Review Article

Current Status of Ureteric Stents on Extraction Strings and Other Non-cystoscopic Removal Methods in the Paediatric Setting: A Systematic Review on Behalf of the European Association of Urology (EAU) Young Academic Urology (YAU) Urolithiasis Group

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Ureteric stents are an important tool in urology and have a wide range of indications. While they offer a number of advantages, limitations remain despite modern advancements. These include discomfort, migration and encrustation. Standard removal is via cystoscopy but in the paediatric setting this mandates general anaesthetic, which holds disadvantages. Alternative removal methods include use of extraction strings and magnetic retrieval devices, which can be performed in the outpatient setting. This systematic review evaluates the safety and efficacy of different non-cystoscopic methods for stent removal in the paediatric setting. UROLOGY 160: 10–16, 2022. © 2021 Elsevier Inc.

In 1978, Finney et al first described the ureteric stent and since then it has secured it place on the shelves of all urology theatres worldwide.[1] Establishing drainage from the upper urinary tract has a wide range of applications including endourology, reconstructive surgery and in emergencies for decompression of an infected, obstructed system.[2] In recent years, there have been numerous advances in stent technology including material, design and stent coating.[3] Many of these modifications have been driven by the need to improve the tolerability of stents given the adverse effect on quality of life (QoL), which they can yield.[4] Removal of the stent can also be bothersome and in the paediatric setting, cystoscopic removal almost always mandates a general anesthetic (GA).[5] Development of new and effective techniques, which are potentially cost saving and avoid GA would therefore be invaluable. The latter is of particular importance given that exposure to multiple GAs in childhood has been linked with possible later development of a learning disability.[6] With increase in endourological procedures worldwide, this is also mirrored in the stent usage.[7] A range of non-cystoscopic removal methods are now available in clinical practice.[8] This includes use of stent on string (SOS), magnetic retrieval as well as modified snare techniques. Their application has been more largely studied in the adult setting. However, while there has been an increasing number of studies reported in the paediatric setting, formal evaluation of the available evidence remains under-reported. Our aim was to assess the safety, feasibility, and efficacy of these non cystoscopic stent removal methods.

METHODS

A systematic search of world literature was performed in order to identify original articles on this subject. This was performed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidance.[9] All non-cystoscopic stent removal methods were considered, and this included for any endourological surgery. Bibliographic databases searched included Medline, Google Scholar, Embase and Scopus. Search strategies were tailored to each of the databases. No

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time restriction was applied, and the search was completed for all English language articles up until September 2021. Search terms included the following: "stent," "ureteroscopy," "calculi," "extraction string," "magnet," "cystoscopy," "paediatric," "drainage," "ureteric catheter" and "thread." Papers dealing with case reports and adult patients were not included in this review. Outcomes of interest included procedural time, cost, success, and QoL assessment. Complications and safety were recorded including the need for multiple attempts at removal of stent and failures requiring standard cystoscopic removal. Both the search and then data extraction were carried by two of the authors, independently of each other. The senior author checked for any discrepancies. The heterogenous nature of the results has resulted in a narrative review format.

RESULTS

Twelve studies were identified for inclusion in this review (Table 1 and Supplementary Figure 1).[10-21] Three studies investigated use of SOS whereby a thread attached to the distal end of the stent, which can be taped to the inner thigh of the patient and can be manually removed at follow up.[10-12] Four studies evaluated magnetic retrieval device, which use a magnet attached to the distal end of the stent which can be withdrawn with a magnetic retrieval device.[13-16] Three studies implemented use of modified feeding tubes with a suture loop attached the end to snare to the distal end of the stent.[17-19] One study described outcomes using a urethral sound to "drag" the stent out and another study had developed a novel method of attaching the urinary catheter to the stent itself so that it all could be removed at once post operatively.[20,21]

