World Journal of Nephrology

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DOI: 10.5527/wjn.v3.i4.243

World J Nephrol 2014 November 6; 3(4): 243-248
ISSN 2220-6124 (online)

MINIREVIEWS

Ureteroscopy and stones: Current status and future expectations

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Received: June 16, 2014 Revised: August 5, 2014
Accepted: August 27, 2014
Published online: November 6, 2014

Abstract

Urolithaisis is becoming an ever increasing urological, nephrological and primary care problem. With a lifetime prevalence approaching 10% and increasing morbidity due to stone disease, the role of ureteroscopy and stone removal is becoming more important. We discuss the current status of stone disease and review the ever increasing role that ureteroscopy has to play in its management. We discuss technological advances that have been made in stone management and give you an overview of when, how and why ureteroscopy is the most common treatment option for stone management. We touch on the role of robotic ureteroscopy and the future of ureteroscopy in the next 10 years.

Key words: Ureteroscopy; Techniques; Ureteral stones; Calculi; Treatment; Advances

Core tip: This manuscript demonstrates the advent, technical progression and modern use of ureteroscopy for stone disease. It begins with a brief epidemiology of renal stone disease, technological advances in flexible ureteroscope, use of laser for stone disease and the different types of surgical options available. We also share the current evidence of ureteroscopy for stone treatment in obesity, pregnancy, pediatrics and patients with bleeding diathesis and large renal stones. In the end we discuss what the future holds for ureteroscopy including an insight into robotic ureteroscopy.

Wright AE, Rukin NJ, Somani BK. Ureteroscopy and stones: Current status and future expectations. *World J Nephrol* 2014; 3(4): 243-248 Available from: URL: http://www.wjgnet.com/2220-6124/full/v3/i4/243.htm DOI: http://dx.doi.org/10.5527/wjn.v3.i4.243

INTRODUCTION

With an increasingly ageing population, rising obesity, poor dietary habits and lack of adequate fluid intake we are seeing a rise in the incidence of renal and ureteric calculi[1-9]. This directly effects patient morbidity and places an ever increasing demand on healthcare resources. The concept of urinary stones is not new, indeed "cutting for the stone" was one of the classic three operations described more than 2000 years ago. It is somewhat ironic now, that endourological surgeons rarely "cut for the stone", but more "fish out" the stone with ureteroscopy (URS). Without doubt, the technological advances over the last 30 years has revolutionised our current management of urinary tract stone disease. We aim to highlight the importance of stone disease and take you through the important technological changes, discuss current concepts in stone management, explain what is new in ureteroscopy and touch on the future of ureteroscopy in the management of stone disease.

EPIDEMIOLOGY OF STONE DISEASE

Urolithiasis is a major clinical and economic burden for modern healthcare systems[10]. International epidemiological data suggest that the prevalence of stone disease is increasing[11]; with a rise in lifetime prevalence between 7%-12%. The mean age of patients with upper tract stones has remained constant at 49 years, although there has been an alarming increase of 19% in the number of children diagnosed[11]. The ever increasing prevalence of stone disease has a direct effect on healthcare resources, with the number of URS performed for stone disease increasing by 127% over the last 10 year period 2000-2010[11].

The rising prevalence of stone disease is multifactorial, but poor dietary habits and fluid intake, increasing levels of obesity and "metabolic syndrome" may further increase stone-related clinical episodes[12,13]. This emphasises the importance of education and lifestyle adaptations in attempting to prevent stone formation for at risk groups and the critical role of secondary prevention for those who have already suffered with stones.

