MP8-11: SUPERPULSE THULIUM FIBER LASER VS. HOLMIUM LASER FOR “DUSTING” OF RENAL CALCULI IN AN *IN-VIVO* PORCINE MODEL

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INTRODUCTION

We evaluated the effectiveness and efficiency of Superpulse Thulium Fiber Laser (sTFL) versus Holmium Fiber Laser (Ho:YAG) lithotripsy to treat implanted canine calcium oxalate renal stones during ureteroscopy in an *in-vivo* porcine model.

METHODS

- 24 kidneys from 12 juvenile female Yorkshire pigs were randomized into Ho:YAG or sTFL groups.
- CT scans of canine calcium oxalate stones measured stone volumes and densities.
- Stones were randomized and implanted via an open pyelotomy into a calyx **(Figure 1)**.
- Retrograde flexible URS was performed with a 9.9 Fr Wolf dual lumen ureteroscope passed via a 14 Fr, 35 cm ureteral access sheath (UAS).
- Intra-renal temperatures were measured with percutaneously placed K-type thermocouples placed in the renal pelvis and stone-containing calyx, along with a temperature sensor probe passed through the ureteroscope lumen **(Figure 2).**
- Laser lithotripsy was performed using “dusting” settings:
  - **Ho:YAG**: 200 µm laser fiber at 16 W (0.4 J and 40 Hz)
  - **sTFL**: 200 µm laser fiber at 16 W (0.2 J and 80 Hz)
- Kidneys were bi-valved and irrigated to capture all residual stones.
- Residual stones were dried, weighed, and measured with an optical laser particle sizer.

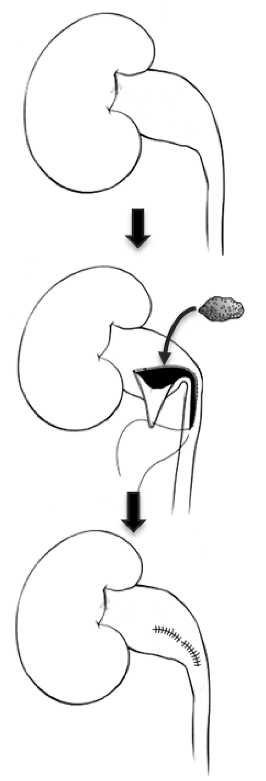

Figure 1: Implantation of canine calcium oxalate renal stones into a calyx via an open pyelotomy

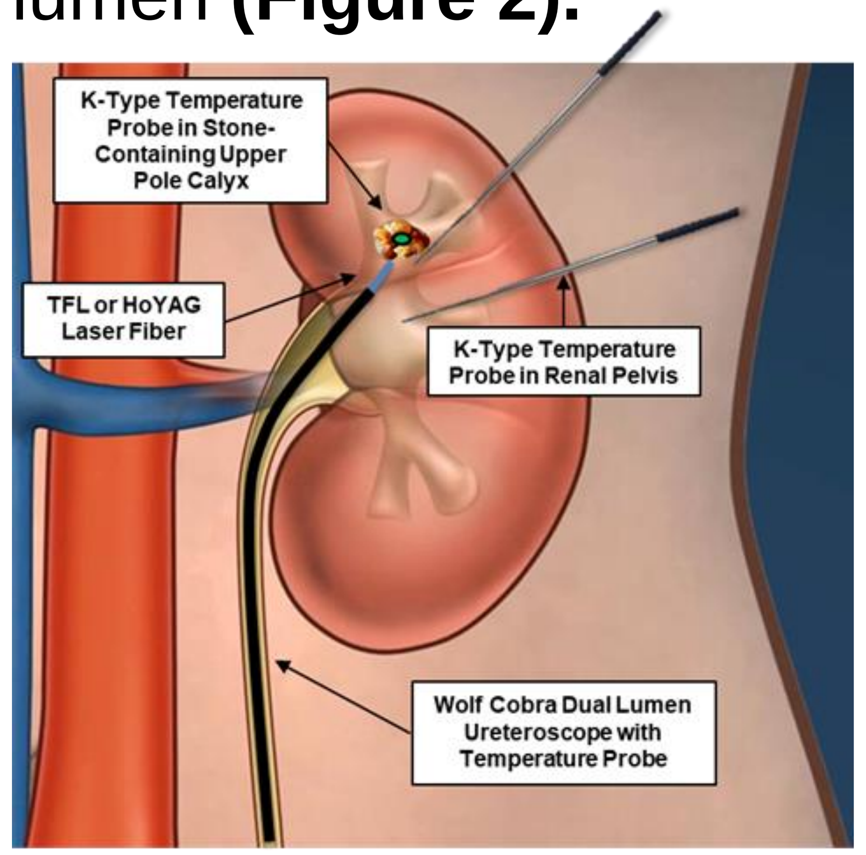

Figure 2: K-Type thermocouple placement in the renal pelvis and upper pole stone-bearing calyx

RESULTS

- There were no differences in stone volume or stone density between the sTFL and Ho:YAG groups.
- Compared to Ho:YAG, stones treated with sTFL **(Table 1)**:
  - Were ablated **three times** faster
  - Required **three-fold** less energy expenditure
  - Had **1.6 times** higher stone clearance rate
  - Had **three-fold** higher stone dusting efficiency
- After sTFL lithotripsy, **77%** of the remaining fragments were ≤1 mm while only **17%** of fragments were ≤1 mm following Ho:YAG treatment (p<0.001) **(Table 2)**.
- Maximum temperatures reached in any given kidney:
  - Renal pelvis: **sTFL** 37ºC vs. **Ho:YAG** 37ºC
  - Stone-containing calyx: **sTFL** 40ºC vs. **Ho:YAG** 39ºC

	Ho:YAG n=12	sTFL n=12	
Parameters	**Mean ± SD**	**Mean ± SD**	***p*-value**
Volume (mm³)	400 ± 100	400 ± 100	0.404
Hounsfield Units (HU)	1762 ± 80	1700 ± 129	0.166
Ablation Time (min)	27 ± 14	9 ± 6	**<0.001**
Energy Expenditure (kJ)	26 ± 13	8 ± 5	**<0.001**
Stone Clearance (%)	45 ± 22	73 ± 13	**0.001**
Stone Dusting Efficiency (mm³/min)	17 ± 9	53 ± 33	**0.001**

Table 1: Ablation time, energy expenditure, clearance, and “dusting” efficiency.

Size of Residual Fragments	Ho:YAG (%)	sTFL (%)	*p*-value
<100 µm	7%	21%	0.058
100 – 250 µm	2%	10%	0.080
251 – 500 µm	3%	19%	**0.021**
501 µm – 1 mm	5%	26%	**0.017**
1 – 3 mm	68%	23%	**0.002**
>3 mm	15%	1%	**0.019**

Table 2: Mass distribution by residual stone dimension ranges.

CONCLUSIONS

Thulium Fiber Laser (sTFL) lithotripsy, using “dusting” settings, resulted in significantly greater stone clearance, shorter ablation time, greater lithotripsy efficiency, and smaller stone fragments than Holmium Fiber Laser (Ho:YAG) lithotripsy.