INTRODUCTION AND OBJECTIVE:
Encrustation of the ureteral stent or catheter is the tendency of crystalloids and colloids to adhere to the surface of the biomaterial. Encrustation is affected by many different variables such as surface roughness or irregularity, hydrophobicity and wetability, charge, polymer chemistry and surface coatings. All alloplastic materials placed within the urological tract are subject to encrustation which can lead to associated complications. Encrustation may lead to urothelial damage, and/or blockage of the drainage lumens, which could prevent drainage of urine. Another complication of encrustation is weakening of the stent material, which could make it difficult to remove. The objective of this paper is to summarize the findings of a laboratory study that investigated the ability of various commercially available ureteral stents to resist the accumulation of calcium urine salts, a component of encrustation.

METHOD:
Whitfield and his associates at the Institute of Urology and Nephrology, University College of London, London England developed an in-vitro encrustation model, which provides a reproducible and quantitative assessment of stent encrustation. Hugh Whitfield is a world-renowned researcher with numerous scientific publications. Utilizing this model, the Institute of Urology and Nephrology tested and compared commercially available stents to quantify the adherence of encrustation. The stents tested were the Bard InLay Optima® stent, Microvasive Percuflex® Plus stent, Cook Sof-Flex® stent and the Circon Lubri-Flex® stent. A silicone stent manufactured by Cook was used as the control. Each of these stents was placed in a test model, which mimics the urinary tract.

Human urine was collected, pooled and sterilized using antibiotics. The urine was placed in the model and pumped through the stents at a flow rate of 0.5ml/min. The entire system was kept at 37°C and fresh urine was added twice per day. The pH of the system was monitored and recorded daily. If the pH varied above 6.0, it was adjusted using 0.1M hydrochloric acid. The test ran continuously for 5 days. At the end of the test period, the stents were removed, air dried and sent out for calcium and magnesium analysis by Atomic Absorption Spectroscopy (AAS). This entire procedure was done 10 times so that a total of 10 results for each stent could be analyzed for statistical relevance.

RESULTS:
The AAS data was collected for each of the runs, collated and used to calculate the calcium encrustation ratio. Dividing the mean raw calcium number for the stent by the mean raw number of the control (silicone) does this. Following are the results:

<table>
<thead>
<tr>
<th></th>
<th>Bard InLay Optima® Stent</th>
<th>Cook Sof-flex® Stent</th>
<th>Microvasive Percuflex® Plus Stent</th>
<th>Circon Lubri-Flex® Stent</th>
<th>Silicone Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.63</td>
<td>0.85</td>
<td>1.14</td>
<td>3.34</td>
<td>1.00</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>0.16</td>
<td>0.17</td>
<td>0.37</td>
<td>4.28</td>
<td>0.167</td>
</tr>
<tr>
<td>p value</td>
<td>0.0003</td>
<td>0.0461</td>
<td>0.319</td>
<td>0.167</td>
<td></td>
</tr>
</tbody>
</table>

The results indicate that the InLay Optima® stent had less calcium urine salt accumulation than any of the other products tested including the silicone control sample.

The Institute of Urology and Nephrology utilizes another analysis technique to look at the relationship of encrustation between the various stents tested. In this case, they used the encrustation ratio for the InLay Optima® stent as the denominator and the competitive stent as the numerator. This analysis technique provides on average, how much more or less the competitive stent encrusts when compared to the InLay Optima® stent. The results are as follows:

- The Cook Sof-flex® stent had 34% more calcium urine salt accumulation than the InLay Optima® stent.
- The Microvasive Percuflex® Plus stent had 80% more calcium urine salt accumulation than the InLay Optima® stent.
- The Circon Lubri-Flex® stent had 427% more calcium urine salt accumulation than the InLay Optima® stent.
CONCLUSION:
Based upon this bench testing, the Bard InLay Optima® stent resisted calcium urine salt accumulation better than the competitive products that were tested in this in-vitro study.

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