SURGICAL MANAGEMENT of URINARY CALCULI

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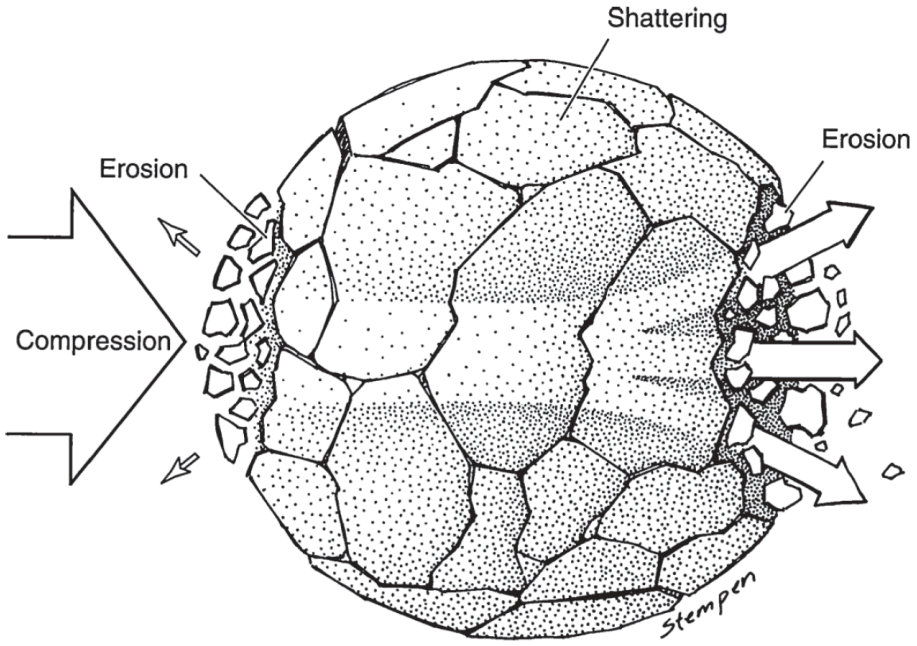
SHOCKWAVE LITHOTRIPSY

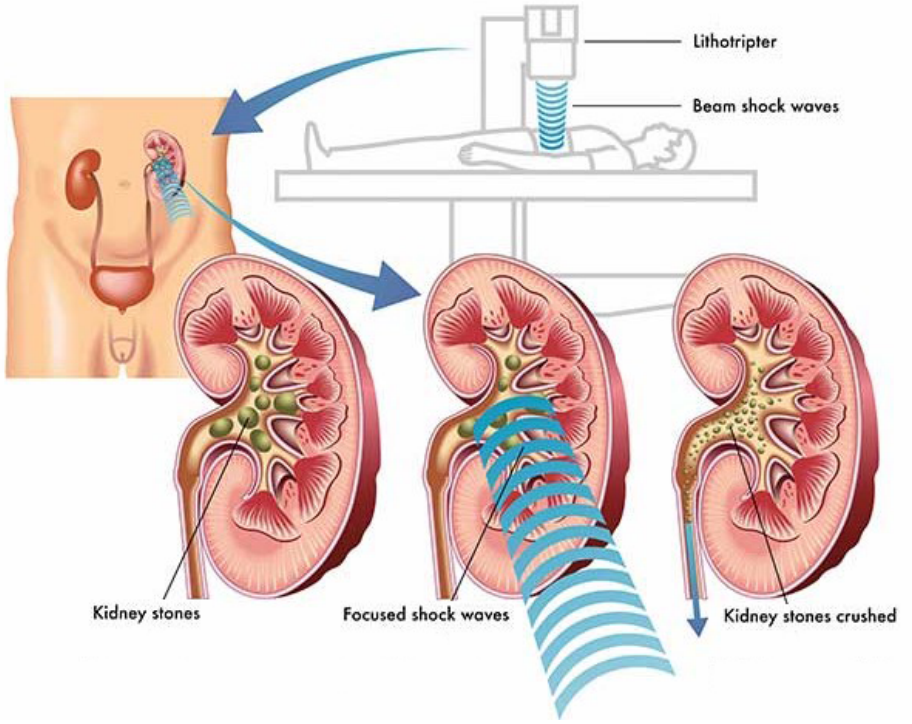
SHOCKWAVE LITHOTRIPSY (SWL)

- Revolutionized the Tx of urinary stones
- First clinical application: 1980 (Dornier Co.)



SWL (cont'd)

- Success depends on
  - Efficacy of the lithotripter
  - Stone features
    - Size
    - Location (ureteral, pelvic or calyceal)
    - Composition
  - Patient's habitus
  - Performance of SWL

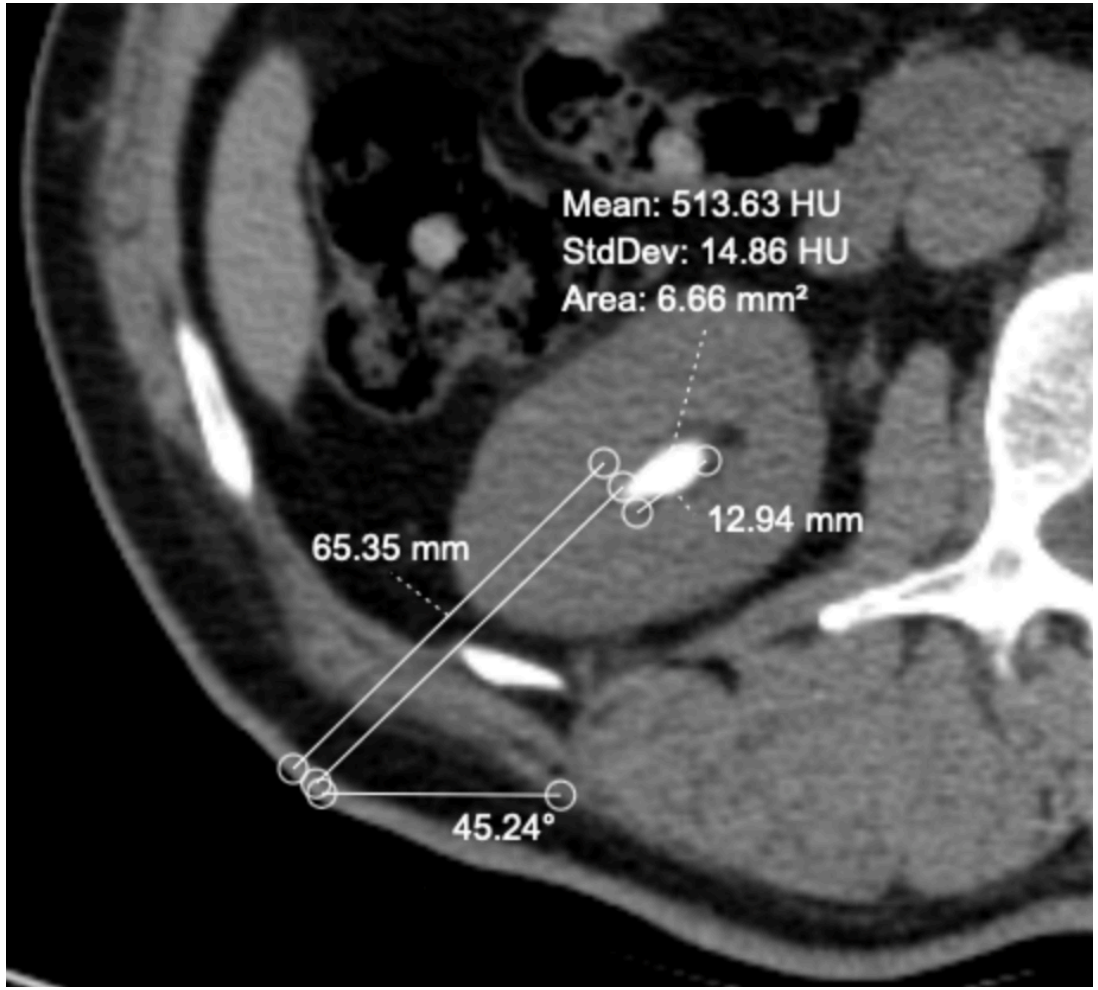


SWL (cont'd)

- Factors that impair successful stone treatment by SWL
  - Steep infundibular-pelvic angle
  - Long calyx
  - Long skin-to-stone distance
  - Narrow infundibulum
  - Shock wave-resistant stones (calcium oxalate monohydrate, brushite, or cystine)

