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Under pressure: irrigation practice patterns during flexible ureteroscopy

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Abstract

Introduction: Irrigation parameters during flexible ureteroscopy (fURS) may impact patient outcomes, yet there are limited data on current practice patterns of irrigation methods and parameter selection. We assessed the common irrigation methods, pressure settings, and situations that present the most problems with irrigation among worldwide endourologists.

Methods: A questionnaire on fURS practice patterns was sent to Endourology Society members in January 2021. Responses were collected through QualtricsXM over a 1-month period. The study was reported according to the Checklist for Reporting Results of Internet E-Surveys (CHERRIES). Surgeons were from North America (the United States and Canada), Latin America, Europe, Asia, Africa, and Oceania.

Results: Questionnaires were answered by 208 surgeons (response rate 14%). North American surgeons accounted for 36% of respondents; 29% Europe, 18% Asia, and 14% Latin America. In North America, the most common irrigation method was the pressurized saline bag using a manual inflatable cuff (55%). Saline bag (gravity) with a bulb or syringe injection system was the most common method in Europe (45%). Automated systems were the most common method in Asia (30%). For pressures used during fURS, the majority of respondents used 75–150 mmHg. The clinical scenario which had the greatest issue with adequate irrigation was during biopsy of urothelial tumor.

Conclusion: There is variation in irrigation practices and parameter selection during fURS. North American surgeons primarily used a pressurized saline bag, in contrast to European surgeons who preferred a gravity bag with a bulb/syringe system. Overall, automated irrigation systems were not commonly used.

Keywords: irrigation, ureteroscopy

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Introduction

Flexible ureteroscopy (fURS) is now the most common treatment modality for upper urinary tract calculi in the United States.[1,2] An important part of fURS is the provision of saline irrigation into the endoscopic field which allows for luminal expansion and renal visualization. With the increasing use of high-power holmium lasers[3] and the emergence of the thulium fiber laser for laser lithotripsy and dusting techniques,[4] the importance of irrigation to remove stone debris from the field of view has become vitally important. Inadequate irrigation may limit laser settings and efficiency of lithotripsy. Irrigation also plays an important role in ensuring visualization during stone basketing and biopsy of urothelial tumors.

Despite the widespread use of irrigation in fURS, limited data exist on irrigation practice during surgery. Currently, anecdotal feedback based from courses suggests that surgeons deploy varied tactics for irrigation and there may be differences based on global region of practice. Different forms of irrigation techniques may have benefits and disadvantages. For example, manual irrigation systems that include a hand pump/syringe

have been shown to have higher peak intrarenal pressures when tested experimentally.[5] Also, there is emerging interest in the use of automated irrigation systems, but it is unknown what parameters should be selected because current practice data are limited. This is of importance because increased irrigation flow rates during endoscopic stone surgery may come at the expense of increased intrarenal pressure which could have consequences related to pyelovenous backflow,[6] postoperative pain,[7] and risk of infection.[8]

For these reasons, we examined irrigation practice patterns during fURS among urologists in different regions of the world through an online survey distributed to members of the Endourology Society. Our objective was to identify the common irrigation methods and pressure settings employed by surgeons as well as the clinical situations that present the most problems with irrigation. Our survey aims to determine if there is variation in practice and consensus on the ideal method and setting. No prior data on this subject exist, and our work may help investigators and manufacturers move toward evidence-based procedural practices.

Methods

In January 2021, an anonymous and confidential online survey investigating practices in fURS was sent by email to all members of the Endourology Society (1500 members). The survey contained questions that focused on fURS irrigation practices including (1) participant demographics, (2) irrigation methods, (3) irrigation pressure strategies, and (4) issues with irrigation. Question format included multiple-choice questions with options for free response as well as ranking answer choices. The survey was built on web-based QualtricsXM (Provo, UT) and tested for technical functionality before release. The survey necessitated that all questions must be answered and that users can only submit one response. See Appendix 1 to view the specific questions asked. An introductory email containing a hyperlink invited Endourology Society members to participate in the survey. Participation was encouraged with a monetary gift award offered to one randomly selected respondent. A second email sent at 2 weeks reminded recipients to complete the survey. The survey remained open for 5 weeks. The survey was reviewed by the Institutional Review Board at the University of Michigan and deemed as exempt (registration number: IRB00000246). The study was reported according to the Checklist for Reporting Results of Internet E-Surveys (CHERRIES).[9]

