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ORIGINAL ARTICLE

Feasibility and safety of magnetic-end double-J ureteral stent insertion and removal in children

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Abstract

Purpose The need for surgical removal of a double-J ureteral stent (DJUS) is considered one of its disadvantages. Apart from increased cost, repeated exposure to general anesthesia is a concern in children. Alternative techniques have been described, all failing to become integrated into mainstream practice. Stents with a distal magnetic end, although introduced in the early 1980s, have only recently gained acceptance. We report the feasibility and safety of insertion and removal of a magnetic-end double-J ureteral stent (MEDJUS) in a pediatric population.

Materials and methods We retrospectively analyzed the use of the Magnetic Black-Star Urotech® MEDJUS between 11/2016 and 12/2019 in children. Stents were removed in the outpatient clinic using a transurethral catheter with a magnetic tip.

Results MEDJUS insertion was attempted in 100 patients (65 boys). Mean age was 7.8 years (0.5–18). The stent was placed in an antegrade procedure ($n=47$), by a retrograde route ($n=10$), and during open surgery ($n=43$). Stent insertion was successful in 84 cases (84%). All 16 failures occurred during the antegrade approach in laparoscopic pyeloplasty, with inability to push the stent and its magnet through the ureterovesical junction in 14. Magnetic removal was attempted in 83 patients, successful in 81 (98%). There was no added morbidity with the MEDJUS.

Conclusions The use of MEDJUS is a safe and effective strategy that obviates the need for additional general anesthesia in children. Its insertion is similar to that with regular DJUS, and its easy and less time-consuming removal benefits both the patient and the hospital and validates its clinical use.

Keywords Children · Urology · Ureteral stent · Magnetic stent · Removal

Abbreviations

DJUS	Double-J ureteral stent
GA	General anesthesia
MEDJUS	Magnetic-end double-J ureteral stent
UVJ	Ureterovesical junction

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Introduction

Initially reported in 1967, ureteral stenting evolved rapidly until the introduction of the double-J ureteral stent (DJUS) in 1978 [1]. The stent became one of the most common devices used in urology [2]. Many modifications have been introduced to reduce stent-related complications and disadvantages, one being its removal technique under general anesthesia (GA) in children [3] [4] [5]. Preventing the patient from undergoing a second surgical experience is not the only issue. For institutions, DJUS removal is time-consuming and costly in terms of resources, operating room occupancy, and staff [6]. In children, the potential neurotoxicity of repeated GA exposure is also a concern [7].

Alternatives to surgical removal of DJUS vary from basic solutions such as a stent with a dangler, hook, or other tools [3, 4, 8, 9] to more complex innovations such as the single-use flexible cystoscope [10] and biodegradable stent [11].

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Moreover, some pediatric teams have used the externalized pyeloureteral stent as an alternative to DJUS [12, 13].

Using a magnet for ureteral stent removal was introduced in the 1980s [14]. Difficulties related to its insertion as well as its low removal success rate restricted its popularity. Then, in 2002, Taylor and McDougall revisited the concept of magnetic removal of the ureteral stent [15]. Since then, a few teams have published their experience with magnetic-end DJUS (MEDJUS) [5], including in pediatric populations [15].

We report a large monocentric study highlighting the feasibility and safety of MEDJUS in children. The primary aim was to evaluate the success of stent removal without the need for additional GA in children. The second aim was to evaluate the success of stent insertion and associated morbidity with this new device.

Materials and methods

We retrospectively analyzed the use of a MEDJUS, the Magnetic Black-Star Urotech® (Achenmühle, Germany), between November 2016 and December 2019 in a series of 100 surgeries by 4 surgeons in our department. Because this study was a feasibility study, all the surgeons did not use the MEDJUS to reduce the learning curve. Indications for MEDJUS were the same as for regular DJUS in children and were based on the surgeon's preference.

In children younger than 1 year old, posterior lumbotomy was performed for pyeloplasty according to our protocol [17]. Because of the tiny ureterovesical junction (UVJ) in these children, an external ureteropelvic stent was used, with no attempt at MEDJUS insertion. These children were subsequently excluded from the study. We excluded children younger than 1 year old with retrograde cystoscopy insertion as well.

The Magnetic Black-Star Urotech® is a 4.8 French DJUS with a small 7 French cylindrical-shaped magnet fixed with a string at the distal loop (76€). The magnet has an opening allowing for passage of a hydrophilic wire inside (Fig. 1). The length of the stent varied from 12 to 24 cm. The stents, at standard cost, were purchased by the hospital.

