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The Use of a Novel Antimicrobial Implant Coating In Vivo to Prevent Spinal Implant Infection

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Abstract

Study design: A controlled, interventional animal study.

Objective: Spinal implant infection (SII) is a devastating complication. The objective of this study was to evaluate the efficacy of a novel implant coating that has both a passive antibiotic elution and an active-release mechanism triggered in the presence of bacteria, using an in vivo mouse model of SII.

Summary of background data: Current methods to minimize the frequency of SII include local antibiotic therapy (vancomycin powder), betadine irrigation, silver nanoparticles, and passive release from antibiotic-loaded poly(methyl methacrylate) cement beads, all of which have notable weaknesses. A novel implant coating has been developed to address some of these limitations but has not been tested in the environment of a SII.

Methods: A biodegradable coating using branched poly(ethylene glycol)-poly(propylene sulfide) (PEG-PPS) polymer was designed to deliver antibiotics. The in vivo performance of this coating was tested in the delivery of either vancomycin or tigecycline in a previously established mouse model of SII. Noninvasive bioluminescence imaging was used to quantify the bacterial burden, and implant sonication was used to determine bacterial colony-forming units (CFUs) from the implant and surrounding bone and soft tissue.

Results: The PEG-PPS-vancomycin coating significantly lowered the infection burden from postoperative day 3 onwards ($P < 0.05$), whereas PEG-PPS-tigecycline only decreased the infection on postoperative day 5 to 10 ($P < 0.05$). CFUs were lower on PEG-PPS-vancomycin pins than PEG-PPS-tigecycline and PEG-PPS pins alone on both the implants (2.4×10, 8.5×10, and 1.0×10 CFUs, respectively) and surrounding bone and soft tissue (1.3×10, 4.8×10, and 5.4×10 CFUs, respectively) ($P < 0.05$).

Conclusion: The biodegradable PEG-PPS coating demonstrates promise in decreasing bacterial burden and preventing SII. The vancomycin coating outperformed the tigecycline coating in this

model compared to prior work in arthroplasty models, highlighting the uniqueness of the paraspinal infection microenvironment.