Results

Demographics

A total of 208 surgeons answered the survey (completion rate 13.9%). North American (the United States and Canada) surgeons accounted for 36.1% of all respondents, 28.9% from Europe, 13.0% from Asia, 13.9% from Latin America, 1.4% from Africa, and 1.4% from Oceania. Most respondents practiced at an academic hospital setting (55.8%) followed by community/private practice (23.6%); 35.6% of respondents had been practicing for $\leq$10 years while 33.2% had $>$20 years experience; 53.8% of respondents reported performing $>$101 fURS cases/year.

Irrigation methods used

The most common irrigation method used by North American surgeons was the pressurized saline bag using a manual inflatable cuff (55%) (Table 1). The most common method used by European surgeons was the saline bag (gravity) with a bulb or syringe injection system (45%). In contrast, only 12% of European respondents used the pressurized saline bag. The most common method in Asia was the automated irrigation system (30%). For regions with greater than 10 respondents, North America showed the most uniformity in practice with $>$50% of all respondents using one method. Automated irrigation systems were not used by any of the respondents in Latin America. In this region, pressurized saline bag was the most common (41%) and was closely followed by saline bag methods. The most common irrigation method used for urologists with $\leq$10 years of experience was pressurized saline bag using a manual inflatable cuff (38.8%) while for those $>$20 years experience, the most common was saline bag (gravity) with a bulb or syringe injection system (31.9%).

Irrigation pressure practice

A pumping pressure between 75 and 150 mmHg was the most common setting used for pressurized saline bag placed at $\leq$1 meter height (51.1%), saline bag at $\leq$2 meter height (55%), and automated irrigation systems (51.4%). The pressurized saline bag at $\leq$2 meter height was the system

Table 1. Frequency (%) of different irrigation methods used during fURS by endourologists according to region of the world.

	Saline bag (gravity)	Saline bag (gravity) with bulb or syringe system	Pressurized saline bag using manual inflatable cuff	Automated irrigation system
North America (*n* = 75)	5	23	55	17
Europe (*n* = 60)	25	45	12	18
Asia (*n* = 38)	26	26	18	30
Latin America (*n* = 29)	31	28	41	0
Africa (*n* = 3)	67	33	0	0
Oceania (*n* = 3)	0	100	0	0

fURS, flexible ureteroscopy.

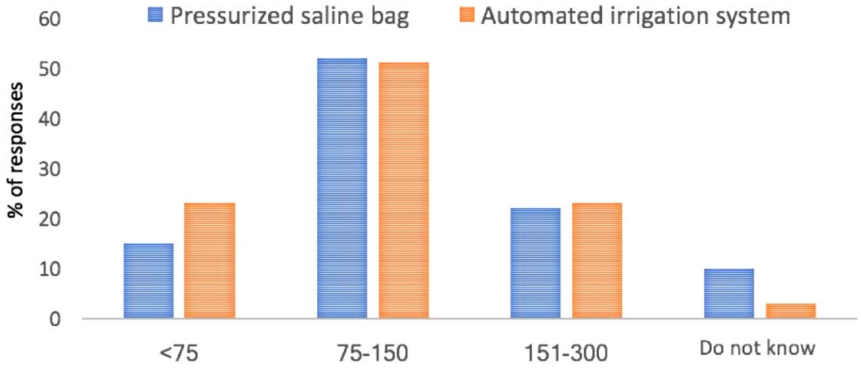

Figure 1. Survey responses for selection of irrigation pressure when using pressurized saline (blue) or automated irrigation systems (orange).

with most respondents using a pressure of 151–300 mmHg at 30% of the time. Respondents only used pressurized saline bag at ⩽1 meter and automated irrigation systems at 151–300 mmHg pressure 19.2% and 22.9% of the time, respectively. Figure 1 compares the proportion of responders who use various pumping pressures when using pressurized bags with automated irrigation systems.

