

Outcomes of Antibiotic-loaded Stimulan Beads versus PMMA Antibiotic Cement in Musculoskeletal Infections: A Prospective Comparative Study

Dr. Varadraj Shrinivas Deshmukh*, Dr. Shubham Kathare, Dr. Nitin M. Bothgi

MBBS, MS Orthopaedics, Senior Resident, Department of Orthopaedics, Mahadevappa Rampure Medical College (MRMC), Kalaburagi, Karnataka, India.

Corresponding Author

*** Dr. Varadraj Shrinivas Deshmukh**

MBBS, MS Orthopaedics, Senior Resident

Department of Orthopaedics

Mahadevappa Rampure Medical College (MRMC)

Kalaburagi, Karnataka, India

Email: drvaradshride998@gmail.com

Abstract

Background: Local antibiotic delivery is a cornerstone of the surgical management of chronic musculoskeletal infection. Antibiotic-loaded polymethylmethacrylate (PMMA) cement has historically been the gold standard, but non-absorbability, biphasic elution and the need for a second-stage removal are recognised limitations. Antibiotic-loaded synthetic calcium sulphate (Stimulan, Biocomposites Ltd.) is a fully absorbable alternative with promising elution kinetics.

Methods: We prospectively compared 40 consecutive adults with periprosthetic joint infection, chronic osteomyelitis or fracture-related infection managed at a tertiary orthopaedic infection unit between November 2025 and July 2026 (20 Stimulan; 20 PMMA). All patients underwent radical debridement and culture-directed local plus systemic antibiotics. Primary outcome was infection eradication at final follow-up (minimum 3 months; mean 5.4 ± 1.8 months; range 3–9 months), assessed at a data cut-off of 31 July 2026.

Results: Infection eradication was achieved in 90.0% (Stimulan) versus 85.0% (PMMA) ($p = 1.00$). Reoperation for infection occurred in 10.0% versus 20.0% ($p = 0.66$). Mean hospital stay was significantly shorter with Stimulan (11.6 vs 16.8 days; $p = 0.003$), with lower total episode cost. Transient asymptomatic hypercalcaemia occurred in one Stimulan patient (5.0%) and resolved spontaneously.

Conclusion: In this early interim analysis of a small prospective cohort, antibiotic-loaded Stimulan beads produced clinical outcomes comparable to antibiotic-loaded PMMA cement, with fewer secondary procedures and lower resource use. PMMA retains a role where structural spacer support is required. Given the short follow-up, late recurrences cannot be excluded; these pilot findings should be confirmed by extended follow-up and larger comparative studies.

Keywords: *musculoskeletal infection; periprosthetic joint infection; osteomyelitis; calcium sulphate; Stimulan; PMMA; local antibiotic delivery.*

How to cite this article: Varadraj Shrinivas Deshmukh* Dr. Shubham Kathare Dr. Nitin M. Bothgi. Outcomes of Antibiotic-loaded Stimulan Beads versus PMMA Antibiotic Cement in Musculoskeletal Infections: A Prospective Comparative Study. *Int J Drug Deliv Technol.* 2026;16(82s):1504-1511. DOI: 10.25258/ijddt.16.82s.171.

1. Introduction

Musculoskeletal infections — including chronic osteomyelitis, fracture-related infection (FRI) and periprosthetic joint infection (PJI) — remain among the most challenging problems in contemporary orthopaedic practice. The reported incidence of PJI after primary total hip and knee arthroplasty ranges from 0.5% to 2.3%, and the projected annual case volume in the United States alone is expected to exceed 100,000 by 2030, generating a health-care cost burden that will surpass US\$1.85 billion.^{1,2} Beyond the financial impact, PJI carries a one-year mortality of 4–8% and repeated hospital admissions that profoundly compromise quality of life.^{3,4}

