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Simultaneous Infection Control and Reconstruction Using Continuous Local Antibiotic Perfusion in Septic Knee With Extensive Soft Tissue Defect: A Case Report

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Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
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Patient: Female, 69-year-old
Final Diagnosis: Septic arthritis of the knee
Symptoms: Pain
Clinical Procedure: —
Specialty: Orthopedics and Traumatology
Objective: Unusual setting of medical care
Background: Continuous local antibiotic perfusion (CLAP) has emerged as a treatment strategy for bone and soft tissue infections; however, its role in septic arthritis with extensive soft tissue defects remains unclear. We report a case of septic knee arthritis with joint exposure after patellar fracture fixation, in which a combined strategy of aggressive source control, CLAP, and early flap reconstruction enabled infection management and soft tissue coverage to proceed concurrently rather than sequentially.
Case Report: A 69-year-old woman developed methicillin-resistant *Staphylococcus aureus* infection with a 12 × 8 cm anterior knee soft tissue defect after patellar fracture fixation, presenting 2.5 months after the index surgery. Total patellectomy, extensive debridement, and CLAP were performed. With CLAP maintained throughout, reconstruction with a gastrocnemius muscle flap and split-thickness skin grafting was performed 1 week later, allowing infection management and reconstruction to proceed in parallel. Soft tissue coverage was achieved 17 days after referral, and inflammatory markers normalized within 3 weeks. At the 2-year follow-up, there was no recurrence of infection, and the patient was able to ambulate with full weight-bearing using a knee extension orthosis and a cane.
Conclusions: In selected salvage cases, a combined strategy incorporating CLAP and early flap reconstruction may allow infection control and reconstruction to proceed in parallel. The contribution of individual components cannot be isolated from this single case. Although total patellectomy compromised the extensor mechanism, the outcome was clinically acceptable in the context of limb salvage and eradication of infection.
Keywords: Anti-Bacterial Agents • Arthritis, Infectious • Methicillin-Resistant *Staphylococcus aureus* • Negative-Pressure Wound Therapy • Patella Fracture • Surgical Flaps • Orthopedics • Knee Joint • Surgical Flaps • Case Reports
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Introduction

Septic arthritis accompanied by extensive soft tissue loss is particularly challenging to manage because both adequate infection control and durable soft tissue coverage must be achieved. In the management of infected soft tissue defects around the knee, aggressive debridement and timely provision of well-vascularized soft tissue coverage are fundamental principles [1-3]. Although this staged approach aims to reduce the risk of recurrent infection and flap-related complications, it can prolong treatment and may contribute to functional decline during the treatment course.

Continuous local antibiotic perfusion (CLAP) is a technique that enables sustained delivery of high concentrations of antimicrobial agents directly to infected bone and soft tissue sites [4-6]. In this system, an antibiotic solution is continuously infused through indwelling catheters positioned at the infected site, while the resulting effluent is simultaneously drained, thereby maintaining a stable, high local antimicrobial concentration without the systemic toxicity associated with equivalent intravenous (IV) dosing. This continuous perfusion-and-drainage mechanism differs conceptually from conventional local antibiotic delivery systems such as antibiotic-impregnated beads

or spacers, which release antibiotics passively through elution and cannot be adjusted or replenished once implanted. A recent narrative review summarized the accumulating clinical experience with CLAP across a range of orthopedic infections, including fracture-related infection, osteomyelitis, and periprosthetic joint infection, while also outlining current limitations and areas requiring further investigation [7]. This approach may be particularly useful for biofilm-associated musculoskeletal infections, in which antimicrobial concentrations required for biofilm eradication are substantially higher than those achieved with systemic therapy alone [8,9]. However, reports describing the use of CLAP for septic arthritis, especially in combination with soft tissue reconstruction, remain limited.

We report a case of methicillin-resistant *Staphylococcus aureus* (MRSA) septic knee arthritis with extensive anterior knee soft tissue loss and joint exposure following patellar fracture fixation. The patient was treated with total patellectomy, extensive debridement, CLAP, and early gastrocnemius muscle flap reconstruction. This case highlights a potential strategy in which infection control and soft tissue reconstruction can proceed simultaneously under appropriate conditions.

