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CASE REPORT

Acute Hematogenous and Synchronous Periprosthetic Joint Infection in Bilateral total Knee Arthroplasty: Successful Management with Dair, Intraosseous Vancomycin, and Antibiotic-Loaded Calcium Sulfate Beads

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Abstract

Introduction: Acute hematogenous periprosthetic joint infection (PJI) is rare, and synchronous bilateral presentation is exceedingly uncommon. Prompt and effective treatment is required to prevent implant failure.

Case Presentation: We report the case of a 68-year-old woman with a history of bilateral total knee arthroplasty who developed synchronous hematogenous PJI due to methicillin-resistant *Staphylococcus aureus* (MRSA). A bilateral DAIR procedure was performed in both knees with intraosseous vancomycin administration and antibiotic-loaded calcium sulfate beads.

Discussion: Combined use of intraosseous vancomycin and antibiotic-impregnated beads may enhance local antibiotic concentration in complex infections. This case illustrates successful infection control using an intensified local antimicrobial strategy.

Conclusion: In this case, synchronous acute periprosthetic joint infection was successfully treated using the DAIR procedure combined with intensified local antibiotic delivery strategies.

Keywords: Periprosthetic Joint Infection, DAIR, Synchronous Infection, Intraosseous Vancomycin, Calcium Sulfate Beads, Knee Arthroplasty.

1. Introduction

Periprosthetic joint infections (PJI) represent one of the most challenging complications in joint arthroplasty, with significant impact on patient morbidity and healthcare systems. Among these, **acute hematogenous PJI**—infections that occur due to bloodstream dissemination of pathogens to a previously well-functioning prosthesis—are rare but clinically significant events that require prompt diagnosis and intervention to avoid catastrophic outcomes. The reported incidence ranges from 6% to 11% of all PJIs, and is frequently associated with *Staphylococcus aureus*, particularly methicillin-resistant strains (MRSA) [1,2].

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Even more uncommon is the presentation of **synchronous bilateral hematogenous PJI**, with only isolated reports available in the literature. In such cases, treatment decisions must balance aggressiveness with joint preservation strategies. The **DAIR (Debridement, Antibiotics, and Implant Retention)** procedure has shown acceptable success rates in acute infections when applied early and thoroughly, particularly in the absence of implant loosening [3–5].

In recent years, **adjunctive techniques** have emerged to enhance local antimicrobial concentrations during surgical treatment. Among them, **intraosseous administration of vancomycin** has shown promise in achieving high local tissue levels with minimal systemic toxicity [6,7]. Likewise, **calcium sulfate beads** impregnated with antibiotics offer sustained local release and osteoconductive benefits, potentially improving outcomes in PJI management [8–10].

We present a rare case of synchronous bilateral hematogenous PJI in a patient with prior total knee arthroplasty, successfully managed with DAIR, **pre-incisional intraosseous vancomycin administration**, and **antibiotic-loaded calcium sulfate beads**. This case underscores the importance of early recognition and aggressive combined strategies in selected patients.

2. Case Presentation

A 68-year-old woman with a history of bilateral total knee arthroplasty (TKA) presented to our institution in March 2024 with acute right knee pain, swelling, and limited range of motion. Her past medical history included well-controlled type 2 diabetes mellitus (treated with oral hypoglycemic agents) and hypertension (managed with enalapril 10 mg daily). Her left TKA was performed in November 2018 and the right TKA in July 2019, both without complications. Postoperative recovery was uneventful, and the patient remained asymptomatic until the current episode.

Five days after the onset of symptoms in the right knee, she developed similar pain and effusion in the left knee. Physical examination revealed bilateral knee effusion (figure 1), warmth, and tenderness, with preserved passive range of motion. Laboratory studies showed elevated inflammatory markers: erythrocyte sedimentation rate (ESR) of 76 mm/h and C-reactive protein (CRP) of 142 mg/L.