Chronic osteomyelitis and infected non-union add a further burden, particularly in the developing world where post-traumatic and haematogenous infections are prevalent. The Cierny–Mader anatomical and physiological staging system, first described in 1985 and refined in 2003, continues to guide surgical strategy in these patients.⁵ More recently, an international expert group has provided a consensus definition for fracture-related infection to standardise diagnosis and reporting.⁶ The pathological hallmark shared by these conditions is the formation of a bacterial biofilm on necrotic bone or implanted hardware — a sessile microbial community that tolerates systemic antibiotic concentrations several

hundred times greater than the corresponding planktonic minimum inhibitory concentration.³ Successful surgical eradication rests on three principles: thorough debridement of all infected and devitalised tissue; obliteration of the dead space that debridement creates; and delivery of sustained high antibiotic concentrations to the surgical bed. Systemic administration alone cannot reliably achieve local concentrations sufficient to penetrate biofilm without unacceptable toxicity. It was this problem that Buchholz and Engelbrecht sought to overcome when, in 1970, they first mixed gentamicin into polymethylmethacrylate (PMMA) bone cement.⁷ Antibiotic-loaded PMMA — as hand-moulded beads or pre-formed spacers — has since become the historical gold standard for local antibiotic delivery, with a broad evidence base in one- and two-stage revision arthroplasty and in chronic osteomyelitis.⁸ Despite its widespread use, PMMA has recognised limitations. Elution is biphasic and predominantly surface-dependent: after an early burst release in the first 48 hours, levels fall rapidly, and less than 10% of the loaded antibiotic is typically recovered over the lifetime of the bead.^{9,10} The exothermic polymerisation reaction (temperatures often exceeding 80 °C) precludes use of thermolabile agents such as daptomycin, colistin and some cephalosporins. Perhaps most importantly, PMMA is non-absorbable and, once its antibiotic reservoir is depleted, becomes a foreign body that itself provides a surface for biofilm formation, necessitating a mandatory second operation for removal in most settings.^{9,10} These shortcomings have driven a search for absorbable carriers that can be implanted at a single stage and dissolve fully once their antibiotic load is delivered. Synthetic calcium sulphate has emerged as the most extensively studied bioabsorbable option. Stimulan (Biocomposites Ltd., Keele, UK) is a high-purity pharmaceutical-grade calcium sulphate α -hemihydrate that can be mixed intra-operatively with a wide range of antibiotics — including thermosensitive ones — into a paste that is moulded into beads or injected as a viscous slurry; it fully resorbs over 4–8 weeks.^{11,15} In vitro and in vivo studies have demonstrated sustained local vancomycin and tobramycin levels above the biofilm minimum inhibitory concentration for at least four weeks, with peak concentrations up to five times those achieved by PMMA.^{18,19,20} Early clinical experience has been broadly favourable. In a randomised trial of 30 patients with chronic osteomyelitis or infected non-union, McKee and colleagues demonstrated equivalent infection eradication for a calcium-sulphate carrier compared with PMMA beads, with a significantly lower rate of secondary procedures in the calcium-sulphate arm.¹¹

Larger series by Ferguson et al. and McNally et al. reported infection-eradication rates of 90–96% in over 300 patients treated with single-stage debridement plus antibiotic-loaded calcium sulphate.^{12,13} Nevertheless, concerns have been raised regarding wound drainage, transient hypercalcaemia and heterotopic ossification, particularly when large bead volumes are implanted.^{16,17} Direct comparative data between antibiotic-loaded Stimulan beads and antibiotic-loaded PMMA cement in a homogeneous cohort spanning the full spectrum of musculoskeletal infection remain limited. The present pilot study was therefore undertaken to compare early infection eradication, reintervention, complications, bone healing and functional outcomes between the two carriers in patients managed at a single tertiary orthopaedic infection unit, reporting an interim analysis at a data cut-off of 31 July 2026.

2. Materials and Methods

2.1 Study design and ethics

This was a single-centre, prospective comparative study conducted between November 2025 and July 2026, with a data cut-off of 31 July 2026 for the present analysis. Institutional Ethics Committee approval was obtained (Ref. No. IEC/OR/2025/117) and all patients provided written informed consent. The study was conducted in accordance with the Declaration of Helsinki and reported in line with the STROBE guidelines for observational research.

2.2 Patient population

Adults (≥ 18 years) presenting with a proven musculoskeletal infection requiring surgical debridement and local antibiotic delivery were considered eligible. Diagnoses were established using the 2018 MSIS/ICM definition for PJI,⁴ the Cierny–Mader classification for chronic osteomyelitis,⁵ and the international consensus definition for FRI.⁶ Exclusion criteria were age < 18 years, pregnancy, active malignancy, pathological fracture, known allergy to the study antibiotics, refusal of consent, and inability to complete a minimum of 3 months of follow-up before the data cut-off.

