Laser access and utilization preferences for pediatric ureteroscopy: A survey of the Societies of Pediatric Urology

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Abstract

Introduction: We sought to evaluate laser access and practice variability for pediatric ureteroscopy (URS) across the Societies of Pediatric Urology (SPU) to identify opportunities and barriers for future technology promulgation and evidence dissemination.

Methods: A 25-question survey was sent electronically to members of the SPU. The questionnaire assessed surgeon and hospital characteristics, treatment preferences based on an index case, and information about available laser units. Descriptive and comparative statistical analyses were performed to assess patterns of care and laser accessibility across the SPU.

Results: A total of 105 of 711 (15%) recipients responded. Seventy-seven respondents (73%) reported laser ownership, which was associated with greater after-hours laser access (87% vs. 13%, p<0.01). Fifty-eight individuals provided additional laser specifications, of whom 21 (36%) used a high-powered laser unit (>60 W). Standard-power lasers were used more frequently in free-standing children's hospitals, as compared to those working within a larger hospital complex (75% vs. 50%, p=0.049). Variation existed in treatment preferences with respect to dusting (33, 34%), fragmentation (18, 19%), or a hybrid approach (46 respondents, 48%). Stone clearance was the most important consideration irrespective of treatment choice.

Conclusions: Variability in surgical preferences and accessibility to laser units exist across pediatric urologists who perform URS. Laser ownership and access to newer technologies vary across practices and may influence treatment options. Understanding access to laser technology will be important when considering opportunities for surgical optimization to improve patient outcomes through future studies.

Introduction

Up to 30% of children presenting with an acute episode of upper urinary tract calculi (UUTC) will require surgical intervention.[1] Over the past decade, ureteroscopy (URS) with laser lithotripsy has become the most common surgical modality for treating children with ureteral and renal calculi.[2,3] Benefits of URS include the ability to visualize the calculus for directed lithotripsy and active stone extraction with minimal tissue injury from the laser power source. URS has been associated with a lower risk of subsequent retreatments than shockwave lithotripsy (SWL), although at the apparent cost of increased complications.[3,4] While there are limited data on comparative effectiveness for surgical management of UUTC in the pediatric population, this knowledge gap has been identified as an important area of future study by the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK).[5] As such, continued efforts to optimize surgical outcomes for pediatric UUTC must balance the treatment effectiveness against the operative morbidity.

The recent introduction of high-powered laser technology into the marketplace has changed treatment paradigms, demonstrating benefits that include decreased operative time and avoidance of ureteral access sheaths.[6-8] Thus, access to a more versatile armamentarium of ureteroscopic equipment and energy sources may improve surgical efficiency.[9] While institutional factors appear to influence choice of surgical intervention (i.e., SWL vs. URS) in the treatment of UUTC in children, availability of laser technologies and technical preferences in the ureteroscopic management for children with UUTC have not been well-described.[2]

Comparative effectiveness for surgical management of UUTC in children has been identified as a research priority and several efforts are underway to better refine treatment paradigms in this population.[10] Specific to these initiatives are efforts to describe modifiable ureteroscopic surgical techniques, such as use of ureteral access sheaths and postoperative ureteral stents, as well as the technique of

fragmentation (i.e., dusting vs. fragment extraction) in the pediatric population.[11] However, implementing any findings from these efforts will require a broader understanding of access to ureteroscopic technologies and procedural variation across the greater pediatric urological community to facilitate incorporation of new technologies. We believe this information would be of interest to several stakeholders who may influence the development, dissemination, and use of laser technology, including pediatric urologists, industry, hospital administration, and those in health policy.

We surveyed members of the SPU to characterize variation in laser lithotripsy access and practices for pediatric URS. Our aim was to evaluate URS practice patterns and laser accessibility to characterize the current state of laser use across pediatric urologists and inform future efforts to optimize surgical outcomes for pediatric nephrolithiasis. We hypothesized that laser ownership would be associated with surgical volume, greater after-hours availability, and higher-powered laser devices.

