindfoot tissues remain viable**.

The most critical determinant of successful outcomes identified across the literature is the **preservation of a healthy heel pad with adequate vascular perfusion**, which enables the creation of a stable end-bearing stump capable of supporting ambulation.

CASE STUDY: PIROGOFF AMPUTATION IN ACTION

CASE PRESENTATION

Patient Information

A 55-year-old male with a long-standing history of type 2 diabetes mellitus presented to the surgical department with a severe infection of the left foot. The patient reported that the problem began approximately six months prior to presentation following a rat bite injury involving the third toe. Initially, the wound appeared minor but progressively failed to heal despite local treatment.

The patient had undergone a ray amputation of the left third toe in July 2025 at another healthcare facility due to persistent infection. However, the postoperative wound failed to heal and gradually deteriorated with increasing tissue loss and foul-smelling discharge.

The patient also had a significant surgical history of contralateral right foot amputation performed in 2023 due to diabetic foot ulceration. Glycaemic control had been consistently poor, and the patient had irregular follow-up for diabetes management.

At presentation, the patient complained of:

- progressive tissue loss of the left forefoot
- foul-smelling discharge
- severe pain
- inability to bear weight on the affected limb

Peripheral vascular examination revealed:

- palpable posterior tibial artery pulse
- detectable dorsalis pedis pulse

Clinical Findings

On examination, the patient was afebrile but appeared systemically unwell. Local examination of the left foot revealed extensive soft-tissue destruction involving the forefoot.

The wound demonstrated:

- extensive necrotic tissue
- active maggot infestation
- purulent discharge
- exposed bone in multiple areas

The surrounding soft tissues were inflamed, but there was no evidence of proximal spread of infection to the hindfoot region.

Importantly, the heel pad remained intact and viable, with preserved soft-tissue coverage.

Neurological examination demonstrated reduced protective sensation, consistent with diabetic peripheral neuropathy.

Figure 2: Preoperative photograph demonstrating extensive forefoot tissue destruction with necrosis and maggot infestation.

Diagnostic Assessment

Laboratory investigations revealed:

- elevated white blood cell count
- increased inflammatory markers
- uncontrolled blood glucose levels

Renal and hepatic function tests were within acceptable limits.

Microbiological analysis of wound cultures identified:

- Methicillin-resistant Staphylococcus aureus (MRSA)
- Escherichia coli

Both organisms were sensitive to linezolid, doxycycline, gentamicin, and carbapenems.

Plain radiographs of the left foot demonstrated extensive destruction of the forefoot bones, consistent with osteomyelitis and advanced infection.

Lower-limb arterial Doppler ultrasonography revealed biphasic arterial flow with no evidence of deep vein thrombosis, indicating preserved distal perfusion.

Clinical Decision-Making

Considering the following factors:

- extensive forefoot destruction
- active infection with maggot infestation
- preserved hindfoot viability
- intact heel pad
- adequate distal perfusion
- previous contralateral foot amputation

a limb-sparing surgical approach was considered preferable to below-knee amputation.

Based on these findings, Pirogoff amputation was planned as a definitive procedure to remove infected tissues while preserving limb length and functional potential**.**

Surgical Procedure

After preoperative optimisation including glycaemic control and initiation of broad-spectrum antibiotics, the patient was taken to the operating theatre.

The procedure was performed under appropriate anaesthesia with the patient in the supine position.

Step 1 – Debridement of Necrotic Tissue

Extensive surgical debridement was performed to remove all necrotic and infected soft tissues involving the forefoot and midfoot.

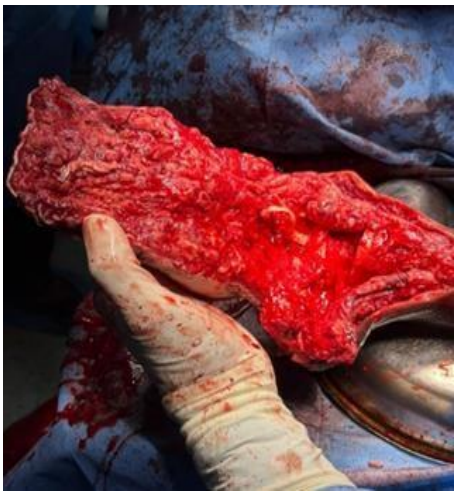

Figure 3: Intraoperative image demonstrating excision of necrotic forefoot tissues following surgical debridement.

Step 2 – Hindfoot Exposure

Following debridement, the hindfoot was exposed and elevated. The talus was removed, while the calcaneus and heel pad were preserved.

Figure 4: Intraoperative photograph showing preservation of the calcaneus during hindfoot exposure.