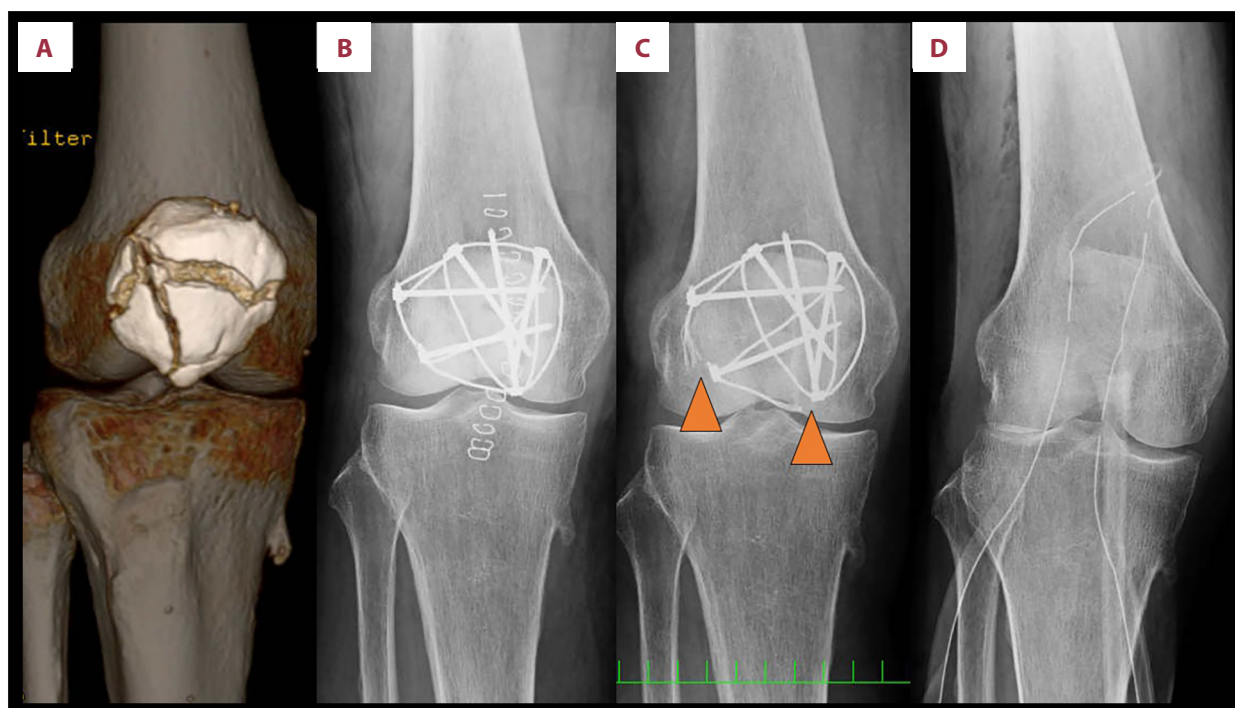


Figure 1. Preoperative imaging and initial surgical management of the right patellar fracture at the referring institution. (A) Three-dimensional CT image obtained at the time of injury, showing a right patellar fracture. (B) Open reduction and internal fixation with self-locking pins and circumferential wiring performed 4 days after injury. (C) Plain radiograph obtained 24 days after surgery, demonstrating wire breakage at the site indicated by the arrow. (D) Debridement and implant removal performed 35 days after surgery, followed by initiation of continuous local antibiotic perfusion (CLAP) with placement of 2 double-lumen tubes.

