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Surgical Management and Delayed Reconstruction of Soft Tissue Defects Following Deep Suppurative Infections

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Abstract **Original Research Article**

Background. Deep suppurative soft tissue infections, occasionally associated with cutaneous and subcutaneous necrosis, may require extensive excision followed by delayed reconstruction. ***Objective.*** To describe the clinical and radiological characteristics, surgical excision and secondary-intention wound management strategies, and methods of delayed wound coverage. ***Patients and methods.*** This single-center retrospective descriptive study covered January–October 2026 and involved a target series of 20 patients. Computed tomography (CT) was the main imaging modality for assessing disease extent. Surgery consisted of incision and drainage, with debridement of nonviable tissue when indicated. ***Results.*** The six individually documented patients had a mean age of 59.3 years (range, 47–73 years) and an equal sex distribution. Dorsal infections and abscess-forming carbuncles predominated. Aggregate data indicated four reoperations (20%), two intensive care admissions (10%), 16 split-thickness skin grafts (80%), and four delayed direct closures (20%). Definitive coverage followed approximately 30 days of wound bed preparation, with favorable early graft take reported and no recorded deaths. Long-term follow-up was limited (approximately 80% lost to follow-up). ***Conclusion.*** A staged approach combining infection source control, wound care, and individualized reconstruction provides a practical management framework. Verification of patient-level data is required before definitive interpretation.

Keywords: Carbuncle; soft tissue infection; computed tomography; drainage; secondary-intention healing; skin grafting; delayed reconstruction.

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1. INTRODUCTION

Bacterial skin and soft tissue infections comprise a heterogeneous group of conditions whose severity depends on whether necrosis is present, the anatomical depth of involvement, local spread, and systemic consequences. The clinical spectrum ranges from follicular infections and localized purulent collections to necrotizing dermohypodermitis and necrotizing fasciitis, which carry substantial morbidity and may be life-threatening [1,2].

Deep suppurative infections, particularly extensive cutaneous carbuncles, can lead to major skin and subcutaneous tissue destruction, especially in patients with predisposing conditions such as diabetes. Delayed diagnosis, metabolic comorbidities, and lesion extent may complicate management and contribute to extensive tissue defects. In confirmed necrotizing infections, early source control through drainage and excision of devitalized tissue, combined with appropriate antibiotics and management of organ dysfunction when present, is the cornerstone of treatment [1,2].

Although controlling infection is the immediate therapeutic priority, management of the residual tissue defect represents a second, specifically reconstructive challenge. The extent of excision, defect depth, local vascularity, and patient comorbidities determine the options for wound coverage. According to the fundamental principles of plastic surgery described by Revol and Servant, selection among secondary-intention healing, primary closure, skin grafting, and flap reconstruction is based on a structured assessment of surrounding skin laxity, recipient-bed vascularity, and the patient's general condition [6,7].

In this setting, secondary-intention wound management is a key step in preparing defects after septic excision. The aim is to obtain a clean, vascularized recipient bed with sufficient granulation tissue for definitive coverage. Although negative-pressure wound therapy may facilitate this process, its use can be limited by financial and material constraints, making conventional dressings particularly important in resource-limited settings [2].

Although the principles of emergency management of necrotizing infections are well established, the literature is less consistent regarding delayed reconstruction strategies, criteria for recipient-bed readiness, and the optimal timing of definitive coverage. Heterogeneity in patient populations, anatomical sites, and reconstructive techniques complicates comparisons across studies [2].

The primary aim of this study was to describe and analyze the staged surgical and reconstructive management of tissue defects secondary to deep suppurative soft tissue infections, from initial source control to delayed skin coverage. Secondary objectives were to characterize clinical and CT findings, assess the need for repeat surgery, clarify the role of secondary-intention wound management, and evaluate early postoperative outcomes of different reconstructive techniques.

2. PATIENTS AND METHODS

2.1. Study design and patient selection

This single-center retrospective descriptive study involved a target population of 20 patients treated between January and October 2026. Proposed eligibility criteria were age ≥18 years; an inflammatory plaque associated with suppurative skin and subcutaneous tissue infection and a clinically or radiologically identified collection; a discrete collection on CT, or ultrasonography when this was the available imaging modality; an indication for surgical incision and drainage; and usable clinical and operative records. Superficial infections without a collection managed exclusively with medical treatment, and infections of visceral origin without primary soft tissue involvement, were excluded. Cutaneous, subcutaneous, or fascial necrosis should be classified according to intraoperative findings: an isolated collection does not establish a necrotizing infection.

