Does Adding Calcium Sulfate Beads Lead to Higher Treatment Success Rates? A Study of 55 Patients with Oncologic Megaprosthesis Prosthetic Joint Infections

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INTRODUCTION: Prosthetic joint infections (PJI) of megaprostheses are associated with high failure rates and treatment strategies are limited. Although spacers seek to locally deliver antibiotics at high doses, studies have reported a rapid reduction to subtherapeutic levels within 24 hours of implantation. Absorbable calcium sulfate (CS) beads have been promoted as an alternative for local antibiotic delivery. However, there are no studies covering the use of CS beads in megaprosthesis PJIs and their efficacy in this setting remains unknown. Our study sought to assess the efficacy of antibiotic-loaded calcium sulfate beads in megaprosthesis PJIs in terms of PJI reinfection, reoperation, and revision.

METHODS: We conducted a retrospective chart review of our institutional megaprosthesis database to identify patients who received antibiotic-loaded CS beads as part of the PJI surgical strategy between 2000 and 2022. Inclusion criteria for cases were: **1**) diagnosis of PJI after megaprosthesis implantation according to Musculoskeletal Infection Society (MSIS) criteria; **2**) intraoperative use of calcium sulfate beads as adjunct to surgical management; and **3**) minimum follow up of one year or occurrence of primary outcome before. Fourteen patients who received calcium sulfate beads as adjunct treatment (cases) were identified (Figure 1). All patients underwent either DAIR *plus* or two-stage revision as main surgical treatment (Figure 2). Cases were compared against 50 patients with megaprosthesis PJIs treated with DAIR *plus* or two-stage revision without addition of calcium sulfate beads (controls). The primary outcome was survivorship free of any PJI at 90 days and 1 year after index PJI surgery. Secondary outcomes were survivorship free of any revision and free of any reoperation at the 90-day and 1-year timepoints. Differences in continuous variables were compared using Mann Whitney U test. The chi-square test was used to compare categorical variables. Survival was assessed using the Kaplan-Meier method.

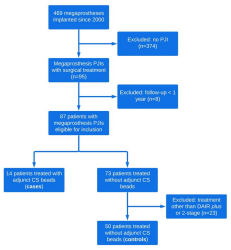
RESULTS:

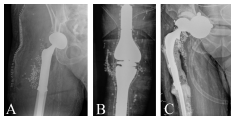
No differences in clinical and demographic characteristics were found between patients treated with and without adjunct calcium sulfate beads (Table 1). Median follow-up time was longer in the group that did not receive calcium sulfate beads. Gram-positive organisms were the most common pathogens in both groups (Table 2).

PJI recurrence-free survival at 90 days was 79% in patients treated with calcium sulfate beads (cases) and 88% in those that did not receive beads (controls) (p=0.36). One-year PJI recurrence-free survival was 50% and 71% for cases and controls, respectively (p=0.13) (Figure 3A). No differences in reoperation-free survival at 90 days (79% vs. 86%, p=0.53) and at one year (63% vs. 64%, p=0.98) were seen between the case and control groups (Figure 3B and 3C). Likewise, there were no differences in revision-free survival between the case and control groups at 90 days (79% vs. 94%, p=0.09) and one year (71% vs. 72%, p=0.84) after index surgery for PJI.

DISCUSSION AND CONCLUSION:

In this retrospective study, addition of calcium sulfate beads did not lead to higher treatment success rates in patients with megaprosthesis PJIs. Considering the substantial cost associated with their use and absence of large-scale studies on their complication profile, routine utilization of calcium sulfate beads for PJI is not justified. Future investigations should prioritize prospective studies that compare efficacy rates and complication profiles while carefully controlling for potential confounding factors. Furthermore, it is crucial to identify the specific patient population in which the use of calcium sulfate beads may prove beneficial.





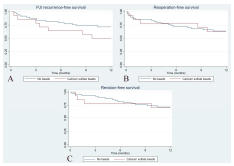


Table 1. Demographic, clinical and treatment characteristics of patients included.

	All patients (n=64)	CS beads (n=14)	No beads (n=50)	*p*
Age (years) *	66 (47-68)	64 (52-71)	67 (45-85)	0.21
Female sex	30 (61%)	6 (43%)	33 (66%)	0.12
BMI *	30 (26-35)	28 (24-36)	30 (27-35)	0.38
Age-adjusted CCI *	5 (3-7.5)	5 (4-8)	5 (3-7)	0.64
Local rekonsky grade (McPherson score)				0.1
1	16 (25%)	2 (14%)	14 (28%)	
2	37 (58%)	7 (50%)	30 (60%)	
3	11 (17%)	5 (36%)	6 (12%)	
CRP (mg/dL) *	75 (31-183)	41 (30-83)	183 (37-245)	0.007
ESR (mm/h)	67 (55-88)	46 (34-94)	82 (55-89)	0.31
PJI Classification				0.81
Acute < 90 days	20 (31%)	4 (29%)	16 (32%)	
Chronic PJI > 90 days	44 (69%)	10 (71%)	34 (68%)	
Indication for MP implantation				0.2
Non-oncologic	11 (17%)	4 (29%)	7 (14%)	
Oncologic	53 (83%)	10 (71%)	43 (86%)	
Type of MP				0.31
PTR	17 (27%)	4 (29%)	13 (26%)	
DFR	28 (41%)	4 (29%)	23 (46%)	
DIR	7 (11%)	2 (14%)	5 (10%)	
PTR	5 (8%)	0 (0%)	5 (10%)	
PFR	2 (3%)	1 (7%)	1 (2%)	
PTR + PTR	5 (8%)	3 (21%)	2 (4%)	
Other	2 (3%)	1 (7%)	1 (2%)	
Surgical treatment				0.79
2-stage	21 (33%)	5 (36%)	16 (32%)	
DAIR plus	43 (67%)	9 (64%)	34 (68%)	
Follow-up (months) *	44 (22-77)	28 (14-43)	51 (34-79)	**0.008**

* Median value and interquartile range between brackets

BMI: body mass index; *CCI*: Charlson comorbidity index; *CRP*: C-reactive protein; *CS*: calcium sulfate; *DAIR*: debridement, antibiotics, and implant retention; *DFR*: distal femur replacement; *ESR*: erythrocyte sedimentation rate; *MP*: megaprosthesis; *PFR*: proximal femur replacement; *PIER*: proximal humerus replacement; *PTR*: proximal tibia replacement; *RT*: radiation therapy; *TFR*: total femur replacement

Table 2. Organisms isolated in cases of prosthetic joint infection.

Organism(s)	**No beads (n=50)**	**CS beads (n=14)**	*P*
Gram-positive	33 (66%)	8 (57%)	0.19
Coagulase-negative Staphylococcus	14 (28%)	5 (36%)	
Staphylococcus aureus	10 (20%)	1 (7%)	
Streptococcus spp.	5 (10%)	1 (7%)	
Enterococcus faecalis	0 (0%)	1 (7%)	
Other Gram-positive	4 (8%)	0 (0%)	
Gram-negative	3 (6%)	1 (7%)	
Candida spp.	0 (0%)	1 (7%)	
Culture-negative	4 (8%)	0 (0%)	
Polymicrobial	10 (20%)	4 (29%)	