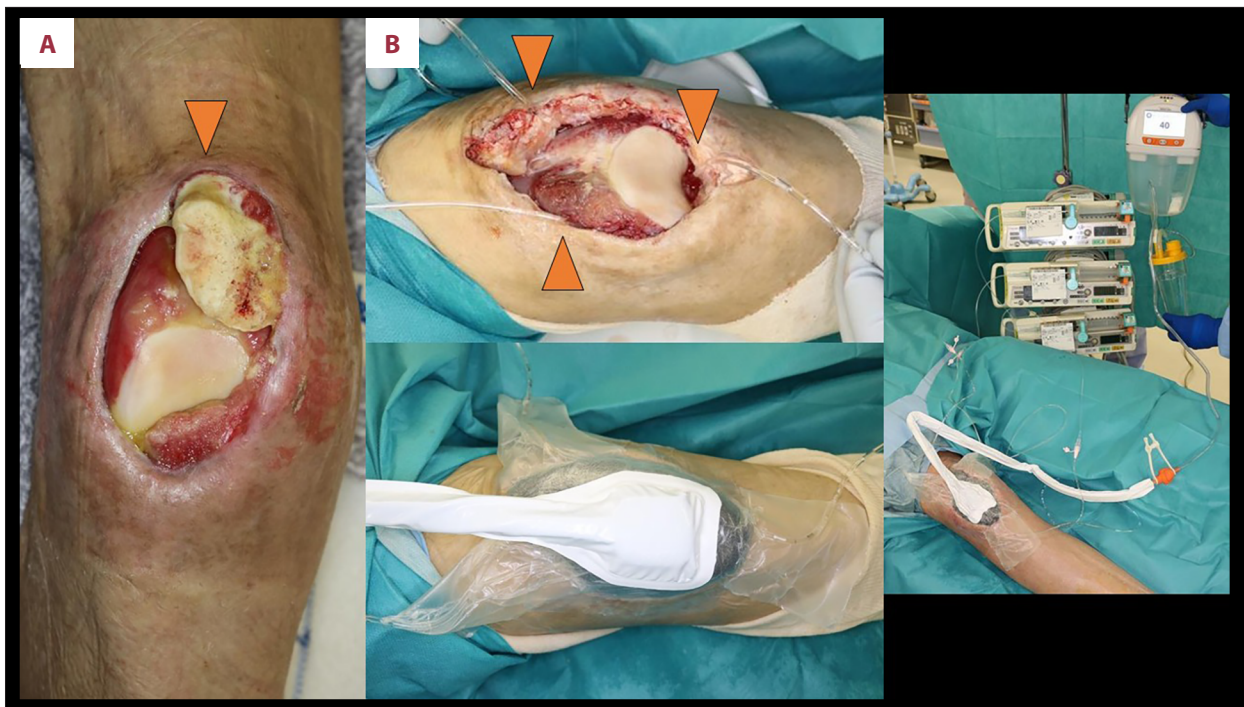


Figure 2. Clinical presentation and initial surgical management at our institution. **(A)** Clinical photograph of the right knee at presentation, 2.5 months after the index surgery, at our hospital. A 12 × 8 cm soft tissue defect is present over the anterior aspect of the knee, with the displaced patella, largely consisting of sequestrum, exposed proximally (arrow). **(B)** Intraoperative photograph obtained during debridement. Arrows indicate infected tissue around the medial and lateral femoral condyles and the anterior cruciate ligament. Three catheters (8-Fr ATOM tubes) were placed with their tips positioned at the sites of infection. A continuous local antibiotic perfusion (CLAP) system was established, and negative-pressure wound therapy was applied to the anterior knee soft tissue defect under continuous negative pressure of -40 mm Hg to enable drainage collection.

Case Report

A 69-year-old woman sustained a right patellar fracture after a fall at home (**Figure 1A**). Her medical history included Parkinson disease and hypertension. Four days after injury, she underwent open reduction and internal fixation with self-locking pins and circumferential wiring at another institution (**Figure 1B**). Hereafter, postoperative days are counted from the date of the initial open reduction and internal fixation.

