Ex Vivo Antimicrobial Efficacy of MDPB-Treated Cobalt Chromium Implants Against Staphylococcus aureus and Staphylococcus epidermidis in Preventing Biofilm Formation

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INTRODUCTION: Periprosthetic joint infection (PJI) is the most common cause of failure in total joint arthroplasty. PJI treatment failure is often caused by antibiotic-tolerant biofilm produced by organism such as Staphylococcus aureus and Staphylococcus epidermidis. A novel polymerizable quaternary ammonium compound, 12-Methacryloyloxydodecyl pyridinium bromide (MDPB), has been investigated to prevent the development of periprosthetic joint infection. This preclinical study assessed the impact of novel implant treatment with MDPB to prevent ex vivo surface biofilm formation.

METHODS: Twenty cobalt chromium molybdenum implants were tested, 10 pretreated with MDPB coating and 10 untreated controls. Implants in both groups were incubated in a bacterial suspension of MSSA or S. epidermidis (5 implants each). Further testing was performed using a spray system to simulate intraoperative airborne contamination. Following incubation, Colony-forming units (CFU) recovered via sonication and vortexing were compared between MDPB-treated and untreated implant surfaces.

RESULTS: Control implants exposed to MSSA demonstrated a mean 1,525 ± 510.7 CFU (95% CI: 891-2,159). In controls exposed to S. epidermidis, a mean 1,904 ± 908.4 CFU (95% CI: 776-3,032) were recovered. No viable bacteria were recovered from any MDPB-treated implants, representing >99.93% reduction for MSSA and >99.94% for S. epidermidis ($p < 0.001$). These results exceed the ASTM E2149-20 benchmark, which defines ≥90% bacterial reduction as the threshold for antimicrobial efficacy. Efficacy was observed across the entire implant surface, including complex geometries.

DISCUSSION AND CONCLUSION: MDPB-treatment prevents biofilm formation by MSSA and S. epidermidis contaminants on implant surfaces in a simulated OR model. These findings support MDPB as a promising antimicrobial surface treatment to combat biofilm deposition. Further clinical and in vivo studies are needed prior to regulatory approval or clinical adoption.