Emerging Topics in Ureteroscopy:
Pressure, Temperature and Suction

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Disclosures

- Consultant
  - Ambu
  - Auris
  - Boston Scientific
  - BD
  - Calyxo
  - Dornier
  - Olympus
- Speaker
  - Cook Medical
  - Karl Storz Endoscopy

Improving Goals of Ureteroscopy

- Faster surgery time
- Less postop pain (?stent)
- Lower complication rate (sepsis, ED rates)
- Better stone ablation/clearance (SFR)

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SCOPE DESIGN

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TEMPERATURE

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Pressure

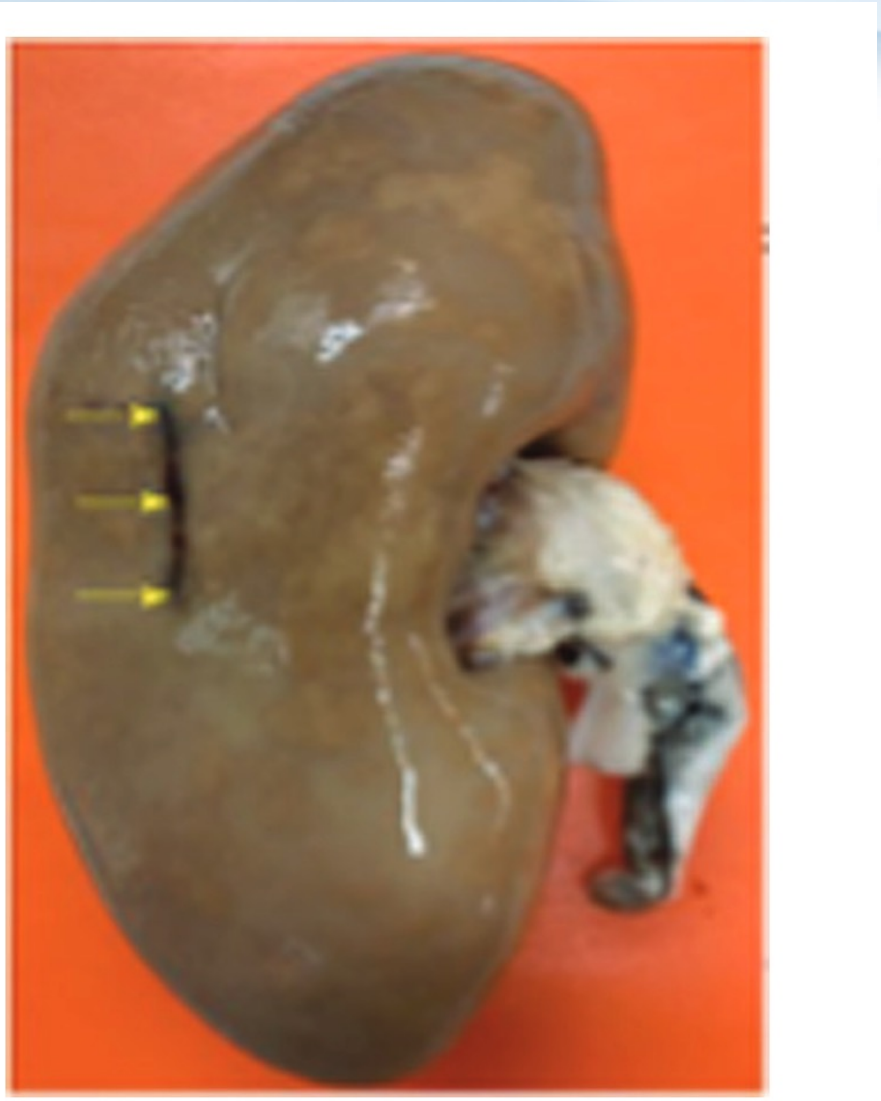

FIG. 1. Parenchymal splitting associated with high IRP. IRP = intrarenal pressure. Color images are available online.

[3]Dean & Krambeck. J Endourol 2023; 37;2. 2023

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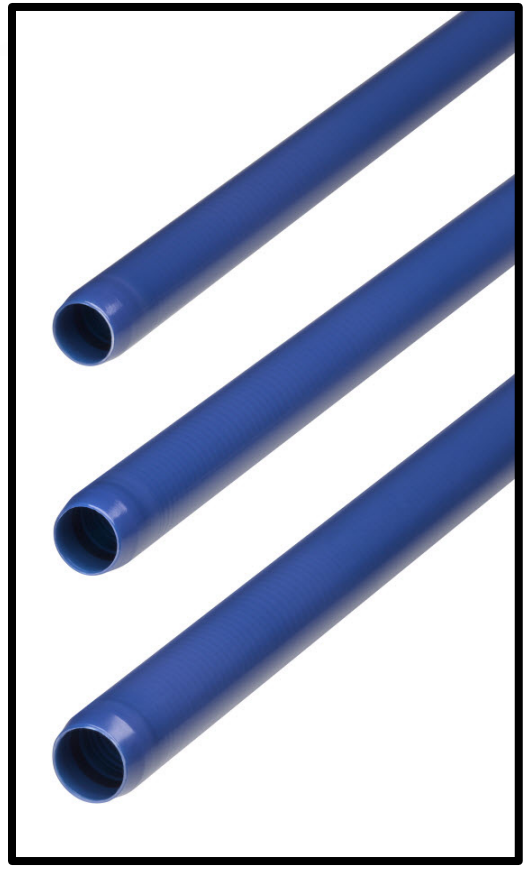
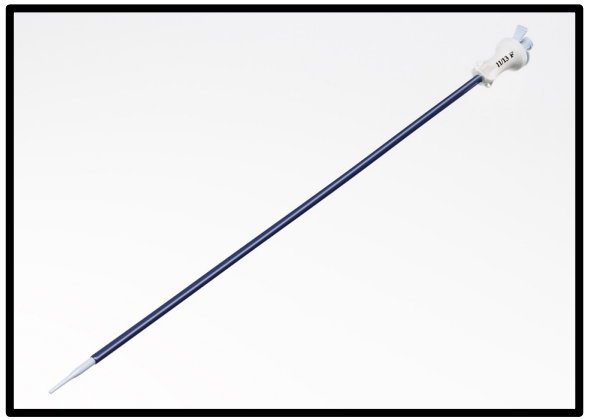
Pressure

- Ureteroscopy- 5-6% risk of urosepsis[1,2]
- Ureteral access sheaths (UAS) reduce risk of sepsis (4.3% vs 15.2%)[3]
- Larger UAS and smaller ureteroscopes reduce intrarenal pressure[4]
- Higher pressure during PCNL associated with greater postop pain, hospital stay[5]





[1]Bhojani et al. BJU Int 132;2. 2023
[2]Bhojani et al. J Enrourol 35;7. 2021
[3]Traxer et al. WJU 33. 2015
[4]MacCraith et al. J Endourol 35;4. 2021
[5]Alsyouf et al. J Urol 199;1. 2018

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Sepsis

Bacteria + High Pressure = Sepsis

- Pyelovenous backflow >30-40 cm H_2O[1]
- Higher pressure irrigation (200 vs 80 mm Hg) increases rates of SIRS after PCNL[2]
  - 46% vs 11%

AUA GUIDELINE STATEMENT[3]:

Clinicians should "make every effort to maintain low intrarenal irrigation pressure" to avoid the consequences of high intrarenal pressure (IRP) during endourologic procedures.