On postoperative day 24, erythema and purulent discharge developed at the surgical site, and laboratory test results showed an elevated white blood cell count and C-reactive protein levels. Synovial fluid culture was positive for MRSA. Plain radiographs demonstrated implant failure (**Figure 1C**). Systemic antibiotic therapy with IV vancomycin (dose not available) was started on postoperative day 31. Because implant retention was considered unfeasible, debridement and implant removal were performed on postoperative day 35 (**Figure 1D**). CLAP was initiated at the referring institution; however, the infection was not controlled. Oral rifampicin (450 mg/day) was added on postoperative day 42. On postoperative day 53, the

patient developed a drug eruption, which was attributed to vancomycin; vancomycin was withdrawn, and the regimen was changed to IV daptomycin (200 mg/day) on postoperative day 55, while oral rifampicin was continued. Because of the extensive soft tissue defect and persistent infection, the patient was transferred to our hospital 2.5 months after the index surgery, at which time she remained on daptomycin and rifampicin.

On admission, the systemic antibiotic regimen was intensified to IV daptomycin (300 mg/day) combined with oral rifampicin (600 mg/day). Physical examination revealed a 12 × 8 cm soft tissue defect over the anterior aspect of the right knee, with exposure of the articular surface (**Figure 2A**). Knee range of motion was limited to -10° of extension and 30° of flexion. Most of the patella had become sequestrum and was considered unsalvageable, and total patellectomy and extensive debridement were planned. On the day before surgery (postoperative day 84), creatine kinase levels increased, and daptomycin-induced rhabdomyolysis was suspected; daptomycin was discontinued, and the regimen was changed to oral trimethoprim-sulfamethoxazole (sulfamethoxazole 2400 mg/day, trimethoprim 480 mg/day). Total patellectomy and extensive debridement were performed on postoperative day 85.



Figure 3. Soft tissue reconstruction and maintenance of the continuous local antibiotic perfusion (CLAP) system. **(A)** Intraoperative photograph, obtained 1 week after debridement and total patellectomy, showing soft tissue reconstruction with a medial gastrocnemius muscle flap and a split-thickness skin graft harvested from the right thigh. **(B)** Postoperative plain radiograph demonstrating complete patellectomy, with double-lumen tubes placed at the medial and lateral aspects of the knee joint as intra-soft tissue antibiotic perfusion (iSAP) catheters.

Intraoperatively, infected tissue was identified around the medial and lateral femoral condyles and the anterior cruciate ligament, and thorough debridement was performed. For intra-soft tissue antibiotic perfusion (iSAP), 3 catheters (8-Fr ATOM tubes) were placed with their tips positioned at these infected sites. A CLAP system was established to enable continuous infusion and drainage, with outflow collected from the anterior knee soft tissue defect (**Figure 2B**). Gentamicin at a concentration of 1200 µg/mL was continuously infused through each of the 3 catheters at a rate of 2 mL/h per catheter. Negative-pressure wound therapy was simultaneously applied to the soft tissue defect, and drainage was collected under continuous negative pressure of -40 mm Hg. Because all necrotic bone was considered to have been removed at this surgery, adjunctive oral rifampicin, which had been continued for biofilm control, was stopped.

After 1 week of CLAP following total patellectomy, 17 days after transfer to our hospital, soft tissue reconstruction was performed using a medial gastrocnemius muscle flap and split-thickness skin graft (**Figure 3A**). During reconstruction, two 20-Fr double-lumen tubes were placed at the medial and lateral aspects of the knee joint as iSAP catheters. The outlets of these tubes were connected to the wound under negative-pressure wound therapy, thereby maintaining the CLAP system with continuous drainage (**Figure 3B**).

Nine days after reconstruction, the patient developed a drug eruption and leukopenia attributed to trimethoprim-sulfamethoxazole; this agent was discontinued, and oral minocycline (200 mg/day) was started 4 days later as suppressive antimicrobial therapy. Two weeks after reconstruction, after a total of 3 weeks of CLAP therapy, the white blood cell count and C-reactive protein level had normalized. Renal function remained within normal limits, and no excessive elevation in serum gentamicin concentration was observed throughout the CLAP treatment period. No recurrence of infection was observed. A course of oral minocycline was continued until approximately 6 months after the patellectomy, with no clinical evidence of infection recurrence during or after this period. The patient was subsequently able to ambulate with full weight-bearing using a cane (**Figure 4A**) and a knee extension orthosis (**Figure 4B**). At the 2-year follow-up, knee range of motion was -10° of extension (**Figure 4C**) and 120° of flexion (**Figure 4D**), with an extension lag of 45° (**Figure 4E**). Although the extension lag persisted, the flap remained well incorporated (**Figure 4F**), and there were no signs of recurrent infection.