Explanation of the MEDJUS use and its potential complications were given to the parents, who signed a specific informed consent before surgery.

MEDJUS procedure

All stents were inserted in children under GA as for regular DJUS: antegrade, retrograde (cystoscopy insertion) or open surgery. A urine culture was performed before surgery. For successful antegrade insertion, the guide wire was pushed 5–7 cm beyond the magnet to unroll the distal loop and forceps was used to clamp and attach the stent and the wire, to achieve the required tension to pass through the UVJ. Before waking the child up, abdominal plain X-ray was routinely performed after pyeloplasty to verify any malposition of the MEDJUS distal loop, in the distal ureter or in the urethra. A successful stent insertion was defined as good positioning of the distal end with the magnet in the bladder. In case of insertion failure, a multi-length DJUS (8–20 cm) (116€) or open-closed (81€) DJUS was inserted.

MEDJUS removal

The MEDJUS was removed in the outpatient clinic, with the child in the supine position, by the surgeon assisted by a nurse. The child did not need to fast. A 9 French customized

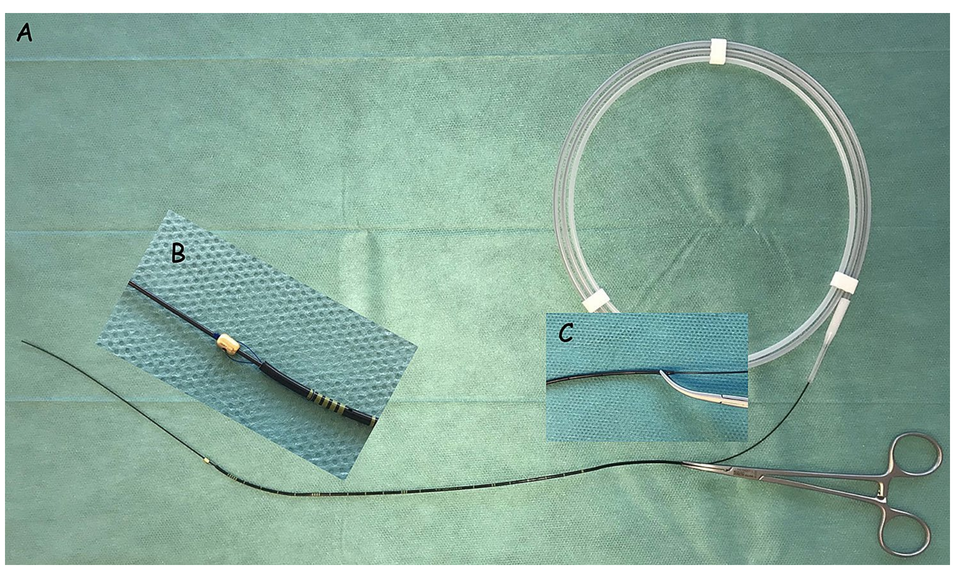

Fig. 1 **a** The 0.032″ hydrophilic guide wire is inserted into the magnetic-end double-J ureteral stent (MEDJUS). **b** The magnet has an opening to facilitate the passage of this guide wire. **c** For successful antegrade insertion, the guide wire is pushed 5–7 cm beyond the magnet to unroll the distal loop, and a Halstead forceps is used to clamp and attach the stent and the wire to achieve the required tension to pass through the ureterovesical junction

catheter-like removal device with a magnetic Tiemann tip (33€), lubricated with 2% lidocaine jelly, was inserted into the urethra. An empty bladder was helpful. The child was offered premixed nitrous oxide/oxygen for pain and anxiety management. Both indwelling magnets connect to each other, and the catheter can be removed together with the MEDJUS. The child is sent immediately home after stent removal. Successful magnetic removal was considered MEDJUS removal in the outpatient clinic with no need for GA.

Pediatric pain scales adapted to the child's age were used for the last 55 patients. The duration of stent removal was evaluated in the last 55 patients.

The study was conducted in accordance with the French legislation, Good Clinical Practices and the Declaration of Helsinki.

Data are expressed as mean (range) for continuous variables and number (percentage) for categorical variables.