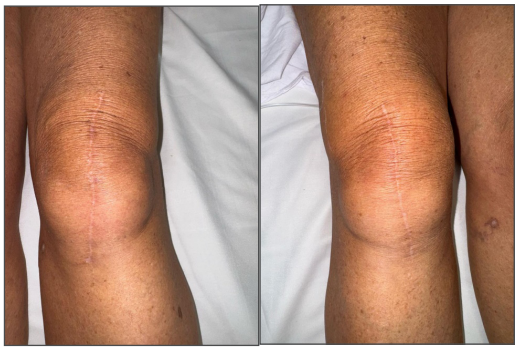

Figure 1. *Joint effusion in both knees*

Arthrocentesis was performed on both knees (Figure 2). Synovial fluid analysis revealed elevated white blood cell counts: 10,200 cells/mm³ in the left knee and 9,700 cells/mm³ in the right, with polymorphonuclear leukocyte percentages of 86% and 89%, respectively. Cultures were positive for methicillin-resistant *Staphylococcus aureus* (MRSA) in both joints. Radiographs showed no signs of loosening or periprosthetic osteolysis. Despite a thorough investigation—including evaluation for bacterial endocarditis—no distant infectious foci were identified.

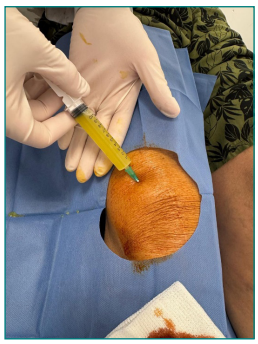

Figure 2. *Plenty of purulent fluid in the joint puncture*

Given the diagnosis of **acute hematogenous and synchronous PJI**, a bilateral and successive DAIR procedure was performed 12 days after symptom onset, starting with the left knee, immediately followed by the right. Both procedures followed an identical protocol.

Intraosseous vancomycin (500 mg diluted in 150 mL of saline) was administered prior to incision in each knee (figure3)

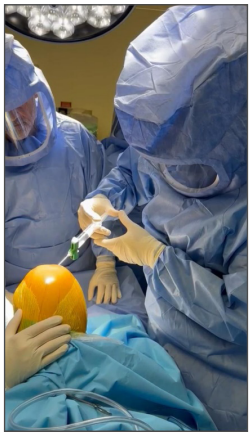

Figure 3. *Administration of intraosseous vancomycin in the knee*

Surgical exposure was achieved through the previous incision, extended using the **quadriceps snip** technique. The tibial modular liner was removed, and a thorough debridement was performed. Irrigation included:

- 3 liters of sterile saline,
- 3% hydrogen peroxide diluted 1:1 with saline,
- 3 liters of sterile saline,
- and 10% povidone-iodine diluted to 0.36%.

After temporary closure, the surgical field, instruments, gowns, and gloves were changed. The skin was re-prepped with antiseptics, a new modular tibial liner was implanted.

Subsequently, **10 cc of calcium sulfate beads** (Stimulan Rapid Cure®) were prepared with **1 gram of vancomycin** and **3 vials of gentamicin (80 mg each)**. These were implanted into the joint cavity before closure (figure 4).

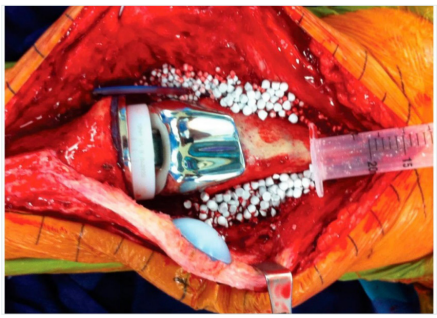

Figure 4. *Placement of calcium sulfate beads with antibiotics*

The patient received **intravenous vancomycin (15 mg/kg/day)** and **rifampin 600 mg/day** for 10 days postoperatively, followed by **oral therapy with rifampin and fluoroquinolones** for a total duration of 6 months.

At the end of treatment, the patient showed complete resolution of symptoms, normalization of inflammatory markers, and excellent functional recovery of both knees. No recurrence was observed at final follow-up.