[1]Tokas et al. WJU 37;1. Jan 2019
[2]Omar et al. J Urol 196;1. July 2016
[3]Dean & Krambeck. J Endourol 2023; 37;2. 2023

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Ways to control pressure

- Nephrostomy tube
- Larger UAS (12/14 Fr)[1]
- Smaller ureteroscope[1]
- Intermittent scope removal[2]
- Controlling irrigation

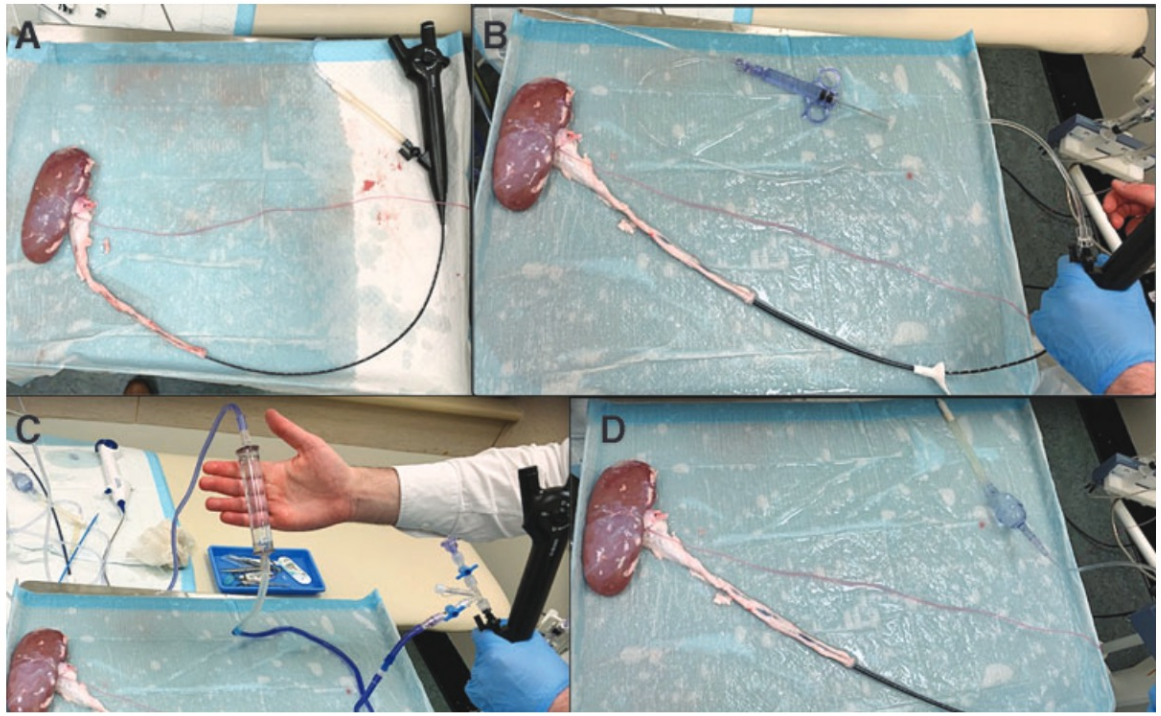

TABLE 2. COMPARISON OF MAXIMUM INTRARENAL PRESSURES (cmH_2O) GENERATED ACCORDING TO URETERAL ACCESS SHEATH AND URETEROSCOPE SELECTION

Comparison	*IRP (mean ± SD)*	p *Value*
No UAS *vs* 11/13F UAS	49.5 ± 29.36 *vs* 32.73 ± 35.66	**0.02**
11/13F UAS *vs* 12/14F UAS	32.73 ± 35.66 *vs* 16.45 ± 5.3	**0.006**
9.5F scope *vs* 8.7F scope	41.68 ± 34.5 *vs* 24.1 ± 21.24	**0.001**

[1]MacCraith et al. J Endourol 35;4. 2021
[2]Oratis et al. PLOS ONE 13;11. 2018

Controlling Irrigation

- Automatic Infusion Pumps
  - Not precise[1]
    - Underestimated pressure
- Pressure bags
- Hand irrigation
  - Beware of strong hands!

[1]De et al. J Endourol 28;5. May 2014

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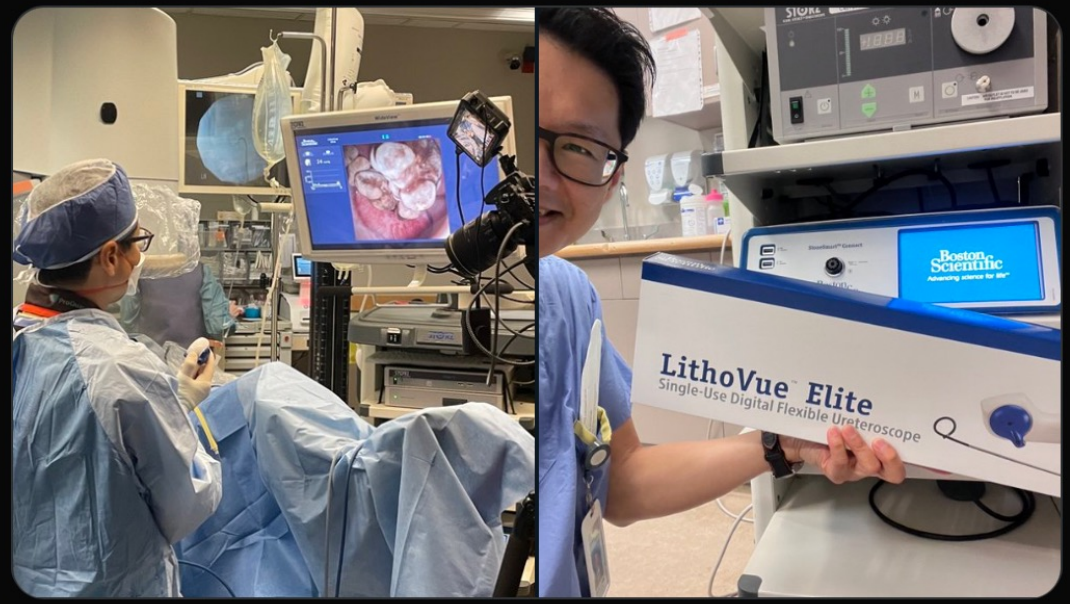
Intrarenal Pressure Can Now be Measured

Dr. Ben Chew @DrBenChew · Apr 28

First-in-human LithoVue Elite case done yesterday! I cannot wait to see clinical studies on intrarenal pressure and sequelae. @bsc_urology @EndoEDGE13



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Naeem Bhojani @NaeemBhojani7 · May 2

📣🔥🔥

Following in the footsteps of @DrBenChew I am very proud to be one of the first to trial the new pressure monitoring LithoVue Elite scope from @bsc_urology

The future is now!