Results

Between November 2016 and December 2019, we attempted to use the MEDJUS in 100 patients (65 boys) (Fig. 2). Mean age was 7.8 years (range 0.5–18); the youngest girl was 6 months old and the youngest boy was 1 year old. Mean weight was 27 kg (8–62).

Stent insertion was successful in 84 cases (84%) including all open surgery cases (kidney transplantation, $n=23$; and ureteral reimplantation, $n=20$), all retrograde cystoscopy insertion attempts (traumatic pyelo-ureteral junction rupture, kidney stone and lumbar pain, $n=10$) and 31 of the 47 pyeloplasty cases with an antegrade approach.

Antegrade stent placement failed during 16 pyeloplasty cases (8 boys and 8 girls, age 1.7–16 years old) (Movie 1). Eleven failures occurred at the beginning of our experience (one-third of patients) and only 5 failures occurred in the latter two-thirds of patients. Failure was immediately recognized in 11 children, because the stent and its magnet did not pass through the UVJ: the MEDJUS was immediately replaced with regular double-J stents in 9 patients, and a ureterocystoscopic repositioning of the stent was successful in 2 cases. In three patients, unsuccessful stent advancement beyond the UVJ was not noticed intraoperatively. Post-operative abdominal X-ray showed that the magnet fixed with a string at the distal loop was stuck in the distal ureter in two cases (Fig. 3a), so magnetic removal was not attempted. In the third case, the abdominal X-ray was considered normal (Fig. 3b), but the magnet was found in the distal ureter during cystoscopy removal performed after an unsuccessful non-surgical removal attempt. The three stents "stuck" in the distal ureter were removed using a ureterocystoscope. In two girls, the distal end of the stent was visible at the vulva at the end of the surgery; in one case, it was pushed back in the bladder, and in the other, the MEDJUS was removed with the patient still anaesthetized.

In one transplant case, the kidney (and its MEDJUS) was removed 24 h after initial surgery due to vascular thrombosis.

Non-surgical magnetic removal of the MEDJUS was attempted in 83 cases and was successful without complications in 81 (98%; 100% of girls, 94% of boys) after a mean