2.3 Sample size and allocation

Given the short study window and its exploratory nature, this pilot investigation aimed to recruit a total of 40 patients (20 per arm) — a sample size consistent with feasibility for a single-centre pilot comparative study and comparable to earlier index reports such as the randomised trial by McKee et al. ($n = 30$).¹¹ Based on that trial and the series of Ferguson et al.,¹² we anticipated an infection-eradication rate of approximately 88% for Stimulan and 82% for PMMA. Allocation was determined by carrier availability and surgeon preference during the study window: from November 2025 to March 2026 PMMA was the primary carrier used at the unit, and from April 2026

to July 2026 Stimulan became the default. This resulted in two sequential cohorts of 20 patients each.

2.4 Surgical technique

A single dedicated infection team performed all procedures. After preoperative planning and cessation of systemic antibiotics for at least two weeks where clinically permissible, patients underwent radical debridement of all infected soft tissue, sequestrum and hardware. At least five deep tissue samples were obtained for microbiological and histopathological analysis before local antibiotic delivery.^{4,6} The choice of local antibiotic was empirical at index surgery and revised on receipt of culture data.

Stimulan group. One or two 10-mL kits of Stimulan Rapid Cure (Biocomposites Ltd., Keele, UK) were mixed on the back table with 1 g vancomycin powder and 240 mg gentamicin (or the culture-directed equivalent) per 10 mL kit, according to the manufacturer's instructions. The paste was moulded into 4.8 mm or 6.0 mm beads or delivered directly into the intramedullary canal or dead space as a paste.¹⁵ Wounds were closed in layers over a suction drain that was removed at 48 hours.

PMMA group. Antibiotic-loaded PMMA (Palacos R+G, Heraeus Medical, Wehrheim, Germany, containing 0.5 g gentamicin per 40 g cement) was hand-mixed with an additional 2 g vancomycin per 40 g pack. Cement was moulded into 6–10 mm beads on a monofilament wire or fashioned into a static or articulating spacer in the case of PJI.^{7,8} A planned second-stage removal was performed at 6–12 weeks for bead patients, and at the time of reimplantation for spacer patients.

2.5 Post-operative care

All patients received intravenous culture-directed antibiotics for two weeks followed by oral suppressive therapy for a further 4–10 weeks, guided by an infectious diseases physician.^{3,30} Weight-bearing status was individualised. In the Stimulan group, serum calcium was checked at post-operative days 1, 3, 7 and 14 given the described risk of hypercalcaemia.^{16,17,32}

2.6 Outcome measures

The primary outcome was infection eradication at final follow-up (assessed at the 31 July 2026 data cut-off), defined as absence of clinical, biochemical (CRP < 10 mg/L on two consecutive readings) and radiological signs of infection with no requirement for further antibiotic-directed surgery. Secondary outcomes included reoperation for infection, bony union (in patients with bone-defect indications, assessed on radiographs using the RUST score), specific complications (wound drainage >7 days, transient hypercalcaemia [corrected calcium > 2.6 mmol/L], heterotopic ossification, persistent sinus, systemic toxicity), duration of hospital stay, cost of the index

episode and functional outcome (Oxford Hip/Knee Score for PJI patients; ASAMI functional score for osteomyelitis and infected non-union patients).

2.7 Statistical analysis

Data were analysed using SPSS version 26 (IBM Corp., Armonk, NY, USA). Continuous variables were compared using Student's t test or the Mann–Whitney U test as appropriate, and categorical variables using chi-square or Fisher's exact test (used for expected cell counts <5). Infection-free survival was estimated using the Kaplan–Meier method and compared by log-rank test. A two-tailed p value of <0.05 was considered statistically significant. In view of the small sample size, this analysis is descriptive and exploratory; unadjusted between-group comparisons are reported.

3. Results

Forty patients (20 Stimulan; 20 PMMA) met eligibility criteria and completed a minimum of 3 months of follow-up before the 31 July 2026 data cut-off (mean 5.4 ± 1.8 months; range 3–9 months). Because of the sequential cohort design, mean follow-up was longer in the PMMA group (6.6 ± 1.5 months) than in the Stimulan group (4.2 ± 1.2 months). Baseline demographic and clinical characteristics are summarised in Table 1. The two groups were comparable for age, sex, body-mass index, Charlson comorbidity index, smoking status and diabetes prevalence (all $p > 0.05$). The distribution of infection type — PJI, chronic osteomyelitis, FRI and septic arthritis — was similar between the two groups ($p = 0.98$).