12 13 157

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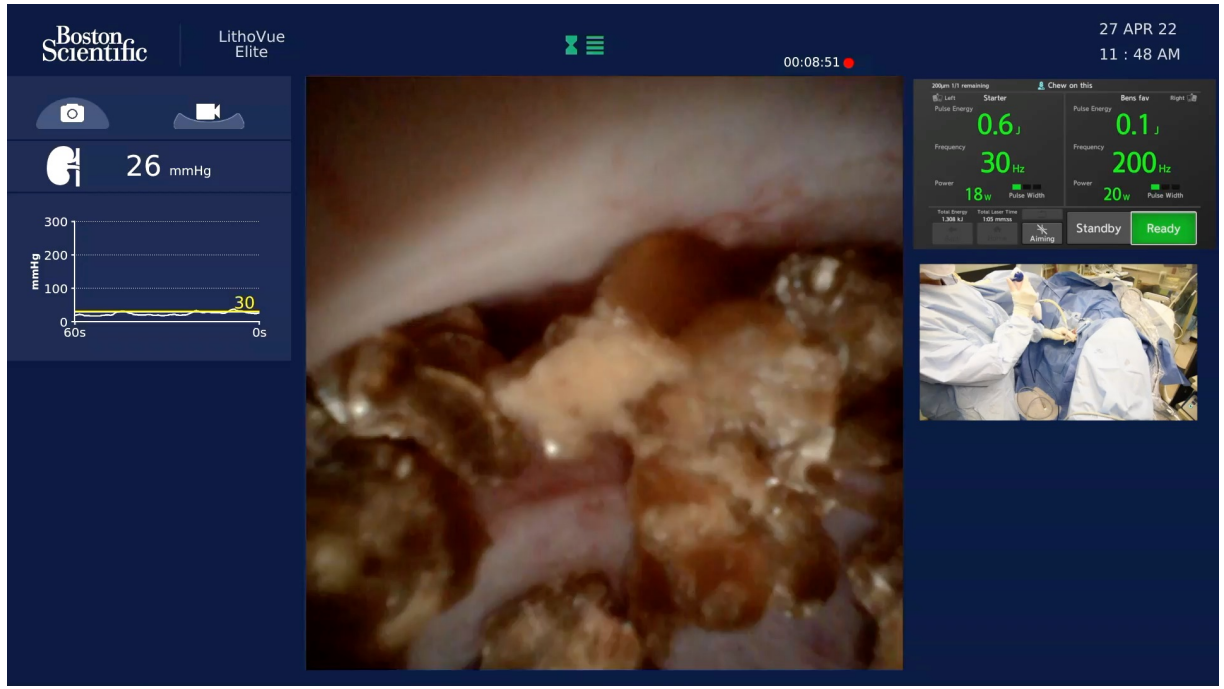
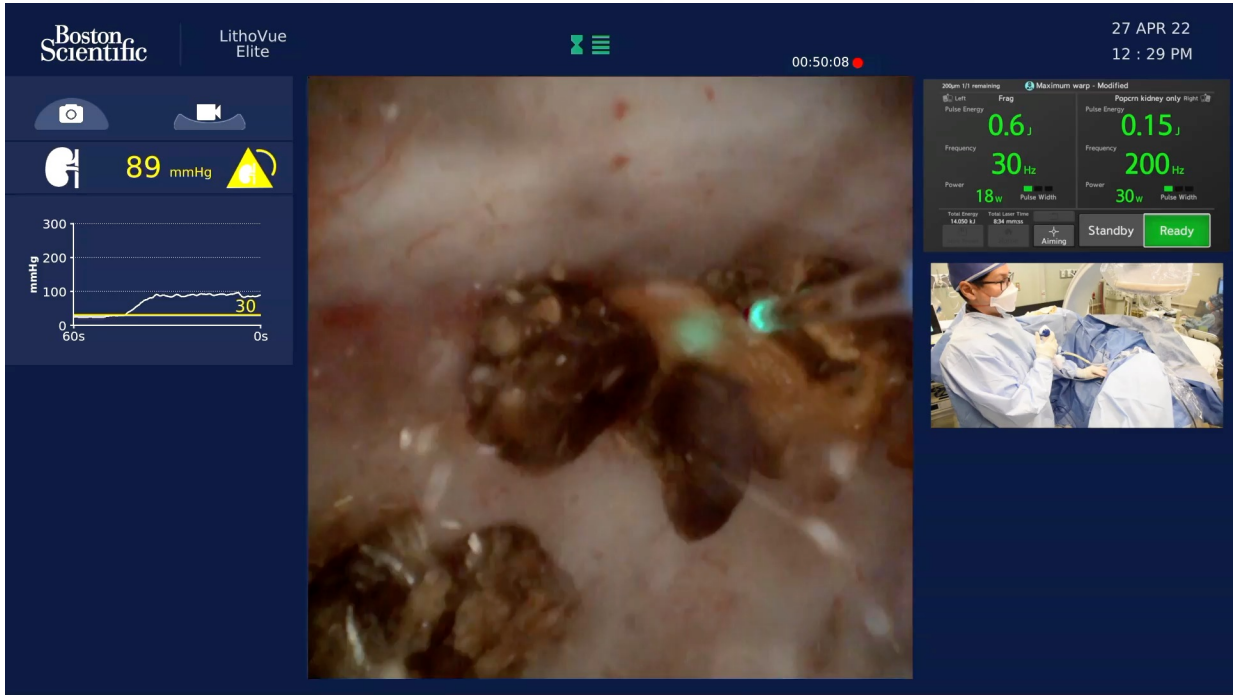
Intrarenal Pressure Can Now be Measured



Ureteroscopy WITH UAS



Ureteroscopy WITHOUT UAS

Videos courtesy of Ben Chew, MD

Bhojani N, Chew B et al. BJU Int 132. 2023.

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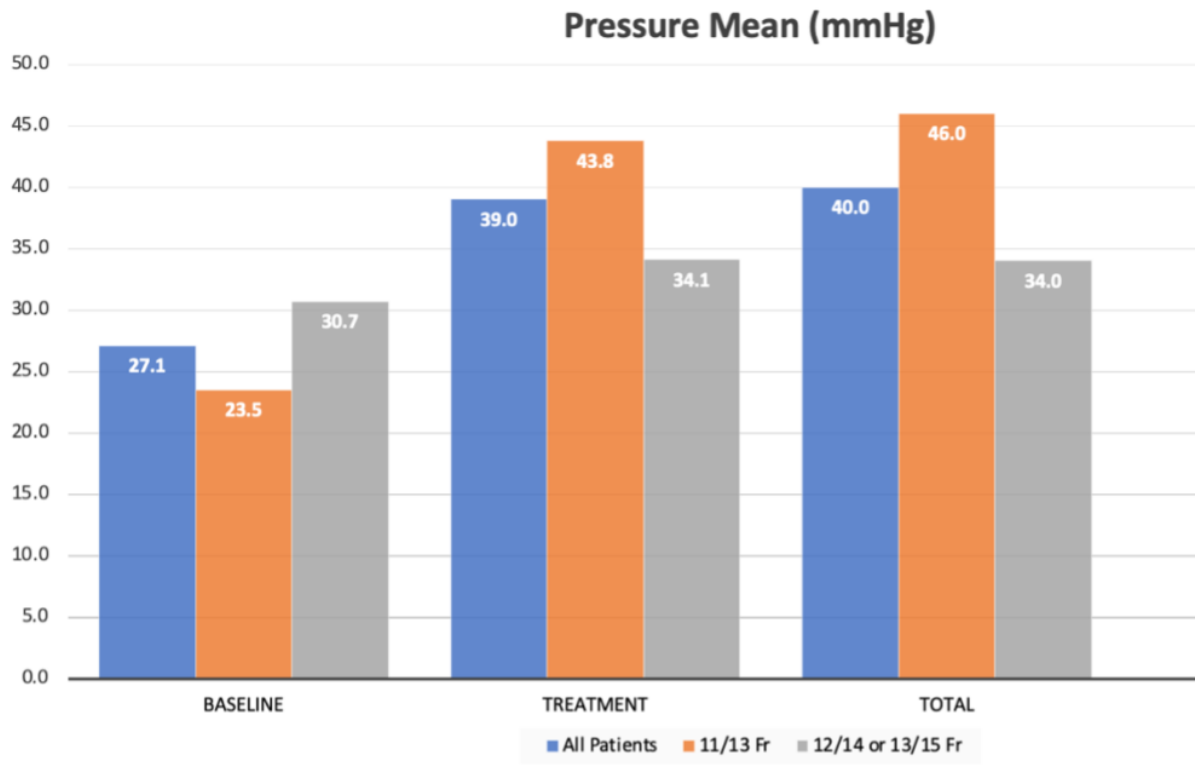
Personal experience with IRP monitoring

- Ongoing UCSD study
- IRP at renal pelvis (Comet wire)
- 26 patients w/ UAS
  - 11/13Fr (13)
  - 12/14Fr (10)
  - 13/15Fr (3)
- Baseline: before UAS insertion

40 cmH2O

30 cmH2O



GOAL: maintain low IRP to reduce sepsis/complications

[1]Finegan J, Katz J, Berger J, Bechis S, Mongha M, Sur R. WCET 2023 abstract, AUA 2024 abstract