Step 3 – Preparation for Tibiocalcaneal Fusion

The superior surface of the calcaneus and the distal tibial surface were prepared to achieve a congruent arthrodesis interface.

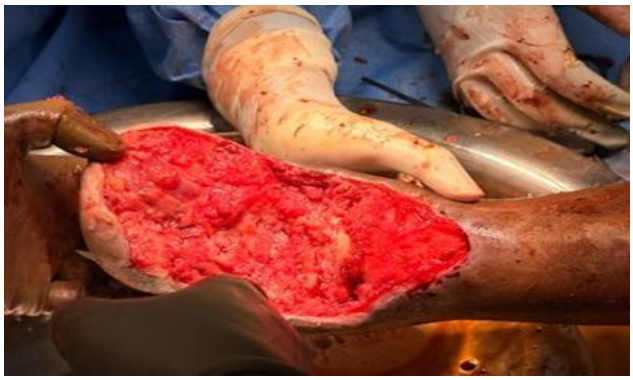

Figure 5: Preparation of the distal tibia and calcaneus prior to tibiocalcaneal fusion.

Step 4 – Creation of the Pirogoff Stump

The calcaneus was positioned against the distal tibia to achieve tibiocalcaneal fusion, thereby creating a stable hindfoot stump capable of end-bearing.

Figure 6: Immediate postoperative appearance of the Pirogoff amputation stump.

Step 5 – Final Stump Configuration

The stump was contoured to create a rounded end-bearing surface suitable for prosthetic rehabilitation.

Figure 7: Completed Pirogoff stump following soft-tissue closure.

Outcome and Follow-Up

Following surgery, complete control of infection was achieved. The postoperative course was uneventful, and the wound demonstrated satisfactory healing.

The resulting stump was:

- durable
- painless
- capable of end-bearing

Limb length was preserved, and the patient was considered suitable for prosthetic rehabilitation using a low-profile Syme-type prosthesis.

DISCUSSION

Severe diabetic foot infection represents a significant surgical challenge and frequently leads to lower-limb amputation. Contemporary vascular guidelines emphasise limb preservation whenever feasible in order to maintain functional ambulation and quality of life [1]. The findings of the present systematic review and case report demonstrate that Pirogoff amputation can serve as an effective limb-salvage procedure in carefully selected patients with extensive forefoot destruction.

Functional Importance of Distal Amputation

Preservation of limb length plays a critical role in postoperative rehabilitation. Quigley et al. [2] reported that patients undergoing partial foot amputations generally demonstrate improved mobility and reduced energy expenditure compared with individuals undergoing transtibial amputation. Similarly, Taylor et al. [5] observed that functional outcomes following below-knee amputation vary considerably and are influenced by patient comorbidities and rehabilitation potential.

Our systematic review similarly found that limb-preserving procedures may provide superior functional outcomes when adequate perfusion and viable tissues remain, particularly in patients with severe forefoot pathology.

Limitations of Midfoot Amputation

Midfoot amputations such as Lisfranc and Chopart procedures have historically been utilised as limb-preserving operations; however, their long-term outcomes in diabetic foot disease remain inconsistent. Van der Wal et al. [3] demonstrated high complication and revision rates following midfoot amputations, while Brodell et al. [4] reported frequent deformity and ulcer recurrence following Chopart amputation.

These findings are consistent with the results of the present systematic review, which identified significant limitations associated with midfoot amputations in diabetic foot pathology, often leading to revision surgery at a more proximal level.

Role of Pirogoff Amputation

The Pirogoff amputation, originally described by Pirogoff [6], preserves the calcaneus and allows the formation of a stable end-bearing stump through tibiocalcaneal fusion. This biomechanical advantage distinguishes the procedure from other distal amputations.

Clinical case series have reported favourable outcomes following modified Pirogoff amputation. Nather et al. [7] described successful limb salvage and wound healing in patients undergoing modified Pirogoff amputation for diabetic foot infection. Similarly, Tunku Zainudin et al. [13] reported good functional outcomes in patients treated with modified Pirogoff amputation under strict selection criteria.

In a larger retrospective study, Andronic et al. [8] analysed over one hundred patients and demonstrated durable stump formation and satisfactory functional outcomes following modified Pirogoff amputation.

Our systematic review identified similar trends, indicating that Pirogoff amputation can provide reliable infection control while preserving limb length and functional ambulation when appropriate surgical indications are present.

Determinants of Successful Outcomes

A key finding of the present systematic review is that **successful Pirogoff amputation depends heavily on the preservation of a viable heel pad**. The heel pad functions as the principal weight-bearing structure of the residual limb and provides durable soft-tissue coverage.