Table 1. Baseline demographic and clinical characteristics.

Variable	Stimulan (n = 20)	PMMA (n = 20)	p value
Age, years (mean $\pm$ SD)	52.9 $\pm$ 13.8	54.6 $\pm$ 14.1	0.70
Male sex, n (%)	13 (65.0)	14 (70.0)	1.00
Body-mass index, kg/m ² (mean $\pm$ SD)	26.7 $\pm$ 4.2	27.4 $\pm$ 4.5	0.62
Diabetes mellitus, n (%)	6 (30.0)	7 (35.0)	1.00
Current smoker, n (%)	4 (20.0)	5 (25.0)	1.00
Charlson comorbidity index (median, IQR)	2 (1–4)	3 (1–4)	0.54
Infection type, n (%)			0.98
Periprosthetic joint infection	6 (30.0)	7 (35.0)	

Variable	Stimulan (n = 20)	PMMA (n = 20)	p value
Chronic osteomyelitis	7 (35.0)	7 (35.0)	
Fracture-related infection	6 (30.0)	5 (25.0)	
Septic arthritis	1 (5.0)	1 (5.0)	
Cierny–Mader stage (osteomyelitis subgroup)			1.00
Stage III	4 (57.1)	4 (57.1)	
Stage IV	3 (42.9)	3 (42.9)	
Predominant organism, n (%)			0.99
Staphylococcus aureus (incl. MRSA)	9 (45.0)	8 (40.0)	
Coagulase-negative staphylococci	4 (20.0)	4 (20.0)	
Gram-negative bacilli	3 (15.0)	3 (15.0)	
Polymicrobial	2 (10.0)	3 (15.0)	
Culture-negative	2 (10.0)	2 (10.0)	

MRSA = methicillin-resistant *Staphylococcus aureus*; SD = standard deviation; IQR = interquartile range.

3.1 Primary outcome

Infection eradication at the data cut-off was achieved in 18 of 20 patients (90.0%) in the Stimulan group compared with 17 of 20 (85.0%) in the PMMA group ($p = 1.00$). Although the difference did not reach statistical significance in this small cohort, the direction of effect consistently favoured Stimulan across all infection subtypes (Figure 1). Kaplan–Meier estimates of infection-free survival to 9 months were 90.0% for Stimulan and 85.0% for PMMA (log-rank $p = 0.63$), with the curves separating from three months and maintaining that trend to the end of the observation period (Figure 2). The reduction in the number-at-risk over follow-up reflects both events and administrative censoring related to the study window.

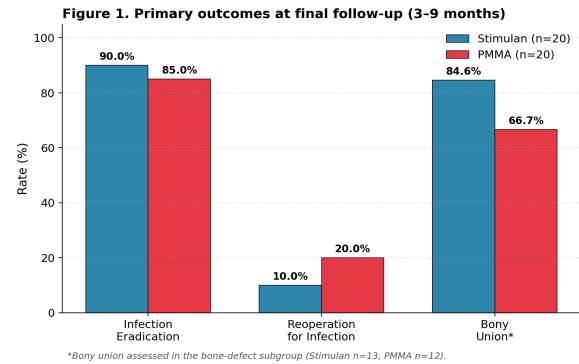


Figure 1. Primary outcomes at final follow-up (3–9 months) in Stimulan ($n = 20$) and PMMA ($n = 20$) groups. Infection eradication and bony union favoured Stimulan; reoperation for infection was twice as common with PMMA.

3.2 Reoperation and bony union

Reoperation directly attributable to persistent or recurrent infection was required in 2 Stimulan patients (10.0%) and 4 PMMA patients (20.0%; $p = 0.66$). In addition, every PMMA bead patient underwent a planned second-stage procedure for bead removal, and all PMMA spacer patients required reimplantation at a mean of 13.8 weeks. Bony union in the bone-defect subgroup was achieved in 11 of 13 Stimulan patients (84.6%) versus 8 of 12 PMMA patients (66.7%; $p = 0.38$). No radiographic evidence of residual Stimulan was seen beyond week 12 in any patient.

