A Comparative Study of *in Vitro* Degradation of a Biodegradable Ureteral Stent in Human and Artificial Urine

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Introduction: A biodegradable ureteral stent can retain its supporting function in the ureter for defined periods, which will avoid a secondary removal surgery and the relevant complications that the commercial permanent stent may bring. The mechanism, rate and process of stent degradation are critical to the clinical success of the stent's usage. Artificial urine has been widely used in most urological studies because its content and pH are standardized so the *in vitro* degradation and other studies involving urine can be controlled. But according to a previous study[1], the *in vivo* degradation rate of a biodegradable ureteral stent was faster than that predicted by *in vitro* degradation. This may have been due to the degradation medium of artificial urine which is different between the two test methods. So the *in vitro* degradation with the medium of human urine may simulate the *in vivo* degradation more accurately and the difference between the rate of degradation with these two media needs to be investigated further. The main goal of this study was to determine the *in vitro* degradation rate with the degradable media for both human urine and artificial urine so as to compare the effect of the media on the degradation of the stents and better understand the degradation mechanism.

Methods: The biodegradable stents used in this experiment were manufactured from PGA and PGLA multifilaments and films (Chinese Invention Patents: Publication No. CN103211671A), while the control stent was a commercial 6Fr double pigtail Percuflex® Plus whose main component was polyurethane which remained stable in most degradation solutions. Human urine (HU, pH=7.4) and artificial urine (AU, pH=5.8)[2] were used as degradation media in this study. After being sterilized, several biodegradable and permanent stent samples were immersed in degradable solutions and held at (37 ± 1)°C in a constant temperature shaker bath. During the degradation process, the solutions were changed every other day. At the same time the mechanical properties including radial compression and tensile strength tests and morphology, including digital photos and SEM, were observed and compared at different degradation times, namely: 0, 7, 14, 21, 28, 35 days.

Results: Before the degradation study, the mechanical properties of biodegradable stents were much higher than those of commercial permanent control stents (Figures 1 & 2). The stents in artificial urine had a higher radial compressive load during degradation. Although the stents in human urine claimed superior mechanical properties after the 1st week, they then declined rapidly and became lower than the permanent stent at Day 14. The stents in human urine began to break into fragments at Day 18, which finally became powder by Day 21 (Figure 3). The degradation rate of the stents in artificial urine was slower than that in human urine. The difference between the degradation in these two media is so significant that it may not only be influenced by pH but also by some of the components in the urine which may be trace elements and/or urine enzymes. For the two areas of the stents, the membrane area tends to degrade faster than the fibers which exhibited several cracks. This may be due to the difference of crystalline structure of the two areas. Although the fibers look intact from the SEM micrographs, they have already fully degraded which can be seen from the results of mechanical testing. This is mainly because of the bulk degradation of the ester-based absorbable polymers including PGA and PGLA.

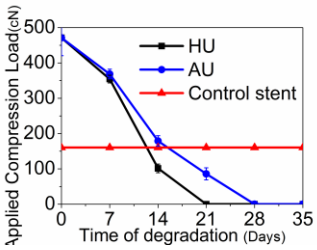

Figure 1. Radial compression results

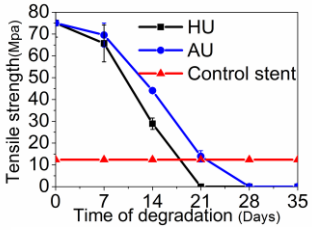

Figure 2. Tensile strength results

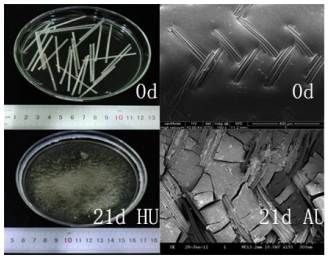

Figure 3. Morphology of degradation

Conclusions: In summary, the *in vitro* rate of degradation of the stents was significantly different depending on which kind of media was used. This was evident from both the rate of change in mechanical properties and the morphological observations. Further work will be required to identify the actual factors that cause the difference of degradation rate. This will assist in establishing a standard method for measuring the *in vitro* degradation of biodegradable ureteral stent.

References:

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[2] Domergue R, Castano I, de Las Penas A, et al. Nicotinic Acid Limitation Regulates Silencing of Candida Adhesins during UTI. Science, 2005, 308(5723): 866-870.