In total, 1114 patients (male to female ratio 1.86:1) were included, ranging from 2.5 months to 18 years of age. In two thirds (n = 8) of the studies, only local anaesthesia (LA) was used, while in the remainder implemented a combination of LA and sedation. Four of the studies were prospective (3 x randomised, 1 x case control), while the remainder were retrospective in nature. Randomised studies compared the novel method against conventional cystoscopic stent removal. No studies provided head-to-head comparison of different novel methods for example, stent on string vs magnet. The initial surgery type consisted of a range of procedures including pyeloplasty, ureteroscopy, ureterocele surgery, ureteral re-implantation, and renal transplant. This subsequently affected the range of time stents were left in situ across the studies which was from 2 days to 4 months.

Operation Time, Cost and QoL

None of the SOS studies provided information on operation time for stent removal (Table 2). In the magnet group, Chalhoub et al recorded mean time of 4 minutes (range 1-25 minutes).[15] For the modified feeding tubes with suture loop, two of the studies revealed significantly shorter procedural times compared to standard cystoscopy. In contrast to this, Sundaramurthy et reported longer times associated with their locally made device (41 vs 38 minutes).[19] Regarding cost, one study on SOS reported this outcome measure. Le at al recorded significantly lower overall costs associated with SOS compared to standard stent removal (¥400.48* vs ¥2290.86, P <.05). All studies which used modified feeding tubes with suture loop reported significant cost savings also.[17-19] QoL measurement was done poorly across all the studies with only two studies implementing some kind of pain assessment. Chalhoub et al reported mean pain score of 3/10 for magnetic devices and Shao et al recorded lower pain scores with use of their modified feeding tube (36% vs 17%) although the assessment tool was not specified.[15,18]

Complications and Removal Failures

SOS appears to yield the highest removal rate on a single attempt with a 100% record in the two studies, which documented this.[11,12] None of the studies using SOS required cystoscopic removal due to failure (Supplementary Table 1). The reported early dislodgement rate in this group ranged between 0% and 7%.[12] Of note, no cases of early dislodgement required intervention for example, re-insertion. In contrast, the magnetic device was only associated with a single case of early dislodgement among the four studies but lack of removal upon first attempt was reported between 6 and 25% of cases. On average, 4% of magnetic retrievals were unsuccessful and required conversion to cystoscopic removal under GA. Regarding success of removing stents with the modified feeding tube method, on average, 89% of cases underwent successful removal at first attempt and 3% of patients eventually required cystoscopic removal. The urethral sound method was not associated with any complications, and there were no reports of early dislodgement. The stents were successfully removed in all cases, however, 25% of patients required multiple attempts.[20] All cases using the novel method of attaching catheter to distal end of stent were successful removed at the first attempt.[21] Overall, conversion to standard cystoscopic removal was necessary as follows: SOS 0%, Magnetic device 4%, Modified feeding tube 3%, urethral sound 0% and stent attached to catheter 0%.

There were no major complications associated with any of the methods described. The most frequently reported minor complication was urinary tract infection (UTI). Overall UTI rates were as follows SOS 2%, Magnetic device 4%, Modified feeding tube <1%, urethral sound 0%, stent attached to catheter 0%. None of the methods were reported to have encrustation upon removal.

DISCUSSION

To our knowledge, this is the first review of its kind to provide a summary of evidence available for non-cystoscopic stent removal methods in the paediatric population. Half of the articles (n = 6) have been published within the last 2 years, which highlights the increasing interest in these methods.[12,14-16,19,21] All of these methods can be safely performed under local anaesthetic with or without sedation (Table 3). The advantage of being performed in outpatient setting rather than operating room is huge, not least due to the associated costs with the latter choice. The average cost of an operating theatre in the US has been calculated at $62/min, which excludes additional costs for specialist equipment and payment to surgeon and anesthetist.[22] Interestingly, despite these potential advantages, none of these novel methods have gained recommendation or comment in the current urolithiasis guidelines for children.[23]