TECHNOLOGICAL ADVANCES IN URETEROSCOPY

The use of URS has dramatically increased over the last 30 years mainly due to the rapid speed of technological advances. Since the advent of the first recorded URS in 1912[14]; the past century has seen a continued development of the ureteroscope alongside diversification of its use. Evaluation of the urinary tract was initially explored with specula, next came urethroscopy with dilatations of the urethra using knives and wax instruments[15]. The prototype endoscope, the "Lichtleiter", was introduced back in 1806 by Phillip Bozzini, and consisted of a hollow tube transmitting candlelight *via* a mirror[15]. This enabled the first true endoscopic operation in 1853 when Desormeaux extracted a urethral papilloma through the endoscope[15]. Further modifications to the endoscope were introduced by the dermatologist Grunfield of Vienna, who developed an endoscopic loop threader and scissor forceps allowing the first endoscopic bladder papilloma excision in 1881. The step from idea to realisation of endoscopic surgery was difficult and protracted. Bozzini *et al* ideas from the early 1800's were well ahead of their time. They were considerably hindered by the technical capabilities of the nineteenth century engineering, which resulted in clumsy and heavy instruments. In parallel with the development of the cystoscope there was continuing advancements in the endoscopic light source. A system of mirrors and lens' were introduced alongside candlelight to transmit light through a hollow tube; this idea was superseded by fibre-optic technology utilising the principle of internal reflection permitting the "bending" of light within flexible glass[16]. These principle and understanding lead onto the development of the first rigid ureteroscope in 1980. This was developed by Perez-Castro in collaboration with Karl Storz, incorporating a separate working and optic channel. These developments allowed the art of ureteroscopy to flourish and develop over the last 35 years[17].

The development of electrohydraulic and ultrasonic lithotripsy soon followed, enabling the fragmentation of ureteric stones[17]. Flexible tip ureteroscopes were introduced in 1983[16], and the modern digital scopes soon followed. Modern digital flexible ureteroscopes consists of a fiberoptic lens, with a single cable electronically transferring the image detected at the tip of a scope to the image display on a monitor ("Chip to tip" technology). Digital and conventional (fibre-optic) flexible ureteroscopes have seen a dramatic improvement in ergonomics, with lighter scopes and improved manoeuvrability[18]. The advent of digital images has resulted in improved resolution and colour discrimination, as well as significantly reduced operative times[16,19-21]. Figure 1 demonstrates the modern flexible ureterorenoscopes that we use in clinical practice today.

Despite improvements in scope technology, one still needs to fragment and/or remove the stone once visualised. Stones are commonly fragmented with a holmium laser (Light Amplification by Stimulated Emission of Radiation). Albert Einstein and Satyendranath Bose proposed the concept of lasers, but lasers were initially seen as a great invention with no obvious use. With time and hard work by laser pioneers, we now cannot imagine a world in which we don't use lasers. Indeed, the role of the Holmium laser in the management of renal tract stones has resulted in many stones in the urinary tract have been accessible to treatment in a minimally invasive fashion. Laser offers the surgeon a safe, effective method of stone fragmentation. One real benefit is the fact that laser can be manoeuvred around bends, enabling it to be used throughout the kidney. The lithotripter, although a useful adjuvant for ureteroscopy, has its limitations including stone retropulsion back into the kidney. The lithotripter is still commonly used for percutaneous nephrolithotomy surgery (PCNL), where larger stones can be fragmented quickly, without the need to manoeuvre around each calyx.

SURGICAL MANAGEMENT OF STONE DISEASE

Traditionally ureteric and renal stones were managed by open surgical techniques, and it was not until the 1980s and the advent of the Dormier H3 lithotriptor that shock wave lithotripsy (SWL) became common place[16]. SWL offered a relatively minimally invasive treatment option for patients, with acceptable outcomes in terms of stone free rates (SFR)[22]. With the advent of minimally invasive surgery, particularly URS, SWL treatment numbers are falling. Recent United Kingdom, American and Australian data clearly demonstrate dramatically rising rates of ureteroscopy, which far exceed small rises in

Figure 1 Flexible ureterorenoscope.

the use of SWL[1,11,23].

Current American and European Urology Association Stone guidelines summarise the current evidence based treatment for stone management based on stone size and location[24]. The size and location of the stone are the most important factors in determining which treatment options are most suitable, but individual surgeon's treatment preference is important in making treatment decisions for each treated stone.

The position of the stone in the ureter directly reflects in the success of the procedure. More distal stone have higher success rates when treated with rigid ureteroscopy, compared to the more proximal stones[24]. Indeed proximal stones can fall back into the kidney, therefore they often require a concurrent flexible ureteroscopy to achieve good stone free rates. Current guidelines recommend ureteroscopy, over other treatments including SWL, for the majority of ureteric stones[24].