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Temperature

Temperature

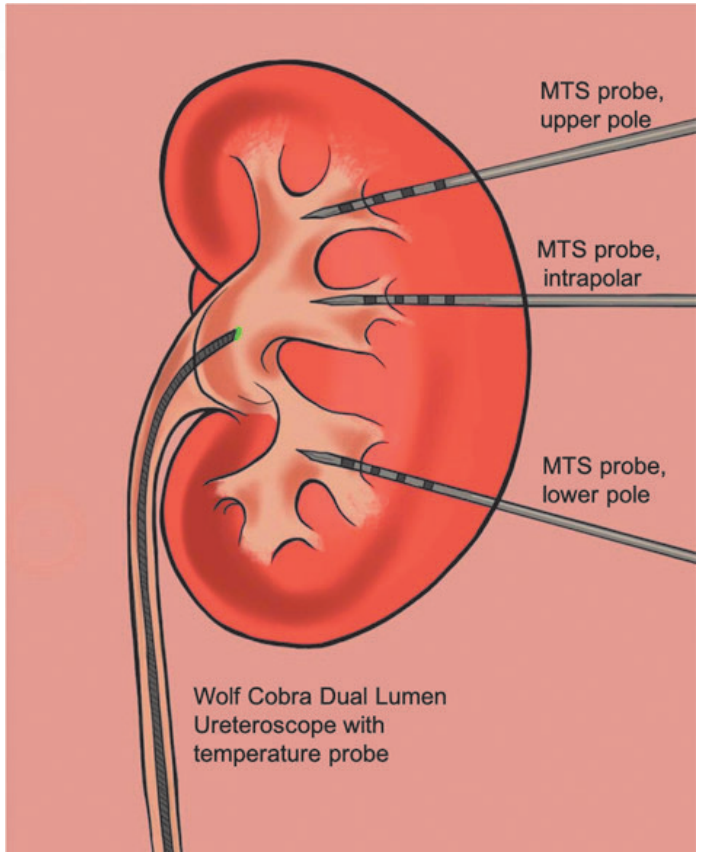
- T >43°C → protein denaturation
- T_{43}: time to induce cellular injury
- 0.5J x 80 Hz (40W) x 60 s

Irrigation	No	Medium	High
Peak Temp (° C)	**84.8**	**63.9**	**43.6**
T_{43} (sec)	**12.7**	**17.8**	**--**

[1]Aldoukhi et al. J Endourol 32;8. Aug 2018

Renal Temperature -- TFL

- In-vivo porcine kidney
- Measured intrarenal fluid and tissue temp
  - 0.5J x 80 Hz
  - 1J x 10 Hz
  - 1.5J x 20 Hz
- +/- 14F UAS
- Single vs Dual lumen ureteroscope
- Room temp vs warmed irrigation



Okhunov et al. J Endo 2021. 35;11

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Renal Temperature -- TFL

Laser Activation Site		Fiber at Upper Calyx				Fiber at Intercalyx				Fiber at Lower Calyx				Fiber at Renal Pelvis					
Scope Type	Irrigation	Setting	Upper Pole	Interpole	Lower Pole	Ureteroscope	Upper Pole	Interpole	Lower Pole	Ureteroscope	Upper Pole	Interpole	Lower Pole	Ureteroscope	Upper Pole	Interpole	Lower Pole	Ureteroscope	
Single Lumen Ureteroscope	Room Temp.	Dusting	44	38	36	46	38	46	41	48	36	36	53	43	36	37	51	38	
		Low Frag	37	36	36	36	37	41	37	39	37	36	42	37	36	36	36	33	
		High Frag	38	36	36	36	37	41	38	38	37	37	40	38	36	36	37	35	
	Warm	Dusting	44	39	36	53	44	54	40	70	36	37	52	51	36	38	53	54	
		Low Frag	40	37	36	44	45	50	42	69	37	38	46	42	36	36	41	40	
		High Frag	38	37	36	40	43	45	39	60	37	37	56	35	36	36	38	39	
Dual Lumen Ureteroscope	Room Temp.	Dusting	38	36	37	35	36	40	36	37	36	36	39	36	37	36	36	34	
		Low Frag	36	39	36	30	37	43	39	33	36	36	36	29	37	37	38	30	
		High Frag	37	36	36	30	37	36	36	29	36	37	39	30	36	36	37	30	
	Warm	Dusting	45	44	36	42	37	52	36	35	37	36	45	35	36	37	50	36	
		Low Frag	33	36	37	35	36	40	36	35	37	36	38	39	37	36	36	36	
		High Frag	41	36	36	36	37	42	36	35	37	36	42	44	39	36	36	39	

Keep temp low: use sheath, room temp irrigation, and dual lumen URS

Dust with caution!

Okhunov et al. J Endo 2021. 35;11

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Laser Pedal Activation Time Affects Temperature

- Operator Duty Cycle (ODC) = lasing time/lithotripsy time
  - 40W with 50% ODC
    - for every 60 sec, 50% of time is on the pedal (total 30 sec)

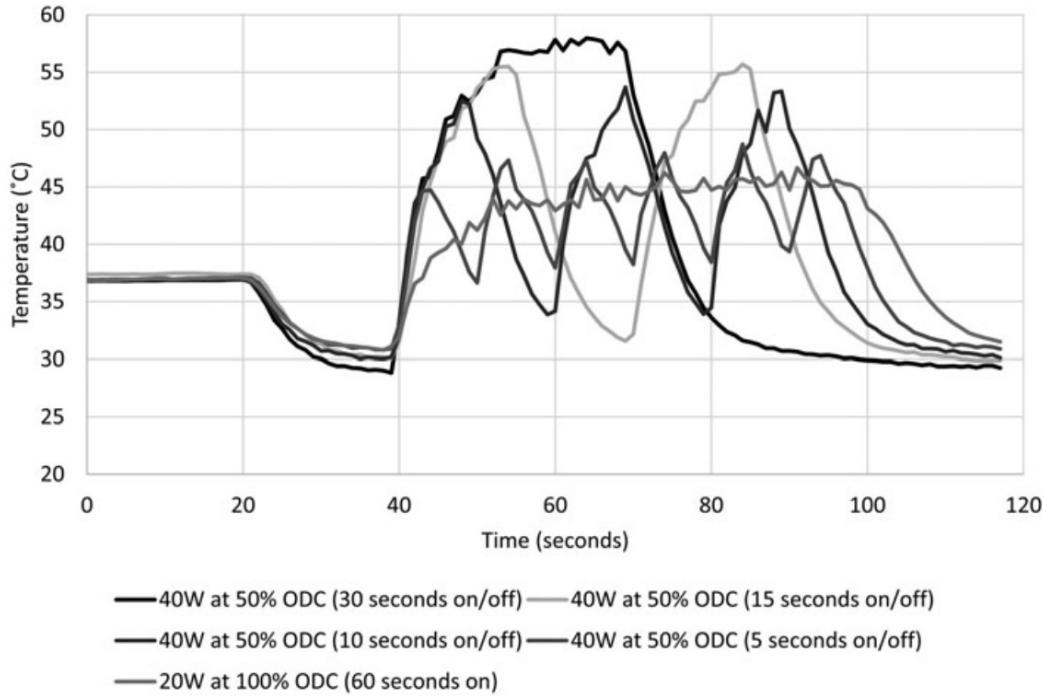

TABLE 2. TIME TO THRESHOLD OF THERMAL INJURY AND THERMAL DOSE FOR DIFFERENT PATTERNS OF LASER ACTIVATION AND ROOM TEMPERATURE IRRIGATION AT 8 mL/MIN

Pattern of laser activation for 60 seconds	*Time to threshold of thermal injury (seconds)*	t_{43} *thermal dose (equivalent minutes)*
40 W applied with 50% ODC (30 seconds on/30 seconds off)	9	6813
40 W applied with 50% ODC (15 seconds on/15 seconds off) × 2	9	1333
40 W applied with 50% ODC (10 seconds on/10 seconds off) × 3	45	158
40 W applied with 50% ODC (5 seconds on/5 seconds off) × 6	—	6
20 W applied with100% ODC	—	4