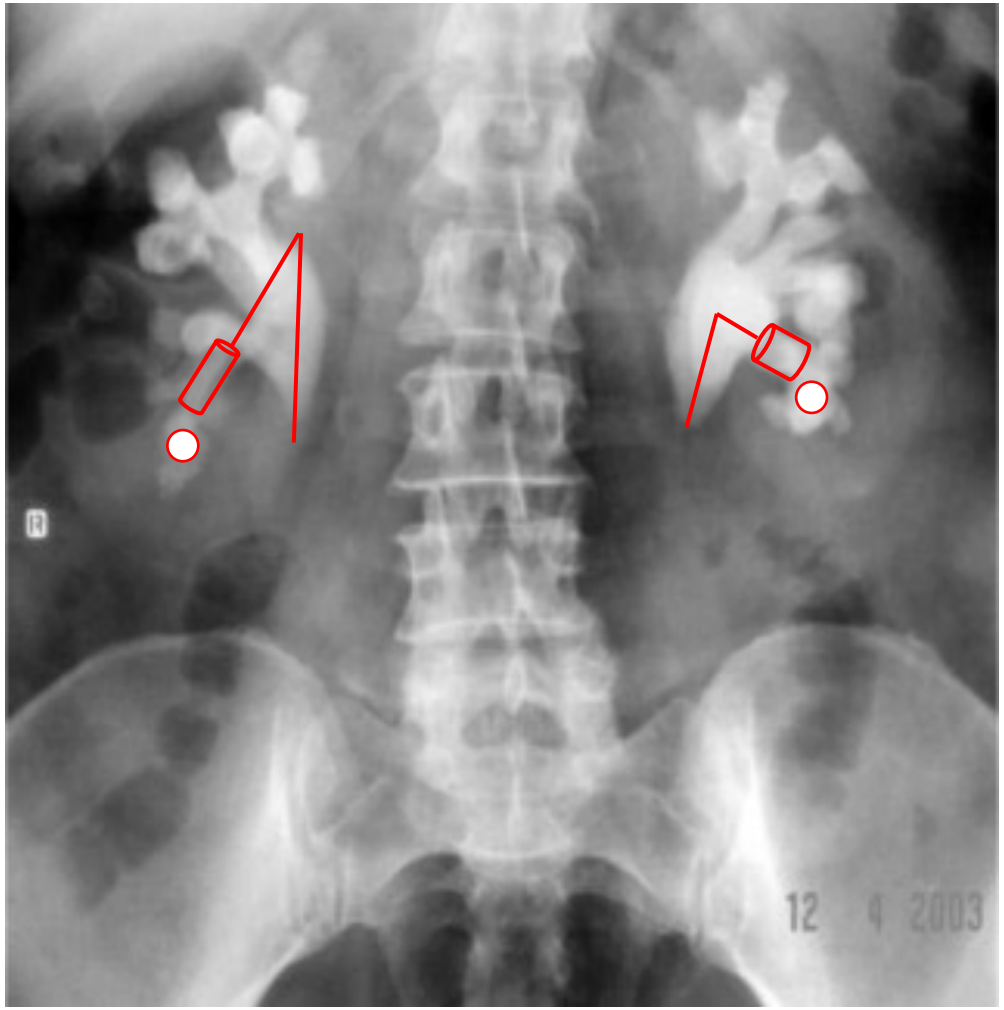
SWL (cont'd)

SSD & HU



SWL (cont'd)

ANATOMICAL INDICES



SWL (cont'd)

- Contraindications
  - Pregnant women
  - Large abdominal aortic aneurysms
  - Uncorrectable bleeding tendency
  - Urinary tract infection
  - Severe skeletal malformations and severe obesity
  - Anatomical obstruction distal to the stone
- Caution
  - Pacemaker

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SWL (cont'd)

- No standard antibiotic prophylaxis before SWL is recommended
- Prophylaxis is recommended when
  - Internal stent placement ahead of anticipated treatments
  - In the presence of increased bacterial burden
    - Indwelling catheter
    - Nephrostomy tube
    - Infectious stones

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SWL (cont'd)

- Fewer complications compared to PCNL and ureteroscopy
- Relationship between SWL and hypertension or diabetes is unclear

Complications			%
Related to stone fragments	Steinstrasse		4 – 7
	Regrowth of residual fragments		21 – 59
	Renal colic		2 – 4
Infections	Bacteriuria in non-infection stones		7.7 – 23
	Sepsis		1 – 2.7
Tissue effect	Renal	Haematoma, symptomatic	< 1
		Haematoma, asymptomatic	4 – 19
	Cardiovascular	Dysrhythmia	11 – 59
		Morbid cardiac events	Case reports
	Gastrointestinal	Bowel perforation	Case reports
		Liver, spleen haematoma	Case reports

Tzelves, L., et al. Shockwave Lithotripsy Complications According to Modified Clavien-Dindo Grading System. A Systematic Review and Meta-regression Analysis in a Sample of 115 Randomized Controlled Trials. Eur Urol Focus, 2022, 8: 1452.

SWL (cont'd)

BOX 94.1 Acute Renal Side Effects: Risk Factors for Shock Wave Lithotripsy

Age	Diabetes mellitus
Obesity	Coronary heart disease
Coagulopathies	Preexisting hypertension
Thrombocytopenia	Body mass index >30 or <21.5

SWL (cont'd)

- Future direction
  - Visio-Track (VT) locking system
  - Ultrasonic propulsion of renal and ureteral calculi
  - Burst wave lithotripsy
    - Potential to revolutionize the future of SWL

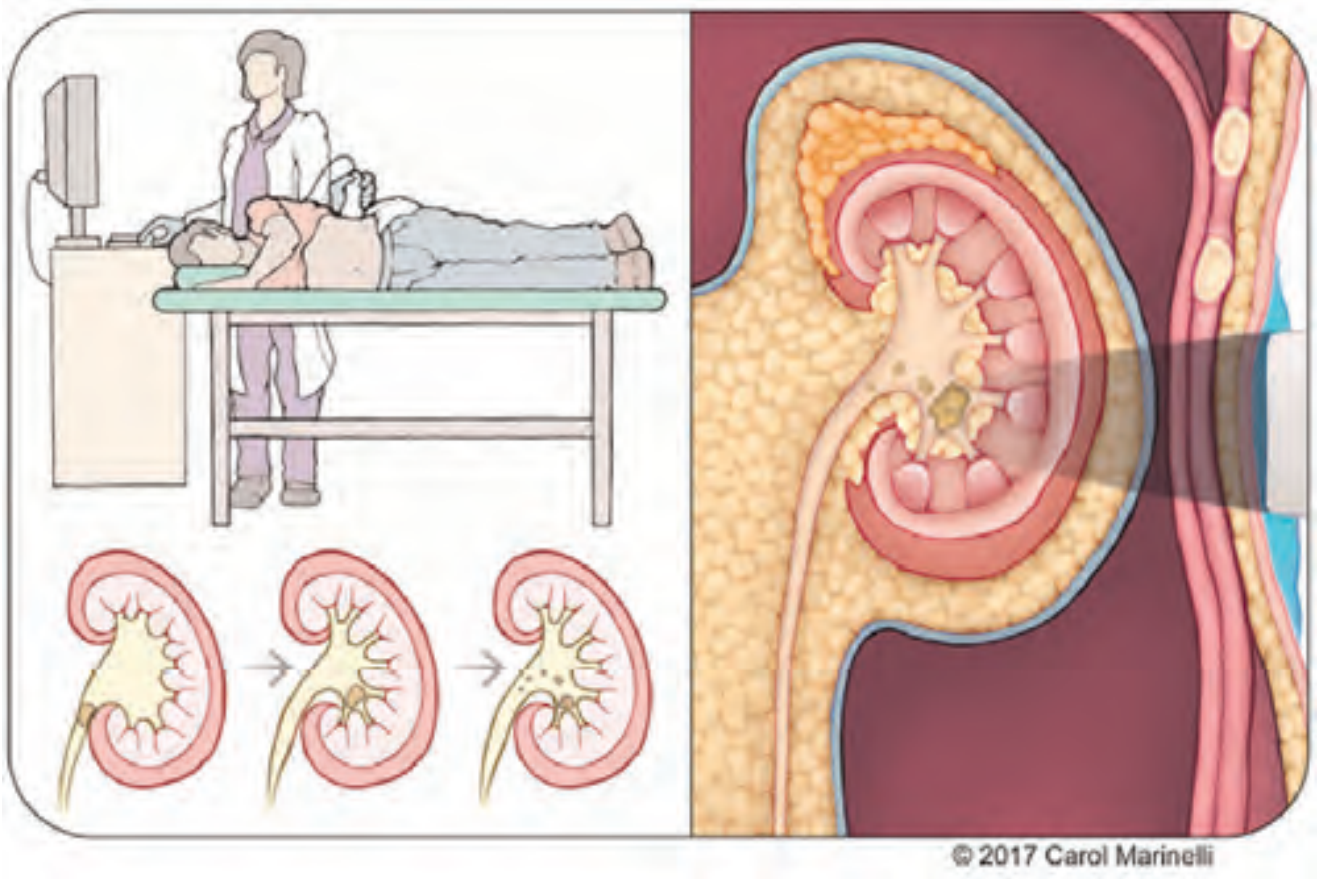
SWL (cont'd)

Visio-track configuration


LITEMED
Doctors first use the auto localization system

SWL (cont'd)