Methods

Survey development

A 25-question survey was created by a multidisciplinary research team, including three pediatric urologists with an interest in pediatric nephrolithiasis, an endourologist treating primarily adult patients, and an experimental physicist expert in laser technology, thus providing content validity; however, the survey instrument lacks construct validation. Survey questions were developed primarily by the senior author (JE) and then reviewed and edited by four of the authors (GT, KK, WR, AM) for content and readability. Due to the exploratory nature of the survey and intended audience of pediatric urologists familiar with management of urinary stone disease, we elected to not engage in pilot testing or cognitive interviews for item development.

The survey included questions related to surgeon demographics, estimated individual and institutional surgical volumes, accessibility of laser technology, and preferences for treatment strategies, including laser settings, lithotripsy technique (dusting vs. fragmentation/extraction), use of pre-treatment ureteral stents, and ureteral access sheaths. Additionally, respondents were asked to identify treatment preferences ("dusting" vs. "basket extraction and laser fragmentation" vs. "hybrid") based on the following index case: "For a 1 cm renal pelvis stone in a healthy 10-year-old child, your preferred ureteroscopic management is…" A full survey can be found in the Appendix (Supplementary Fig. 1; available at *cuaj.ca*). The survey was created in Survey Monkey™ (San Mateo, CA, U.S.).

Survey distribution

The survey was approved by the SPU and distributed via email to all active, affiliate, corresponding, candidate, and senior members (n=711) in June and July of 2019. Email blast reminders were sent at two and four weeks. Data were abstracted six weeks following initial survey distribution. The SPU list-serve was not directly available to the research team. As such, information regarding the demographics of non-responders cannot be ascertained. Additionally, alternative communication strategies for non-responders, beyond the email blasts, were not feasible.

Data definitions

Ownership of a laser was defined if a respondent answered "own" or "combination of ownership and rental" to the laser ownership survey question. Based on the distribution of the data, surgeon and group volumes were dichotomized into low- and high-volume categories for both SWL and URS. High volumes were defined as follows: URS group >50 cases/year (top quartile); URS individual >30 cases/year (top quintile); SWL group >10 cases/year (top quintile). High-powered laser was defined as greater than 60 W. Respondents were asked to identify their practice as either working in a free-standing children's hospital or as children's practice within a larger hospital complex.

Statistical analysis

Descriptive statistics were used to define practice pattern and laser access variability across survey respondents. Chi-squared tests were used to assess hospital factors hypothesized to be associated with laser ownership, as well as surgeon characteristics hypothesized to be associated with treatment preferences. A p-value less than 0.05 was defined a priori to indicate statistical significance. Statistical analyses were completed in Stata v15.1 (College Station, TX U.S.).

Institutional research board approval was sought and granted for this project (PRO00033805) prior to proceeding with survey distribution.

Results

A total of 105 respondents (15% response rate) from the SPU completed the survey. Data regarding demographics and practice settings are displayed in Table 1. All participants indicated the holmium laser (Ho:YAG) was their preferred energy source. All but one respondent indicated concomitant membership within the American Urological Association (AUA) and all sections of the AUA were represented.

Seventy-three percent of respondents (n=77) reported Ho:YAG laser ownership. Practice characteristics, case vol-

Table 1. Response demographics across the SPU

	n	%
AUA section		
Northeastern	8	8%
New England	7	7%
New York	1	1%
Mid Atlantic	7	7%
North Central	21	20%
Southeastern	24	23%
Western	24	23%
South Central	12	12%
Years in practice		
0–5	29	28%
6–10	16	15%
11–15	26	25%
16–20	5	5%
>20	29	28%
Fellowship-trained		
Yes	101	96%
No	4	4%
Practice primarily pediatric-focused		
Yes	103	98%
No	2	2%
Practice type		
Academic	75	71%
Community	30	29%
Hospital setting		
Free-standing pediatric hospital	60	57%
Within a larger hospital complex	45	43%
Yearly URS volume, group		
Low (<50 cases per year)	77	73%
High (>50 cases per year)	27	28%
Yearly URS volume, individual		
Low (<30 cases per year)	91	87%
High (>30 cases per year)	14	13%
Yearly SWL volume, group		
Low (<30 cases per year)	84	80%
High (>30 cases per year)	21	20%

AUA: American Urological Association; SPU: Societies of Pediatric Urology; SWL: shockwave lithotripsy; URS: ureteroscopy.