Table 1. Demographics of the included studies (NR — not recorded)

Author (Year)	Removal Method	Anaesthetic	Study Type	Preceding Surgery	Sample Size	Mean Age (range)	Male/ Female	Mean Dwell Time (d) (range)	
								Standard	Non-cystoscopic Method
Yucel (2006)[10]	SOS	LA	Retrospective case series	Pyeloplasty	20	NR (4-16)	16/4	-	10.3 d (7-18)
Kajbafzadeh et al (2015)[11]	SOS	LA	Retrospective cohort	Ureteroscopy/ endoureterotomy/ ureterocele surgery/anti-reflux surgery	325	3.97 y (NR)	199/126	-	22.3 d (NR)
Le et al (2019)[12]	SOS	LA	Retrospective non-randomised comparative study	Ureteroscopy/ ureteral reimplantation/ ureterocele surgery	109	5 y (NR)	80/29	35 d (NR)	10 d (NR)
Mykulak et al (1994)[13]	Magnet	LA	Retrospective case series	Pyeloplasty	7	NR (2.5 mo to 11 y)	4/3	-	NR (4 wk to 4 mo)
Mitchell et al (2020)[14]	Magnet	LA	Prospective case control	Ureteroscopy/ ureteral reimplantation/ trauma/pyeloplasty	80	NR (1-10 y)	NR	48.8 d (NR)	24.9-44.1 (NR)
Chalhoub et al (2020)[15]	Magnet	LA	Retrospective cohort	Pyeloplasty/ureteral reimplantation/ kidney transplant	100	7.8 (0.5-18)	65/35	-	67.5 (2-179)*
Arce et al (2021)[16]	Magnet	LA+/- sedation	Retrospective cohort	Pyeloplasty/ ureteroscopy	32	46.2 (1.3-182.7)*	17/15	-	NR
Lin et al (2016)[17]	Modified feeding tube (5FR) and loop	LA + sedation	Randomised trial	Pyeloplasty/ureteral reimplantation/ ureterocopy	277	NR (1 mo to 12 y)	195/85	3.27 wk (3-4)	
Shao et al (2018)[18]	Modified feeding tube (8FR) and loop	LA + sedation	Retrospective non-randomised comparative study	Pyeloplasty/ureteral reimplantation	102	NR (1 mo to 13 y)	67/35	7 wk (4-12)	
Sundaramurthy et al (2019)[19]	Modified feeding tube (6 or 8FR) and loop	LA + sedation	Randomised trial	Pyeloplasty/ureteral reimplantation	40	NR (0-16 y)	36/4	63 (NR)	48 (NR)
Corrales et al (2008)[20]	Urethral sound (8-12FR)	LA	Retrospective case series	Pyeloplasty/ureteral reimplantation	12	NR (0.5-13 y)	4/8	-	NR
Taylor et al (2020)[21]	Stent attachment to urinary catheter	LA	Retrospective case series	NR	10	9.3 (1.3-16.3 y)	6/4	-	2 (NR)*

LA, local anesthetic; SOS, stent on string.
* = median.

Table 2. Results of the included studies (NR — not recorded)