ULTRASONIC PROPULSION



American Urological Association

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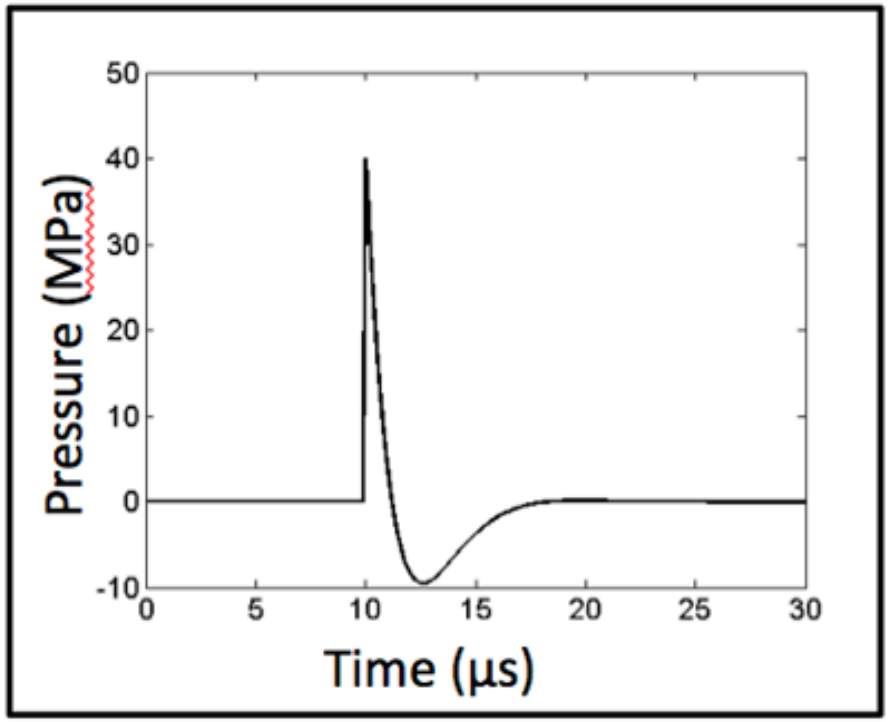
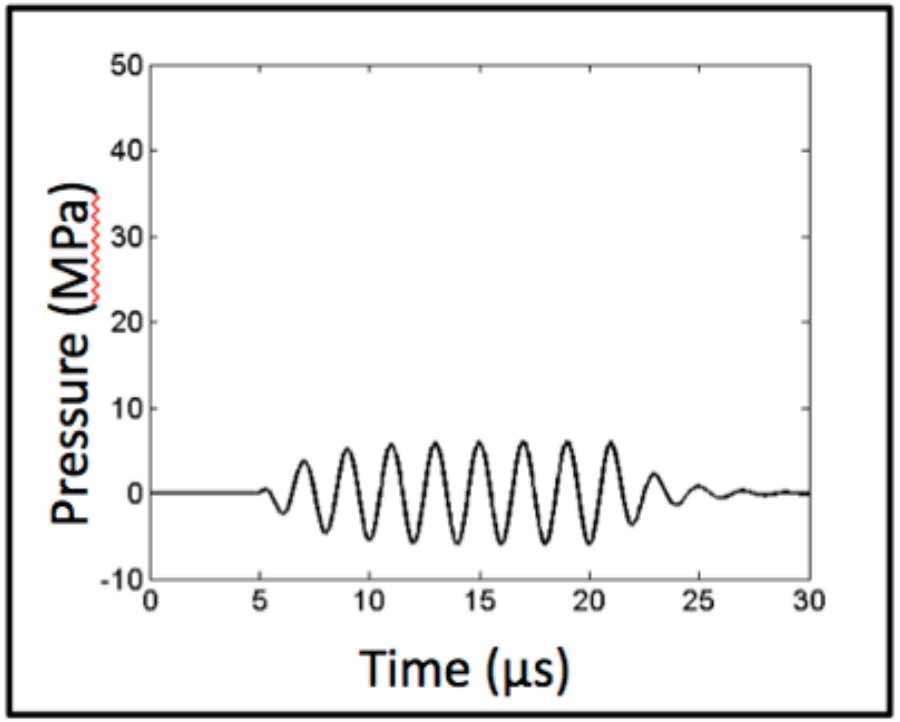
BURST WAVE LITHOTRIPSY (BWL)

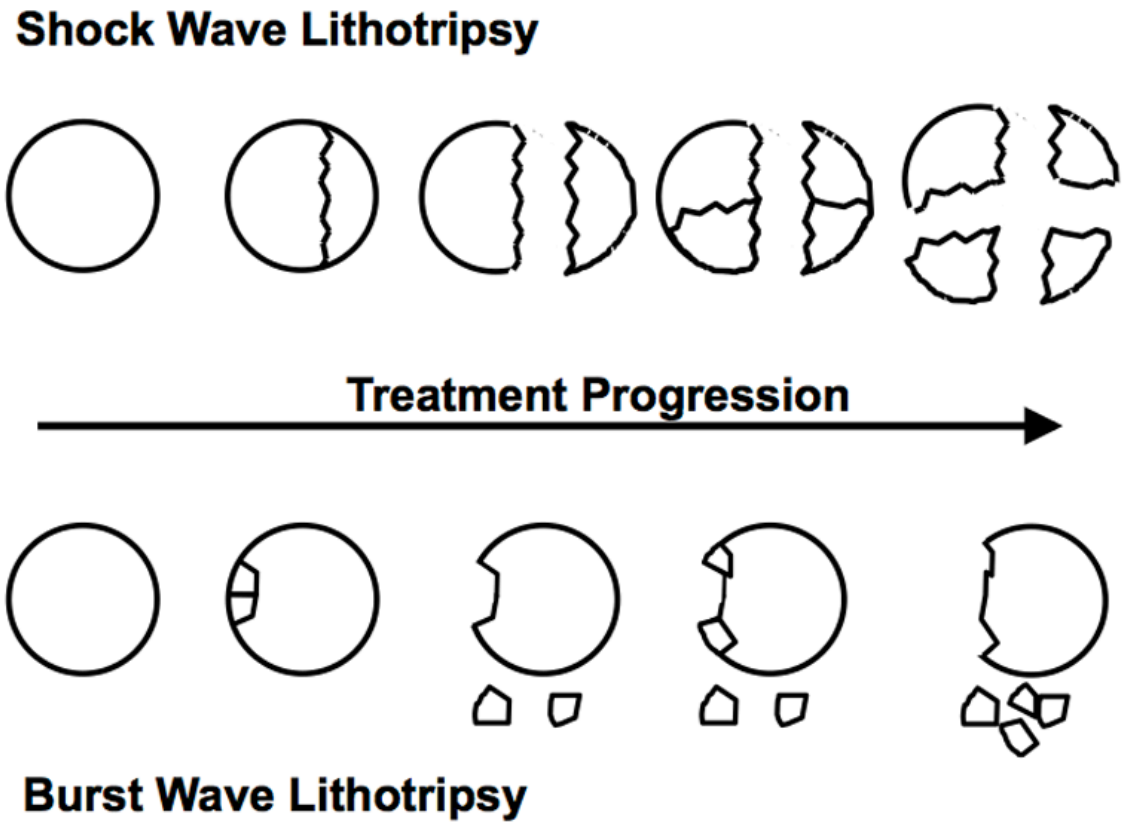
SWL - Shock Waveform



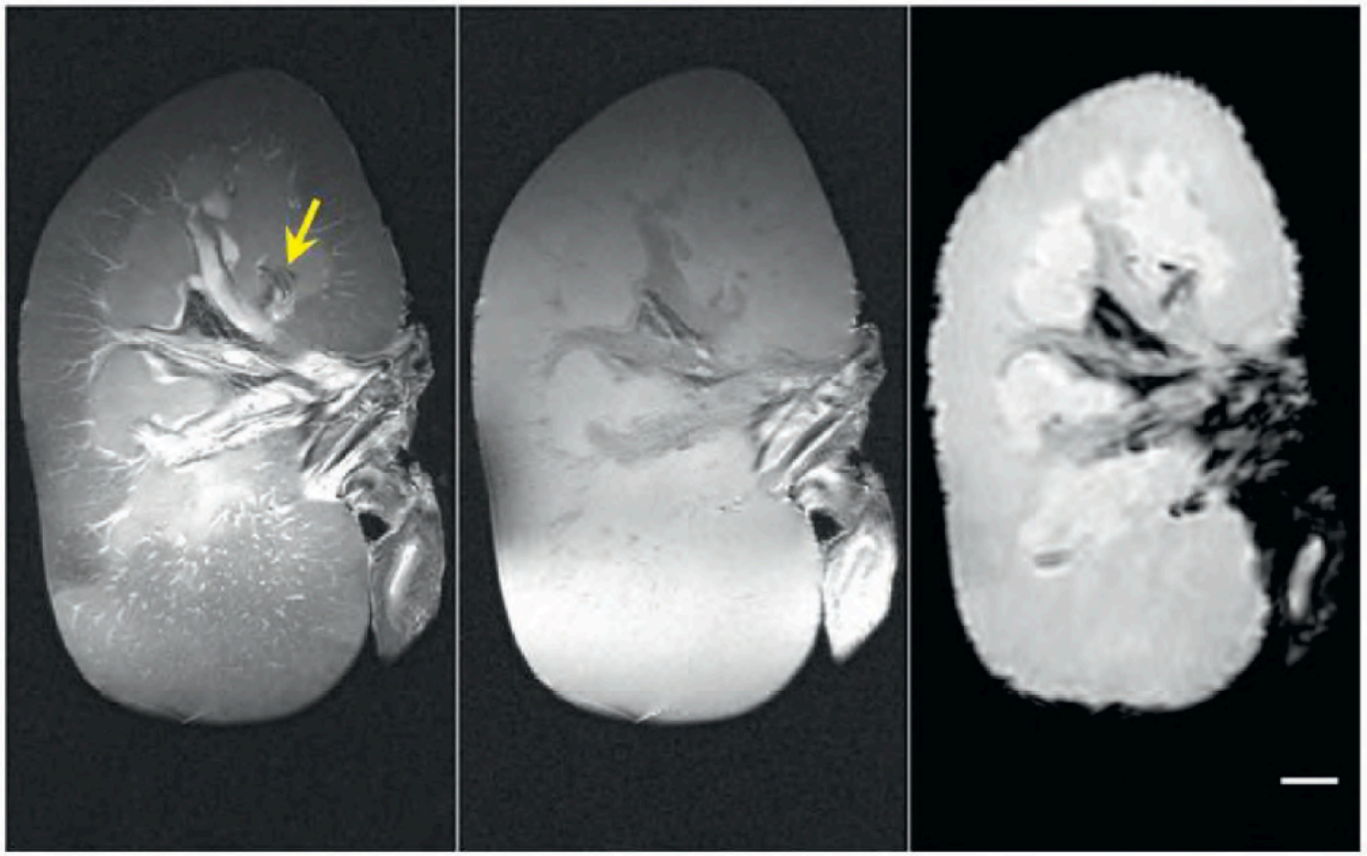
BWL - Burst Waveform



BWL (cont'd)