In terms of stone size conservative management may be appropriate for smaller stones; 95% of stones up to 4 mm pass within 40 d[25]. Current recommendations advise the use of PCNL over URS and laser for larger more complex stones. The recommended size of stone treated by URS is increasing with each new update of stone guidelines, with the current size value of 20 mm and above favouring a percutaneous approach to treatment (PCNL)[24]. Despite this there is very good clinical evidence[26] for using URS for stones greater than 20 mm in size, with 94% deemed stone free after a mean number of 1.6 URS treatments. This data is comparable, and arguably better, than standard PCNL treatment with reduced morbidity and shorter length of hospital stay[27].

Stones greater than 2 cm often require planned two stage URS procedures to achieve complete stone clearance[28]. Although this necessitates staged procedures, it may be a worthwhile sacrifice in view of nephron preservation and the low complication rate[29]. This is not an insignificant consideration when treating an ever-increasing co-morbid patient. A comparison of the available treatment modalities, in terms of advantages, disadvantages and contraindications is summarised in Table 1.

URETEROSCOPY IN THE CURRENT ERA

Technological advances in the design and size of the ureteroscopes has enabled easier access to the kidney and ureters *via* the urethra, removing the need for any surgical incision. With rigid and flexible URS nearly all areas in the urinary tract can be readily accessed, with stunning high quality digital optics providing very accurate assessment of stones and mucosal lesions. One of the main benefits of URS is that there are minimal contra-indications for the procedure. A general anaesthetic is often required, but upper tract access with spinal or local anaesthetic can be achieved[30]. The only real contraindication would be a ureteric stricture preventing successful ureteric access and scope passage[24]. Fluoroscopy is required during URS, but radiation exposure can be reduced with careful consideration of when and how much fluoroscopy is needed. The benefits of URS are clearly evident in the literature, with low complication rates, high SFR, and short length of stay[26,28].

As with any procedure complications can happen, but the reported complication rates are relatively low[29,31]. The overall complication rate for URS is approximately 3.5%; which are mostly minor. Probably the most feared complication of ureteroscopy is ureteral avulsion, however it is rare (< 1%). Common complication include mucosal or ureteric injury (1.5%-1.7%), post-operative fever (1.8%), urosepsis, haematuria, ureteral stricture (0.1%) and persistent vesicoureteric reflux (0.1%)[29,32]. Due to its minimally invasive nature, URS can be performed as a day case procedure. This has obvious benefits for hospital finances, as well as patient satisfaction levels[11].

In recent years the role of URS has expanded, particularly with reference to an increasingly obese population, during pregnancy, bleeding diathesis and paediatric stone disease. With obesity rates at an all-time high[12,13] and the association of kidney stones in such patients, these groups can often be difficult to manage. The anaesthetic risk can be significantly increased and other treatment such as SWL or PCNL are often less successful[33]. Ureteroscopy is often ideal for such patients, as their renal tract can be readily be accessed[34]. Indeed, currently guidelines recommend URS as the most promising therapeutic option in obese patients[24].

Pregnancy offers a unique situation in terms of urinary stones disease. A cascade of metabolic changes occurs during pregnancy that may be associated with an increased likelihood of stone formation, particularly in the second and third trimester[35,36]. Whenever possible, conservative treatment of stones are encouraged. If complications do develop, URS can offer a minimally invasive treatment option for patients and hopefully avoid the need for long term urinary diversion with either a stent or nephrostomy tube[37,38]. A recent systematic review suggests that URS is a safe and effective procedure that can be used as the first line surgical management of

Table 1 Advantages and disadvantages of different techniques[24]

	Contra-Indications	Advantages	Disadvantages
Percutaneous nephrolithotomy	Pregnancy, potential malignant kidney tumour, tumour in access tract area, atypical bowel interposition	Large renal and staghorn stones Able to remove large fragments Quicker large stone fragmentation and removal	Needs renal puncture plus dilatation Renal bleeding +/- embolisation Patient positioning (often prone) Requires a general anaesthetic (with risk in prone ventilation) Multiple days inpatient stay
Shock wave lithotripsy	Infection, pregnancy, arterial aneurysm, bleeding diatheses, distal ureteric obstruction	Non-invasive treatment Out-patient treatment No anaesthetic needed	Lower success rates Renal colic (secondary stone fragments) Steinstrasse May need multiple treatments Success rates less for lower calyx stones
Ureteroscopy	None	No incisions Day case procedure Can be used in pregnancy, obese and patients not suitable for prone position	Might require 2 operations for stone clearance May need a ureteric stent post op Ureteric avulsion/strictures Requires a general anaesthetic

