MPBS2-09 COMPARISON OF URETERAL STENT BIOMATERIAL ENCRUSTATION PROFILE IN LITHOGENIC ARTIFICIAL URINE MODELS

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INTRODUCTION

Encrustation complicates and limits ureteral stent indwell time. To date, no material has shown complete encrustation resistance over long-term urine exposure. Recently, 2-hydroxyethyl methacrylate (HEMA)-coated Pellethane showed promise as an encrustation-resistant biomaterial in an artificial urine model. Accordingly, we evaluated the degree and composition of encrustation on this material in comparison to other leading stent brands using two lithogenic artificial urine environments (AUE): (1) struvite ($NH_4MgPO_4 \cdot 6H_2O$) plus calcium phosphate ($Ca_{10}(PO_4)_6(OH)_2$) and (2) calcium oxalate.

METHODS

- Five 8 mm pieces of HEMA-coated Pellethane, Boston Scientific Tria, Bard InLay Optima, Cook Universa Hydrogel, and Cook Black Silicone were suspended in each AUE batch flow model at 37℃ **(Figure 1)**.
- Every 24 hours, 50% of the AUE was replaced using a programmed peristaltic pump system.
- Scanning electron microscopy (SEM) was used to assess the stent surfaces at 0, 2, and 4 weeks.
- After 11 weeks, stents were weighed, followed by inductively coupled plasma mass spectrometry (ICP-MS) analysis to quantify the amount of encrusted elements.

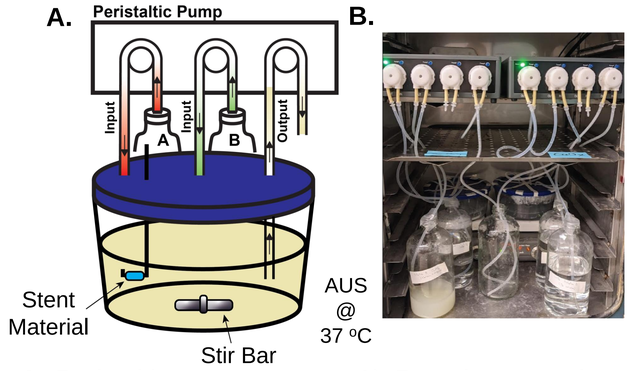

Figure 1. Peristaltic pump set up. A) Reaction vessel set up for batch-flow encrustation model. B) The final setup of the batch-flow experiment.