Shock Wave Lithotripsy
Treatment Progression
Burst Wave Lithotripsy

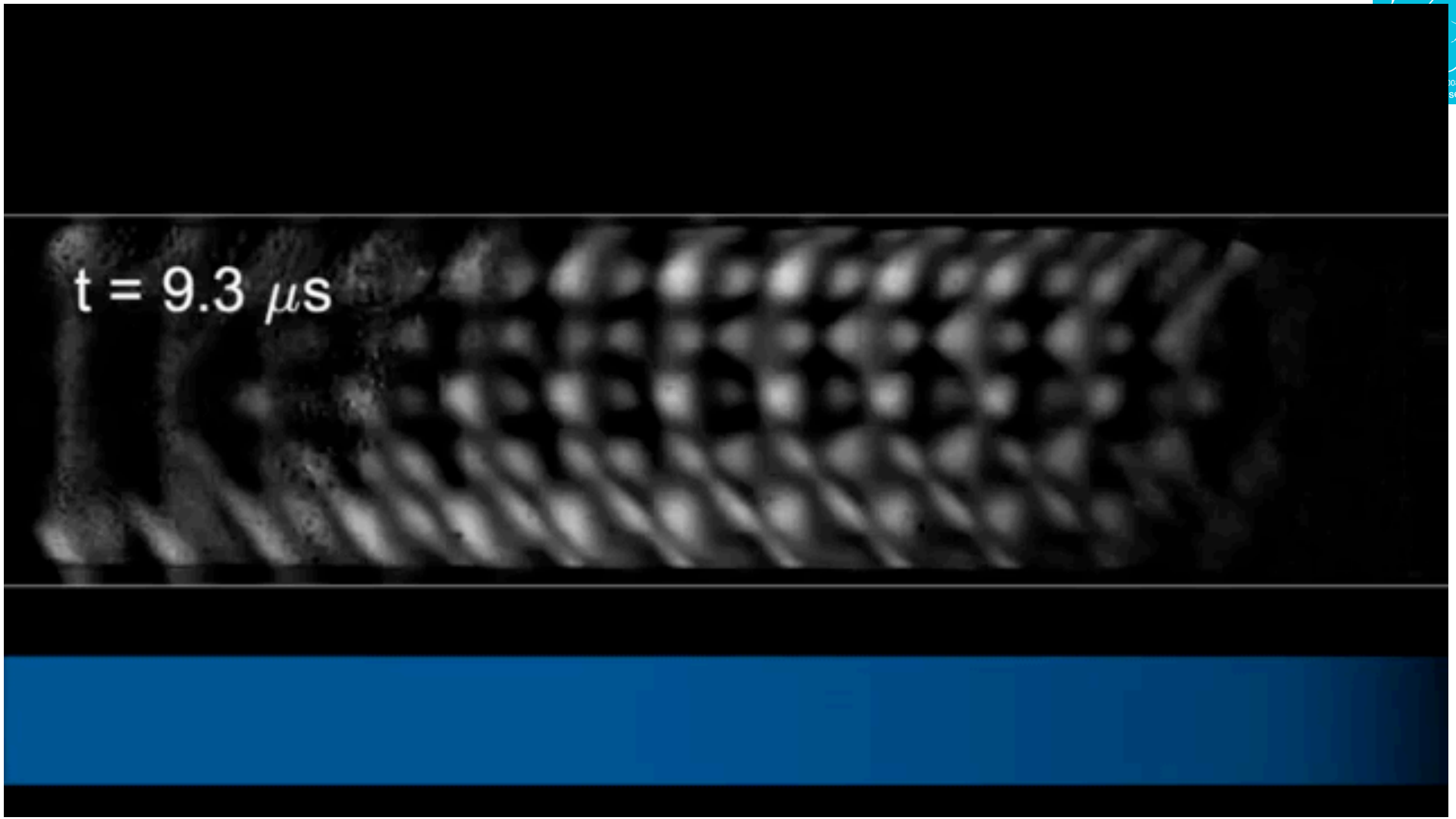
BWL (cont'd)



BWL (cont'd)

a: Portable Burst Wave Machine

b: Portable Burst Wave shock head


t = 9.3 μs

BWL (cont'd)

World Journal of Urology (2025) 43:250
https://doi.org/10.1007/s00345-025-05645-x

REVIEW

Burst wave lithotripsy - a paradigm shift: inferences from a scoping review

Steffi Kar Kei Yuen[1,2] · Vineet Gauhar[2,3] · Chu Ann Chai[4] · Connor M. Forbes[5] · Victor K. F. Wong[5] · Ryan F. Paterson[5] · Ivan Ching Ho Ko[1] · Joseph Li[6] · Daniele Castellani[2,7] · Ben H. Chew[5]

Received: 14 March 2025 / Accepted: 16 April 2025

BWL (cont'd)

	BWL	SWL
Advantages	👍 Avoids kidney injury 👍modulate settings for variable fragment sizes 👍 Can couple with ultrasonic propulsion for clearance of residual fragments post-lithotripsy or stone relocation prior to lithotripsy 👍 Portable	✅Established clinical data to support and guide best practices
Risks and limitations	⚠Need to be visualized on ultrasound; effective at a skin-to-stone distance of 4-14cm	⚠Possible tissue injury

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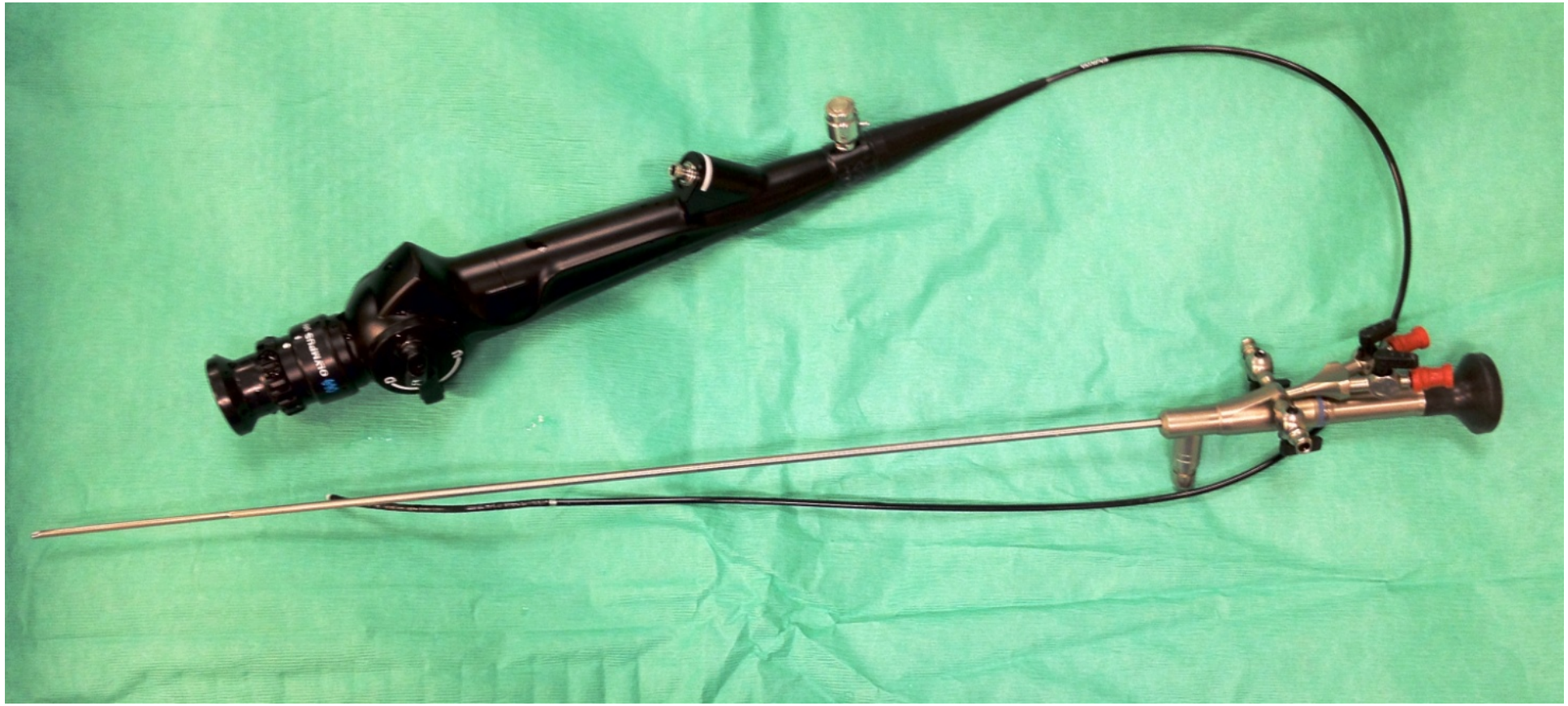
URETEROSCOPY

URETEROSCOPY

- Current standard for rigid ureteroscopes is a tip diameter of < 8 French
- Reusable and disposable flexible ureteroscopes allow access to the entire upper collecting system.
- Rigid URS can be used for the whole ureter
  - Rigid, semirigid: mid and distal ureteral stones
  - Flexible: proximal and intrarenal

Deng, T., et al. Systematic review and cumulative analysis of the managements for proximal impacted ureteral stones. World J Urol, 2019. 37: 1687.

URETEROSCOPY (cont'd)



URETEROSCOPY (cont'd)

- Stone-free rates approach 95–100%
  - Dependent on
    - Stone burden
    - Location
    - Length of time that the stone has been impacted
    - Hx of retroperitoneal surgery
    - Experience of the operator.