Although a pressure of 75–150 mmHg was the most common setting regardless of urologist experience for saline bag at ⩽2 meter height (60% for ⩽10 years experience and 50% for >20 years experience) and automated irrigation systems (64.3% for ⩽10 years experience and 33.3% for >20 years experience), the most common pressure for urologists with >20 years using a pressurized saline bag placed at ⩽1 meter height was <75 mmHg (54.5%). The proportion of respondents with >20 years experience who used a pressure between 151 and 300 mmHg was slightly lower across all systems when compared with urologists with ⩽10 years experience (0.0% *versus* 35.3% for saline bag ⩽1 meter height, 33.3% *versus* 40.0% for saline bag at ⩽2 meter height, and 33.3% *versus* 35.7% for automated irrigation systems).

Table 2. Frequency of irrigation issues reported (%) by surgeons when doing fURS and different endoscopic activities.

Question	Most of the time (%)	Some of the time (%)	Never (%)	Total
Laser lithotripsy of kidney stone	19.2	63.9	16.8	208
Basketing of kidney stone	20.3	58.0	21.7	207
Biopsy of urothelial tumor	29.6	58.7	11.7	206
Diagnostic inspection	13.0	36.7	50.2	207

fURS, flexible ureteroscopy.

Irrigation issues in various clinical scenarios

Surgeons were asked 'Do you have issues with adequate irrigation during the following scenarios?' and asked to categorize the answer as 'most of the time', 'some of the time', or 'never'. Table 2 demonstrates the results. The most common procedural scenario where adequate irrigation was problematic 'most of the time' was biopsy of urothelial tumors (29.6%). Laser lithotripsy and basketing of kidney stones was reported to have inadequate irrigation 'most of the time' in 19.2% and 20.3% of cases, respectively. Issues with adequate irrigation during laser lithotripsy were reported to occur at least 'some of the time' in 83.1% of respondents.

Discussion

We conducted an online survey study to better understand practice patterns for irrigation methods and parameters during fURS. Our study has several key findings. fURS irrigation practices differ across the world. The most common method in North America was a pressurized saline bag while European surgeons preferred a saline bag with a manual handheld bulb/syringe system. When using pressurized saline cuff bag, a pumping pressure between 75 and 150 mmHg was the most common setting used. Overall, automated irrigation systems were not commonly used, but when they were, a pressure between 75 and 150 mmHg was the common setting. About a fifth of surgeons reported issues with inadequate irrigation 'most of the time' during laser lithotripsy or basketing stones. Biopsy of urothelial tumors was the clinical scenario with the greatest reported issues.

There are limited data on what irrigation methods are used during fURS. One recent survey study with 114 completed responses (completion rate not reported) from the European Association of Urology Young Academic Urologist and Uro-Technology groups found that the preferred irrigation method varied between manual pump (46%), mechanical (automated) irrigation (22%), and gravity irrigation (27%).[10] Their findings are consistent with ours where European respondents indicated gravity-based handheld systems as the most commonly used method. To date, there are no other studies that provide information about irrigation practices in other regions for comparison. This is significant because differences exist in operating room efficiency among various irrigation practices. A randomized controlled trial of 51 patients in the United States undergoing percutaneous nephrolithotomy and URS found significantly less irrigation concerns, decreased pump time, and increased nurse satisfaction when using automated irrigation pumps when compared with manual pumps.[11]

While there are no data on the most commonly chosen irrigation pressures in North America, a recent bench study of automated irrigation systems conducted by urologists in the United States were done at pressure settings with a maximum of 300 mmHg to mimic clinical practice.[12] In another US bench study where a setting of 200 mmHg with the pressurized saline bag was used, it was noted that a pressure in excess of 300 mmHg may occur in the operating room.[13] We found that North American practice was different to that in Europe where most surgeons used pressurized saline and practiced more uniformly; it was the only region to have more than half of all respondents prefer one irrigation method. We found that urologists with greater experience preferred a saline bag (gravity) with a bulb or syringe injection system while urologists with less experience preferred pressurized saline with a manual inflatable cuff.