[1]Aldoukhi et al. J Endourol 35;8. Aug 2021

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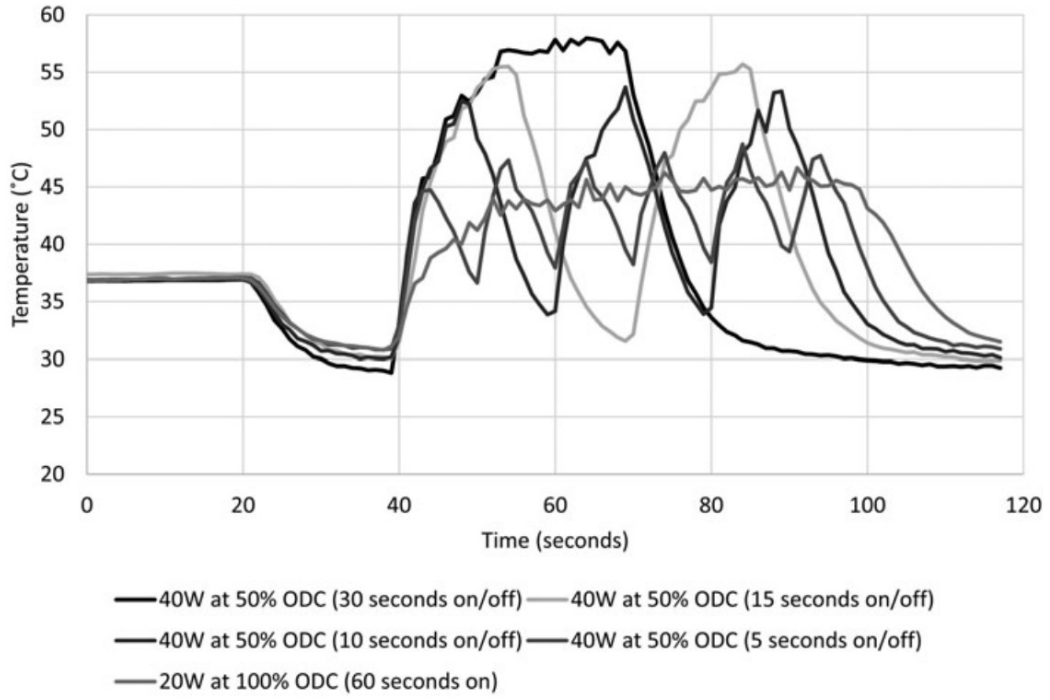

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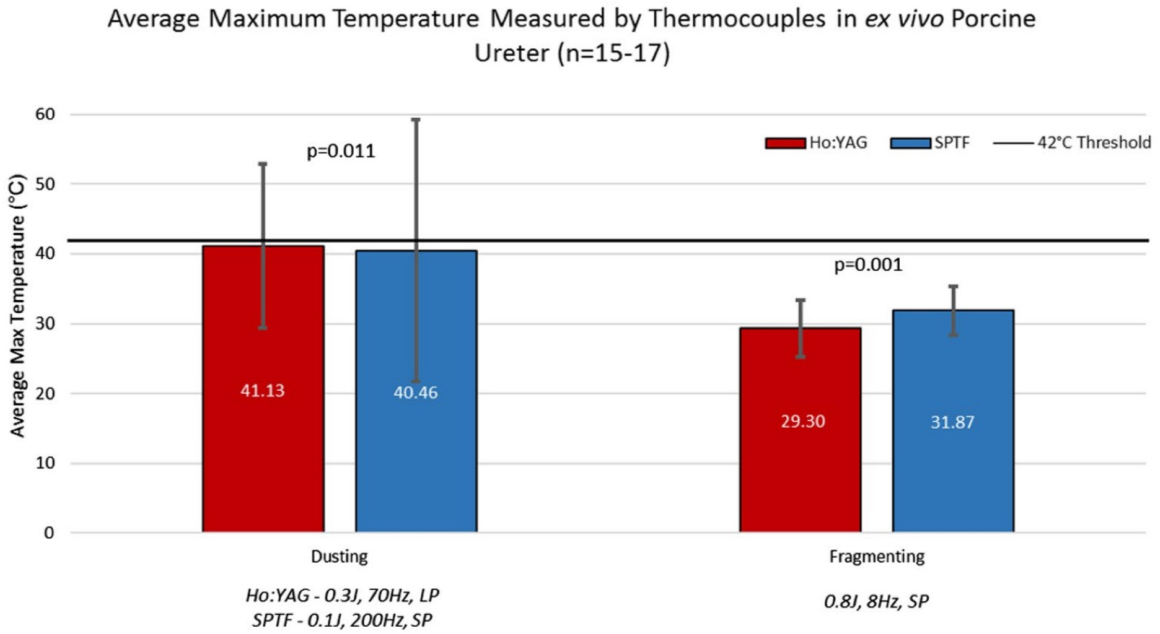
[1]Aldoukhi et al. J Endourol 35;8. Aug 2021

TFL vs Ho:YAG–Similar Ureteral Heat

- Ex-vivo porcine kidneys
- Antegrade URS/LL
- TFL vs p120
  - Fragmentation
    - 0.8J x 8 Hz
  - Dusting
    - 0.1J x 200 (TFL)
    - 0.3J x 70 Hz (p120)



Okhunov et al. J Endo 2021. 35;11

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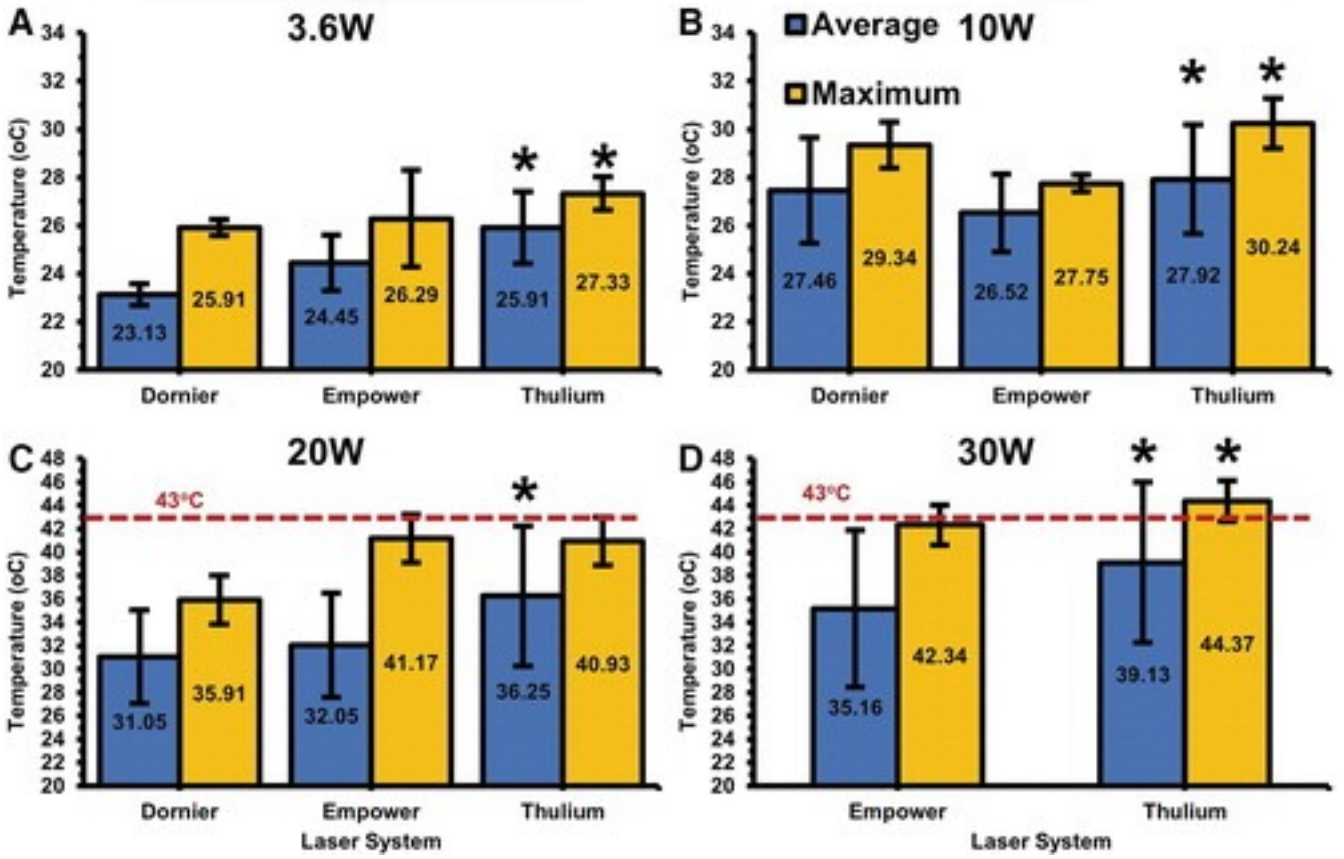
TFL generates more heat during ureteral lithotripsy