RESULTS

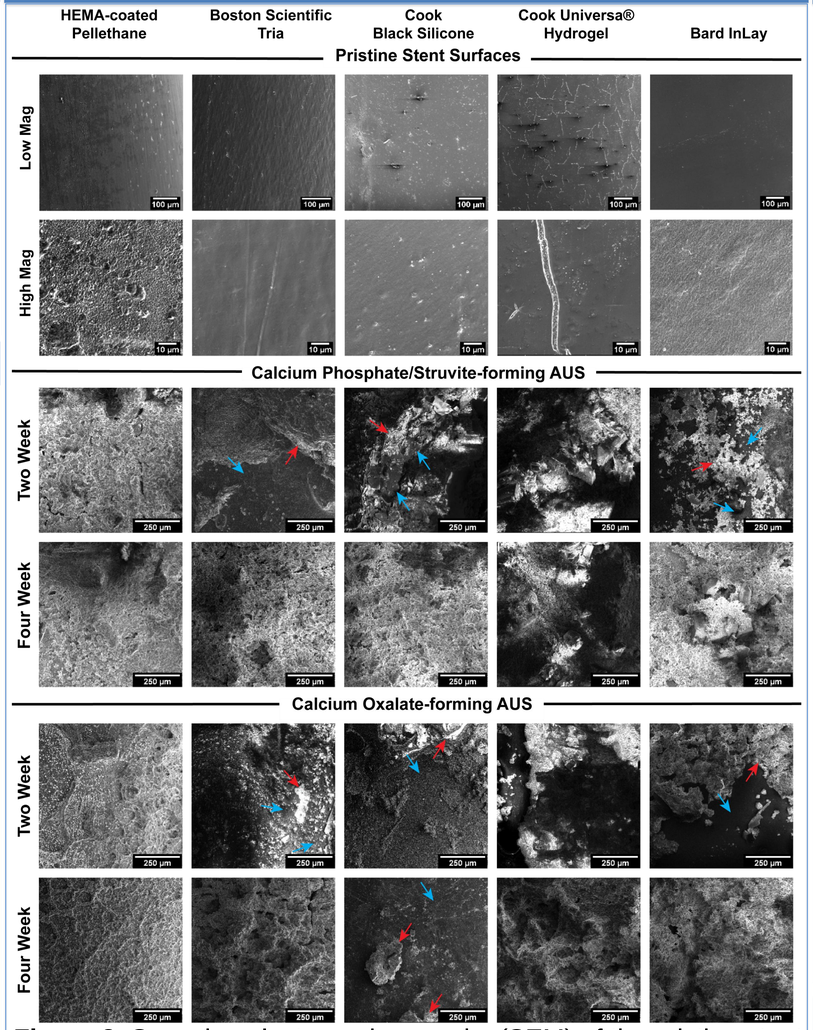

Figure 2. Scanning electron micrographs (SEM) of the pristine stent surfaces and then after two and four weeks of incubation in struvite/calcium phosphate and calcium oxalate-forming AUE. The blue arrows indicate pristine stent surfaces while the red arrows illustrate the encrusted areas. High magnification of SEM (1500X) shows the features and texture of the pristine stents.

RESULTS

- After two weeks in the struvite/calcium phosphate AUE, SEM revealed complete encrustation of HEMA-coated Pellethane and Cook Hydrogel with partial encrustation of the other stents. At 4 weeks, all stents were fully encrusted (**Figure 2**).
- At two weeks in the calcium oxalate AUE, HEMA-coated Pellethane and Cook Hydrogel stents were fully encrusted with partial encrustation of the Boston Scientific and Bard stents; the latter two were fully encrusted by 4 weeks. Cook Black Silicone demonstrated resistance to encrustation, even after four weeks (**Figure 2**).
- After 11 weeks, HEMA-Pellethane had the most significant average mass gain in both AUE, while Cook Black Silicone had the least (**Table 1**).

	Struvite/Calcium Phosphate-Forming AUE				Calcium Oxalate-Forming AUE			
	Encrustation Composition			*Avg. Percent Change in Mass*	*Encrustation Composition*			*Avg. Percent Change in Mass*
	Magnesium	*Phosphorus*	*Calcium*		*Magnesium*	*Phosphorus*	*Calcium*	
HEMA-coated Pellethane	0.215 ± 0.030	1.983 ± 0.169	3.853 ± 0.253	66.90%	0.354 ± 0.038	5.516 ± 0.657	11.459 ± 1.313	189.80%
Boston Scientific Tria	0.126 ± 0.027	0.991 ± 0.130	1.846 ± 0.243	37.60%	0.077 ± 0.011	0.930 ± 0.179	1.861 ± 0.368	30.00%
Cook Black Silicone	0.032 ± 0.007	0.226 ± 0.088	0.398 ± 0.187	-5.30%	0.056 ± 0.014	0.668 ± 0.187	1.332 ± 0.390	17.20%
Cook Universa® Hydrogel	0.180 ± 0.037	1.687 ± 0.263	3.272 ± 0.532	49.10%	0.226 ± 0.011	3.247 ± 0.037	6.727 ± 0.148	115.30%
Bard InLay	0.178 ± 0.023	1.626 ± 0.228	3.129 ± 0.438	49.10%	0.109 ± 0.037	1.548 ± 0.608	3.111 ± 1.226	55.20%

Table 1. Average mass (mg) changes of all stent samples after 11 week of incubation in the artificial urine environments. Average mass (mg ± SD) of elements detected encrusted on the stents after 11 weeks of incubation in AUEs using ICP-MS.

CONCLUSIONS

- In this study, HEMA-coated Pellethane was found to encrust more rapidly and to a larger extent than other stent materials.
- Cook Black Silicone stent was the most resistant to encrustation.