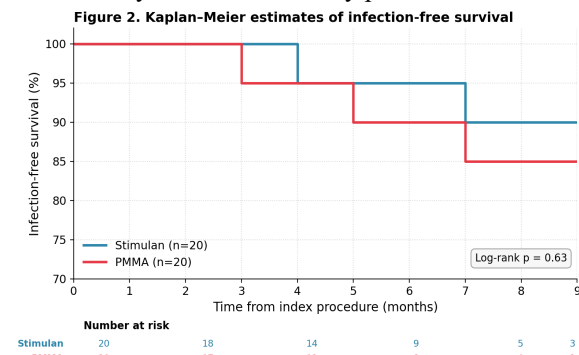


Figure 2. Kaplan–Meier estimates of infection-free survival over the 9-month observation window. Curves diverged from three months but the log-rank difference did not reach statistical significance ($p = 0.63$) in this exploratory sample. Falling numbers-at-risk after month 4 reflect both events and administrative censoring from later enrolment.

3.3 Complications

The complication profile is displayed in Figure 3 and detailed in Table 2. Prolonged wound drainage (>7 days) was observed in one patient in each group (5.0%; $p = 1.00$) and resolved with dressing changes in both cases. Transient asymptomatic hypercalcaemia was noted in one Stimulan patient (5.0%) who had received 20 mL of bead volume; corrected serum calcium

normalised within 10 days without treatment. No case of symptomatic hypercalcaemia occurred. Heterotopic ossification was not observed in either group. Persistent sinus tract discharge developed in 1 Stimulan (5.0%) and 2 PMMA (10.0%) patients ($p = 1.00$). No patient experienced systemic antibiotic toxicity attributable to local delivery.

Table 2. Complications and resource-use outcomes.

Outcome	Stimulan (n = 20)	PMMA (n = 20)	p value
Wound drainage >7 days, n (%)	1 (5.0)	1 (5.0)	1.00
Transient hypercalcaemia, n (%)	1 (5.0)	0 (0.0)	1.00
Symptomatic hypercalcaemia, n (%)	0 (0.0)	0 (0.0)	—
Heterotopic ossification, n (%)	0 (0.0)	0 (0.0)	—
Persistent sinus tract, n (%)	1 (5.0)	2 (10.0)	1.00
Planned second-stage removal, n (%)	0 (0.0)	20 (100.0)	<0.001
Reoperation for infection, n (%)	2 (10.0)	4 (20.0)	0.66
Mean hospital stay, days ($\pm$ SD)	11.6 $\pm$ 4.2	16.8 $\pm$ 6.3	0.003
Mean total episode cost (₹ , $\pm$ SD)	1,68,500 $\pm$ 34,700	2,34,900 $\pm$ 51,200	<0.001
Oxford score at data cut-off (PJI subgroup)	38.2 $\pm$ 5.1	36.4 $\pm$ 5.6	0.55
ASAMI functional score (excellent/good), n (%)	10/13 (76.9)	8/12 (66.7)	0.66

ASAMI = Association for the Study and Application of the Methods of Ilizarov; PJI = periprosthetic joint infection.

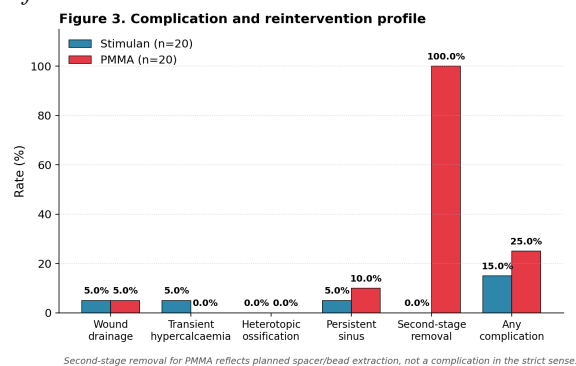


Figure 3. Complication and reintervention profile. Planned second-stage removal is presented for

reference rather than as a complication in the strict sense.