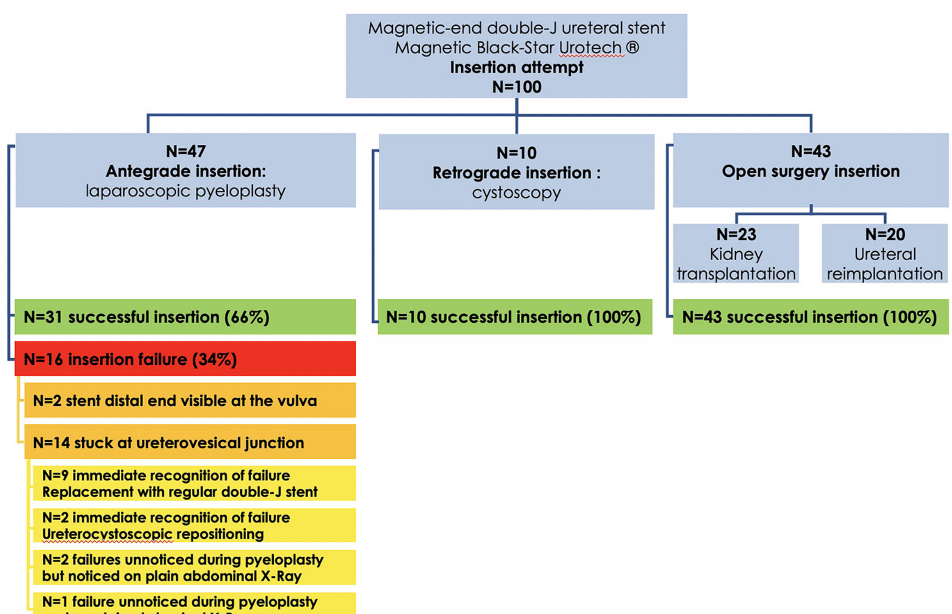

Fig. 2 Flow of participants with stent insertion

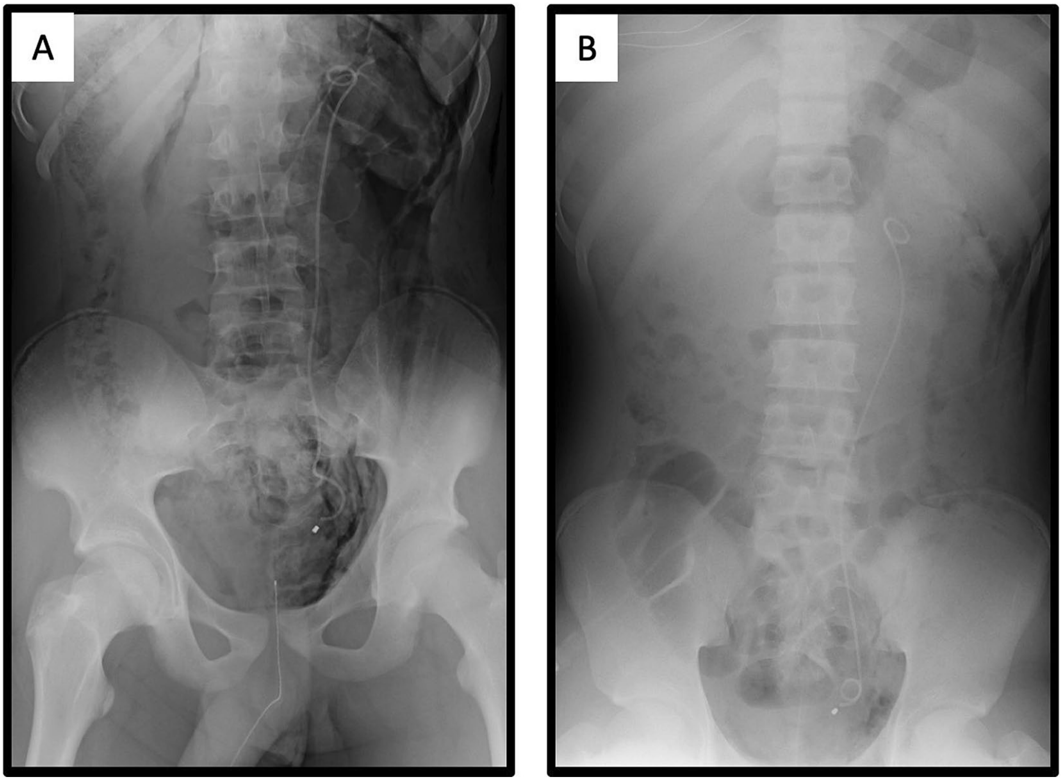

Fig. 3 **a** Abdominal X-rays. **a** Magnet fixed with a string at the distal loop lodged in the distal ureter. **b** X-rays considered normal, but the magnet was found in the distal ureter during cystoscopy removal performed after unsuccessful non-surgical removal attempt

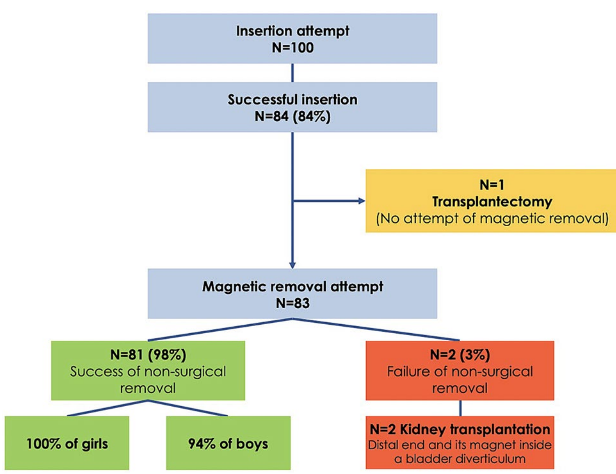

Fig. 4 Flow of participants with stent removal

of 35 days (5–92) (Fig. 4). The 9-French removal device was easily inserted into the urethra of boys, even in toddlers.

One stent was removed after 5 days because of major urinary symptoms and pain. In one case, the MEDJUS was removed via the Mitrofanoff, and in three cases (en bloc kidney transplant and bilateral kidney stones), the two MEDJUSs were removed at the same time in a single pass (Fig. 5).

There were two failures of non-surgical removal: two kidney transplant cases for posterior urethral valve in which the distal end with the magnetic bead was inside a bladder diverticulum, resulting in an impossible bead contact.

The mean pain score was 3/10 (range 0–7) in the last 55 children, with 40% of children not reporting pain during removal of the stent.

The mean duration of stent removal was 4 min (range 1–25), with two-thirds of the procedures lasting ≤ 2 min.

