Antibiotic-Eluting Calcium Sulfate Beads as a Prophylactic Strategy in High-Risk Primary Total Hip Arthroplasty

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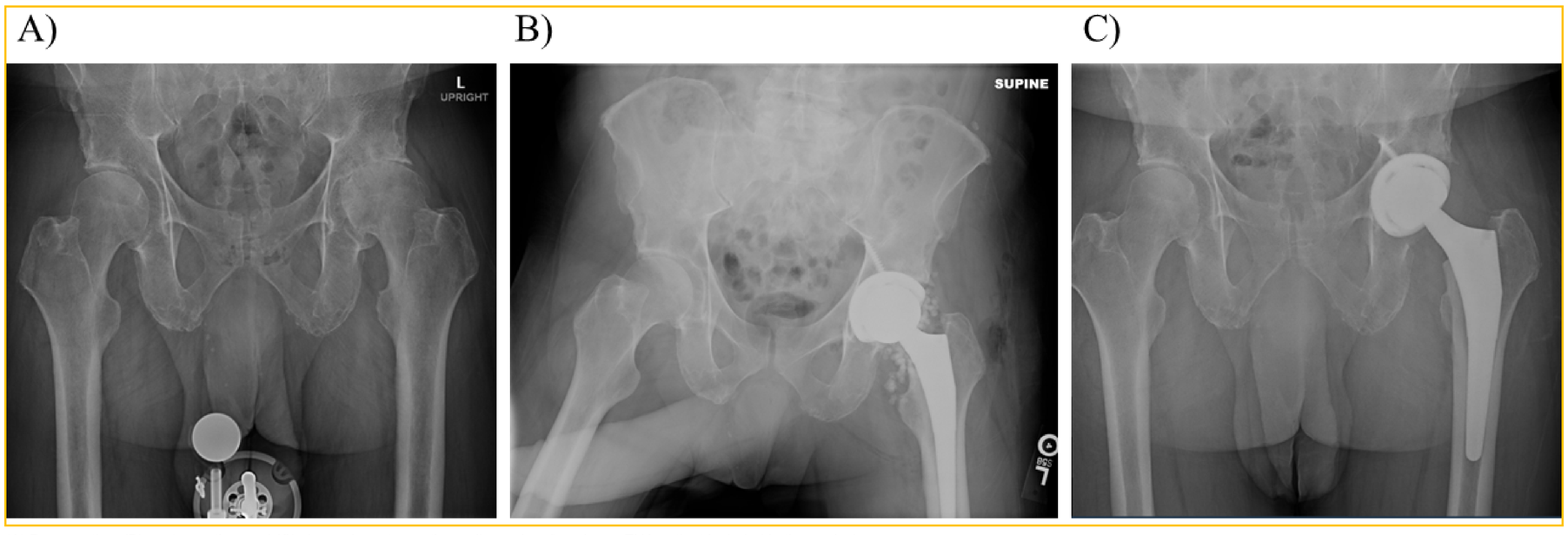
AIM

- Prosthetic joint infection (PJI) remains a serious complication after total hip arthroplasty (THA), particularly in patients with significant comorbidities.
- Systemic antibiotic prophylaxis sometimes fails to achieve adequate periarticular tissue concentrations, prompting interest in local antimicrobial delivery methods.
- Antibiotic-eluting calcium sulfate beads provide sustained, high local antibiotic levels, but their role in preventing PJI during primary THA remains unestablished.
- This study aimed to assess whether prophylactic intra-articular antibiotic beads reduce PJI rates compared with the expected infection risk in high-risk patients undergoing primary and conversion THA.

METHODS

- A retrospective review by a single surgeon was conducted of consecutive primary and conversion THAs performed from 2018 to 2023, with prophylactic vancomycin- and tobramycin-loaded calcium sulfate beads (primarily 10 cc) used as an adjunct to systemic prophylaxis.
- The predicted lifetime risk of infection was calculated using the 2018 International Consensus Meeting (ICM) PJI risk calculator.
- The primary outcomes were PJI, reoperation, and wound complications.
- Secondary outcomes included medical complications and treatment-related adverse events.

Figure 1. Representative Radiographs of a Primary THA Patient



(A) Preoperative, (B) postoperative, and (C) six-week postoperative radiographs of a primary THA patient included in the analysis.