Table 2. Practice demographics and laser access stratified by laser ownership

	Own	Rent	p
Practice type			
Academic	57 (77%)	17 (23%)	0.34
Community	20 (67%)	10 (33%)	
Hospital setting			
Free-standing children's hospital	42 (71%)	17 (29%)	0.5
Within a larger hospital complex	35 (78%)	10 (22%)	
Group URS volume			
Low (<50 cases per year)	55 (71%)	22 (29%)	0.44
High (>50 cases per year)	22 (81%)	5 (19%)	
Group SWL volume			
Low (<30 cases per year)	62 (75%)	21 (25%)	0.43
High (>30 cases per year)	15 (71%)	6 (29%)	
After-hours laser access			
Yes	66 (87%)	10 (13%)	**<0.01**
No	11 (39%)	17 (61%)	
Laser power			
Standard (<60 W)	30 (81%)	7 (19%)	0.25
High (>60 W)	17 (81%)	4 (19%)	
Unsure	30 (67%)	15 (33%)	
Pulse settings			
Variable	41 (73%)	15 (27%)	0.92
Non-variable	13 (72%)	5 (28%)	
Unsure	23 (77%)	7 (23%)	

SWL: shockwave lithotripsy; URS: ureteroscopy.

ume, or laser technology did not vary by ownership status. However, respondents who owned a laser had greater after-hours (i.e., evenings and weekends) laser access (87%, n=66, vs. 13%, n=15, p<0.01). Table 2 displays practice characteristics and laser technology stratified by laser ownership. For intraoperative laser support, 50% (n=52) of respondents depend on a circulating nurse and 41% (n=43) depend on an operating room (OR) technician, with the remainder (9.5%, n=10) working with other OR personnel to operate the laser. A sub-analysis was performed to identify current practice variations in respondents who reported access to high-powered lasers (≥60 W). This sub-analysis found that access to high-powered lasers was associated with a practice setting within a larger hospital complex (50%, n=13 vs. 25%, n=8, p=0.04), though not associated with academic practice or urolithiasis surgical volumes (either URS or SWL) (data not shown).

Based on an index case of a healthy 10-year-old child with a 1 cm calculus in the renal pelvis, 33 respondents (34%) preferred a dusting approach, 18 respondents (19%) preferred a fragmentation approach, and 46 respondents (48%) preferred a hybrid approach. An additional eight respondents chose not to answer. Additional practices stratified by treatment preferences can be seen in Table 3. Respondents who prefer a dusting approach report less frequent access sheath usage (p=0.002), while those who prefer a hybrid approach report a greater ability to vary laser pulse settings (p=0.015). The importance of seven factors in one's treatment preference is shown in Fig. 1. Duration of treatment was chosen more frequently as an influencing factor for those respondents who prefer a hybrid approach (p=0.038). None of the other factors differed significantly across treatment preferences. Stone clearance was unanimously the

Table 3. Factors associated with treatment preferences

	Total	Dusting	Fragmentation	Hybrid	p
Demographics					
Years in practice					
<10	44	10 (23%)	10 (23%)	24 (55%)	0.124
>10	52	22 (42%)	8 (15%)	22 (42%)	
Individual URS volume					
Low (<30 cases per year)	82	30 (37%)	13 (16%)	39 (48%)	0.116
High (>30 cases per year)	14	2 (14%)	5 (36%)	7 (50%)	
Practice patterns					
Pre-stenting					
<60% of cases	44	17 (39%)	8 (18%)	19 (43%)	0.583
>60% of cases	52	15 (29%)	10 (19%)	27 (52%)	
Access sheath use					
<50%	64	26 (41%)	6 (9%)	32 (50%)	**0.002**
>50%	32	6 (19%)	12 (38%)	14 (44%)	
Laser access					
Laser ownership					
Own	74	24 (32%)	12 (16%)	38 (51%)	0.372
Rent	22	8 (36%)	6 (27%)	8 (36%)	
Laser power					
Low power (<60 Hz)	36	15 (42%)	5 (14%)	16 (44%)	0.251
High power (≥60 Hz)	19	5 (26%)	6 (32%)	8 (42%)	
Pulse setting variation					
Yes	49	15 (31%)	6 (12%)	28 (57%)	**0.015**
No	18	7 (39%)	7 (39%)	4 (22%)	

URS: ureteroscopy.

most influential factor irrespective of treatment preference. Additional variation in practice patterns was assessed which are shown in Supplementary Table 1 (available at *cuaj.ca*).