- 3D printed model at 35.5°C
- 10 mm bego stone in ureter
- No UAS
- Room temp irrigation, 30cc/s
- Lasers 60s activation
  - 30W HoYAG
  - 100W HoYAG
  - 60W TFL



Belle et al. J Endo 2022. 36;9.

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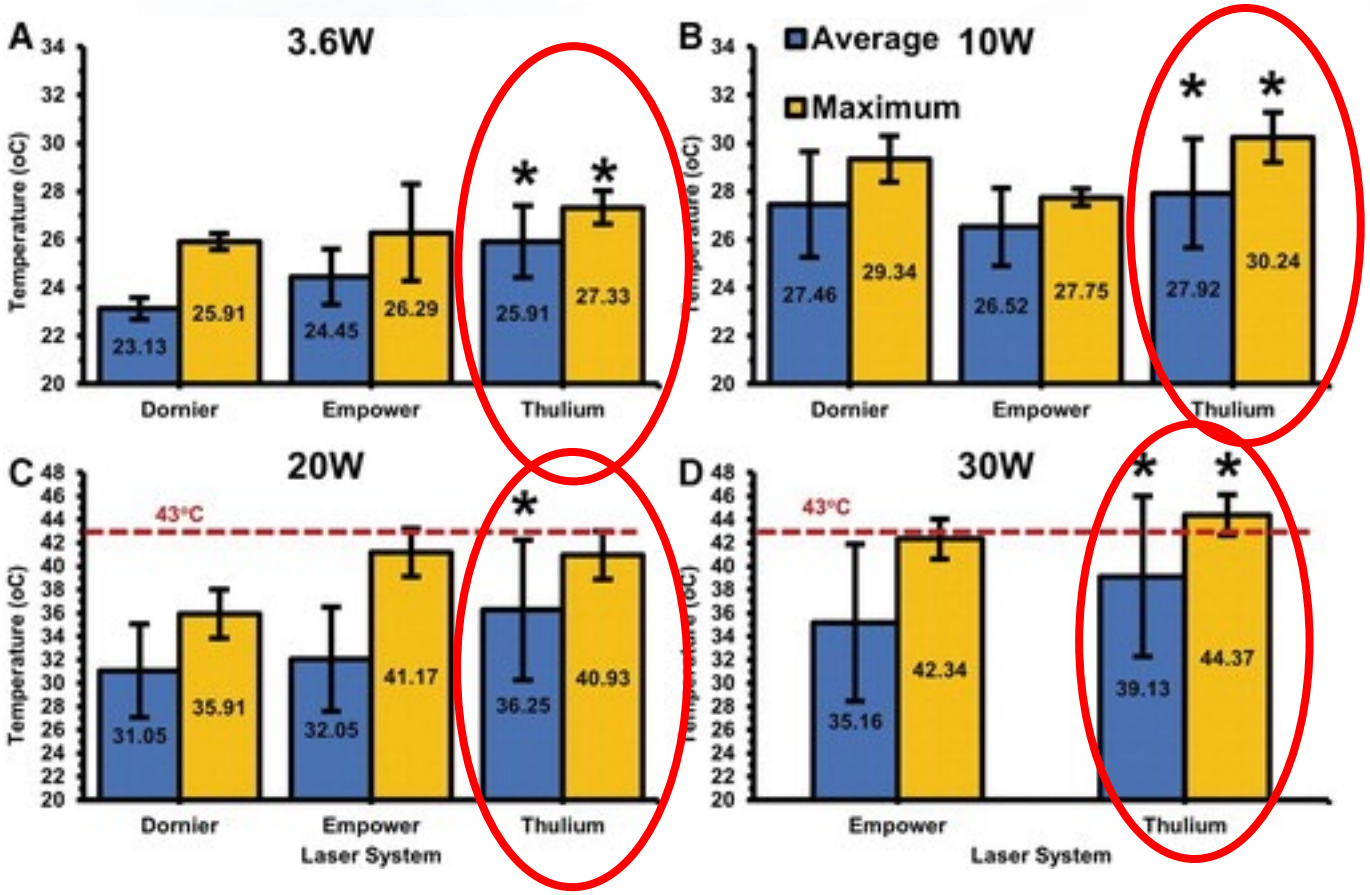

Belle et al. J Endo 2022. 36;9.

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Controlling Temperature

- Ureteral access sheath
- Room temperature irrigation with flow on
- Short laser activation cycles
- <10W in ureter

Suction

Courtesy of Karen Stern. MD

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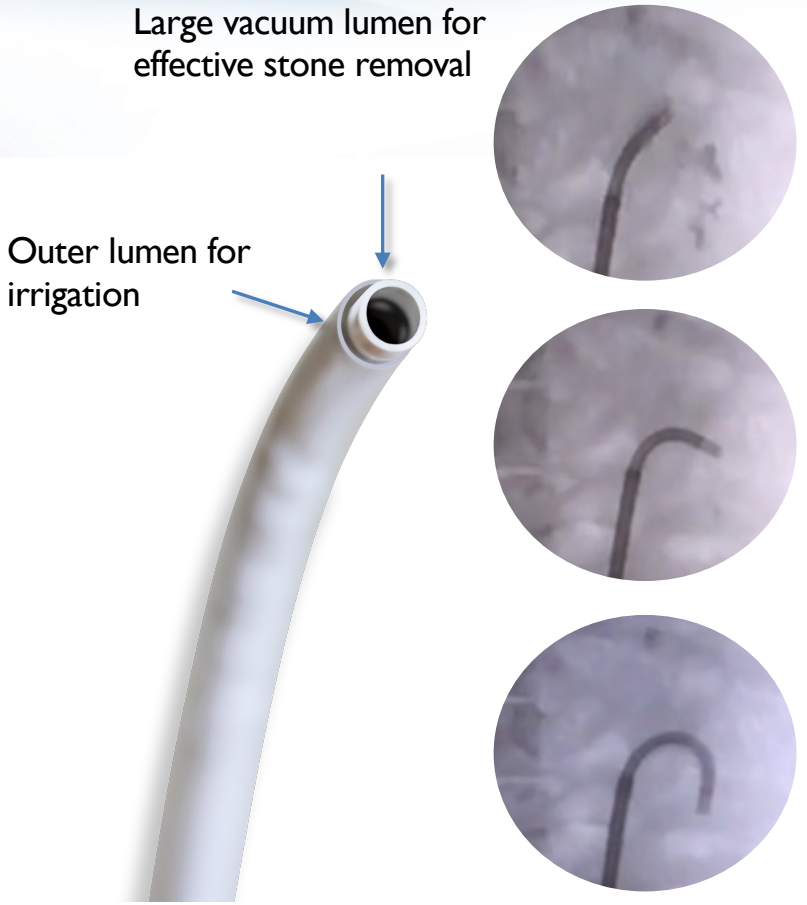
Suction – CVAC® Aspiration System