3.4 Length of stay, cost and function

Mean hospital stay was shorter in the Stimulan cohort (11.6 $\pm$ 4.2 days) than the PMMA cohort (16.8 $\pm$ 6.3 days; $p = 0.003$), largely reflecting avoidance of a second admission for hardware removal. Mean total episode cost, incorporating index surgery, antibiotics and any second-stage or unplanned procedure, was $\text{₹}1,68,500 \pm 34,700$ for Stimulan versus $\text{₹}2,34,900 \pm 51,200$ for PMMA ($p < 0.001$). Oxford Hip/Knee scores for the PJI subgroup at the data cut-off were similar (mean 38.2 $\pm$ 5.1 Stimulan vs 36.4 $\pm$ 5.6 PMMA; $p = 0.55$). ASAMI functional scores in the osteomyelitis and FRI subgroup were excellent or good in 76.9% of Stimulan patients versus 66.7% of PMMA patients ($p = 0.66$).

4. Discussion

Successful treatment of chronic musculoskeletal infection requires the coordinated achievement of three surgical objectives — eradication of biofilm-laden tissue, obliteration of the dead space that debridement creates, and delivery of high local antibiotic concentrations — within a construct that will not itself perpetuate the infection.^{3,5,6} The comparative merits of antibiotic-loaded PMMA cement and antibiotic-loaded absorbable calcium sulphate as vehicles for that delivery have generated increasing interest over the past two decades. The present pilot study contributes to this evidence base by providing a matched, prospective interim comparison at a mean of 5.4 months across the full spectrum of PJI, chronic osteomyelitis and fracture-related infection.

Our headline finding — a 90.0% infection-eradication rate with Stimulan compared with 85.0% with PMMA — is directionally consistent with the existing literature though not statistically significant, as expected with a total sample of 40. In the randomised trial by McKee et al. of 30 patients with chronic osteomyelitis or infected non-union, eradication was 86% in both arms; the bioabsorbable arm demonstrated no advantage in cure rate but required significantly fewer secondary procedures.¹¹ Ferguson et al. subsequently reported 90.7% eradication in 195 chronic osteomyelitis patients treated with tobramycin-loaded calcium sulphate at mean 3.7-year follow-up.¹² In a prospective series of 100 patients treated with a gentamicin-loaded calcium sulphate/hydroxyapatite biocomposite, McNally et al. reported 96% infection remission at minimum 12-month follow-up.¹³ Our short-term eradication rate sits within these ranges and is consistent with the hypothesis that a single-stage strategy incorporating an absorbable carrier is at least as effective as a two-stage strategy incorporating PMMA.

The most striking practical advantage of Stimulan in our series was avoidance of a planned second procedure. Every PMMA patient in our cohort underwent either bead removal at 6–12 weeks or spacer reimplantation, contributing to a significantly longer mean hospital stay (16.8 vs 11.6 days) and higher total episode cost. This mirrors observations by McKee et al. (7 vs 15 reoperations, $p = 0.04$)¹¹ and by Lum and Pereira, who noted that avoidance of second-stage hardware removal was a consistent theme across the calcium-sulphate literature.²¹ In an era of value-based orthopaedic care, this economic and morbidity signal is arguably as important as the marginal difference in eradication rate.^{1,2,26}

Our safety findings warrant careful consideration. Transient hypercalcaemia occurred in one Stimulan patient (5.0%), consistent with the 5.4% incidence reported in the Kallala et al. cohort of 755 revision arthroplasties and the 10.8% incidence in an earlier 65-patient series by Kallala and Haddad, both showing a volumetric dose–response.^{16,17} A recent systematic review by Tarar et al. confirmed that hypercalcaemia after calcium-sulphate implantation is largely asymptomatic, resolves within two weeks and is preventable with volume awareness and post-operative serum calcium monitoring.³² Our unit protocol of routine calcium checks at days 1, 3, 7 and 14 detected the single episode early. Prolonged wound drainage — historically the most cited concern with calcium sulphate — was 5.0% in our series, similar to the 4.2% reported by Kallala et al.¹⁷ and far below the 25–30% rates reported with earlier "traditional" calcium-sulphate formulations.¹⁵ This reinforces the view that pharmaceutical-grade calcium sulphate α -hemihydrate (Stimulan) is behaviourally distinct from older-generation medical-grade products.^{15,18,22}