The success rate of insertion was 84% (16 failures among 100 attempts) and the success rate of removal was 98% (2 failures among 83 attempts). The overall success rate (insertion + removal) was 81%.

Five children (four girls and one boys) were treated for febrile urinary tract infection (Clavien Grade 2) with oral antibiotics.

Discussion

Double-J ureteral stents are commonly used in adults and children. Few alternatives to its surgical removal under GA have been developed. The analysis of our use of MEDJUS in a large cohort of children demonstrates that this

Fig. 5 Removal of the 2 MEDJUS (right and left side) at the same time

strategy is safe, with a low failure rate obviating the need for additional GA.

Techniques for non-surgical removal of DJUS have been developed with basic solutions such as a stent with a dangler (4), including in pediatric populations (19), with risk of accidental dislodgement (17–18), or the crochet hook device, inserted through the urethra inside the bladder to blindly retrieve the stent (3).

Currently, office-based removal of DJUS using a resterilizable flexible cystoscope and local anesthesia is widely accepted as the standard removal technique in adults [18]. In 2015, Doizi et al. published the first evaluation of a single-use cystoscope, with 94% success rate. The cost of the device was not clear, but obviously a 16 French cystoscope is not adequate for the pediatric population [10].

One of the alternatives to DJUS is the external ureteropelvic stent. The stent was first used in open pyeloplasty, then in retroperitoneal laparoscopic pyeloplasty in 2011 [12], and in robot-assisted laparoscopic pyeloplasty in 2018 [19], with good results as compared with DJUS. However, external stents carried a significant risk of leakage, displacement, urinary tract infection and longer hospital stay.

"Magnetip", the first DJUS with a magnetic end, emerged in 1989 [14]. Magnetip's complications and disadvantages in adults as well as the catheter size for removal, which was not adapted to children, stalled its acceptance in the pediatric urology community [20]. In 2002, Taylor and McDougall published their revisited concept of magnetic removal of the ureteral stent [15]. A magnetically attractive stainless-steel bead was attached to the distal end of the DJUS using a nylon tether, which was looped through the last drainage perforation. This tether allowed the bead to rotate independently of the position of the end of the stent, thereby achieving an optimal connection with the magnet used on the removal urethral catheter.

The use of MEDJUS was first reported in an abstract by Rassweiler et al. [21]. The same group conducted a randomized trial comparing 40 patients with MEDJUS to 20 with regular DJUS after ureterorenoscopy for stone removal. MEDJUS removal was significantly less painful and faster than regular DJUS removal. A cost analysis also showed substantial cost reduction with the non-cystoscopy technique [5]. Finally, O'Connell et al. prospectively assessed the impact of use of MEDJUS on the quality of life of patients. Removal by a nurse specialist was successful in all patients [22].

Mitchell et al. recently published their experience with MEDJUS in two Canadian pediatric centers [16]. The authors used MEDJUS in 40 children with similar indications as in our protocol. Removal was performed under fluoroscopy in 60% of patients and was successful in all but one. Of note, fluoroscopy was never used in our practice. We were able to successfully retrieve the MEDJUS using its removal device in 81 of 83 patients. Removal was a success in all our female patients but was not possible in two boys: two kidney transplant cases for a posterior urethral valve in which cystoscopy demonstrated the magnetic bead stuck inside a bladder diverticulum, which we believe prevented a magnetic contact.

The issue of stent insertion was not mentioned in Mitchell et al. or in other papers. However, Mitchell et al. identified several methods to optimize insertion of the magnetic stent in young patients (< 2 years old) undergoing pyeloplasty [16]. Because the magnetic tip needs to be fed from above, past the UVJ, the authors recommended having substitute stents available if passage of the magnetic stent fails, or alternatively, the magnetic tip can be cut off and the stent converted to a regular double pigtail. The authors also proposed to insert the double pigtail when performing the initial retrograde pyelogram.

Indeed, stent insertion was the only difficulty we encountered with this stent, owing to the tiny UVJ in children.