- 7.5 Fr inner vacuum lumen
- 12 Fr outer lumen
- Deflectable
- Goes through 12/14Fr UAS
- Vacuum up to 2.5mm fragments
- Hand irrigation



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Suction – CVAC® Aspiration System

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Suction – CVAC® aspiration system is effective

Initial Safety and Feasibility of Steerable Ureteroscopic Renal Evacuation: A Novel Approach for the Treatment of Urolithiasis

Roger L Sur [1], Shashank Agrawal [2], Brian H Eisner [3], George E Haleblian [4], Arvind P Ganpule [5], Ravindra B Sabnis [2], Mahesh R Desai [2], Glenn M Preminger [6]

Affiliations + expand

- 17 patients, RCT
- Baseline stone volume 267 mm^3 CVAC® vs. 210 mm^3 (p = 0.55)
- CT scan on day 1 and 30

TABLE 3. PERIOPERATIVE OUTCOMES

	SURE group (n=9)	*Basket group (n=8)*	p
Volume of stone removed at postoperative day 1, (mm^3)	202±94 (64–318)	91±42 (33–140)	<0.01
% Stone volume removed at postoperative day 1, (% of baseline)	84±19 (37–100)	56±24 (21–88)	0.022
Stone-free rate based on 30-day CT scan	100%	75%	0.20
Fluoroscopy time, seconds	318±120 (184–600)	295±213 (125–673)	0.78
Procedure time, minutes	54±17 (30–80)	39±22 (15–75)	0.13
Stone removal rate (mm^3/min)	16.6±9.5 (6.0–35.9)	9.6±6.4 (2.0–22.0)	0.099

Mean ± standard deviation (range).

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Suction – CVAC® works for large stones

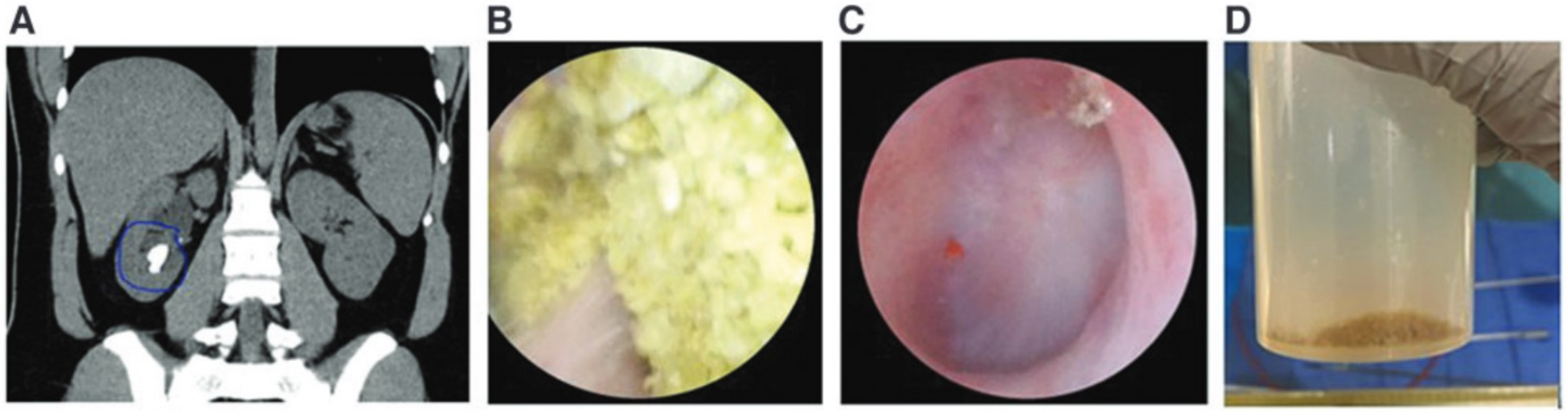
- 43 patients
- Mean stone size 29 ± 12mm

TABLE 3. STONE CLEARANCE

	Total baseline Stone burden 10–20 mm (n = 6)	*Total baseline stone burden 20–30 mm* (n = 6)	*Total baseline Stone burden >30 mm* (n = 12)	*All patients with follow-up CT imaging* (n = 24)
Stone clearance, % (mean ± SD)	97.9 ± 3.0	98.9 ± 2.5	93.8 ± 11.5	96.1 ± 8.5
Volume removed, mm^3 (mean ± SD)	945.9 ± 559.3	2345.1 ± 1280.8	3382.3 ± 2088.1	2513.9 ± 1884.7

Baseline stone burden stratification analysis among patients with follow-up CT imaging ($n = 24$).

- Replacement for PCNL in morbid patients



Stern et al. J Endo 2023. 37;11.

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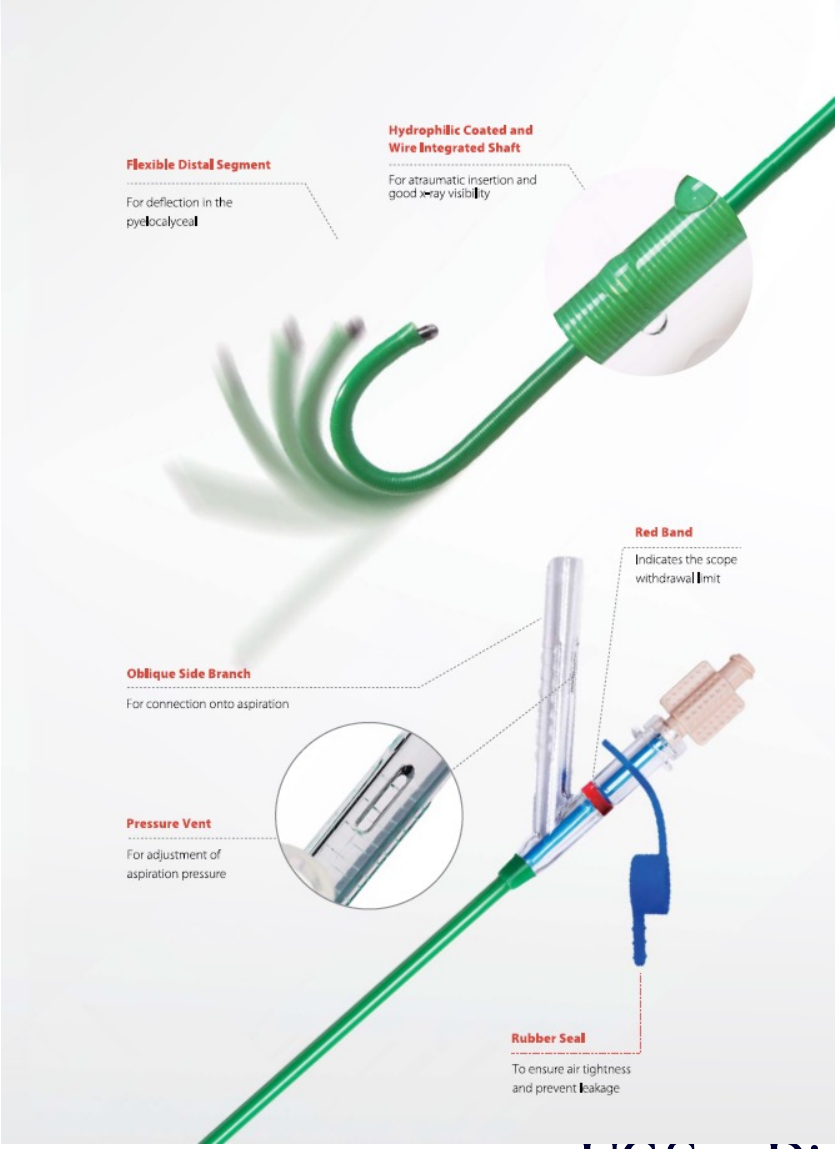
Suction – ClearPetra Ureteral Access Sheath