		Mean Operation Time (mins)		Mean Cost (Price in $ Unless Otherwise Stated)		Quality of Life	
Author (Year)	Removal Method	Cystoscopy	Non-cystoscopy	Cystoscopy	Non-cystoscopy	Cystoscopy	Non-cystoscopy
Yucel (2006)[10]	SOS	-	NR	-	NR	-	NR
Kajbafzadeh et al (2015)[11]	SOS	-	NR	-	NR	-	NR
Le et al (2019)[12]	SOS	NR	NR	2290.86	400.48*	NR	NR
Mykulak et al (1994)[13]	Magnet	-	NR	-	NR	-	NR
Mitchell et al (2020)[14]	Magnet	NR	NR	NR	NR	NR	NR
Chalhoub et al (2020)[15]	Magnet	-	4 (1-25)	NR	NR	-	Pain score 3/10
Arce et al (2021)[16]	Magnet	NR	NR	NR	NR	NR	NR
Lin et al (2016)[17]	Modified feeding tube and suture loop	Boys: 12.57 ± 0.82 Girls: 9.61 ± 0.86	Boys: 5.05 ± 1.20* Girls: 4.63 ± 1.13*	Boys: 3788.78 ± 21.47 (₹) Girls: 3788.78 ± 21.47 (₹)	Boys: 477.56 ± 27.64* (₹) Girls: 477.56 ± 27.64* (₹)	NR NR	NR NR
Shao et al (2018)[18]	Modified feeding tube and suture loop	18.42 ± 2.77	8.04 ± 4.82*	736.70 ± 105.96	618.23 ± 110.31*	36.4%	17.0%
Sundaramurthy et al (2019)[19]	Modified feeding tube and suture loop	38.0	41.3	14579.0 (INR)	5636.5* (INR)	NR	NR
Corrales et al (2008)[20]	Urethral sound	NR	NR	NR	NR	NR	NR
Taylor et al (2020)[21]	Stent attachment to urinary catheter	-	NR	-	NR	-	NR

SOS, stent on string.
* = statistically significant ($p<0.05$).

Table 3. Advantages and disadvantages of different methods

	Advantages	Disadvantages
SOS	– Can be done in outpatient clinic – Avoids GA – No additional equipment required – No higher infection rates – Visibility of thread helps reduce risk of neglected ureteral stents – Time saving – Cost saving – High removal success rate – Alternative in low-income countries	– Early dislodgement can occur – Patient anxiety regarding loose thread
Magnetic device	– Can be done in outpatient clinic – Avoids GA – decreases OR time – Available in variety of sizes, length – complications rate was no different to a control group (Mitchell et al) – Bilateral stents can be removed with a single retrieval devise in a single pass. – if the insertion magnetic stent fails, magnetic tip can be cut off	– Higher upfront costs for device – Use of fluoroscopy can be required – Association with insertion failure rate – Not approved for use in all countries worldwide – need of retrieval catheter (larger than the stent) – The smallest available size of the magnetic stents is 4,8 FR. Retrieval advice 9 FR. – Cannot undergo MRI – Magnet can become stuck in bladder diverticulum – Disconnection of magnet can occur at external sphincter
Modified feeding tube with suture loop	– Can be done in outpatient clinic – Avoids GA – Alternative in low-income countries	– No standardised method to make it – Can require several attempts at retrieval
Urethral sound	– No additional costs – Alternative in low-income countries	– Several attempts can be required – Learning curve higher – Patient discomfort
Catheter affixed to stent	– Alternative in low-income countries	– Catheter can become blocked and everything needs to be removed – Can be replaced by urethral catheter

GA, general anesthetic; MRI, magnetic resonance imaging.

SOS

This method is the most studied in the adult population.[3] Oliver et al determined that there was no difference in pain scores or urinary symptoms between SOS and conventional stent use but that nearly 10% of SOS users were affected by early dislodgment.[24] In the adult population, dwell time can be reduced because patients can remove the stent at a specific time and this process is not affected by availability of hospital appointments. The worry of early dislodgement is a widely reported concern among surgeons and patients, however, our review highlights this to be only as high as 7% in the paediatric setting.[24] A key advantage of SOS is the simplicity of removal, which was achieved at the first attempt in all reported cases and without need for any additional procedures. There were also no reports of string breakages. In many hospitals, the stent is originally packaged with the thread attached and therefore there are no additional costs. Le et al performed cost analysis which shows savings over $1800 for every procedure. Finally, the additional risk of UTI is another commonly cited concern for SOS despite adult studies revealing that it is not associated with additional risk of infection.[25] However, rates of UTI were very low across the studies and compare favourably to cystoscopic stent removal. Indeed, among the studies which had a comparator group, no method was associated with higher rates of UTI.