URETEROSCOPY (cont'd)

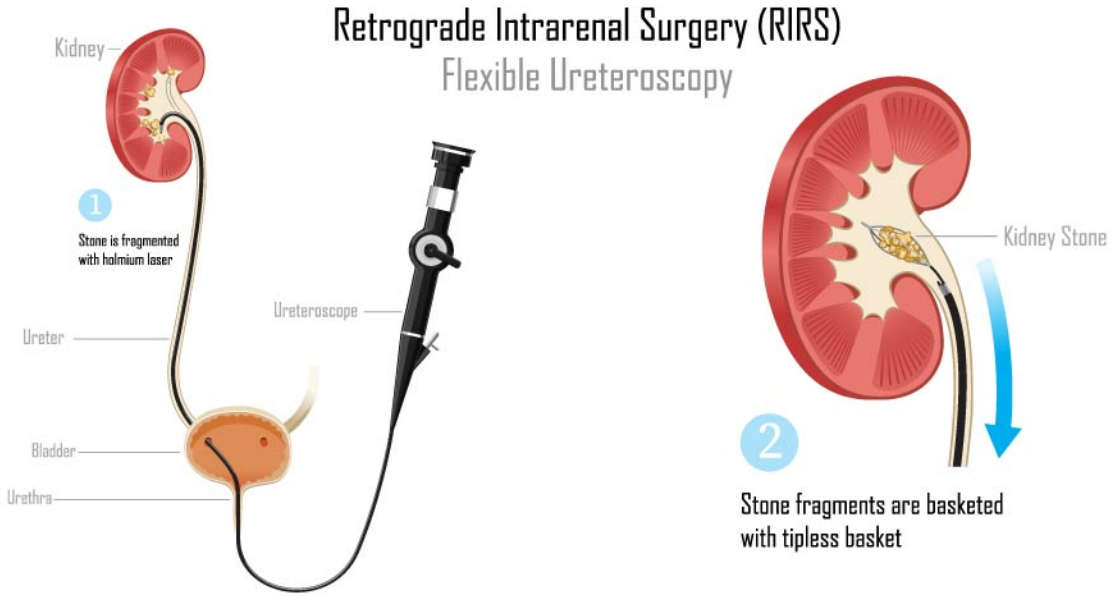
- URS is the modality of choice for patients with
  - Obesity
  - Hard stones
  - Pregnant
  - Have a bleeding diathesis

URETEROSCOPY (cont'd)

- Variety of lithotrites
  - Electrohydraulic
  - Ultrasonic probes
  - Laser systems (most effective)
  - Pneumatic (stone migration)

URETEROSCOPY (cont'd)

- Ureteroscopy for renal stones (RIRS)
- Because of
  - Endoscope miniaturization
  - Improved deflection mechanism
  - Enhanced optical quality and tools
  - Introduction of disposables




FLEXIBLE URETEROSCOPY
and LASER LITHOTRIPSY

URETEROSCOPY (cont'd)

- Stents should be inserted in patients who are at increased risk of complications
  - Ureteral trauma
  - Residual fragments
  - Bleeding
  - Perforation
  - UTIs
  - Pregnancy
  - Doubtful cases

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URETEROSCOPY (cont'd)

- Complication rates are rare (overall 9-25%)
- The rates increase → in proximal ureter
- Excessive force with any instrument → ureteral injury
- Complications
  - Ureteral stent discomfort (>25 %)
  - Post-operative urosepsis (up to 5%)
  - Ureteral wall injury (5 %)
  - Ureteral avulsion and strictures are rare (1%)

De Coninck, V., et al. Complications of ureteroscopy: a complete overview. World J Urol, 2020. 38: 2147.

MINIMALLY INVASIVE THERAPY & ALLIED TECHNOLOGIES
https://doi.org/10.1080/13645706.2020.1741388

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ORIGINAL ARTICLE

The effects of shock wave lithotripsy and retrograde intrarenal surgery on renal function

Turgay Turan[a], Ferruh Kemal Isman[b], Özgür Efiloğlu[a], Nevin Genc Kahraman[b], Furkan Şendoğan[a], Yavuz Onur Danacioğlu[c], Ramazan Gokhan Atis[a] and Asif Yildirim[a]

[a]Department of Urology, Istanbul Medeniyet University, Istanbul, Turkey; [b]Department, of Biochemistry, Istanbul Medeniyet University, Istanbul, Turkey; [c]Department of Urology, Istanbul Bakirkoy Dr. Sadi Konuk Education Research Hospital, Istanbul, Turkey

ABSTRACT

Introduction: The aim of this study was to compare the early effects of shock wave lithotripsy (SWL) and retrograde intrarenal surgery (RIRS) on renal function using the cystatin C levels.

Material and methods: Serum samples were taken from each of the patients preoperatively, on the first postoperative day, and on the 30th postoperative day in order to evaluate the renal damage. The cystatin C level was determined using a particle-enhanced turbid metric immunoassay with a clinical chemistry analyzer.

Results: In the comparison between the preoperative and postoperative cystatin C levels on day 1, there was an increase in the SWL group ($p = .001$); however, the decrease in the RIRS group was statistically significant ($p = .007$). There were statistically significant differences in the cystatin C levels on the first postoperative day in both groups ($p = .001$). In the SWL group, there was a statistically significant increase between the preoperative and the 30th postoperative day cystatin C levels ($p = .006$), but no differences were found between these levels in the RIRS group or between the two groups ($p = .255$).

Conclusions: RIRS may be the preferred procedure for patients who need more renal function protection when treating renal stones <2 cm

ARTICLE HISTORY
Received 10 July 2019
Accepted 20 February 2020

KEYWORDS
Cystatin C; shockwave lithotripsy; retrograde intrarenal surgery; renal stones

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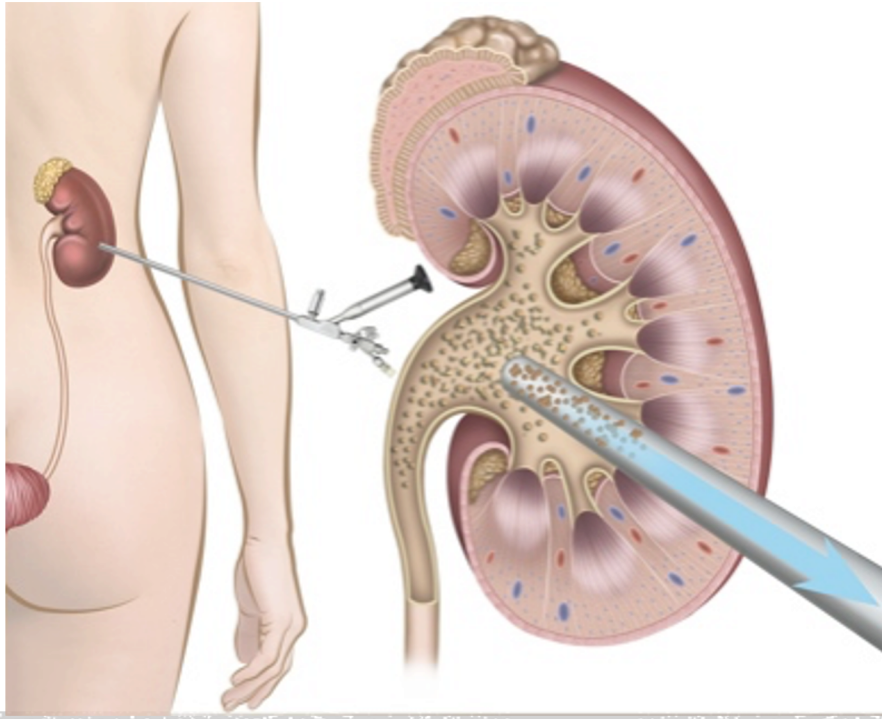
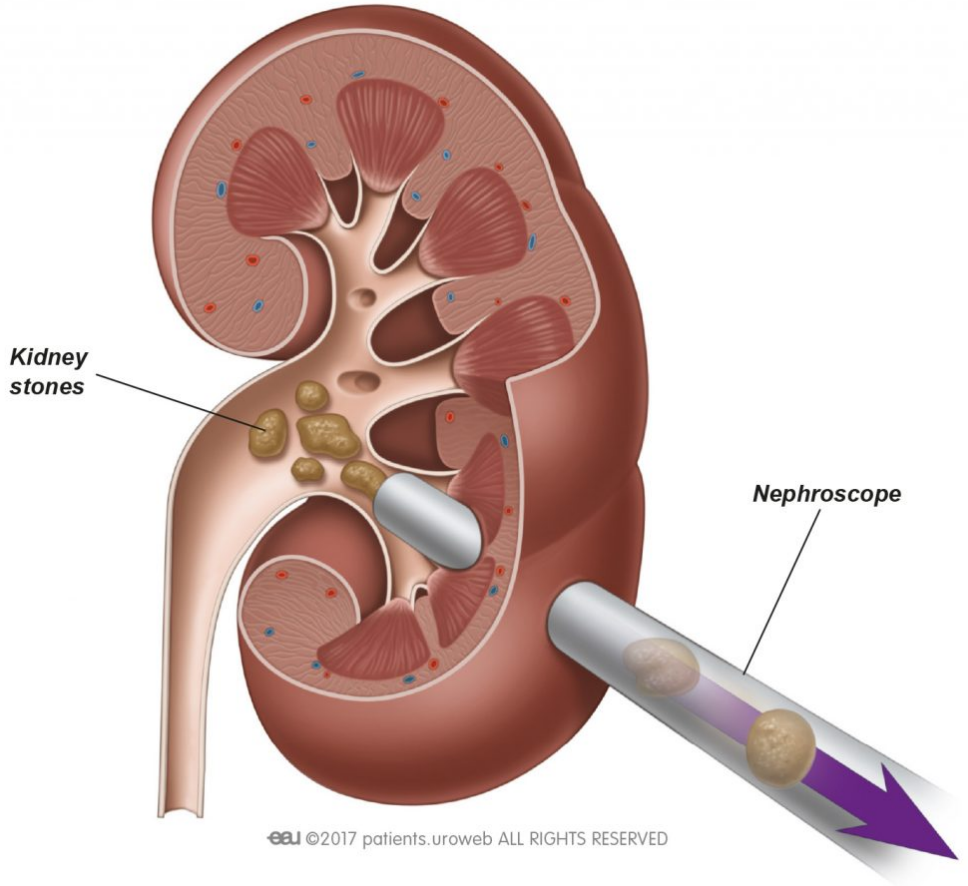
PERCUTANEOUS NEPHROLITHOTOMY



