Loma Linda Student Journal

Structural and Mechanical Changes of Soft and Firm Polyurethane Stents: A Benchtop Study

Ashley Li[1], Jeremy Brown[1], John Smith[1], Hyelin You[1], Andrew Krause[1], Williamson Le[1], Muhannad Alsyouf[2], Phillip Stokes[1], Mohammad Hajiha[1], D. Duane Baldwin[1]

[1] Loma Linda University, Loma Linda, CA, United States
[2] Loma Linda University Medical Center, Loma Linda, CA, United States

INTRODUCTION AND OBJECTIVES: Ureteral stents help relieve obstruction and maintain ureteral drainage. However, chronic indwelling stents carry complications including fragmentation, migration, and encrustation. Other than indwelling time, factors contributing to stent encrustation are unknown. The purpose of this study is to compare the risk for encrustation and force required for removal in soft, firm, multi-length, and fixed length stents in a controlled artificial urine bath.

METHODS: Twenty four double pigtail stent coils (6 firm multi-length, 6 soft multi-length soft, 6 firm fixed length, 6 soft fixed length stent coils) were bathed in an vitro artificial urine solution to stimulate a rapid encrustation model. The stents were bathed for 15 days in an incubator at human body temperature. The urine bath was exchanged every 3 days and the length and diameter of the stent coils were measured. The force required for stent extraction from a ureteral benchtop model was measured using a force gauge before and after the urine bath. Mann-Whitney U test was used for statistical analysis with $p<0.05$ considered significant.

RESULTS: After 15 days, all stents showed evidence of encrustation on gross evaluation and scanning electron microscopy. The mean force required for stent removal after the urine bath was 0.664N (firm fixed), 0.549N (firm multi), 0.502N (soft fixed), 0.475N (soft multi). Firm stents required significantly more force for removal than soft stents prior to the urine bath (0.290N vs 0.162N respectively; $p<0.001$) and after the urine bath (0.606N vs 0.488N respectively; $p=0.01$) regardless of whether these stents were fixed or multi-length. Soft stents increased in both length (9.5 to 12.7 cm; $p<0.001$) and diameter (1.4 to 3.3 mm; $p<0.001$) while firm stents only increased in diameter (1.4 to 2.3 mm; $p<0.001$).

CONCLUSIONS: Signs of stent encrustation occurred as early as 15 days. While firm stents required more force for removal, soft stents demonstrated significant spatial changes in vitro. These transformations should be considered at time of stent selection to optimize patient comfort and quality of life.

Accepted for Publication: Mar 2019
The authors have no funding, financial relationships, or conflicts of interest to disclose.
Send correspondence to: asli@llu.edu