Magnetic Device

The magnetic retrieval method is one of the most studied techniques in the paediatric setting. While it has not gained full approval for usage across all countries worldwide, it is available in a range of sizes (smallest 4.8FR) although the retrieval device is a fixed size of 9FR and therefore its suitability needs to be considered in small children and infants. While studies support cost savings over the long term, the higher startup costs are cited as a reason for its lack of adoption among poorer healthcare systems. The latter is one of the key motivations for developing novel modifications such as the feeding tube with suture loop. An important disadvantage is that it can be difficult to insert and insertional failure has been reported as high as 34% in the paediatric setting.[15] The commonest reason for this is that it becomes stuck at the vesicoureteral junction due to the size of the magnet. Of note, the distal tip with the magnet can be cut off and the stent converted to conventional form, or a regular stent can be inserted instead. This insertional failure rate likely incurs

a hidden cost to this method, but no data has provided formal calculation yet of how much this amounts to. Unlike SOS, magnet and other novel methods are less successful at removal on the first attempt. Problems associated with the magnetic device are that it can become lodged in a bladder diverticulum and disconnection can occur at level of external sphincter upon extraction. For this reason, many centers now use fluoroscopy when removing magnetic stents. However, this is clearly a further disadvantage, especially for the paediatric population. The magnet also acts as a contra-indication if patient requires magnetic resonance imaging while the stent is in situ.

Modified Feeding Tube

This review has found three studies with similar locally designed devices using feeding tubes (ranging between 5FR and 8FR) and a suture loop attached to the end, to snare the distal loop of the stent. As for magnetic stents, it is also associated with a removal failure rate mandating cystoscopic removal. However, this was <4% and Sundaramurthy et al highlight it as a promising alternative in low-income countries with high patient volumes.[19] Fluoroscopy is not suitable for this method to aid when initially unsuccessful at retrieving the device. Ultrasound has therefore been proposed as an area of future research for this device.

Other Novel Methods

Use of urethral sounds has been described in a single study with a small sample (n = 12).[20] The authors of this review anticipate that this method would be associated with high failure rates and cause patient discomfort if adopted in standard practice. However, it does highlight how novel alternatives can be found using existing equipment. Attaching the end of urinary catheter to distal portion of the stent is another resourceful alternative.[21] However, it is only suitable in patients where the catheter is planned for removal in the early post-operative period. The authors would argue that in such cases, the use of a ureteral catheter left in situ could offer the same benefits.

LIMITATIONS

While there has been a rise in interest in these novel methods, the conclusion drawn from this review are limited by several factors. Firstly, there exist only relatively few studies in this research area in the paediatric setting and the majority are single centre series which have been carried out retrospectively and without a comparator group. Outcome measures adopted across the studies vary a lot, particularly with respect to QoL and pain which was poorly reported. Regardless of the potential for cost savings, QoL must be a focus of future studies.[26] A range of initial surgeries were performed while using them, which must also be borne in mind when interpreting the results, given that variable stent dwell time are needed for different surgeries.

FUTURE RESEARCH

Future studies are therefore required with standardised outcome parameters and ideally, within context of randomised trials. Stent technology and efforts to improve care for patients who have them is growing constantly. Biodegradable stents and single use cystoscopes for removal are examples of how this field is rapidly changing.[27,28]

CONCLUSION

Several non-cystoscopic methods for stent removals now exist, which serve as feasible alternatives to standard cystoscopy. Besides cost savings, these offer the advantage of being delivered in the outpatient setting and avoiding GA. Further studies are awaited to help delineate their place in current paediatric international guidelines.

CONSENT

N/A

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SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.urology.2021.11.022.