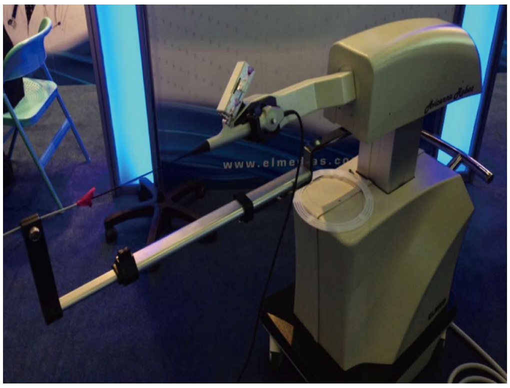

Figure 2 Robotic ureteroscopy.

symptomatic stones during pregnancy[36].

Patient with bleeding diathesis are at significantly increased risk of complications with treatments including SWL, PCNL, laparoscopic or open surgery[39-42]. For such patients, URS offers a safe and effective treatment modality. With ever increasing use of anticoagulation, based on risk assessment, these patients are an at-risk group and can be very difficult to manage surgically[24,43]. In term of URS and anticoagulation the literature is limited. A critical analysis of the published literature has shown good SFR with minimal complications when performing URS whilst the patient remains on anticoagulation. One worries about the rate of bleeding, but the combined data on URS reports a relatively low figure of 4% minor bleeding whilst on anticoagulation[44].

Childhood urolithiasis is becoming more prevalent, with a significant number of patients experiencing their first stone episode in childhood[24]. Such patients present diagnostic and treatment dilemmas, particularly their suitability for treatment due to their organ size. Traditionally the majority of these patients were treated with SWL, with reported SFR of approximately 80%[45]. With smaller calibre scopes and improved scope instrumentation such as smaller baskets and laser fibres, the role for URS has slowly increased. A recent systematic review has demonstrated SFR of up to 93% can be achieved with URS in a paediatric population[45].

FUTURE ADVANCES IN URETEROSCOPY

The future of URS is one of massive technological advances. With ever decreasing scope size, better optics and new device coming to market no corner of the urinary tract is inaccessible or unsuitable for access with URS. Ever more complex patients, with a plethora of medical problem are now becoming increasingly appropriate for URS.

Robotic surgery has recently entered the field of urology, particularly with reference to prostate, bladder and renal cancer treatment. URS has also had the robotic treatment, with the introduction of robotic flexible ureteroscopy. This "Robot" offers the surgeon the ability to control their flexible ureteroscope and laser fibre via the comfort of a robotic console. Figure 2 demonstrates this robotic device. The main robotic station holds the flexible ureteroscope whilst the surgeon controls the URS via a console and joystick devices. With only a few prototypes in clinical use and the procedure in its infancy this is a large area for future clinical development. Initial results are interesting; with the biggest benefit seeming to favour surgeon ergonomics rather than SFR[46]. Long term outcome data is awaited with anticipation.

Another area of future interest is the use of peptide-coated iron oxide-based microparticles[47]. These microparticles selectively adhere to calcium stone fragments enabling quicker retrieval of intraoperative stone fragments with the aid of a magnetic device, when compared to standard stone removal[47]. URS is without doubt an attractive area for technical innovation; where new advances have a huge potential to improve outcome and SFR.

CONCLUSION

With an ever-increasing prevalence of stone disease careful consideration needs to be given to meet future demand. A large area of attention needs to be placed on primary and secondary stone prevention, with simple but effective patient education and lifestyle interventions.

In terms of URS, the future is one of great excitement. Larger stones, more complex patients, paediatric patients, pregnancy, bleeding diathesis and the obese are becoming more suitable than ever for minimally invasive URS. With the advent of future technological advances, the boundaries of what is achievable will be further expanded. Robotic is entering the playing field and is potentially the next big development in URS. The next 10 years is one of great excitement in URS and is likely to further transform of our current treatment strategies for the management of stone disease.