2.2. Radiological assessment

CT was the principal imaging examination for evaluating anatomical extent when clinically indicated and feasible without delaying surgery. Assessed features included collection size, peripheral enhancement, fat stranding, relationships to fascia and muscle, gas, and abnormal enhancement of deep tissue planes. Ultrasonography was used for superficial lesions.

2.3. Treatment and wound management

Patients underwent initial stabilization, laboratory evaluation, and correction of metabolic disturbances. According to the available records, empirical antibiotic therapy included a third-generation cephalosporin and an aminoglycoside, sometimes with additional agents, and was subsequently adjusted to culture results when available. This description of local practice should not be interpreted as a recommendation for empirical treatment of necrotizing infections. Surgical treatment included incision, drainage, irrigation, and excision of nonviable tissue when required. Following local infection control, the recipient bed was prepared with dressings and local wound care promoting secondary-intention healing. Negative-pressure wound therapy was proposed for one patient but was not performed because of cost. Delayed coverage consisted of split-thickness skin grafting or direct closure, depending on recipient-bed vascularity and wound-edge laxity.

2.4. Outcomes and statistical analysis

Outcomes of interest included reoperation frequency, time to definitive coverage, reconstructive technique, early graft viability, complications, intensive care admission, and mortality. Post-grafting assessments were scheduled on postoperative days 3, 5, and 15. Aggregate outcomes reported for the 20-patient target series were distinguished from the available individual observations. Extrapolated age and sex distributions are illustrative and must not be interpreted as observed counts. No inferential statistical testing was performed because a complete patient-level registry was unavailable.

3. RESULTS

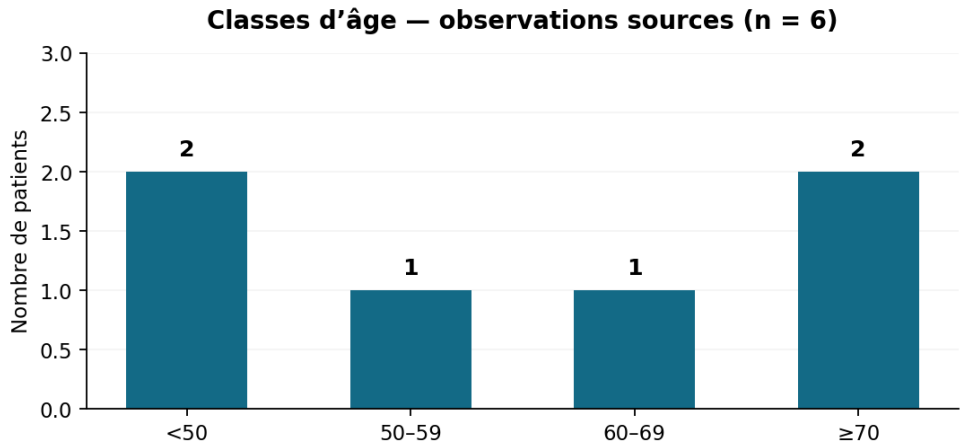
3.1. Demographic characteristics

The ages of the six source cases were 47, 49, 50, 64, 73, and 73 years, yielding a mean of 59.3 years, a median of 57 years, and a range of 47–73 years. Three men and three women were documented (male-to-female ratio, 1:1). Proportional extrapolation to 20 patients would yield ten men and ten women, but these are not measured figures for the complete target series. Diabetes was documented in four of the six source cases (66.7%), with individual HbA1c values reaching 11.4% and 12%.