MEDJUS insertion was successful in all open surgery and cystoscopy cases but only 66% of pyeloplasty cases. Because 69% of failures occurred during the first third of our experience, the learning curve is a critical point to pass the UVJ in children. As described in materials and methods, we have modified our technique to reduce failure. The challenge to pass the UVJ is probably due to the diameter of the magnet (7 French), which is larger than the stent (4.8 French), with a higher risk of failure in children < 5 years old. Insertion of the MEDJUS was not attempted in children < 1 year old undergoing pyeloplasty and in children requiring retrograde cystoscopy insertion. We believe that the passage of the UVJ will become easier with experience, especially because smaller magnetic beads are being developed. In our experience, similar insertion difficulties are encountered with antegrade insertion of regular DJUS: the distal end of the stent does not pass the UVJ or the stent goes too far, into the posterior urethra in boys or visible at the vulva in girls. To avoid abdominal radiography, the use of methylene blue at the time of antegrade insertion has been described [23]. The appearance from the upper end and side holes of the DJUS confirms the correct placement of the lower end of the stent. However, such a technique does not allow for excluding any malposition of the distal loop in the posterior urethra. Finally, no added morbidity occurred due to the use of the MEDJUS, such as disconnection between the double-J ureteral stent and its magnet.

The removal was easily performed by the surgeon assisted by the nurse in a controlled atmosphere. The setting is comparable to a catheter insertion. Nitrous oxide/oxygen, commonly used in the pediatric emergency room to reduce fractures [24], was very well tolerated and accepted by the children and their family. There was no specific learning curve to overcome, just the same learning curve as with catheterizing the urethra. Two of the failures were due to the trabeculated bladder in the posterior urethral valve. In case of failure, cystoscopic removal has been used as in any case of regular non-magnetic DJUS removal.

The time for the MEDJUS removal was collected for only the last 55 cases. The mean duration of removal was 4 min (range 1–25), with two-thirds of the procedures lasting ≤ 2 min. This time compares favorably with the mean time reported by Rassweiler et al.: 9 min (7–14) [5].

The only specific disadvantage of MEDJUS is that patients cannot undergo MRI imaging, which could be a limitation especially after renal transplantation, for which MRI is preferred to CT scan to investigate post-operative complications. However, vascular complications are rare in children (5%) and with vascular thrombosis, an angio-CT scan can be performed [25].

The potential neurotoxicity caused by anesthesia has been of interest for more than a decade. Recent papers have described a significant association between pediatric exposure to GA and learning disabilities and behavioral problems [7]. This association seems to increase with repeated exposure [26]. By applying the MEDJUS strategy, we avoided 81 uses of GA.

There are several limitations that should be considered when interpreting the results of this study. One is its retrospective nature. Others are that an adapted pain scale to evaluate the pain of stent removal was used for only the last 55 patients and tolerance of the MEDJUS was not evaluated during the indwelling time. Finally, we lack data on parental satisfaction of the use of MEDJUS. Therefore, further study is warranted to answer these questions. A prospective health economic study will be conducted in our institution to evaluate the impact of the use of MEDJUS in children. Our aim is to study its potential on reducing the removal time and cost, as well as operating-room and staff occupancy, in comparison with a control group with regular DJUS.

Conclusion

The use of a MEDJUS is a safe and effective solution for ureteral stenting without exposing children to additional GA. Nevertheless, there is a learning curve with pyeloplasty, especially for the antegrade insertion. Insertion is similar to that with regular DJUS, and easy removal without GA and under less time constraints benefit both the patient and the hospital, thereby validating its clinical use.

Author contributions MC: data collection or management. JK: data collection or management. NV: data collection or management. NB: data analysis. YA: data analysis; manuscript writing/editing. YH: data analysis; manuscript writing/editing. HL: protocol/project development; data analysis. TB: protocol/project development; data analysis; manuscript writing/editing.

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Availability of data and material All data discussed in the paper can be found within the main text, figures and movie.

Compliance with ethical standrads

Conflict of interest No financial conflicts are declared.

Ethics approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional national research committee at Necker-Enfants malades Hospital and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Given that this was a retrospective analysis, a separate IRB approval was not required by the institutional or national standards.

Consent to participate Yes, written informed consent was obtained from the parents.

Consent for publication Not applicable.