Discussion

The management of septic arthritis accompanied by extensive soft tissue defects remains highly challenging because



Figure 4. Clinical and functional findings at the 2-year postoperative follow-up. (A) Photograph showing the patient ambulating with full weight-bearing using a cane. (B) Lateral view showing the patient wearing a knee extension orthosis. (C) Lateral view of the right knee, showing -10° of extension. (D) Lateral view demonstrating 120° of flexion. (E) Lateral view demonstrating the extension lag of 45° . (F) Anterior view of the right knee, showing the flap well incorporated with no signs of recurrent infection.

both infection control and durable soft tissue coverage must be achieved. Aggressive debridement and timely provision of well-vascularized soft tissue coverage are fundamental principles in the management of infected soft tissue defects around the knee [1-3]. However, achieving adequate source control may require repeated surgical debridement in some cases of septic arthritis [10], which can further complicate the timing of definitive reconstruction.

In the present case, we adopted a different strategy by performing soft tissue reconstruction during the active phase of infection management. This combined approach, incorporating aggressive source control, CLAP, and early flap reconstruction, allowed infection management and soft tissue coverage to proceed simultaneously, with definitive soft tissue coverage achieved 17 days after transfer to our hospital, after 1 week of continued CLAP following total patellectomy and extensive debridement. Inflammatory markers normalized after a total of 3 weeks of CLAP therapy at our institution. The time to definitive coverage was shorter than that reported in a previous case of an infected anterior knee wound with joint exposure after patellar fracture fixation, although direct comparison is limited by differences in clinical context and treatment strategy. For example, Lee et al reported a similar case managed with negative pressure wound therapy, in which granulation

tissue covered the exposed bone and joint after 20 days, split-thickness skin grafting was performed after 21 days, and complete wound healing was achieved after 70 days [11]. In contrast, the present case illustrates that this parallel approach may be feasible within a combined salvage strategy, although the relative contribution of each component, including debridement, patellectomy, CLAP, and flap reconstruction, cannot be determined from a single case.

The primary contribution of this report lies in illustrating the feasibility of early flap reconstruction during CLAP within a combined salvage strategy for septic knee arthritis with extensive soft tissue loss. Published guidance for this clinical scenario remains limited. The novelty is not the individual use of CLAP, nor flap reconstruction alone, but rather the integration of these components within a single treatment course in a context in which prior CLAP had not achieved adequate infection control, and conventional staged management might have prolonged the infectious and reconstructive burden. This case therefore offers incremental clinical positioning of CLAP within a combined salvage pathway, rather than proposing a wholly new therapeutic concept.

One component that may have contributed to this outcome was CLAP, which allows sustained delivery of high concentrations

of antimicrobial agents directly to infected sites [4-6]. This is particularly relevant in biofilm-associated infections, where the minimum biofilm eradication concentration is substantially higher than the minimum inhibitory concentration and may not be achieved with systemic therapy alone [8,9]. In addition, high-concentration and prolonged gentamicin exposure has been reported to be effective against MRSA biofilms, supporting the rationale for sustained local gentamicin delivery in this setting [12]. By maintaining a favorable local antimicrobial environment, CLAP may support infection control even during the reconstruction phase; however, its independent effect cannot be isolated from those of debridement, patellectomy, and flap coverage in the present case. CLAP combined with debridement, antibiotics, and implant retention has also been reported to be a useful option for chronic periprosthetic joint infection after total knee arthroplasty in a small case series [13]. Although that setting differs from the present case in both the infectious context and the source-control strategy, since implant retention rather than removal of native tissue was the goal, it similarly illustrates the expanding range of clinical scenarios in which CLAP has been applied within the knee joint.