- Deflectable sheath
- Different sizes –
  - 10/12 Fr, 11/13 Fr, 12/14 Fr.
- Irrigation via scope, aspiration between scope & sheath
- Aspiration adjusted by pressure vent on sheath
- Flexible tip pushed over scope, directed into calyx of choice by scope flexion



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Other Suction Devices

BJUI
BJU International

Research Communication | Open Access

A novel flexible vacuum-assisted ureteric access sheath in retrograde intrarenal surgery

Yujun Chen, Liangliang Zheng, Longhui Lin, Chen Li, Liang Gao, Longlong Ke, Renrui Kuang, Jie Chen

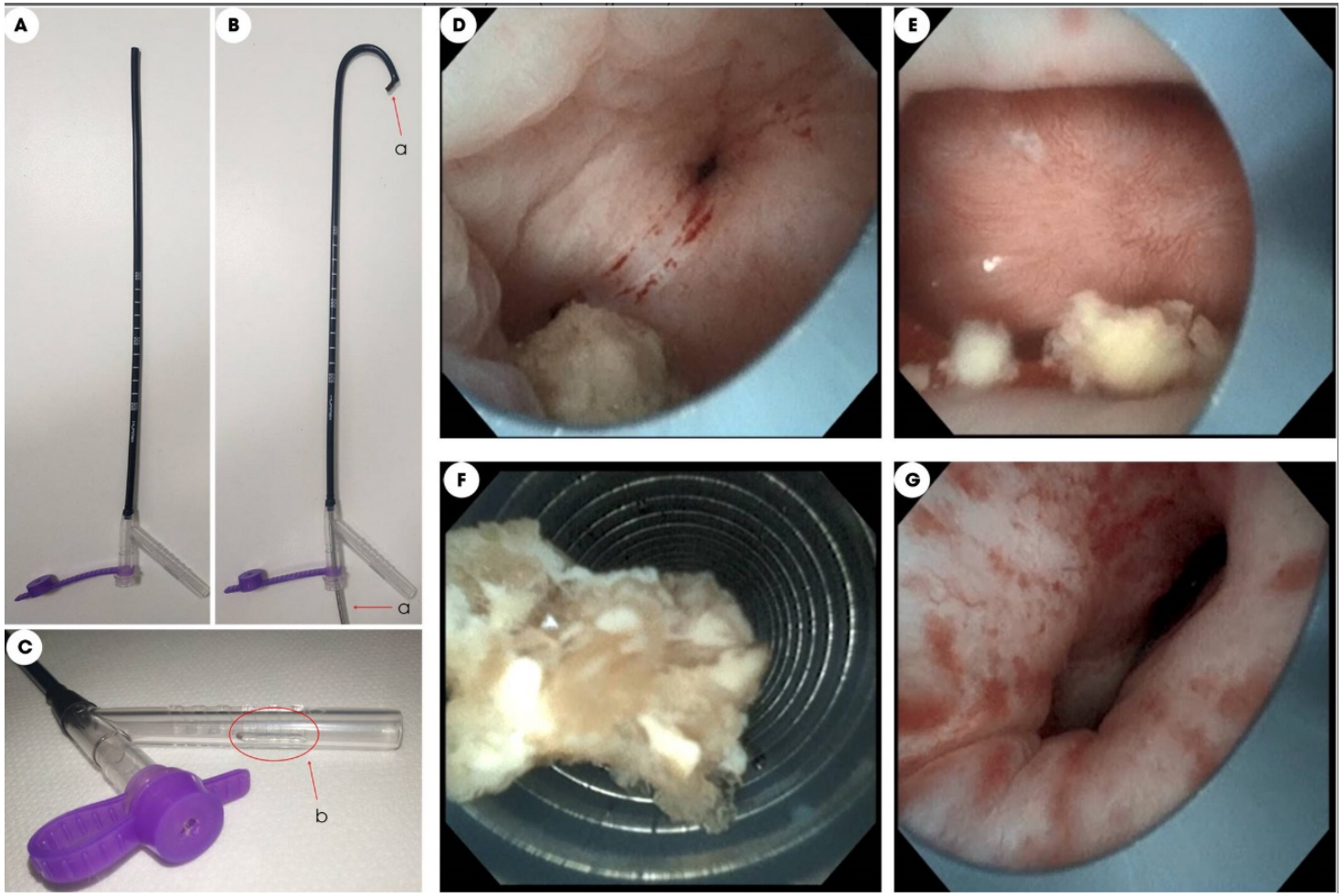
First published: 20 August 2022 | https://doi.org/10.1111/bju.15873 | Citations: 3

Y.C., L.Z. and L.L. contributed equally to this work.

FV-UAS 12/14Fr, Passive bending
53 consecutive patients
Stone burden 11 – 25 mm

Post-op CT on POD#1 and 1 month
37 (69.8%) - 100% stone free

Mean stone volume clearance rate: 97.7% (81.1%-100%)



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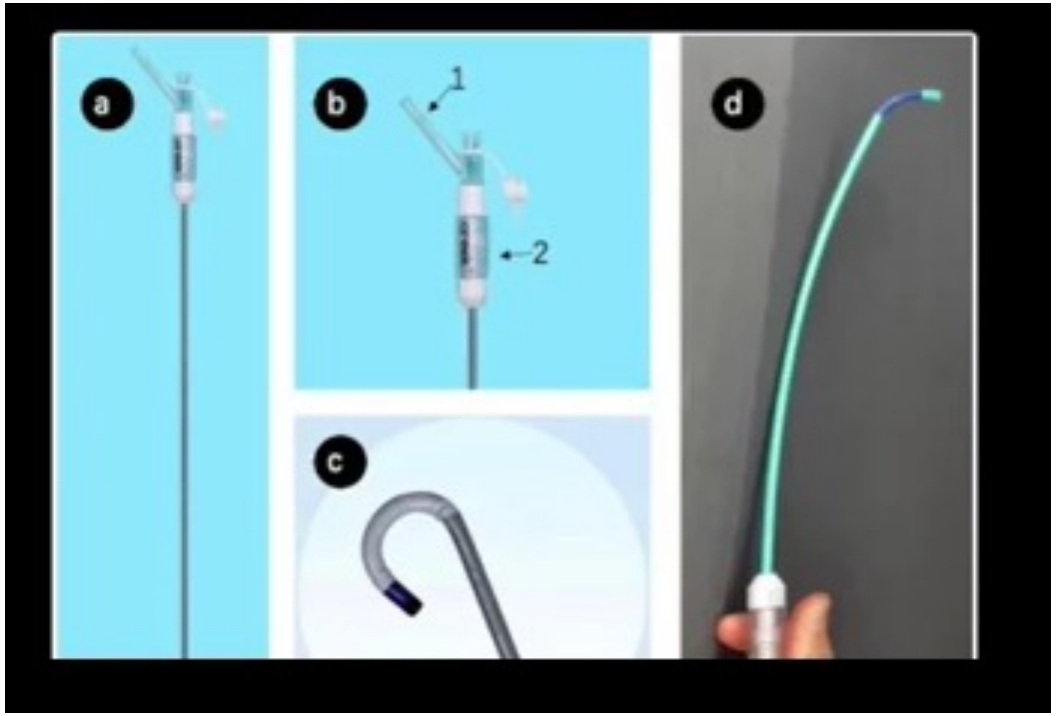
Other Suction Devices

A Novel Distal Active Flexible Vacuum-assisted Ureteric Access Sheath in Retrograde Intrarenal Surgery

Gaoyuanzhi Yue, Shangwen Dou, Chao Cai, Bangfeng Liu, and Yongda Liu

UROLOGY 179: 204–205, 2023.



- Case Report
- Distal active flexible vacuum-assisted ureteric access sheath (DAFV-UAS)
- 10 / 12.5 French
- 10 cm deformability at the tip
- Knob controls direction at the handle

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Suction Takeaways

- Potential for higher stone free rates
- Pairs well with dusting
- Enables large stone removal in poor surgical candidates
- Room for improvements

Thank you!

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