It is not surprising that we found variation in irrigation practice. The American Urological Association (AUA) guidelines do not provide guidance on specific irrigation practices or pressures during URS,[14] and the European Association of Urology (EAU) guidelines provide no recommendations or discuss the importance of irrigation and intrarenal pressure maintenance during URS.[15] The AUA guidelines do emphasize the importance of low intrarenal pressure in two specific scenarios. The first is for complex, high-volume, and branched renal stones. The second is for patients with uncorrected bleeding diatheses or those who require continuous anticoagulation or antiplatelet therapy. In these scenarios, the AUA guidelines recommend clinicians should make every effort to maintain low intrarenal irrigation pressure with a ureteral access sheath (UAS) for the reasons that these procedures can be lengthy, and prolonged high intrarenal pressures can increase the risk of hemorrhage, infection, sepsis, collecting system perforation, and fluid absorption.[14] A urologist's decision to use a UAS, as well as its size, can influence practice patterns on irrigation given its effects on intrarenal pressure.[16–18] In particular, one may opt to use higher flow rates/irrigation pressures when a UAS is used.

Another reason for the variation in use of these different irrigation methods is the limited evidence comparing irrigation methods and relationship to outcomes. In a retrospective analysis of 234 patients undergoing URS over 4 years at an Australian center, using either gravity-driven pressure bags fixed at 60–204 cm H_2O ($n = 90$) or procedures performed with a hand-operated irrigation pump capable of delivering 1–10 ml per flush ($n = 144$), emergency room presentations were significantly greater in the hand irrigation group (32% *versus* 13%).[19] Postoperative fever was also greater in the hand pump group (9% *versus* 1%). In a separate study of 231 patients from a US center undergoing URS without a UAS, an automated pressure system at 150 mmHg ($n = 206$) was compared with irrigation utilizing a syringe ($n = 25$).[20] While more patients in the hand irrigation group presented to the emergency department (25%) compared with the automated system (14%), this did not reach statistical significance.

Our survey study is the first that evaluates worldwide patterns in irrigation methods during fURS. However, certain limitations must be acknowledged. First, the study represents only a small proportion of urologists. Although low, the number who responded is consistent with recent published survey studies in endourology.[21–24] Second, the respondents were a highly specialized group of urologists that may not be reflective of community practice. Half of the survey respondents have been practicing for more than 15 years, which may influence practice patterns. Nevertheless, this group consists of many leaders in endourology and will likely influence practice in the general community. Third, a possibility of questionnaire bias exists, particularly where respondents must choose from a limited number of options regarding irrigation methods and clinical scenarios. Although the survey was designed by a research team involved in endourology research, it is possible that some common responses were left out. A possibility of reporting bias also exists, in which respondents say one thing and do another.

The use of a UAS and the relationship between irrigation techniques and whether a UAS is in play, or the size of the ureteroscope, were not examined in our study and is a limitation which presents a direction for future investigation. Evidence suggests UAS provides protection against elevated renal pressures.[25] It is possible North American surgeons use pressurized saline because many of them use UAS during fURS. Furthermore, some surgeons may not use a UAS in the kidney and therefore rely on gravity-based irrigation methods.

Limitations notwithstanding, our survey is important because it establishes a review of global irrigation methods during fURS. With limited data regarding irrigation methods, our study reveals opportunities to develop evidence-based procedural practices. By identifying that no single irrigation method is the most common in multiple regions, this study supports the anecdotal evidence that urologists in different parts of the world prefer different irrigation methods. It identifies the pressurized saline bag using a manual inflatable cuff method preferred by over half of the respondents in a region (North America). Interestingly, automated systems are not commonly used. This study also identifies that at least 20% of procedures are reported to have issues with adequate irrigation. In specific, biopsy of urothelial tumors has the most irrigation issues and points to the need for better biopsy devices that overcomes this.

