Carbapenem-Resistant *Klebsiella pneumoniae* Prosthetic Hip Infection Following a Pelvic Pressure Ulcer: Therapeutic Value of Ceftazidime–Avibactam

Abstract

Periprosthetic joint infections (PJI) after total hip arthroplasty (THA) remain a major cause of morbidity, particularly when caused by multidrug-resistant Gram-negative bacteria. Carbapenem-resistant Klebsiella pneumoniae (CRKP) poses a critical therapeutic challenge, with limited antimicrobial options and poor clinical outcomes. We describe the case of an elderly woman with a complicated pelvic pressure ulcer infected by CRKP who subsequently developed a chronic PJI of a recently implanted hip prosthesis caused by the same strain, strongly suggesting hematogenous spread from the remote infectious focus. This case illustrates the diagnostic complexity and therapeutic difficulties associated with CRKP PJI and highlights the successful use of ceftazidime–avibactam after failure of conventional therapies, supporting its role as a valuable treatment option for severe prosthetic joint infections due to carbapenem-resistant Enterobacterales.

Keywords: Carbapenem-resistant *Klebsiella pneumoniae*; ceftazidime–avibactam; total hip arthroplasty.

Introduction:

Periprosthetic joint infections (PJI) after total hip arthroplasty (THA) represent a serious postoperative complication, associated with high morbidity and considerable therapeutic difficulty (1). These challenges are further compounded by the emergence of multidrug-resistant

pathogens, particularly carbapenem-resistant Klebsiella pneumoniae (CRKP), for which treatment options are limited and clinical outcomes often poor.

In some patients, PJI may occur through hematogenous dissemination from a distant infectious focus. Pelvic pressure ulcers, especially when complicated and heavily colonized by resistant organisms, may constitute an underrecognized source of bacteremia and subsequent prosthetic infection.

The advent of ceftazidime–avibactam, a β-lactam/β-lactamase inhibitor combination active against carbapenem-resistant strains, has provided new therapeutic opportunities in the management of bone, joint, and implant-associated infections (2).

We describe a case of chronic CRKP PJI developing in the aftermath of a complicated pelvic pressure ulcer in an elderly patient. Particular emphasis is placed on the pathophysiological mechanism of hematogenous spread and the beneficial role of ceftazidime–avibactam in this complex clinical scenario.

Case Report:

An 86-year-old woman with poorly controlled diabetes mellitus and chronic kidney disease (baseline estimated glomerular filtration rate, eGFR: 29 mL/min/1.73 m^2) was confined to bed for several days following pelvic trauma. She was admitted for management of a complicated pelvic pressure ulcer.

On presentation, she exhibited perineal pain with subcutaneous necrosis, right hip pain, and fever of 39 °C. Radiological assessment demonstrated a fracture of the right femoral neck, subcutaneous emphysema, and a pelvic abscess. Initial laboratory investigations revealed severe inflammation (C-reactive protein, CRP: 211 mg/L), marked neutrophilic leukocytosis ($34.3\times10^3/\mu L$), normal procalcitonin, HbA1c of 8.2%, microcytic hypochromic anemia (hemoglobin 8 g/dL), and moderate polyclonal hypergammaglobulinemia.

Bacteriological analysis of pus from the necrotic area isolated carbapenem-resistant Klebsiella pneumoniae (antibiogram in Table 1) and Enterococcus faecalis.

Initial management consisted of colistin and imipenem, combined with hyperbaric oxygen therapy, resulting in clinical and local improvement. One month later, the femoral neck fracture was treated surgically with implantation of a total hip arthroplasty.

Ten days after surgery, the patient developed fever, local inflammation of the operative site, leukocytosis ($29\times10^3/\mu L$), CRP of 100 mg/L, PCT of 0.5 ng/mL, HbA1c of 7%, and eGFR of 27 mL/min/1.73 m^2.

Cultures from superficial and deep pus samples yielded CRKP in both specimens, with Enterococcus faecalis additionally isolated from the superficial site. Synovectomy and arthrotomy lavage were performed, and antimicrobial therapy with colistin and imipenem was continued, resulting in transient improvement.

Over the following three years, the patient experienced persistent purulent discharge from the surgical wound. Computed tomography revealed a deep collection at the root of the right thigh, initially without signs of prosthetic loosening. Later progression was marked by septic loosening, warranting removal of the prosthesis. Cultures from the explanted material again isolated CRKP with the same resistance profile observed in previous episodes.