PERCUTANEOUS NEPHROLITHOTOMY

- The standard procedure for large renal calculi
- Usually under GA
- Rigid and flexible endoscopes
- Standard access tracts are 24-30 F
- Prone or supine position
- Fluoroscopy or ultrasound guided
- Inpatient hospital stay of one to three days

PCNL (cont'd)


Kidney stones
Nephroscope
eau ©2017 patients.uroweb ALL RIGHTS RESERVED

PCNL (cont'd)

PCNL (cont'd)

- Contraindications
  - Uncorrected coagulopathy
  - Untreated UTI
  - Tumor in the presumptive access tract area
  - Potential malignant kidney tumor
  - Pregnancy

PCNL (cont'd)

- Rigid nephroscopy
  - Pneumatic
  - Ultrasonic
  - Laser (for miniaturized devices)
- Flexible endoscope
  - Ho:YAG laser (standard)

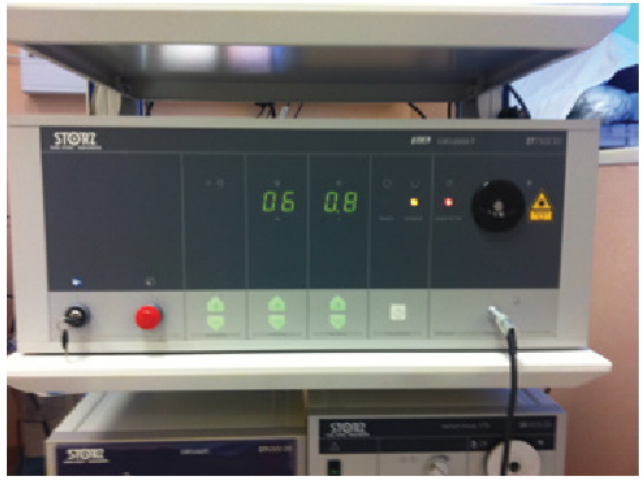


Fig.1 20 W Ho:YAG Laser Calculase II

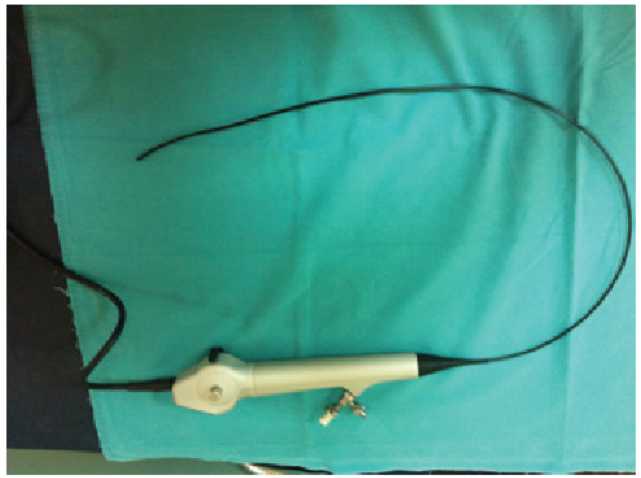


Fig. 2 Storz Flexible Ureteroscope Flex – XC

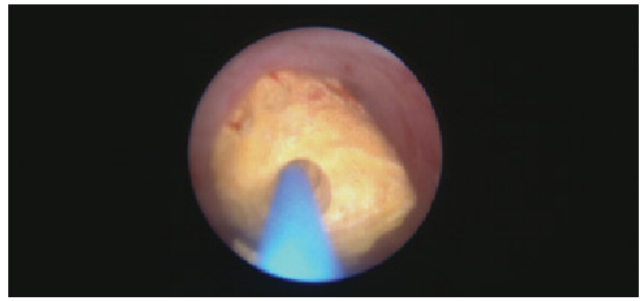


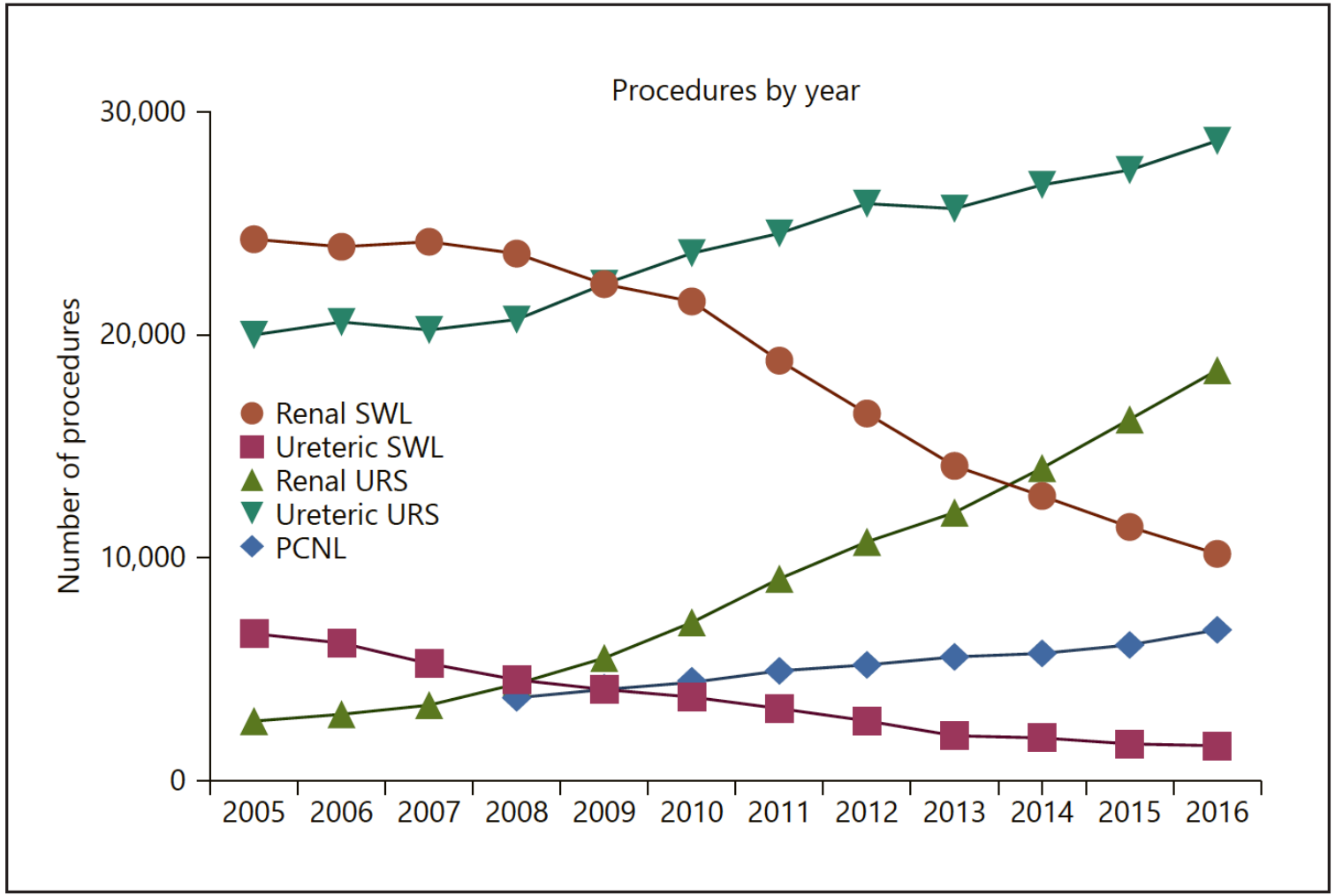
Fig 3. Laser fragmenta-tion of pyelic calculi

PCNL (cont'd)

- Higher complication rate compared with URS and SWL
  - Fever 10.8%
  - Transfusion 7%
  - Thoracic complication 1.5%
  - Sepsis 0.5%
  - Organ injury 0.4%
  - Embolization 0.4%
  - Urinoma 0.2%
  - Death 0.05%

Seitz, C., et al. Incidence, prevention, and management of complications following percutaneous nephrolitholapaxy. Eur Urol, 2012. 61: 146.