RESULTS

- The final cohort included 153 patients (Table 1; mean age 58.1 years, 146 primary and 7 conversion THAs) with a median follow-up of 24.4 months (IQR 12.0-31.2).
- The median number of risk factors per patient was 2 (IQR 1-3), and 62.1% had two or more risk factors (Table 2).
- The mean predicted lifetime PJI risk was 5.22%, corresponding to 8.0 expected infections across the cohort (Table 3).
- No PJIs occurred during follow-up (0%) (Table 4).
- Seven patients (4.6%) returned to the operating room, resulting in 8 reoperations (5.2%), primarily for superficial wound procedures (4) or instability (4).
- No cases of hypercalcemia requiring treatment were observed.

Table 1. Patient demographics and clinical characteristics.

Variable	Cohort (n)	Frequency (%)
Sample size	153	
Age, y (SD)	58.1 (17.8)	
Follow-up duration, months (median, IQR)	24.4 (12.0-31.2)	
Sex		
Female	92	60.1
Male	61	39.9
Race		
White	85	55.6
Unknown/other	37	24.2
Black/African American	21	13.7
Asian	10	6.5
Ethnicity		
Not Hispanic/Latino	104	68.0
Hispanic/Latino	43	28.1
Unknown	6	3.9
BMI (SD)	29.4 (6.7)	
ASA Classification		
I	3	2.0
II	47	30.7
III	98	64.1
IV	5	3.3
Preoperative diagnosis		
Osteoarthritis	100	65.4
Posttraumatic arthritis	15	9.8
Inflammatory arthritis	13	8.5
Other complex hip pathologies	25	16.3

SD, standard deviation; BMI, body mass index; ASA, American Society of Anesthesiologists.

Table 2. Patient risk factors for prosthetic joint infection.

Risk Factor	Cohort (n)	%
Long-term DMARDs/immunosuppressives	43	28.1
BMI > 35	36	23.5
Long-term steroid use	33	21.6
Rheumatologic disease	32	20.9
Renal disease	30	19.6
Diabetes mellitus	30	19.6
Liver disease	24	15.7
Previous surgery same joint	21	13.7
Drug use	18	11.8
Deficiency anemia	12	7.8
Coagulopathy	12	7.8
CHF	11	7.2
Metastatic disease	6	3.9
Alcohol use disorder	6	3.9
HIV/AIDS	5	3.3
Current smoker	5	3.3
Psychosis	1	0.7

Risk factors were defined per the ICM PJI risk calculator. Percentages reflect the proportion of the 153-patient cohort with each identified risk factor; patients may have had more than one risk factor.

Table 3. Predicted lifetime PJI burden stratified by individual risk tier.

Lifetime PJI Risk	n (%)	Expected PJIs	% of Predicted Burden	Median Follow-up (months, IQR)
< 2%	69 (45.1%)	0.74	9.3%	24.8 (12.2-31.2)
2-5%	42 (27.5%)	1.40	17.5%	27.5 (9.5-37.4)
5-10%	19 (12.4%)	1.28	16.0%	12.4 (7.1-24.9)
10-20%	14 (9.2%)	1.90	23.8%	16.1 (4.1-28.8)
> 20%	9 (5.9%)	2.67	33.4%	22.5 (3.9-23.5)
Total	153 (100%)	8.0	100%	24.4 (12.0-31.2)

Total expected PJIs represent the aggregate predicted burden across the cohort.

Table 4. Observed surgical and medical outcomes.

Outcome	n	Frequency (%)
Prosthetic joint infection	0	0
Return to the operating room	8	5.2
Superficial incision and drainage	4	2.6
Instability	4	2.6
Hypercalcemia	0	0

CONCLUSIONS

- The discrepancy between predicted and observed PJI incidence suggests that local antibiotic bead prophylaxis may significantly reduce the risk of PJI in high-risk patients undergoing primary THA.
- The biologic plausibility lies in achieving supratherapeutic local antibiotic levels that disrupt early bacterial adhesion and biofilm formation, especially during the vulnerable postoperative period when systemic prophylaxis alone may be inadequate.
- Limitations include the retrospective design, modest follow-up relative to lifetime risk, and the lack of a control group.