Future directions of our evidence base include research to learn more about the advantages and disadvantages, including intraoperative and postoperative complications, between pressurized saline irrigation *versus* gravity-based methods given its wide-reaching consequences. Once explored, these studies will provide a framework for establishing a consensus-driven standard for irrigation during fURS. Further work is also needed to understand the value and barriers to the use of automated systems, as we found that they are not commonly used, and many in the field think this is the next frontier. Efforts at future surveys should focus on increasing the number of respondents to best represent a diverse group of practice patterns.

In conclusion, there is wide variation in the use of irrigation methods and parameter selection during fURS. North American surgeons primarily used a pressurized saline bag in contrast to European surgeons who preferred a gravity bag with a handheld syringe system. Overall, automated irrigation systems were not commonly used. There is some association between surgeon experience and the choice and parameter selection for irrigation. Variation may be a consequence of limited guidelines and studies comparing different irrigation strategies and their relationship to outcomes. Our work demonstrates an opportunity to establish evidence-based recommendations for irrigation parameters during fURS.

Declarations

Ethics approval and consent to participate

The survey was reviewed by the Institutional Review Board at the University of Michigan and deemed as exempt (registration number: IRB00000246). All participants consented to participate by voluntarily completing the survey.

Consent for publication

Not applicable.

Author contributions

Bassel Salka: Validation; Visualization; Writing – original draft; Writing – review & editing.

Jamsheed Bahaee: Conceptualization; Data curation; Methodology.

Jeff Plott: Formal analysis.

Khurshid R. Ghani: Conceptualization; Investigation; Methodology; Project administration; Supervision; Writing – original draft; Writing – review & editing.

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Competing interests

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Availability of data and materials

None.

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Appendix 1

Survey

Practices of single-use flexible ureteroscopes

Question 1: Where do you practice?

- United States
- South America
- Europe
- Africa
- Oceania
- Asia
- Middle East
- Canada
- Mexico
- Central America

Question 2: Primarily what environment do you practice in?

- University hospital/setting
- Community/Private practice
- Combination university and private practice
- Government facility (VA, military base)

Question 3: How many years have you been practicing?

- < 5
- 5–10
- 11–15
- 16–20
- > 20

Question 4: How many flexible ureteroscopy cases do you perform every year?

- < 25
- 25–50
- 51–100
- 101–200
- > 200

Question 5: What is your primary irrigation method when performing flexible ureteroscopy and laser lithotripsy?

- Saline bag (gravity) at ⩽ 1 m height
- Saline bag (gravity) at ⩽ 2 m height
- Saline bag (gravity) at ⩽ 1 m height with bulb or syringe system
- Saline bag (gravity) at ⩽ 2 m height with bulb or syringe system
- Pressurized saline bag using manual inflatable cuff at ⩽ 1 m height
- Pressurized saline bag using manual inflatable cuff at ⩽ 2 m height
- Automated irrigation system

Question 6: (*Only appears to respondents who choose 'Pressurized saline bag using manual inflatable cuff at* ⩽ 1 m height' *for question 24)* When using a pressurized saline bag at ⩽ 1 m height, what pressure is the bag typically pumped to?

- < 75 mmHg
- 75–150 mmHg
- 151–300 mmHg
- Do not know

Question 7: (*Only appears to respondents who choose 'Pressurized saline bag using manual inflatable cuff at* ⩽ 2 m height' *for question 24)* When using a pressurized saline bag at ⩽ 2 m height, what pressure is the bag typically pumped to?

- < 75 mmHg
- 75–150 mmHg
- 151–300 mmHg
- Do not know

Question 8: (*Only appears to respondents who choose 'Automated irrigation system' for question 24)* When using an automated irrigation system, what pressure is the system typically set at?

- < 75 mmHg
- 75–150 mmHg
- 151–300 mmHg
- Do not know

Question 9: Do you have issues with adequate irrigation during the following scenarios? (Most of the time, some of the time, never)

- Laser lithotripsy of kidney stone
- Basketing of kidney stone
- Biopsy of urothelial tumor
- Diagnostic inspection