REFERENCES

1 **Pearle MS**, Calhoun EA, Curhan GC. Urologic diseases in America project: urolithiasis. *J Urol* 2005; **173**: 848-857 [PMID: 15711292 DOI: 10.1016/j.juro.2008.03.141]

2 **Romero V**, Akpinar H, Assimos DG. Kidney stones: a global picture of prevalence, incidence, and associated risk factors. *Rev Urol* 2010; **12**: e86-e96 [PMID: 20811557]

3 **Stamatelou KK**, Francis ME, Jones CA, Nyberg LM, Curhan GC. Time trends in reported prevalence of kidney stones in the United States: 1976-1994. *Kidney Int* 2003; **63**: 1817-1823 [PMID: 12675858 DOI: 10.1046/j.1523-1755.2003.00917]

4 **Soucie JM**, Thun MJ, Coates RJ, McClellan W, Austin H. Demographic and geographic variability of kidney stones in the United States. *Kidney Int* 1994; **46**: 893-899 [PMID: 7996811 DOI: 10.1038/ki.1994.347]

5 **Sánchez-Martín FM**, Millán Rodríguez F, Esquena Fernández S, Segarra Tomás J, Rousaud Barón F, Martínez-Rodríguez R, Villavicencio Mavrich H. [Incidence and prevalence of published studies about urolithiasis in Spain. A review]. *Actas Urol Esp* 2007; **31**: 511-520 [PMID: 17711170 DOI: 10.1016/S0210-4806(07)73675-6]

6 **Amato M**, Lusini ML, Nelli F. Epidemiology of nephrolithiasis today. *Urol Int* 2004; **72** Suppl 1: 1-5 [PMID: 15133324 DOI: 10.1159/000076582]

7 **Serio A**, Fraioli A. Epidemiology of nephrolithiasis. *Nephron* 1999; **81** Suppl 1: 26-30 [PMID: 9873211 DOI: 10.1159/000046295]

8 **Hesse A**, Brändle E, Wilbert D, Köhrmann KU, Alken P. Study on the prevalence and incidence of urolithiasis in Germany comparing the years 1979 vs. 2000. *Eur Urol* 2003; **44**: 709-713 [PMID: 14644124 DOI: 10.1016/S0302-2838(03)00415-9.x]

9 **Trinchieri A**, Coppi F, Montanari E, Del Nero A, Zanetti G, Pisani E. Increase in the prevalence of symptomatic upper urinary tract stones during the last ten years. *Eur Urol* 2000; **37**: 23-25 [PMID: 10671780]

10 **Saigal CS**, Joyce G, Timilsina AR. Direct and indirect costs of nephrolithiasis in an employed population: opportunity for disease management? *Kidney Int* 2005; **68**: 1808-1814 [PMID: 16164658 DOI: 10.1111/j.1523-1755.2005.00599.x]

11 **Turney BW**, Reynard JM, Noble JG, Keoghane SR. Trends in urological stone disease. *BJU Int* 2012; **109**: 1082-1087 [PMID: 21883851 DOI: 10.1111/j.1464-410X.2011.10495.x]

12 **Zaninotto P**, Head J, Stamatakis E, Wardle H, Mindell J. Trends in obesity among adults in England from 1993 to 2004 by age and social class and projections of prevalence to 2012. *J Epidemiol Community Health* 2009; **63**: 140-146 [PMID: 19074182 DOI: 10.1136/jech.2008.077305]

13 **Taylor EN**, Stampfer MJ, Curhan GC. Obesity, weight gain, and the risk of kidney stones. *JAMA* 2005; **293**: 455-462 [PMID: 15671430 DOI: 10.1001/jama.293.4.455]

14 **Young HH**, McKay RW. Congenital valvular obstruction of the prostatic urethra. *Surg Gynaecol Obstetr* 1929; **48**: 509-512.

15 **Reuter MA**, Reuter HJ. The development of the cystoscope. *J Urol* 1998; **159**: 638-640 [PMID: 9474116 DOI: 10.1016/S0022-5347(01)63691-7]

16 **Smith AD,** Preminger G, Badlani G, Kavoussi L. Smith's Textbook of Endourology. 3rd Ed. USA: Wiley, 2012: 365-387

17 **Somani BK**, Aboumarzouk O, Srivastava A, Traxer O. Flexible ureterorenoscopy: Tips and tricks. *Urol Ann* 2013; **5**: 1-6 [PMID: 23662000 DOI: 10.4103/0974-7796.106869]

18 **Beiko DT**, Denstedt JD. Advances in ureterorenoscopy. *Urol Clin North Am* 2007; **34**: 397-408 [PMID: 17678989 DOI: 10.1016/j.ucl.2007.05.003]