References

1. Finney RP. Experience with new double J ureteral catheter stent. *J Urol.* 1978;120:678–681. https://doi.org/10.1016/S0022-5347(17)57326-7.
2. Mattei A, Danuser H. Stents in der Urologie [Stents in urology]. *Ther Umsch.* 2003;60:233–237. https://doi.org/10.1024/0040-5930.60.4.233. GermanPMID: 12731434.
3. Mosayyebi A, Manes C, Carugo D, Somani BK. Advances in ureteral stent design and materials. *Curr Urol Rep.* 2018;19:35. https://doi.org/10.1007/s11934-018-0779-y. PMID: 29637309; PMCID: PMC5893657.
4. Ramachandra M, Mosayyebi A, Carugo D, Somani BK. Strategies to improve patient outcomes and QOL: current complications of the design and placements of ureteric stents. *Res Rep Urol.* 2020;12:303–314. https://doi.org/10.2147/RRU.S233981. PMID: 32802807; PMCID: PMC7403435.
5. Jones P, Rob S, Griffin S, Somani BK. Outcomes of ureteroscopy (URS) for stone disease in the paediatric population: results of over 100 URS procedures from a UK tertiary centre. *World J Urol.* 2020;38:213–218. https://doi.org/10.1007/s00345-019-02745-3. Epub 2019 Apr 4. PMID: 30949802; PMCID: PMC6954136.
6. Wilder RT, Flick RP, Sprung J, et al. Early exposure to anesthesia and learning disabilities in a population-based birth cohort. *Anesthesiology.* 2009;110:796–804. https://doi.org/10.1097/01.anes.0000344728.34332.5d. PMID: 19293700; PMCID: PMC2729550.
7. Pietropaolo A, Proietti S, Jones P, et al. Trends of intervention for paediatric stone disease over the last two decades (2000-2015): a systematic review of literature. *Arab J Urol.* 2017;15:306–311. https://doi.org/10.1016/j.aju.2017.10.006. PMID: 29234533; PMCID: PMC5717467.
8. Kim DJ, Son JH, Jang SH, Lee JW, Cho DS, Lim CH. Rethinking of ureteral stent removal using an extraction string; what patients feel and what is patients' preference?: a randomized controlled study.