3.Discussion

Acute hematogenous periprosthetic joint infection (PJI) is a relatively uncommon but serious complication, accounting for approximately 10–20% of all PJIs, depending on the series and the joint involved [1,3]. Its clinical presentation is typically abrupt and can affect previously well-functioning prostheses, often resulting from bacteremia originating from a distant source. *Staphylococcus aureus*, particularly methicillin-resistant strains (MRSA), is the most commonly isolated pathogen [2].

Even more uncommon is the **synchronous presentation of bilateral PJI**, especially of hematogenous origin. Cases of simultaneous infection of bilateral knee prostheses are extremely rare, with only a few case reports published in the literature [6,7]. This synchronous presentation significantly increases diagnostic and therapeutic complexity and requires careful surgical planning along with aggressive local and systemic infection control strategies.

The **DAIR procedure** (Debridement, Antibiotics, and Implant Retention) remains the standard approach for acute hematogenous infections when the prosthetic components are well-fixed and symptoms have been present for less than three to four weeks [4,5]. Reported success rates vary from 50% to 80%, depending on the timing of intervention, the virulence of the organism, and host-related factors [8].

In this case, three factors may have contributed to the favorable outcome. The first was the **intraosseous administration of vancomycin**. This technique has recently been shown to be effective in orthopedic infections, particularly PJI and osteomyelitis. Intraosseous (IO) delivery allows for high local bone concentrations with minimal systemic exposure, optimizing the bactericidal effect against biofilm-producing pathogens such as MRSA. Young et al. demonstrated that IO vancomycin administration during total knee arthroplasty results in bone concentrations several times higher than those achieved via intravenous infusion, without increasing nephrotoxicity [9,10,11]. Similarly, Kheir et al. reported successful outcomes using IO antibiotics as part of a limb salvage protocol in complex PJI cases [12]. In our case, vancomycin was administered intraosseously immediately before the surgical incision, which may have helped reduce intraoperative bacterial load and enhanced local tissue prophylaxis.

The second strategy we used was the **application of antibiotic-loaded calcium sulfate beads**. This technique has gained interest due to its biocompatibility and sustained antibiotic release capacity. The use of Stimulan® beads loaded with vancomycin and gentamicin has shown promising results in eradicating residual bacteria in the periprosthetic environment. Kallala et al. reported high infection control rates in chronic PJI cases treated with antibiotic-loaded beads as an adjunct to debridement or revision arthroplasty [13]. Anagnostakos et al. also reported favorable outcomes combining surgical debridement with local antibiotic carriers in joint infections [14]. More recently, Lum et al. emphasized that calcium sulfate beads may reduce recurrence rates when used in conjunction with DAIR, particularly against biofilm-forming organisms [15].

In our case, **10 cc of beads loaded with 1 g of vancomycin and three vials of gentamicin** were used, likely contributing to sustained antimicrobial activity at the surgical site.

Finally, another noteworthy aspect of our case was the **sequential performance of DAIR in both knees during the same surgical session**, a strategy that has rarely been reported. Although simultaneous bilateral procedures may carry theoretical risks (e.g., surgical fatigue, cross-contamination), these were mitigated by a strict intraoperative asepsis protocol, which included: re-disinfection of the skin, change of gloves, drapes, instruments, and gowns; and reimplantation of the modular components.

This approach is consistent with the recommendations of the **International Consensus Meeting (ICM)** on Musculoskeletal Infections, which supports DAIR in acute infections provided that modular components are exchanged and a strict protocol is followed [16].

4. Conclusion

A previously well-functioning total knee arthroplasty can be compromised by acute hematogenous infections, even in synchronous presentation—a rare and scarcely reported clinical scenario. This case demonstrates that a rigorous DAIR approach, combined with advanced local strategies such as intraosseous vancomycin administration and antibiotic-loaded calcium sulfate beads, may effectively control infection and preserve the implant. This approach may offer a valid alternative in selected patients, provided that early diagnosis and protocolized treatment are ensured. Higher-level studies are needed to confirm these findings and better define the indications for these adjunctive therapies.

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