Notably, CLAP had already been initiated at the referring institution but failed to control the infection. One possible explanation is that adequate source control had not yet been achieved at that stage. In the present case, extensive debridement including total patellectomy was performed, which may have reduced the infectious burden and contributed to the subsequent favorable response to the overall treatment strategy. This observation underscores the importance of adequate surgical source control as a prerequisite for any local antimicrobial strategy and suggests that the prior failure of CLAP at the referring institution may reflect insufficient debridement rather than an inherent limitation of the technique itself. Distinguishing between these possibilities, however, is not possible from this single case.

Reconstruction of the resulting soft tissue defect required well-vascularized autologous tissue, and the gastrocnemius flap satisfied this requirement while offering coverage well suited to the anterior knee [14,15]. In a series of 27 patients who underwent medial gastrocnemius flap reconstruction for infected total knee arthroplasty, persistent or recurrent infection was reported in 14 patients (52%), with an implant survival rate of 48% at 4 years; notably, no flap-related complications were observed [15]. These findings suggest that such outcomes reflect the inherently refractory nature of septic knee arthritis with extensive soft tissue loss rather than a limitation of the medial gastrocnemius flap itself. The present case similarly involved intra-articular infection with extensive soft tissue loss, representing a comparably challenging clinical scenario. We therefore combined the gastrocnemius flap with CLAP, aiming not only for infection control but for early coverage with well-vascularized tissue.

This reconstructive approach was made possible by total patellectomy, which addressed the underlying difficulty of managing patellar infections: the limited soft tissue envelope and close proximity to the knee joint. Reported infection rates after patellar fracture fixation range approximately from 3.2% to 9.3%, and fracture-related infection of the patella can require multiple operations and may result in persistent functional impairment [16,17]. Total patellectomy, as performed in this case, represents one salvage option for achieving source control in the presence of extensive infection and sequestration [18]. Although this procedure inevitably compromises the extensor mechanism, previous reports have shown that acceptable functional outcomes can still be achieved in selected cases [19]. In the present case, the patient was able to ambulate with full weight-bearing using a knee extension orthosis and a cane and maintained her activities of daily living without recurrence of infection. Therefore, while the functional outcome was not anatomically ideal, it may be considered an acceptable result in the context of limb salvage and eradication of infection.

This report has several limitations that also inform the boundaries of its applicability. First, it describes a single case, and the generalizability of this approach remains uncertain. The parallel strategy appeared feasible in this case because several conditions were simultaneously met: aggressive surgical source control, including total patellectomy, was achievable; durable flap coverage was anatomically feasible; and the CLAP system could be maintained continuously across the reconstructive procedure. This combination of conditions is not universally present in septic knee arthritis, and the findings should not be generalized to cases without comparable reconstructive requirements or without the ability to achieve adequate source control. Second, the relative contributions of debridement, total patellectomy, CLAP, and flap reconstruction cannot be separated. Third, the optimal indications, antibiotic regimen, catheter placement, and duration of CLAP therapy have not yet been established. Further accumulation of cases is required to clarify the role of CLAP within combined salvage strategies for complex septic arthritis with extensive soft tissue defects.

Despite these limitations, this case highlights a potential treatment strategy in which infection control and soft tissue reconstruction are not necessarily sequential but can be pursued concurrently when appropriate surgical source control and local antimicrobial delivery are integrated within a combined reconstructive strategy.

Conclusions

In this case of MRSA septic knee arthritis with extensive soft tissue loss and joint exposure after patellar fracture fixation,

CLAP combined with total patellectomy, extensive debridement, and early gastrocnemius muscle flap reconstruction enabled infection control and soft tissue coverage to proceed in parallel. Although total patellectomy resulted in residual extensor dysfunction, the patient achieved an acceptable salvage outcome with no recurrence of infection and functional ambulation using a knee extension orthosis. This strategy may represent a useful option for selected complex periarticular knee infections in which both infection control and early soft tissue coverage are required.

Department and Institution Where Work Was Done

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Informed Consent

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

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