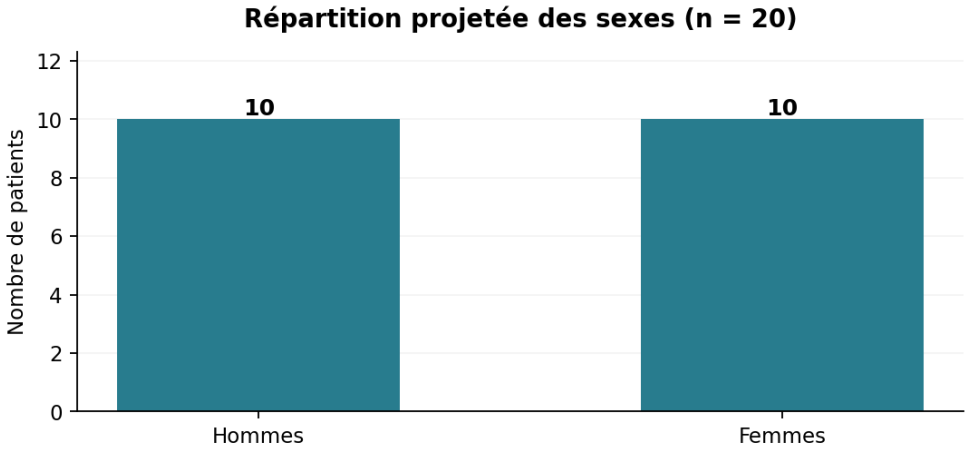
3.2. Anatomical distribution, laboratory findings, and CT

Dorsal and scapular presentations predominated and were frequently initially described as furuncles complicated by abscess-forming carbuncles; one vulvoperineal infection was documented. Symptoms included swelling, erythema, pain, warmth, and purulent discharge, with symptom duration of approximately 10–20 days in the available records. C-reactive protein levels were estimated overall at 200–450 mg/L. Reported organisms belonged to the genera Staphylococcus and Streptococcus; patient-level microbiological distributions were unavailable.

CT findings included subcutaneous collections superficial to the deep fascia, surrounding inflammatory infiltration, and rim enhancement. One examination identified a dorsal collection measuring 14 × 3.7 × 14.4 cm from T4 to T9, abutting the rhomboid muscles without deep muscular or spinal extension. The absence of documented gas or fascial nonenhancement does not establish that these signs were absent.



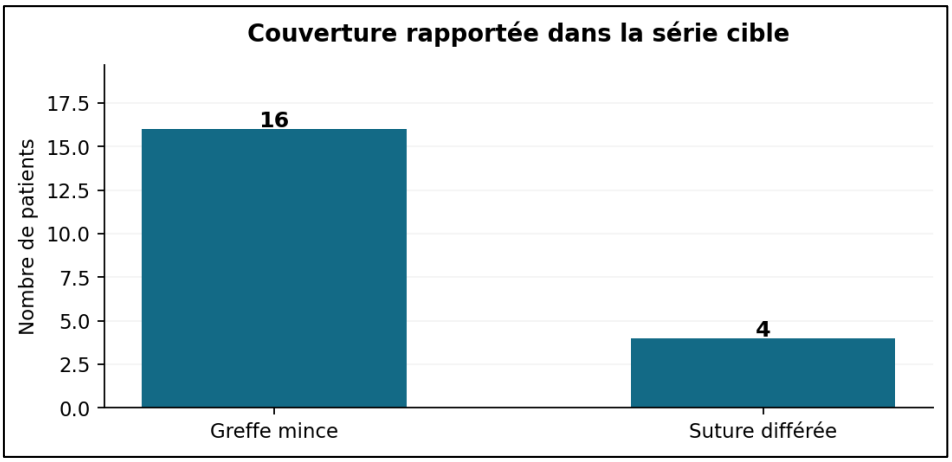
Statistical Figure 1 — Age groups observed in the source records (n = 6), not in the complete target cohort.