TRENDS



Color version available online

Urolithiasis in Germany: Trends from the National DRG Database

Hendrik Heers[a] David Stay[b] Thomas Wiesmann[b] Rainer Hofmann[a]

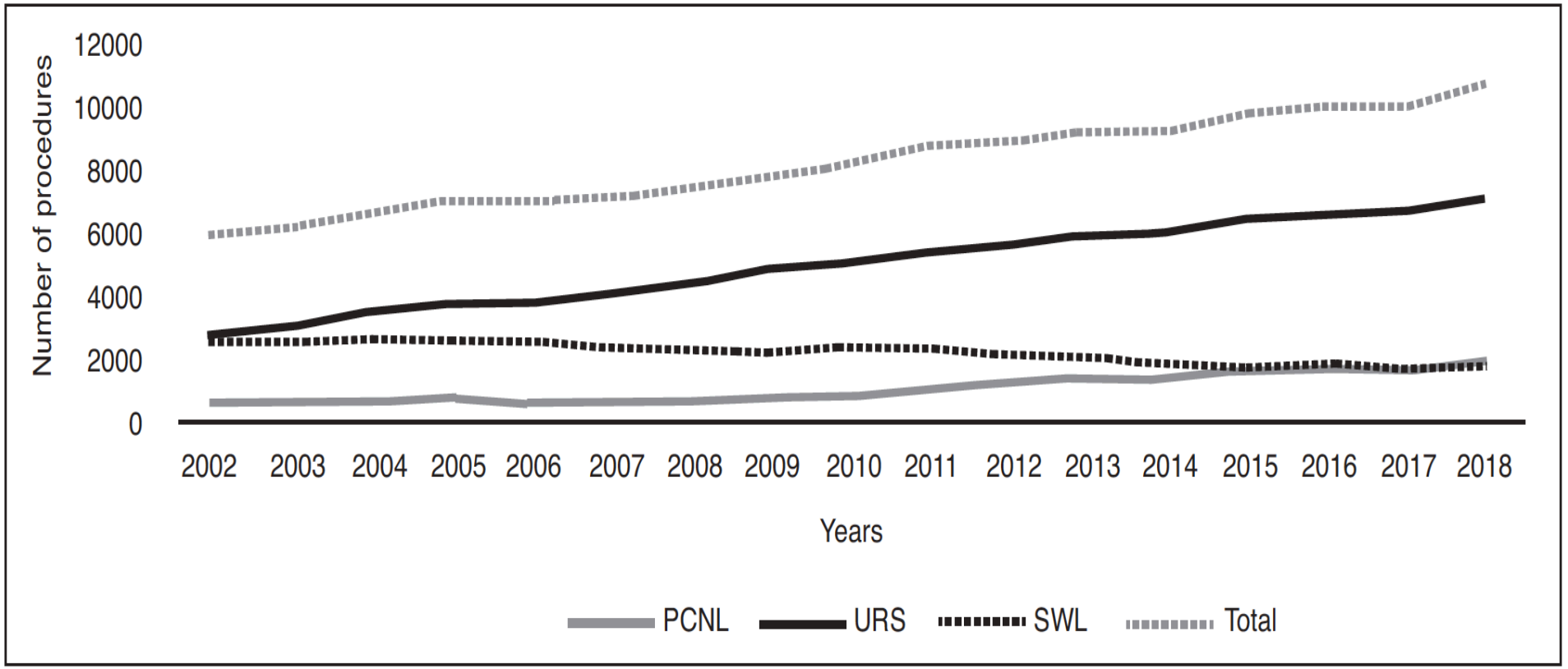


Fig. 3. Surgical intervention rate with percutaneous nephrolithotomy (PCNL), ureteroscopy (URS), and shockwave lithotripsy (SWL) from 2002–2019.

A population-based, retrospective cohort study analyzing contemporary trends in the surgical management of urinary stone disease in adults

Dor Golomb[1]; Sumit Dave[1]; Fernanda Gabrigna Berto[1]; J. Andrew McClure[2]; Blayne Welk[1]; Peter Wang[1]; Jennifer Bjazevic[1]; Hassan Razvi[1]

46 OTHER PROCEDURES

Complications

- Fever 10.8%
- Transfusion 7%
- Thoracic complication 1.5%
- Sepsis 0.5%
- Organ injury 0.4%
- Embolisation 0.4%
- Urinoma 0.2%
- Death 0.05%

OTHER PROCEDURES

- Open, laparoscopic, and robotic surgeries are rarely performed
- Selected patients

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APPROACH TO URETERAL STONES

URETERAL STONES

- Indications for active removal of ureteral stones
  - Stones with a low likelihood of spontaneous passage
    - >10mm
    - No movement after 2-3 weeks
    - Not expulsed after 4-6 weeks
  - Persistent pain despite adequate analgesic medication;
  - Persistent obstruction;
  - Renal insufficiency (renal failure, bilateral obstruction, or single kidney).

Skolarikos, A., et al. The role for active monitoring in urinary stones: a systematic review. J Endourol, 2010. 24: 923

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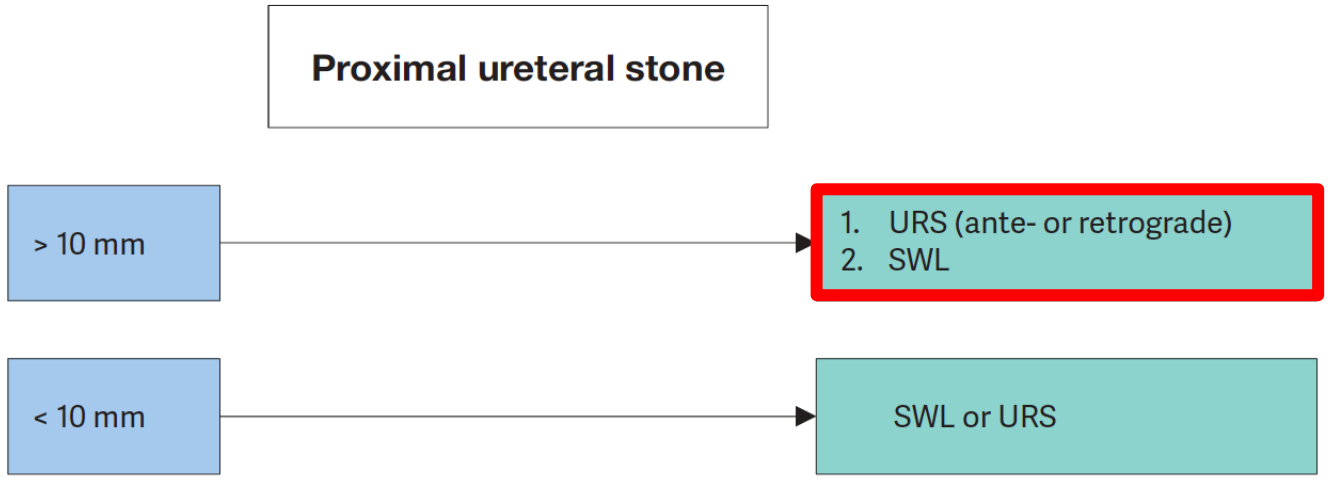
URETERAL STONES



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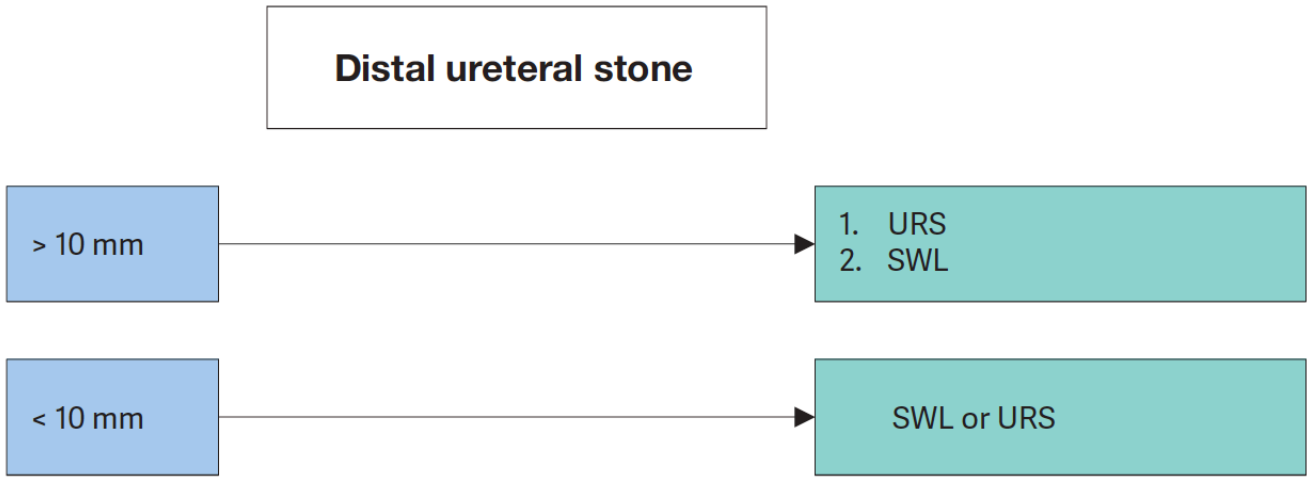
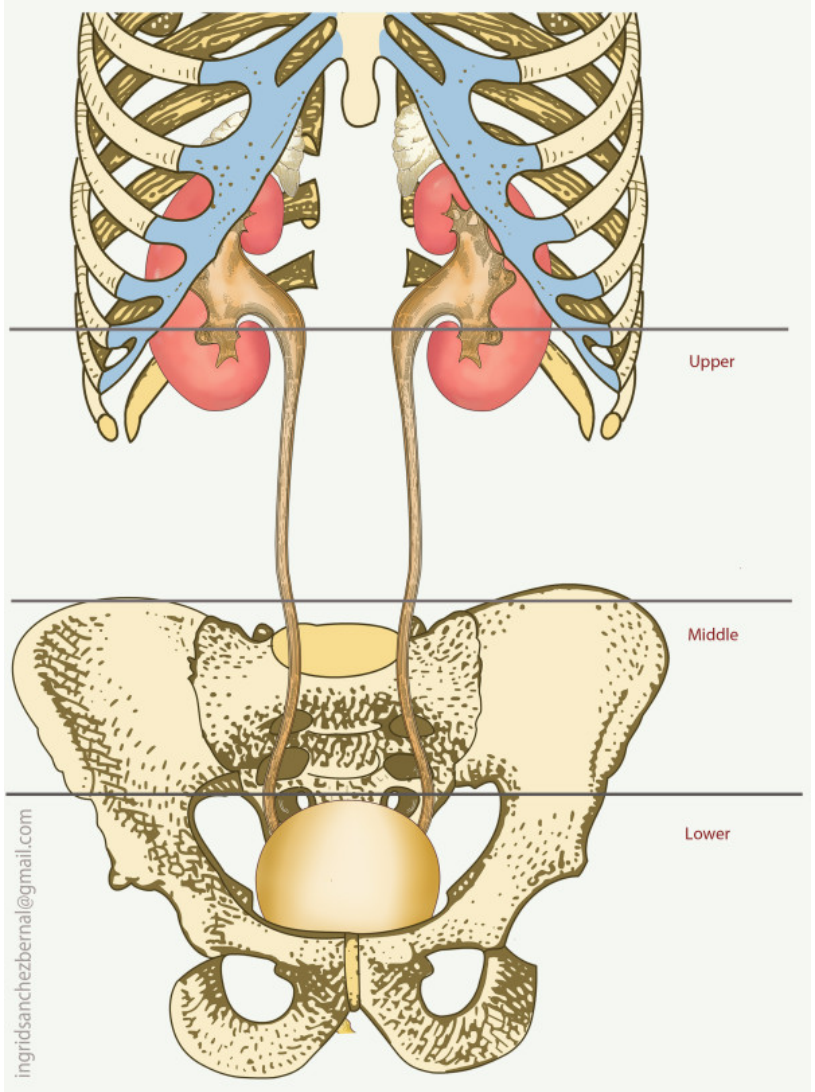