Antibiotic susceptibility testing revealed a pronounced multidrug-resistant profile in both the necrotic tissue and the explanted material. The isolates were resistant to all tested β-lactams, including amoxicillin, ticarcillin, amoxicillin–clavulanic acid, cephalosporins (cefixime, ceftriaxone, cefadroxil, cefazolin, cefuroxime), as well as carbapenems (imipenem and ertapenem). Resistance was also observed to aminoglycosides (tobramycin, gentamicin, amikacin), fluoroquinolones (ciprofloxacin, ofloxacin, nalidixic acid), and trimethoprim–sulfamethoxazole. In contrast, colistin remained the only active agent, with preserved

susceptibility in both types of samples.

Targeted therapy with ceftazidime–avibactam was initiated, leading to marked and sustained clinical improvement.

Discussion:

PJI remains a clinically significant complication, particularly among elderly, diabetic, or multimorbid patients. Although perioperative contamination is the predominant mechanism described in the literature, hematogenous seeding from a distant infectious focus is increasingly recognized. This mechanism is well supported by the work of Zimmerli et al. (1) and Tande and Patel (3), who emphasize the contribution of bacteremia—particularly in vulnerable patients with malnutrition, immobility, or infected pressure ulcers.

In the present case, the pelvic pressure ulcer previously infected by multidrug-resistant K. pneumoniae and E. faecalis constituted a clear infectious focus. Several authors have demonstrated that complicated pressure ulcers may lead to severe sepsis and bone dissemination (4)(5).

Moreover, studies on psoas abscesses have highlighted potential routes of direct or hematogenous spread to the hip. Dauchy et al. reported that 12% of hip PJI cases were associated with psoas abscesses, strongly correlating this pathology with hematogenous infections (6).

The presence of subcutaneous gas, a pelvic abscess, and a pronounced inflammatory response in our patient supports the likelihood of hematogenous bacterial dissemination.

Although no study has explicitly described spread from a pressure ulcer to a THA, the broader literature linking deep skin infections to subsequent prosthetic infection supports such a mechanism (1) (3).

The early postoperative infection of the THA by a CRKP strain identical to that previously isolated from the pressure ulcer further reinforces the hypothesis of hematogenous seeding.

Zimmerli's recommendations underline that bacteremia due to invasive organisms may seed prosthetic devices, particularly within the first three months after implantation (1), consistent with the clinical timeline observed. Tande and Patel similarly highlight the capacity of Enterobacterales to colonize prosthetic material during episodes of bacteremia (3).

Bone, joint, and implant-associated infections caused by carbapenem-resistant Enterobacterales, particularly K. pneumoniae, are associated with high rates of therapeutic failure with conventional regimens such as carbapenems or colistin.

Several studies support the efficacy of ceftazidime–avibactam in these infections. Schimmenti et al. described successful treatment of a CRKP PJI using ceftazidime–avibactam (7).

Experimental data also indicate robust bone penetration of the molecule: an in vitro model of osteomyelitis due to KPC-producing Klebsiella demonstrated significant bacterial load reduction with ceftazidime–avibactam (8).

Severe osteoarticular infections—including discitis and vertebral osteomyelitis caused by KPC—have also responded favorably to ceftazidime–avibactam, even in anatomically challenging sites, indicating potential superiority over colistin (9).

Nonetheless, vigilance remains necessary. Liu et al. documented the rapid emergence of resistance to ceftazidime–avibactam in certain KPC variants, underscoring the need for early initiation and appropriate dosing strategies (10).

In our patient, sustained clinical improvement was achieved only after initiation of ceftazidime–avibactam, following the failure of colistin and imipenem. The consistent resistance profile of K. pneumoniae across all infection episodes—from the pressure ulcer, to the early prosthetic infection, to the explanted material—provides strong evidence for hematogenous dissemination from the original ulcer.

Conclusion:

This case underscores the potential for hematogenous spread of carbapenem-resistant Klebsiella pneumoniae from a complicated pelvic pressure ulcer to a recently implanted hip prosthesis. It highlights the diagnostic complexity and therapeutic challenges posed by multidrug-resistant Gram-negative pathogens in PJI.

Ceftazidime–avibactam demonstrated clear clinical benefit after the failure of conventional therapies, supporting its role as an important therapeutic option for PJI caused by carbapenem-resistant Enterobacterales.

Early recognition and management of distant infectious foci—particularly pressure ulcers—are essential to preventing prosthetic contamination in high-risk patients.

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