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Development and Validation of an *in vitro* Kidney Model for Measuring Intrapelvic Pressure During Ureteroscopy

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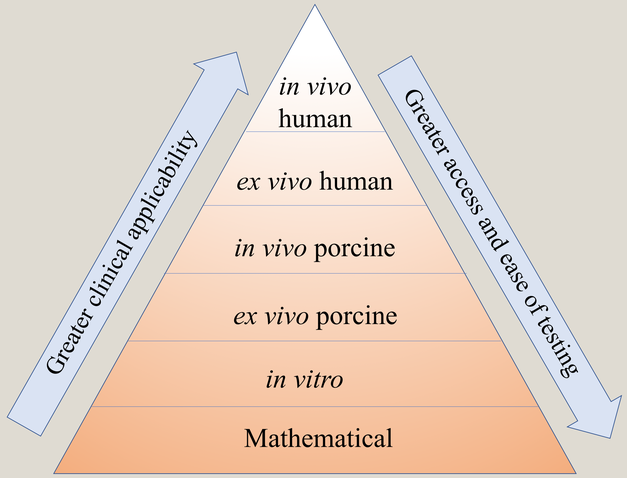
INTRODUCTION

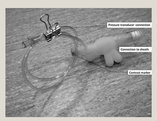
1. Intrapelvic pressure (IPP) during ureteroscopy (URS) → Risk of infectious complications and pain
2. Models used to study IPP have advantages and disadvantages



IN VITRO MODEL → Easy, replicable, repeated testing
No need for tissue handling

3. Existing *in vitro* kidney models are modest, anatomically unrealistic, and cannot replicate *in vivo* IPPs


(Sener et al, 2016, Journal of Endourology)


(Ng et al, 2010, Journal of Endourology)

4. **GOAL:** Can we create an anatomically accurate *in vitro* kidney model that can permit intrarenal navigation with URS while replicating *in vivo* IPPs ?

OBJECTIVES

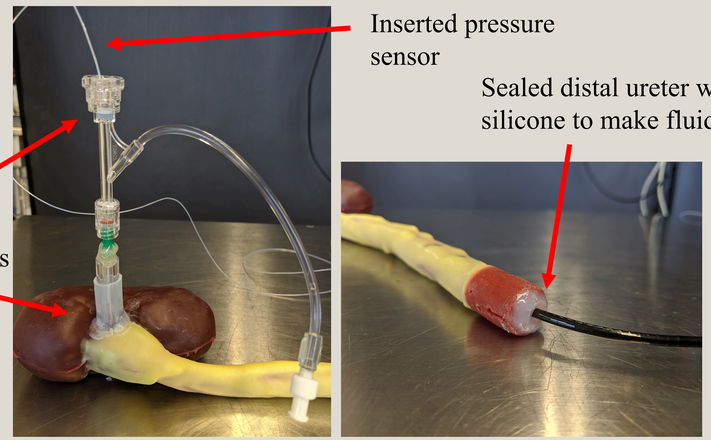
1. Modify an anatomically accurate synthetic kidney model for use in bench testing of new URS technologies
2. Validate its IPP profile against past *in vivo* and *ex vivo* data

METHODS

1. An anatomic kidney model that permits intrarenal navigation was acquired (Simagine Health, WA).
Ureteroscopic view of model's intrarenal architecture →

Model Modifications:

2.



Model Calibration

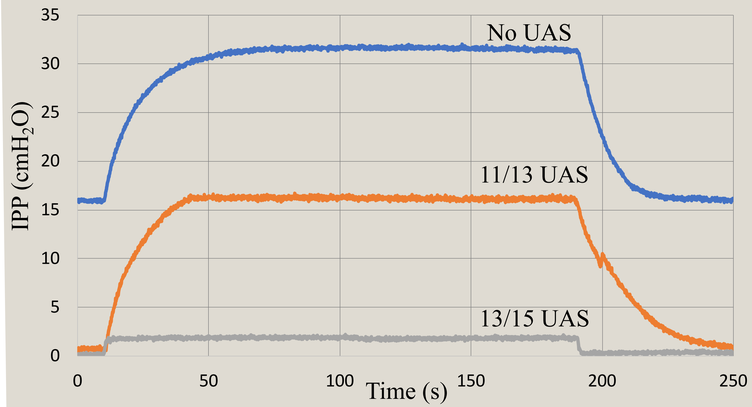
3. Under 200 cmH_2O irrigation, the kidney filled completely with fluid
4. With the kidney under 200 cmH2O irrigation pressure, the Tuohy-Borst valve was adjusted to allow fluid to leak in order to reach a steady-state IPP of 54 cmH_2O, which is the reported *in vivo* human IPP at this irrigation.

IPP Measurement:

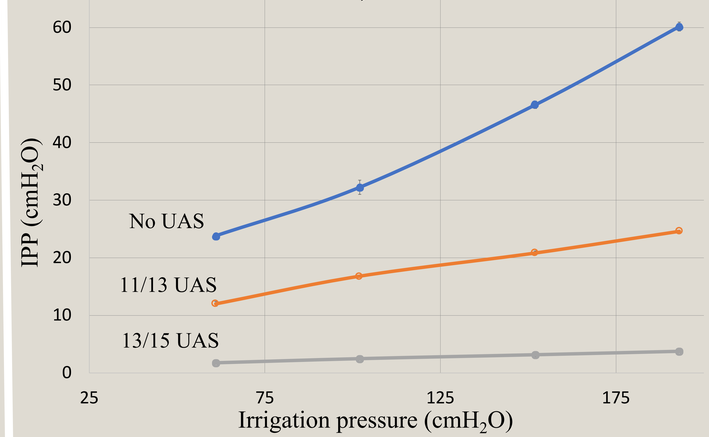
5. **With or without a ureteral access sheaths (UAS):** A Cobra URS was placed through the ureter to the renal pelvis without, and with 11/13F or 13/15F)
6. **Irrigation pressure:** Under 61, 102, 153, and 193 cmH_2O irrigation pressure using an automated system (Rocamed), IPP was measured in the following manner:
10 s baseline, 180 s irrigation ON, 60 s irrigation OFF

RESULTS

IPP values of single trials with irrigation pressure at 102 cmH_2O



Steady-state IPPs at varying irrigation pressure (mean values of three trials for each condition)



CONCLUSIONS

1. An anatomically accurate *in vitro* kidney model can simulate *in vivo* IPP trends and can be calibrated by controlling fluid outflow
2. This model replicated human *in vivo* and porcine *ex vivo* IPP profiles in different irrigation and UAS conditions

IMPLICATIONS

This model can serve as a tool for bench testing of technologies aimed at studying and mitigating rises in IPP

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