LOCAL APPROACH

- **Proximal ureteral stone > 10 mm**
- Preferred: flexible URS
- SWL (only favorable cases)
  - <15 mm
  - SSD < 10 cm
  - HU < 1000
- Otherwise
  - Try rigid URS
  - Push-back and SWL
  - Push-back and PCNL



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APPROACH TO RENAL STONES

RENAL STONES

- Indications for the removal of renal stones:
  - stone growth;
  - stones in high-risk patients for stone formation;
  - obstruction caused by stones;
  - infection;
  - symptomatic stones (e.g., pain or hematuria);
  - stones > 15 mm;
  - patient preference;
  - comorbidity;
  - social situation of the patient (e.g., profession or travelling);
  - choice of treatment.

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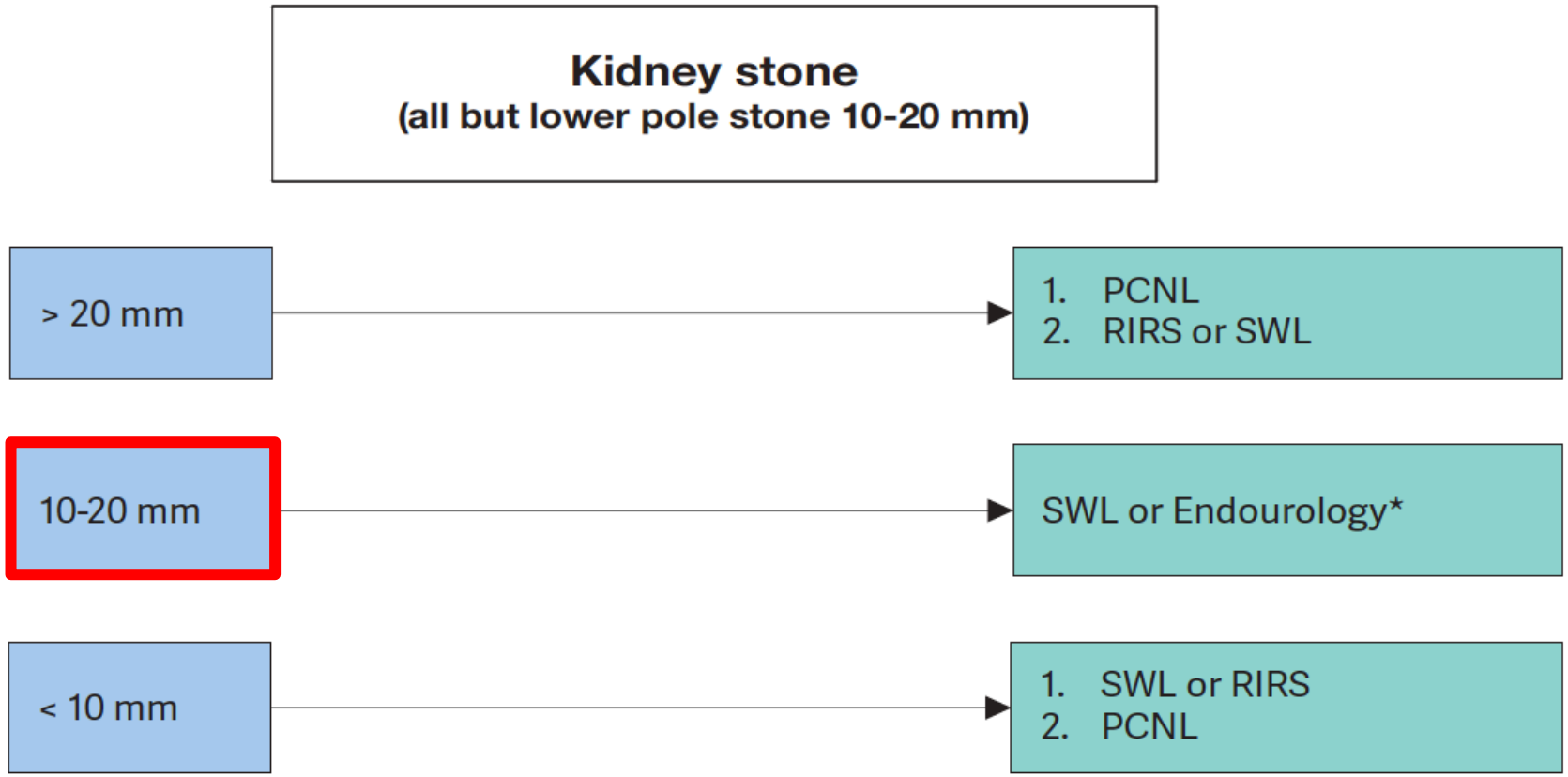
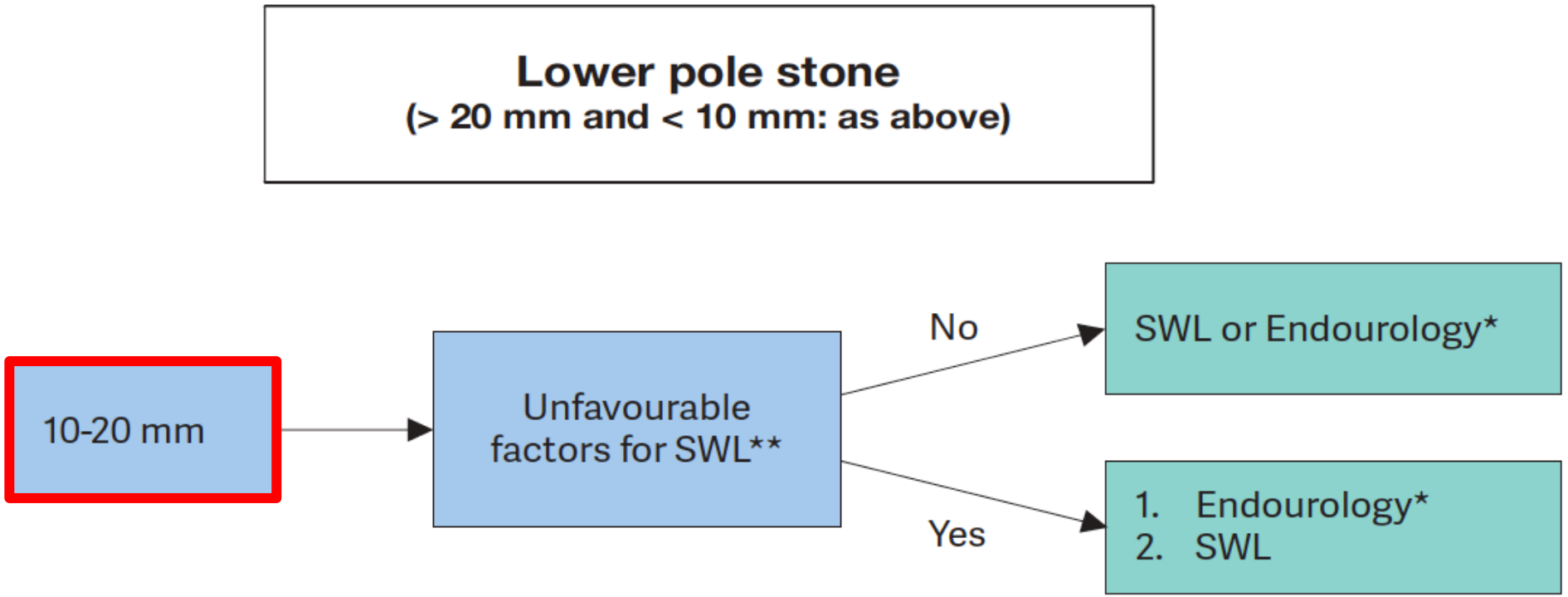
RENAL STONES (cont'd)



RENAL STONES (cont'd)




THANK
YOU