EAS Journal of Orthopaedic and Physiotherapy
Abbreviated Key Title: EAS J Orthop Physiother
ISSN 2663-0974 (Print) | ISSN 2663-8320 (Online)
Published By East African Scholars Publisher, Kenya

OPEN ACCESS

Volume-7 | Issue-4 | Jul-Aug, 2025 | DOI: https://doi.org/10.36349/easjop.2025.v07i04.009

Review Article

Integrated Local and Systemic Vancomycin Therapy for MRSA-Induced Osteomyelitis and Septic Non-Union

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Article History
Received: 17.06.2025
Accepted: 10.08.2025
Published: 13.08.2025

Journal homepage:
https://www.easpublisher.com

Quick Response Code

Abstract: Methicillin-resistant Staphylococcus aureus (MRSA) osteomyelitis is difficult to treat due to multidrug resistance, biofilm formation, and the need for prolonged intravenous therapy. This observational study involved 14 patients (6 chronic osteomyelitis, 8 septic non-union; age 14–78 years), all with MRSA sensitive only to vancomycin. Treatment included surgical debridement, high-dose local vancomycin via polymethylmethacrylate (PMMA) beads or coated nails, and a short intravenous vancomycin course with oral linezolid in selected cases. All patients achieved infection cure; fracture union occurred in all septic non-union cases, with no systemic toxicity. High local antibiotic delivery improved outcomes and reduced hospitalization, though PMMA required secondary removal. Dual mode vancomycin therapy appears effective for MRSA osteomyelitis and septic non-union, but larger controlled trials are needed for validation.

Keywords: MRSA osteomyelitis, septic non-union, vancomycin, PMMA beads, antibiotic-coated nail, local drug delivery, biofilm.

INTRODUCTION

Osteomyelitis occurs in less than 2% of the population annually, with incidence rising in older adults and individuals with diabetes mellitus. In India, chronic osteomyelitis affects approximately 5–25% of patients, with rates increasing to 25–40% among those with diabetes. Effective management of chronic osteomyelitis requires surgical debridement. However, if antibiotic therapy is insufficient in dosage or duration, recurrence remains common despite surgery. Staphylococcus aureus is the leading cause of chronic osteomyelitis and infective non-union [1].

Aim of the Study

"To analyze the microbiological spectrum and evaluate the clinical efficacy of local vancomycin drug elution in the treatment of MRSA osteomyelitis and septic non-unions of long bones."

WHAT IS MRSA OSTEOMYELITIS

Methicillin-resistant Staphylococcus aureus (MRSA) osteomyelitis presents significant challenges in antibiotic selection, particularly in the presence of multidrug resistance. Vancomycin remains the standard treatment; however, its administration typically requires hospitalization and regular serum level monitoring. Suboptimal dosing or premature discontinuation of intravenous therapy increases the risk of chronic infection. Furthermore, biofilm formation can hinder vancomycin penetration even at therapeutic concentrations [1-4].

This study focuses on the efficacy of a dual-mode drug delivery approach as a highly effective strategy in the management of MRSA osteomyelitis.

DUAL MODE DRUG THERAPY

1. Short course intravenous vancomycin during hospital stay, in addition to oral linezolid in selected cases with proven sensitivity.
2. Local drug elution — vancomycin mixed with PMMA cement beads or vancomycin-coated revision nailing (IMIL).

Disadvantage: Requires a second surgery for removal of PMMA.

Alternative options in literature:

- Local antibiotic drug delivery system after surgical debridement.
- Antibiotic-coated nail with absorbable coating for infected non-union.

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- Extended hospital stay (6–8 weeks) for parenteral antibiotics alone.

MATERIALS AND METHODS

- Type of study: Observational cohort study
- Inclusion criteria: MRSA chronic osteomyelitis, septic non-union of long bone (post-traumatic)
- Exclusion criteria: Gap non-union, polymicrobial infection
- Total patients: 14
- Age range: 14–78 years
- Distribution: 8 patients with septic non-union, 6 with chronic MRSA osteomyelitis
- Antibiogram: All cases showed MRSA resistant to most antibiotics except vancomycin (sensitive)
- Treatment: Combination therapy with high-dose local vancomycin-loaded PMMA beads or cement-coated nails in non-union cases, following surgical debridement
- Follow-up: Serial inflammatory markers
- Primary outcome: Complete cure of infection
- Secondary outcomes: Healing of fracture site, closure of discharging sinus in chronic osteomyelitis

Table 1: Patient Data

S. No.	Name	Age/Sex	Diagnosis	Procedure Done
1	Ka	32/M	Septic non-union of right femur with plate	PMMA cement bead (DAIR)
2	Ni	42/M	Septic non-union of left distal tibia	PMMA cement bead
3	Sat	49/M	Septic non-union of right tibia	Vancomycin coated nail (IMIL)
4	Nav	62/F	Septic non-union left tibia	PMMA cement beads
5	Ani	14/F	Chronic osteomyelitis of left femur	PMMA cement beads
6	Ne	26/M	Left iliac osteomyelitis	PMMA cement beads
7	Ar	19/M	Infected non-union of right tibia	Vancomycin coated nail (IMIL)
8	Su	28/M	Infected non-union of right femur	Vancomycin coated nail (IMIL)
9	Bn	26/M	Infected non-union both bones	PMMA cement beads
10	Rag	67/F	Infected non-union of left femur	PMMA / Vancomycin coated nail
11	Kal	54/F	Chronic osteomyelitis of left femur	PMMA cement beads
12	Gow	38/F	Left leg tibial osteomyelitis	PMMA / Vancomycin cement beads
13	De	56/M	Left tibial osteomyelitis	PMMA / Vancomycin cement beads
14	Th	44/F	Chronic surface osteomyelitis left femur	PMMA cement beads

DISCUSSION

The management of MRSA osteomyelitis remains a clinical challenge due to the pathogen's multidrug resistance and ability to form biofilms, which hinder antibiotic penetration. In our cohort, all isolates were resistant to multiple antibiotics but sensitive to vancomycin, supporting existing literature that vancomycin remains the cornerstone for MRSA infections (Liu *et al*., 2011).

Local antibiotic delivery using PMMA beads or vancomycin-coated nails offers several advantages:

- Achieves high local antibiotic concentration surpassing MIC without systemic toxicity (Walenkamp *et al*., 1986).
- Provides sustained drug release at the infection site, enhancing biofilm penetration (Neut *et al*., 2001).
- Avoids prolonged hospitalization required for 6–8 week intravenous therapy.

CONCLUSION

Clinico-radiological assessment demonstrated complete resolution of infection in all 14 patients, with successful fracture union in the non-union cases. Vancomycin maintained consistent sensitivity; however, systemic administration necessitates careful balancing of therapeutic efficacy against toxicity, alongside regular monitoring of serum drug levels. In contrast, higher local concentrations have been shown to enhance biofilm penetration while minimizing systemic toxicity.The use of custom-prepared vancomycin-impregnated PMMA, applied as beads or coated intramedullary nails, proved to be a cost-effective option. Given the limited sample size, statistical analysis could not be performed; therefore, larger randomized controlled trials are warranted to validate these findings [1].

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Citation: P. Muthuvel Rajan & Venkat Kiran (2025). Integrated Local and Systemic Vancomycin Therapy for MRSA-Induced Osteomyelitis and Septic Non-Union. *EAS J Orthop Physiother, 7*(4): 91-93.