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Ex Vivo Evaluation Of A Novel Design Of Anti-reflux Ureteral Stent

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Introduction

- Ureteral stents create an artificial bidirectional connection between the kidney and bladder, which allow for retrograde spread of urinary infections from the bladder to the kidney.
- We designed a novel anti-reflux ureteral stent based on modification of the widely used double-J (DJ) stent to reduce reflux in patient with high intravesical pressure (e.g. bladder outlet obstruction, detrusor overactivity).
- Our design comprised a polymeric membrane (skirting) with reinforcing ridges at the bladder end, which can be fitted onto any types of ureteral stents.
- The optimal skirting angle and length that prevent reflux from the bladder to the ureter were investigated.

Methods

- We 3D printed a 1:1 human urinary tract model with two pressure sensors placed in the ureter and bladder.
- Hand-applied bladder pressure was generated manually to simulate the reflux pressure.
- The differential pressure between the bladder and ureter was measured.
- A combination of different angles (60°, 80°, 100°, 110°, 120° and 130°) and lengths of skirting (0.5, 1, 1.5 and 2cm) was evaluated.

Figure 1

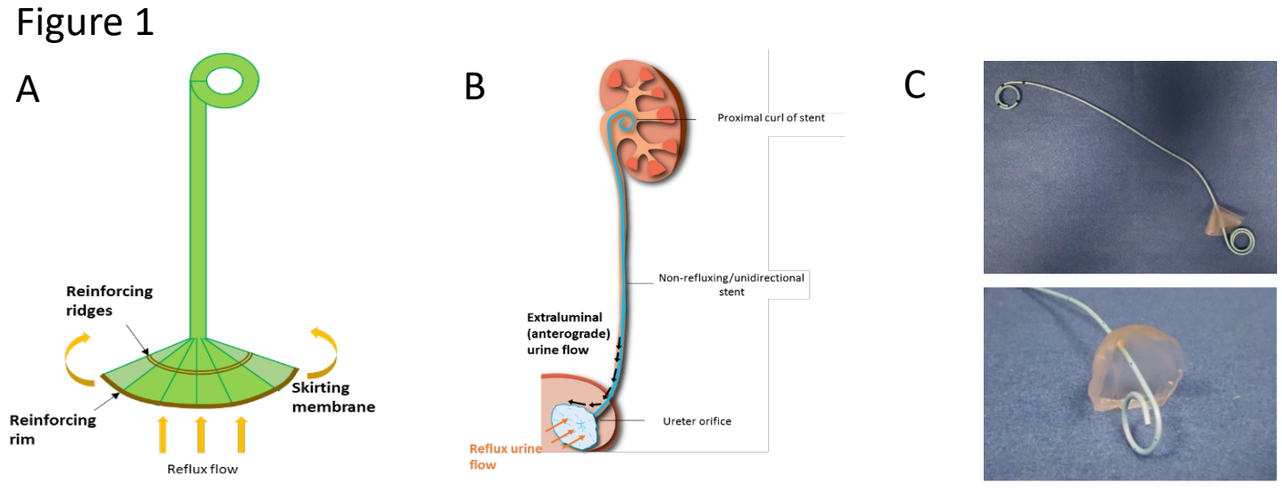

Figure 1. (A) Our design of anti-reflux stent. (B) Proposed concept of anti-reflux mechanism. (C) Skirting with reinforcing ridge at the bladder end of DJ stent.