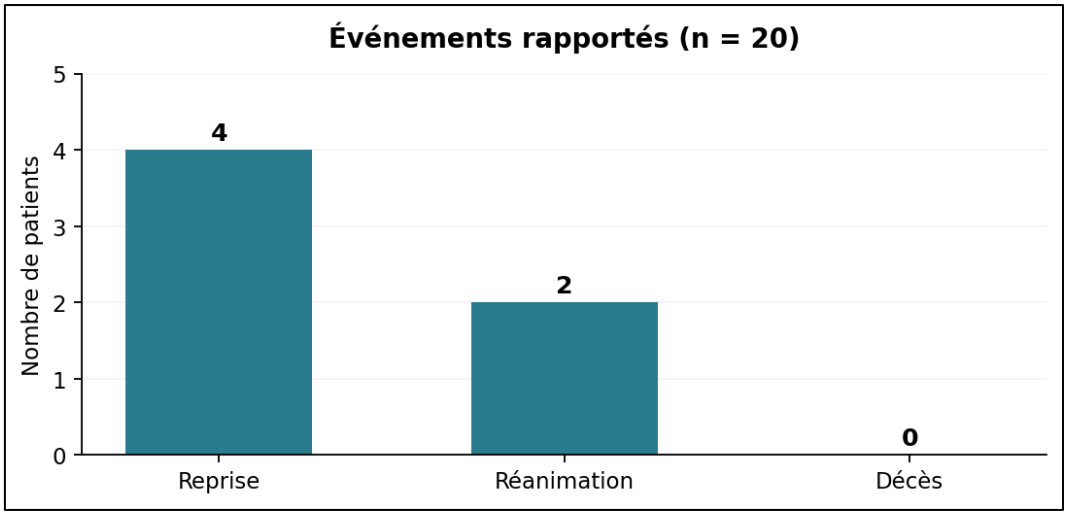
Statistical Figure 2 — Theoretical sex distribution extrapolated to n = 20. Illustrative data.

3.3. Surgery, wound coverage, and follow-up

According to the aggregate data provided for the target series, all 20 patients underwent initial incision and drainage; four reoperations were reported (20%). Two patients required intensive care (10%), and no deaths were reported. Initial hospitalization generally lasted one to two weeks. Secondary-intention wound management and conventional dressings preceded delayed coverage after approximately 30 days. Sixteen split-thickness skin grafts (80%) and four delayed direct closures (20%) were reported. Favorable graft take was observed at postoperative days 3, 5, and 15, although the viable graft surface area was not assessed using a standardized method. Approximately 80% of patients were lost to longer-term follow-up.



Statistical Figure 3 — Reported wound coverage techniques in the target population (aggregate estimates)



Statistical Figure 4 — Reported reoperations, intensive care admissions, and deaths (non-mutually exclusive categories)

3.4. Clinical photographs: evolution of the recipient bed

The following photographs illustrate the observed clinical sequence: an abscess-forming infection, a post-excisional tissue defect, and development of granulation tissue during secondary-intention wound management. Without a calibrated scale, they do not permit reliable measurement of wound area in cm².



Clinical Figure 1 — Initial appearance of a suppurative dorsal collection



Clinical Figure 2 — Tissue defect following excision and drainage



Clinical Figure 3 — Granulating wound bed after approximately one month of local wound care



Clinical Figure 4 — Post-excisional defect following dorsal infection



Clinical Figure 5 — Tissue defect following drainage of a scapular carbuncle



Clinical Figure 6 — Granulation tissue formation during secondary-intention healing

3.5. Example of delayed closure in the perineal region

In one patient with vulvoperineal involvement, incision, drainage, and irrigation were followed by delayed direct closure after resolution of suppuration and improvement of the local wound condition. The photographs illustrate the tissue defect and secondary closure but do not, on their own, establish long-term functional outcomes.



Clinical Figure 7 — Perineal tissue defect after infection control



Clinical Figure 8 — Delayed direct closure of the perineal region

4. DISCUSSION

4.1. Nosological framework and clinicopathological classification

Bacterial soft tissue infections should be classified according to suppuration, presence of necrosis, and anatomical depth. A cutaneous carbuncle is a confluence of suppurative follicular foci that may lead to abscess formation and local necrosis. Necrotizing dermohypodermitis involves destruction of dermal and subcutaneous tissue, whereas necrotizing fasciitis affects fascial planes; myonecrosis involves muscle. This anatomical classification should be complemented by microbiological classification, particularly distinguishing polymicrobial (type I) from usually monomicrobial streptococcal (type II) infections. In our records, the predominance of collections superficial to the fascia suggests a cutaneous and subcutaneous process. Necrotizing involvement can only be confirmed for each patient on the basis of intraoperative findings [1,2].