19 **Quayle SS**, Ames CD, Lieber D, Yan Y, Landman J. Comparison of optical resolution with digital and standard fiberoptic cystoscopes in an in vitro model. *Urology* 2005; **66**: 489-493 [PMID: 16140063 DOI: 10.1016/j.urology.2005.04.009]

20 **Borin JF**, Abdelshehid CS, Clayman RV. Comparison of resolution, contrast, and color differentiation among fiberoptic and digital flexible cystoscopes. *J Endourol* 2006; **20**: 54-58 [PMID: 16426134 DOI: 10.1089/end.2006.20.54]

21 **Somani BK**, Al-Qahtani SM, de Medina SD, Traxer O. Outcomes of flexible ureterorenoscopy and laser fragmentation for renal stones: comparison between digital and conventional ureteroscope. *Urology* 2013; **82**: 1017-1019 [PMID: 24001703 DOI: 10.1016/j.urology.2013.07.017]

22 **Tiselius HG**. How efficient is extracorporeal shockwave lithotripsy with modern lithotripters for removal of ureteral stones? *J Endourol* 2008; **22**: 249-255 [PMID: 18294029 DOI: 10.1089/end.2007.0225]

23 **Lee MC**, Bariol SV. Evolution of stone management in Australia. *BJU Int* 2011; **108** Suppl 2: 29-33 [PMID: 22085123 DOI: 10.1111/j.1464-410X.2011.10695.x]

24 **Turk C,** Knoll T, Petrik, Sarica K, Skolarikos A, Straub M, Seitz C. Guidelines on Urolithiasis. EAU. 2014. Available from: URL: http://www.uroweb.org/gls/pdf/22 Urolithiasis_ LR.pdf

25 **Miller OF**, Kane CJ. Time to stone passage for observed ureteral calculi: a guide for patient education. *J Urol* 1999; **162**: 688-690; discussion 690-691 [PMID: 10458343]

26 **Aboumarzouk OM**, Monga M, Kata SG, Traxer O, Somani BK. Flexible ureteroscopy and laser lithotripsy for stones & gt; 2cm: a systematic review and meta-analysis. *J Endourol* 2012; **26**: 1257-1263 [PMID: 22642568 DOI: 10.1089/end.2012.0217]

27 **de la Rosette J**, Assimos D, Desai M, Gutierrez J, Lingeman J, Scarpa R, Tefekli A. The Clinical Research Office of the Endourological Society Percutaneous Nephrolithotomy Global Study: indications, complications, and outcomes in 5803 patients. *J Endourol* 2011; **25**: 11-17 [PMID: 21247286 DOI: 10.1089/end.2010.0424]

28 **Wright AE,** Premachandra, Rukin N, Chakravarti A. Is flexible ureterorenoscopy and laser fragmentation the future for larger renal calculi? *BJU International* 2013; **111**: 17-70

29 **Geavlete P**, Georgescu D, Niţă G, Mirciulescu V, Cauni V. Complications of 2735 retrograde semirigid ureteroscopy procedures: a single-center experience. *J Endourol* 2006; **20**: 179-185 [PMID: 16548724 DOI: 10.1089/end.2006.20.179]

30 **Cybulski PA**, Joo H, Honey RJ. Ureteroscopy: anesthetic considerations. *Urol Clin North Am* 2004; **31**: 43-47, viii [PMID: 15040400 DOI: 10.1016/S0094-0143(03)00087-9]

31 **Preminger GM,** Tiselius HG, Assimos DG, Alken P, Buck C, Gallucci M, Knoll T. American Urological Association Education and Research, Inc; European Association of Urology 2007. Guideline for the management of ureteral calculi. *Eur Urol* 2007; **52**: 1610-1631

32 **de la Rosette J**, Denstedt J, Geavlete P, Keeley F, Matsuda T, Pearle M, Preminger G, Traxer O. The clinical research office of the endourological society ureteroscopy global study: indications, complications, and outcomes in 11,885 patients.