BMC Urol. 2015;15:121. https://doi.org/10.1186/s12894-015-0114-6. PMID: 26653027; PMCID: PMC4675013.
9. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;372:n71. https://doi.org/10.1136/bmj.n71. PMID: 33782057; PMCID: PMC8005924.
10. Yucel S, Samuelson ML, Nguyen MT, Baker LA. Usefulness of short-term retrievable ureteral stent in pediatric laparoscopic pyeloplasty. *J Urol*. 2007;177:720–725. https://doi.org/10.1016/j.juro.2006.10.017.
11. Kajbafzadeh AM, Nabavizadeh B, Keihani S, Hosseini Sharifi SH. Revisiting the tethered ureteral stents in children: a novel modification. *Int Urol Nephrol*. 2015;47:881–885. https://doi.org/10.1007/s11255-015-0963-7.
12. Le HK, Gleber R, Bush RA, et al. Cost analysis of removing pediatric ureteral stents with and without a retrieval string. *J Pediatr Urol*. 2019;15:624.e1–624.e6. https://doi.org/10.1016/j.jpurol.2019.08.004.
13. Mykulak DJ, Herskowitz M, Glassberg KI. Use of magnetic internal ureteral stents in pediatric urology: retrieval without routine requirement for cystoscopy and general anesthesia. *J Urol*. 1994;152:976–977. https://doi.org/10.1016/s0022-5347(17)32634-4.
14. Mitchell A, Bolduc S, Moore K, Cook A, Fermin C, Weber B. Use of a magnetic double J stent in pediatric patients: a case-control study at two Canadian pediatric centers. *J Pediatr Surg*. 2020;55:486–489. https://doi.org/10.1016/j.jpedsurg.2019.03.014.
15. Chalhoub M, Kohaut J, Vinit N, et al. Feasibility and safety of magnetic-end double-J ureteral stent insertion and removal in children. *World J Urol*. 2020. https://doi.org/10.1007/s00345-020-03339-0.
16. Brillat Arce W, Vuille-Dit-Bille RN, Holland-Cunz SG, Frech-Doerfler M. Magnetic Double-J-stent removal without general anaesthesia in children. *Urology*. 2021. https://doi.org/10.1016/j.urology.2021.01.028. S0090-4295(21)00094-7. Epub ahead of print. PMID: 33493511.
17. Lin H, Xu M, Jiang D, et al. Non-cystoscopic removal of retained ureteral stents with mild sedation in children. *Urology*. 2016;94:255–258. https://doi.org/10.1016/j.urology.2016.03.026. Epub 2016 Mar 31. PMID: 27038985.
18. Shao H, Liu P, Zhang H, Chen C, Lin X. Noncystoscopic removal of retained ureteral stents in children: a retrospective study from a single-center. *Medicine (Baltimore)*. 2018;97:e9540. https://doi.org/10.1097/MD.0000000000009540. PMID: 29505530; PMCID: PMC5943098.
19. Sundaramurthy S, Joseph Thomas R, Herle K, Jeyaseelan, Mathai J, Jacob Kurian J. Double J stent removal in paediatric patients by Vellore Catheter Snare technique: a randomised control trial. *J Pediatr Urol*. 2019;15:661.e1–661.e8. https://doi.org/10.1016/j.jpurol.2019.08.009.
20. Corrales J, Meza M, Quiche J, Zorrilla J. A technique for the removal of ureteral catheters in infants and children using a urethral sound. *J Urol*. 2008;180:295–296. https://doi.org/10.1016/j.juro.2008.03.079.
21. Taylor L, Cho A, Smeulders N. Seamless post-operative removal of JJ stents in the paediatric population: securing the JJ stent to the tip of the urethral balloon catheter avoids a further operation. *J Pediatr Urol*. 2020;16:500–501. https://doi.org/10.1016/j.jpurol.2020.06.028. Epub 2020 Jun 26. PMID: 32669216.
22. Macario A. What does one minute of operating room time cost? *J Clin Anesth*. 2010;22:233–236. https://doi.org/10.1016/j.jclinane.2010.02.003. PMID: 20522350.
23. Türk C, NeIsius A, Petrik A, et al. EAU guidelines on urolithiasis. *EAU Guidelines. Edn. presented at the EAU Annual Congress Amsterdam*. 2020; 2020.
24. Oliver R, Wells H, Traxer O, et al. Ureteric stents on extraction strings: a systematic review of literature. *Urolithiasis*. 2018;46:129–136.
25. Fröhlich M, Fehr J, Sulser T, Eberli D, Mortezavi A. Extraction strings for ureteric stents: Is there an increased risk for urinary tract infections? *Surg Infect (Larchmt)*. 2017;18:936–940. https://doi.org/10.1089/sur.2017.165. Epub 2017 Oct 4. PMID: 28976816.
26. Mehmi A, Jones P, Somani BK. Current status and role of Patient-reported Outcome Measures (PROMs) in endourology. *Urology*. 2021;148:26–31. https://doi.org/10.1016/j.urology.2020.09.022. Epub 2020 Sep 28. PMID: 32991909.
27. Chew BH, Paterson RF, Clinkscales KW, Levine BS, Shalaby SW, Lange D. In vivo evaluation of the third generation biodegradable stent: a novel approach to avoiding the forgotten stent syndrome. *J Urol*. 2013;189:719–725. https://doi.org/10.1016/j.juro.2012.08.202.
28. Hughes T, Pietropaolo A, Jones P, Oderda M, Gontero P, Somani BK. Outcomes and cost evaluation related to a single-use, disposable ureteric stent removal system: a systematic review of the literature. *Curr Urol Rep*. 2021;22:41. https://doi.org/10.1007/s11934-021-01055-9. PMID: 34128107.