Figure 2

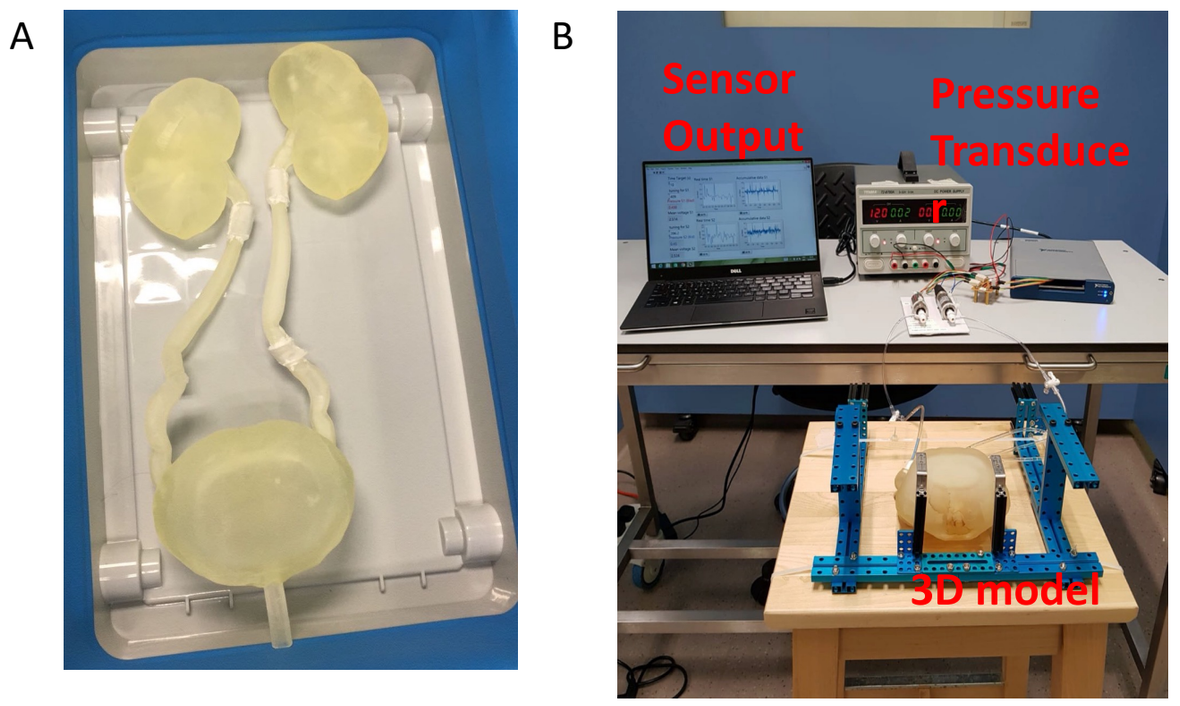

Figure 2. (A) 3D printer human urinary tract model. (B) Our experimental set-up.

Results

- A minimal bladder pressure of 40cm H_2O was generated.
- Baseline average differential pressure for bare stent was 4cm H_2O.
- Highest differential pressure was 25cm H_2O with a skirting angle of 80° °and length of 2cm.
- Significant difference in differential pressure was observed with a skirting length of 2cm or above.
- At skirting length of 0.5cm, 1cm and 1.5cm, increasing skirting angle did not result in significant differential pressure difference.

Figure 3

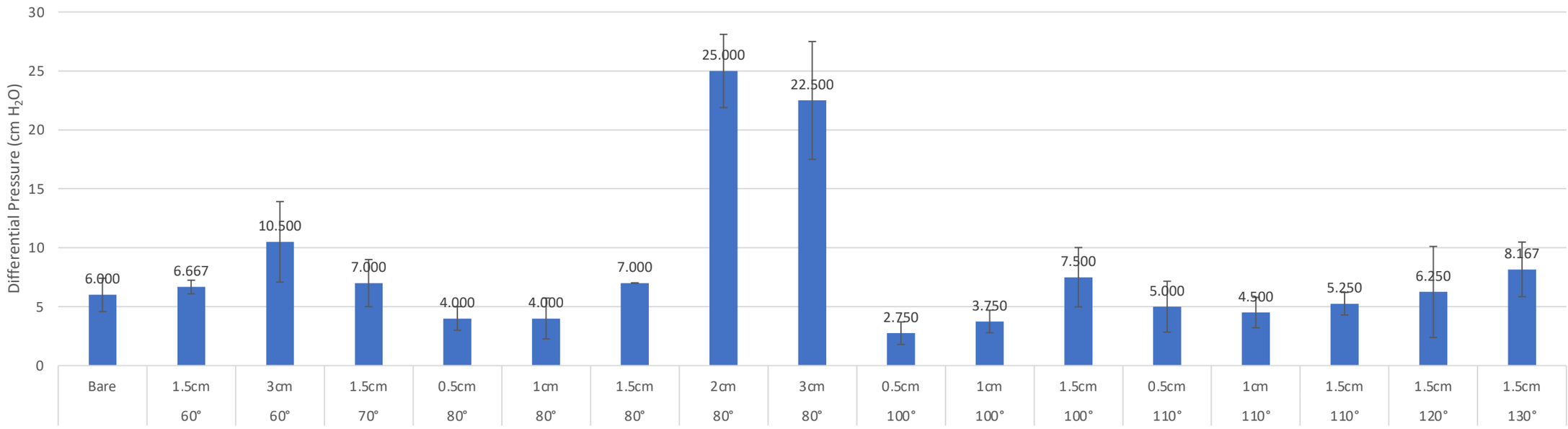

Figure 3. Differential pressures between the the bladder and the ureter at various combination of skirting lengths and angles

Conclusion

- The optimal skirting angle and length are 80° and 2cm.
- Our skirting design can effectively reduce pressure transmission from bladder to ureter in an ex vivo model.
- A deployment of a stent skirting to prevent reflux may help reduce the incidence of ascending upper tract infection and loss of renal function.