4.2. CT and characterization of disease extent

CT helped define collection dimensions, relationships to fascial planes, and extension toward muscle groups. Findings in our radiology reports included hypodense subcutaneous collections, thickened walls with peripheral enhancement, and surrounding inflammatory infiltration. One collection measured 14 × 3.7 × 14.4 cm from T4 to T9 and abutted the rhomboid muscles without demonstrated deep extension. The literature also describes fascial thickening, fluid tracking along fascial planes, absent enhancement, and gas bubbles. A systematic review estimated the sensitivity and specificity of CT-detected gas at 48.6% and 93.2%, respectively; therefore, its absence does not exclude necrotizing infection. CT assists operative planning when the patient's condition allows, but must never delay urgent surgical exploration [2,3].

4.3. Debridement, reoperations, and comparison with published data

Infection source control relies on drainage, exploration, and excision to viable tissue. Four reoperations (20%) were reported in the target population. A French multicenter cohort of 170 critically ill patients with necrotizing soft tissue infections reported a reoperation rate of 69.9%. The same cohort had an in-hospital mortality rate of 28.8%, which cannot be directly compared with the absence of reported deaths in our series. This difference may reflect markedly different populations: deep infections and organ dysfunction predominated in the intensive care cohort, whereas our available records mainly described subcutaneous collections. Preserving viable tissue during excision facilitates reconstruction, in accordance with the principles described by Revol and Servant. No superiority in treatment effectiveness can be inferred from comparing these series [2,4,6].

4.4. Secondary-intention healing and recipient-bed preparation

The four major wound coverage options described by Revol and Servant are secondary-intention healing, direct closure, grafting, and flap reconstruction. Selection depends on surrounding tissue laxity, recipient-bed vascularity, and patient-related factors. In our practice, repeated dressings after incision and drainage constituted an active wound preparation strategy involving exudate control, cleansing and debridement, and monitoring of granulation tissue. Coverage was considered after approximately 30 days, compared with a median of 28 days for secondary grafting in the aforementioned French cohort, in which 32.3% underwent skin grafting. Our reported grafting rate of 80% must be interpreted in light of the selection of patients for reconstruction. These findings do not establish a fixed 30-day interval as optimal [4,6,7].

4.5. Negative-pressure wound therapy and financial constraints

Negative-pressure wound therapy may improve exudate management and granulation tissue formation following complete debridement. It was proposed for one patient but not performed because of cost. Conventional wound care was the accessible alternative. This socioeconomic limitation should be reported as part of the treatment pathway, without implying proven equivalence between conventional dressings and negative-pressure wound therapy. Treatment duration, dressing frequency, and costs should be assessed in prospective studies [2,7].

4.6. Skin coverage and antibiotic therapy

Split-thickness skin grafting requires a clean, vascularized recipient bed capable of supporting graft revascularization. Delayed direct closure is appropriate when wound edges can be approximated without tension. The reported proportions—80% grafts and 20% direct closures—reflect anatomical indications rather than a randomized comparison. The reported staphylococci and streptococci are consistent with suppurative skin infections, although necrotizing infections may be polymicrobial. A third-generation cephalosporin combined with gentamicin was described as local practice; when deep necrotizing infection is suspected, international guidelines support broader empirical coverage, including anaerobes and resistant organisms as appropriate to the clinical context, alongside urgent surgery [1,2,6,8].

4.7. Outcomes and limitations

The initially favorable graft take reported in grafted patients should not be interpreted as a long-term complete healing rate. Assessments on postoperative days 3, 5, and 15 primarily evaluate early adherence and viability. The estimated 80% loss to follow-up makes the incidence of recurrence, contracture, dyschromia, and late functional complications uncertain. Additional limitations include the small sample size, absence of a control group, anatomical heterogeneity, lack of calibrated wound measurements, and incomplete microbiological data. Proportions extrapolated from a subset cannot be considered measurements obtained in all 20 patients. Compliance with PROCESS requires documentation of patient selection, procedures, complications, and losses to follow-up [6,9].

5. CONCLUSION

Reconstructive management of postinfectious tissue defects follows an integrated therapeutic sequence: infection source control, preservation of viable tissue, secondary-intention wound care, and subsequent coverage selected according to surrounding skin laxity, recipient-bed vascularity, and patient-related factors. CT provides useful mapping of collections and their anatomical relationships but does not replace urgent exploration when necrotizing infection is suspected. In resource-limited settings, conventional dressings enabled recipient-bed preparation when negative-pressure therapy was unavailable. Reported early outcomes are encouraging but require patient-level validation and longer follow-up.

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