J Endourol 2014; **28**: 131-139 [PMID: 24147820 DOI: 10.1089/end.2013.0436]

33 **Calvert RC**, Burgess NA. Urolithiasis and obesity: metabolic and technical considerations. *Curr Opin Urol* 2005; **15**: 113-117 [PMID: 15725935 DOI: 10.1097/01.mou.0000160626.36236.22]

34 **Aboumarzouk OM**, Somani B, Monga M. Safety and efficacy of ureteroscopic lithotripsy for stone disease in obese patients: a systematic review of the literature. *BJU Int* 2012; **110**: E374-E380 [PMID: 22471506 DOI: 10.1111/j.1464-410X.2012.11086.x]

35 **Swanson SK**, Heilman RL, Eversman WG. Urinary tract stones in pregnancy. *Surg Clin North Am* 1995; **75**: 123-142 [PMID: 7855714]

36 **Ishii H**, Aboumarzouk OM, Somani BK. Current status of ureteroscopy for stone disease in pregnancy. *Urolithiasis* 2014; **42**: 1-7 [PMID: 24374899 DOI: 10.1007/s00240-013-0635-y]

37 **Semins MJ**, Trock BJ, Matlaga BR. The safety of ureteroscopy during pregnancy: a systematic review and meta-analysis. *J Urol* 2009; **181**: 139-143 [PMID: 19012926 DOI: 10.1016/j.juro.2008.09.029]

38 **Rana AM**, Aquil S, Khawaja AM. Semirigid ureteroscopy and pneumatic lithotripsy as definitive management of obstructive ureteral calculi during pregnancy. *Urology* 2009; **73**: 964-967 [PMID: 19394491 DOI: 10.1016/j.urology.2008.12.054]

39 **Watterson JD**, Girvan AR, Cook AJ, Beiko DT, Nott L, Auge BK, Preminger GM, Denstedt JD. Safety and efficacy of holmium: YAG laser lithotripsy in patients with bleeding diatheses. *J Urol* 2002; **168**: 442-445 [PMID: 12131284 DOI: 10.1016/S0022-5347(05)64654-X]

40 **Fischer C**, Wöhrle J, Pastor J, Morgenroth K, Senge T. [Extracorporeal shock-wave lithotripsy induced ultrastructural changes to the renal parenchyma under aspirin use. Electron microscopic findings in the rat kidney]. *Urologe A* 2007; **46**: 150-155 [PMID: 17221245 DOI: 10.1007/s00120-006-1266-5]

41 **Becopoulos T**, Karayannis A, Mandalaki T, Karafoulidou A, Markakis C. Extracorporeal lithotripsy in patients with hemophilia. *Eur Urol* 1988; **14**: 343-345 [PMID: 3169076]

42 **Ruiz Marcellán FJ**, Mauri Cunill A, Cabré Fabré P, Argentino Gancedo Rodríguez V, Güell Oliva JA, Ibarz Servio L, Ramón Dalmau M. [Extracorporeal shockwave lithotripsy in patients with coagulation disorders]. *Arch Esp Urol* 1992; **45**: 135-137 [PMID: 1567255]

43 **Klingler HC**, Kramer G, Lodde M, Dorfinger K, Hofbauer J, Marberger M. Stone treatment and coagulopathy. *Eur Urol* 2003; **43**: 75-79 [PMID: 12507547 DOI: 10.1016/S0302-2838(02)00538-9]

44 **Aboumarzouk OM**, Somani BK, Monga M. Flexible ureteroscopy and holmium: YAG laser lithotripsy for stone disease in patients with bleeding diathesis: a systematic review of the literature. *Int Braz J Urol* 2012; **38**: 298-305; discussion 306 [PMID: 22765861]

45 **Reddy PP**, Defoor WR. Ureteroscopy: The standard of care in the management of upper tract urolithiasis in children. *Indian J Urol* 2010; **26**: 555-563 [PMID: 21369390 DOI: 10.4103/0970-1591.74459]

46 **Desai MM**, Grover R, Aron M, Ganpule A, Joshi SS, Desai MR, Gill IS. Robotic flexible ureteroscopy for renal calculi: initial clinical experience. *J Urol* 2011; **186**: 563-568 [PMID: 21683380 DOI: 10.1016/j.juro.2011.03.128]

47 **Fernandez R**, Tan YK, Kaberle W, Best SL, Olweny EO, Pearle MS, Gnade BE, McElroy SL, Cadeddu JA. Determining a performance envelope for capture of kidney stones functionalized with superparamagnetic microparticles. *J Endourol* 2012; **26**: 1227-1230 [PMID: 22524431 DOI: 10.1089/end.2011.0598]

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