Discussion

As the use of URS for children with UUTC increases, understanding practice preferences and access to technology will be essential for widespread efforts to improve outcomes. Variation in treatment modalities (i.e., URS vs. SWL) for pediatric UUTC exist across hospital systems, likely driven by local factors and surgeon preference.[2,3] With greater than 100 respondents representative of a broad complement of practice settings and surgeon experience, we found a majority of respondents use a hospital-owned laser. Those urologists indicating laser ownership reported a significantly greater access to after-hours treatment, which may have implications for point-of-care treatment and patient experience.[12] While neither laser ownership nor surgical volume was associated with use of a high-powered laser, surgeons who reported working in free-standing children's hospitals had less access to high-powered laser technology. Furthermore, just over half of respondents were aware of the laser specifications for their most commonly used device, such as power and variable waveform technology, indicating an opportunity for focused education within the pediatric urology community.

A better understanding of available technology and technical practices could help guide surgical algorithms and capital purchases, as high-powered lasers become more accessible. Our study finds local factors, such as laser ownership and practice settings, influence access to after-hours laser activity and to newer Ho:YAG laser technology. As

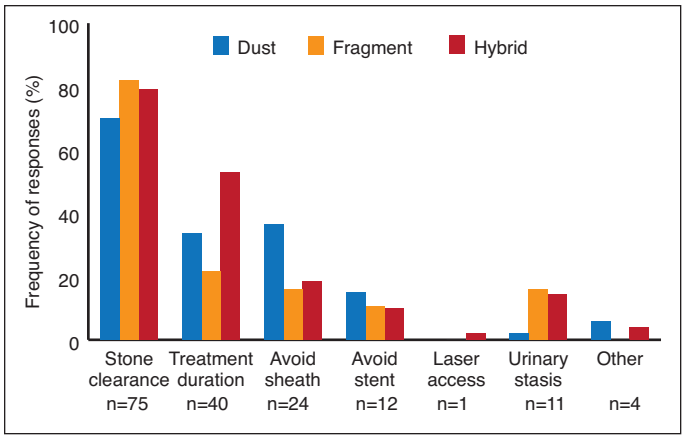

Fig. 1. Factors influencing surgeon preference for dusting, fragmentation, or hybrid approaches to laser lithotripsy. The total number of respondents for each factor is noted below the x-axis.

such, laser accessibility could influence patient outcomes and the patient experience. For instance, after-hours laser use could enable greater point-of-care treatment, thus minimizing need for temporizing ureteral stents and improving patient-reported outcomes, a hypothesis of interest for future study. Meanwhile, access to advanced laser technology may influence treatment decisions and outcomes, as higher-powered lasers have been shown to be associated with decreased operative time and avoidance of ureteral access sheaths.[6,8,13] Few studies exist that support or even explore high-powered laser lithotripsy in children, although similar to dissemination of other technological advances in urological surgery, it follows that use of such lasers could easily gain a foothold in the pediatric realm. Our results support promulgation of such laser technology, especially in healthcare settings in which adults and children are treated in a shared hospital complex and may represent a positive influence of collaboration across pediatric and adult specialists. Conversely, pediatric urologists who do not share resources with their adult colleagues may not have access to high-powered lasers. Barriers to adoption of this technology could include absence of high-level data in children, costs, or lack of awareness of such technical advances, and should be considered as high-powered laser use continues to permeate the pediatric landscape. Additionally, we note that a proportion of our respondents were unaware of the laser power, limiting our assessment of those surgeons with access to high-powered lasers and highlighting an opportunity for additional surgeon education regarding laser use and functionality.