Several studies emphasised the importance of vascular perfusion and hindfoot viability. Gessmann et al. [11] reported that impaired vascular perfusion was a major limiting factor for successful wound healing following Pirogoff amputation. Similarly, Kinner et al. [9] noted that delayed wound healing was more likely to occur in patients with compromised soft- tissue viability.

Across the studies included in this systematic review, the most consistent determinant of successful surgical outcomes was the presence of a healthy heel pad with adequate vascular supply.

Relevance of the Present Case

The present case illustrates these findings clearly. The patient presented with extensive forefoot destruction and maggot infestation, yet the hindfoot structures and heel pad remained viable.

Consistent with the findings reported by Nather et al. [7] and Andronic et al. [8], preservation of the heel pad in this case allowed the performance of Pirogoff amputation rather than below-knee amputation. Following surgery, infection was successfully controlled and a stable end-bearing stump was achieved, allowing preservation of limb length and potential for prosthetic rehabilitation.

Thus, the outcome of the present case supports the findings of the systematic review, reinforcing the concept that **Pirogoff amputation may be a valuable limb-sparing option when the heel pad and hindfoot tissues remain viable**.

Limitations

Despite encouraging results, the available evidence regarding Pirogoff amputation remains limited. Most studies included in this systematic review were case reports or small case series, and no randomised controlled trials were identified. Additionally, variability in surgical techniques and patient selection criteria across studies limits the ability to directly compare outcomes. Nevertheless, the

consistency of findings across multiple studies suggests that Pirogoff amputation can provide favourable outcomes in carefully selected patients.

Clinical Implications for Surgical Practice

The results of this systematic review underscore the critical nature of meticulous patient selection in the context of limb-sparing interventions for severe diabetic foot infections. Although below-knee amputation continues to be a dependable approach for managing infection, Pirogoff amputation could offer a beneficial alternative when hindfoot structures and the heel pad are still intact. The retention of the calcaneus enables the development of a stable, end-bearing stump, potentially leading to enhanced functional rehabilitation and prosthetic utilization.

In contrast, midfoot amputations are frequently associated with deformity and revision surgery. This case shows that even with a serious infection and significant damage to the front of the foot, it's still possible to save the limb. This is true as long as blood flow is good and the heel pad stays intact.

Therefore, thorough assessment of vascular status, hindfoot viability, and soft-tissue integrity is essential in determining the most appropriate surgical approach.

Future Research Directions

Although existing studies suggest favourable outcomes following Pirogoff amputation, the current evidence base remains limited. The existing literature primarily comprises case reports and small case series, which yields a moderate to low level of certainty regarding the evidence. Future investigations should prioritize prospective comparative studies that assess Pirogoff amputation in relation to alternative distal procedures, including Syme and Chopart amputations, to more precisely delineate its comparative benefits.

Longitudinal investigations into functional results, prosthetic integration, and overall well- being are also essential. Furthermore, additional research is warranted to elucidate the impact of vascular evaluation and revascularization techniques on surgical success. The establishment of multicenter registries or collaborative research initiatives could yield more

extensive datasets, thereby facilitating the refinement of patient selection criteria for this limb-preserving intervention.

Strengths and Limitations of the Study

A significant advantage of this investigation lies in its combination of a systematic review and a clinical case report, thereby offering both a synthesis of existing evidence and practical surgical perspectives on the application of Pirogoff amputation in the context of severe diabetic foot infections. Following the PRISMA 2020 guidelines, this systematic review included studies that were assessed for bias risk and the reliability of their evidence using structured methods.

This method allowed for a thorough evaluation of the existing research on Pirogoff amputation. However, there are several limitations that should be acknowledged.

The majority of the included studies consisted of case reports and small case series, which limits the overall level of evidence. In addition, heterogeneity in patient populations, surgical techniques, and outcome reporting across studies limited the possibility of quantitative synthesis. To strengthen the evidence for this procedure, more studies with larger groups of patients are needed.

Conclusion

Pirogoff amputation represents a valuable limb-sparing surgical option in selected patients with severe diabetic foot infection, particularly when hindfoot structures remain viable.

Evidence from the present systematic review indicates that the procedure can achieve effective infection control while preserving limb length and enabling functional ambulation. The most important factor in achieving good results is a healthy, well-supplied heel pad, which is the main weight-bearing area of the remaining limb. This case supports the previous findings, showing that limb salvage was successful in a patient with significant forefoot damage but a healthy hindfoot. When appropriate patient selection criteria are applied, Pirogoff amputation may provide a reliable alternative to more proximal amputations such as below-knee amputation.

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