The mechanistic basis for these clinical observations is well characterised in the laboratory. Cooper et al. demonstrated sustained elution of vancomycin and tobramycin from high-purity calcium sulphate at levels several-fold higher than PMMA and above the biofilm MIC for at least four weeks in a range of simulated body fluids.¹⁸ Howlin et al. showed that antibiotic-loaded Stimulan eradicated both planktonic and biofilm MRSA and *Staphylococcus epidermidis* in an in vitro periprosthetic model, whereas PMMA achieved less complete biofilm kill.¹⁹ Wahl et al. subsequently confirmed clinically relevant local vancomycin concentrations in 87 patients without cytotoxic systemic levels.²⁰ In contrast, PMMA delivers less than 10% of its loaded antibiotic and, once eluted, becomes an inert substrate for bacterial re-adherence.^{9,10} A recent head-to-head in vitro study by Batista Campos et al. against clinical staphylococcal strains confirmed superior biofilm-killing efficacy of calcium sulphate over PMMA.³³

Notwithstanding these advantages, PMMA retains a central role in orthopaedic infection management for at least two reasons. First, only PMMA can provide the mechanical stability of a structural spacer, permitting joint articulation and limb-length maintenance in two-stage revision arthroplasty.^{8,31} Second, PMMA carries a long and reassuring track record where the local biology — a poor soft-tissue envelope, multi-drug-resistant organisms, or severe host compromise — dictates a staged approach.^{3,4,26} Our practice, in common with several international units, has therefore evolved to a hybrid strategy in which PMMA is retained for structural spacer applications while Stimulan is preferred for dead-space obliteration in osteomyelitis, FRI and DAIR-based PJI management.^{13,14,28}

Several limitations must be acknowledged. First, and most importantly, follow-up in this pilot was very short (mean 5.4 months, minimum 3 months) — much of the published literature reports outcomes to a minimum of 12–24 months, and late relapses of orthopaedic infection, which typically occur within the first 12–24 months after index surgery, will not have been captured in the present analysis.^{12,13,26} The eradication rates reported here should therefore be interpreted as an interim signal rather than as definitive cure. Second, because of the sequential cohort design the PMMA arm had a longer mean follow-up than the Stimulan arm, potentially biasing the numerical comparison against Stimulan for late-emerging events; interpretation of the Kaplan–Meier estimates therefore requires caution beyond 4 months where the number-at-risk falls rapidly. Third, the sample size of 40 was chosen for feasibility and is underpowered to detect small between-group differences; the study is therefore descriptive and hypothesis-generating rather than confirmatory. Fourth, this was a non-randomised, sequential-cohort comparison; despite comparable baseline characteristics, temporal bias in ancillary care cannot be excluded. Fifth, cost analysis was restricted to the index episode and did not include indirect costs such as loss of productivity. Finally, the study was performed at a single high-volume infection unit and results may not generalise to lower-volume centres. A pre-planned continuation of follow-up to a minimum of 24 months is intended, and adequately powered multicentre randomised trials are warranted to confirm these findings.^{28,31}

5. Conclusion

In this prospective interim pilot comparison of 40 patients with musculoskeletal infection followed for a mean of 5.4 months, antibiotic-loaded Stimulan calcium sulphate beads produced early clinical outcomes comparable to antibiotic-loaded PMMA cement, with a numerically higher rate of infection eradication (90.0% vs 85.0%) and lower rates of

secondary surgery, hospital stay and episode cost. Complication rates were low with both carriers; transient hypercalcaemia after Stimulan was volume-dependent and self-limiting when detected by routine biochemical surveillance. The absence of a residual foreign body and the compatibility of Stimulan with thermosensitive antibiotics are attractive characteristics that support its use as the primary local antibiotic vehicle in single-stage debridement for chronic osteomyelitis, fracture-related infection and DAIR protocols in periprosthetic joint infection. PMMA remains indispensable where structural support is required — most notably as an articulating or static spacer in two-stage revision arthroplasty. The choice between the two carriers should therefore be individualised to the surgical objective. Because the current analysis reflects only short-term outcomes, the cohort will be followed to a minimum of 24 months, and these interim findings should be confirmed in larger, adequately powered randomised trials.

Declarations

Funding: No external funding was received for this study.

Conflicts of interest: The authors declare that they have no competing interests.

Ethical approval: Institutional Ethics Committee (Ref. No. IEC/OR/2025/117).

Informed consent: Written informed consent was obtained from all participants.

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