Advances in laser technology has sparked debate between treatment techniques on dusting vs. fragmentation. Varying the settings for laser lithotripsy allows the operator to alter the fragmentation effect, techniques that may be augmented by newer laser technologies.[14] Matlaga et al have shown no difference in stone clearance or complications when comparing these techniques in adult populations but do acknowledge a paucity of data for children.[9] Our findings showed a wide variation in treatment preferences exists among engaged pediatric urologists, although treatment efficacy is a key factor for surgeons irrespective of their treatment approach. In accordance with existing literature regarding the benefits of dusting technique and avoidance of ureteral access sheaths, we were not surprised to find our respondents who preferred dusting did so with a goal towards avoidance of access sheaths.[9] While access sheaths have been safely used in the pediatric population, Wang et al reported a 10% complication rate and thus, widespread use should be approached with caution, especially in children with a smaller ureteral diameter.[15-17]

This study has several limitations. First, a limited number of potential participants responded to this survey and respondents may represent a select population with an impassioned interest in pediatric endourology. However, those respondents most engaged with treatment of children with nephrolithiasis may be most likely to provide detailed and thorough responses reflective of their current practices. Additionally, the overall number of respondents is similar to recently published surveys from the same society.[18-20] As senior, corresponding, and affiliate members, who may or may not be actively practicing, were included in the email blast, this could have artificially decreased the apparent response rate from active and practicing pediatric urologists. Survey responses did not categorize membership status and could not further ascertain the membership type. Second, as the responses obtained may have been influenced by those more dedicated to pediatric stone disease, our survey may overestimate the degree of laser access. Additionally, respondents could cluster within institutions. The de-identified nature of the survey process precludes a more detailed assessment of this potential clustering. However, no more than 23% of respondents were from each AUA section, suggesting a broad regional representation. Further, the ever-changing landscape of endourology could render these results out of date in just a few years. For that reason, continued engagement in this arena will be essential. Lastly, reliance on electronic survey distribution, while convenient, limits the survey to those with computer access and limits the ability of the respondents to ask clarifying questions of the research team.

Despite its limitations, our study has several important implications for future endoscopic management of pediatric stone disease, which are especially notable given the predominant preference towards URS for surgical management of UUTC in children. First, institutional factors appear to influence laser access, both in terms of treatment availability and access to high-powered equipment. Both factors could be hypothesized to influence patient outcomes. As additional data further inform ideal treatment patterns, understanding barriers to laser access will be essential for planning knowledge dissemination and implementation across our specialty. Second, embedded technical variability exists across surgeons. Many, if not all, of these technical preferences lack supporting data, and these findings support efforts targeted to harness surgical variability in order to define optimal treatment parameters. Currently the Pediatric KIDney Stone Care Improvement Network (PKIDS) has an ongoing, multi-institutional, prospective cohort study for children undergoing surgical treatment for stone disease, evaluating factors that influence treatment outcomes and patient experience (*clinicaltrials.gov* NCT04285658).[10] Our findings will be key preliminary data to understand optimal targets for and feasibility of evidence dissemination to engaged pediatric urologists across the SPU.

Conclusions

Our data show Ho:YAG laser access and availability to be influenced by practice characteristics, with respondents from free-standing children's hospitals reporting less use of high-powered laser technology, and those with laser ownership reporting greater after-hours laser access. Many respondents were not aware of laser power or accessory settings, representing an opportunity for focused education in this realm. We identified a wide variability in pediatric ureteroscopic practice patterns and treatment preferences, which has the potential to be harnessed within broad collaborative studies to identify optimal operative strategies for pediatric stone disease.

Competing interests: Dr. Tasian serves on scientific advisory boards for Allena Pharmaceuticals, Dicerna Pharmaceuticals, and Novome Biotechnology; and is a consultant for Alnylam. Dr. Roberts is a consultant for Boston Scientific. Dr. Maxwell has equity and consulting arrangements with SonoMotion, Inc and is a consultant for Boston Scientific. Dr. Ellison is a consultant for Dicerna Pharmaceuticals. The remaining authors do not report any competing personal or financial interests related to this work.

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This paper has been peer-reviewed.

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