References

1. Finney RP (1978) Experience with new double J ureteral catheter stent. J Urol 120(6):678–681. https://doi.org/10.1016/S0022-5347(17)57326-7
2. Donahue RP et al (2018) Evolution of the ureteral stent: the pivotal role of the gibbons ureteral catheter. Urology 115:3–7. https://doi.org/10.1016/j.urology.2018.02.007
3. Kawahara T et al (2012) Ureteral stent retrieval using the crochet hook technique in females. PLoS ONE 7(1):e29292. https://doi.org/10.1371/journal.pone.0029292
4. Jones JS (2002) Shortened pull-string simplifies office-based ureteral stent removal. Urology 60(6):1095–1097. https://doi.org/10.1016/s0090-4295(02)02000-9
5. Rassweiler M-C, Michel M-S, Ritter M, Honeck P (2017) Magnetic ureteral stent removal without cystoscopy: a randomized controlled trial. J Endourol 31(8):762–766. https://doi.org/10.1089/end.2017.0051
6. Söylemez H, Sancaktutar AA, Bozkurt Y, Atar M, Penbegül N, Yildirim K (2011) A cheap minimally painful and widely usable alternative for retrieving ureteral stents. Urol Int 87(2):199–204. https://doi.org/10.1159/000327610
7. McCann ME, Soriano SG (2019) Does general anesthesia affect neurodevelopment in infants and children? BMJ 367:l6459. https://doi.org/10.1136/bmj.l6459
8. Shao H, Liu P, Zhang H, Chen C, Lin X (2018) Noncystoscopic removal of retained ureteral stents in children. Medicine (United States) 97(1):e9540. https://doi.org/10.1097/MD.0000000000009540
9. Bockholt NA, Wild TT, Gupta A, Tracy CR (2012) Ureteric stent placement with extraction string: no strings attached? BJU Int 110(11 C):E1069–E1073. https://doi.org/10.1111/j.1464-410X.2012.11219.x
10. Doizi S et al (2017) First clinical evaluation of a new single-use flexible cystoscope dedicated to double-J stent removal (Isiris™): a European prospective multicenter study. World J Urol 35(8):1269–1275. https://doi.org/10.1007/s00345-016-1986-0
11. Soria F et al (2018) Evaluation of a new design of Antireflux-biodegradable ureteral stent in animal model. Urology 115:59–64. https://doi.org/10.1016/j.urology.2018.02.004
12. Helmy T, Blanc T, Paye-Jaouen A, El-Ghoneimi A (2011) Preliminary experience with external ureteropelvic stent: alternative to double-J stent in laparoscopic pyeloplasty in children. J Urol 185(3):1065–1069. https://doi.org/10.1016/j.juro.2010.10.056
13. Braga LHP, Lorenzo AJ, Farhat WA, Bägli DJ, Khoury AE, Pippi Salle JL (2008) Outcome analysis and cost comparison between externalized pyeloureteral and standard stents in 470 consecutive open pyeloplasties. J Urol 180(4 Suppl.):1693–1699. https://doi.org/10.1016/j.juro.2008.05.084
14. Macaluso JN, Deutsch JS, Goodman JR, Appell RA, Prats LJ, Wahl P (1989) The use of the magnetip double-J ureteral stent in urological practice. J Urol 142(3):701–703. https://doi.org/10.1016/S0022-5347(17)38858-4
15. Taylor WN, McDougall IT (2002) Minimally invasive ureteral stent retrieval. J Urol 168(5):2020–2023. https://doi.org/10.1016/S0022-5347(05)64286-3
16. Mitchell A, Bolduc S, Moore K, Cook A, Fermin C, Weber B (2019) Use of a magnetic double J stent in pediatric patients: a case–control study at two Canadian pediatric centers. J Pediatr Surg. https://doi.org/10.1016/j.jpedsurg.2019.03.014
17. Blanc T et al (2013) Retroperitoneal laparoscopic pyeloplasty in children: long-term outcome and critical analysis of 10-year experience in a teaching center. Eur Urol 63(3):565–572. https://doi.org/10.1016/j.eururo.2012.07.051
18. Almeras C et al (2017) Double J stent removal's cost estimate using a re-sterilizable fibroscope in a French private structure. Prog Urol 27(16):1031–1035. https://doi.org/10.1016/j.purol.2017.07.240
19. Chu DI et al (2018) Outcomes of externalized pyeloureteral versus internal ureteral stent in pediatric robotic-assisted laparoscopic pyeloplasty. J Pediatr Urol 14(5):450.e1–450.e6. https://doi.org/10.1016/j.jpurol.2018.04.012
20. Mykulak DJ, Herskowitz M, Glassberg KI (1994) Use of magnetic internal ureteral stents in pediatric urology: retrieval without routine requirement for cystoscopy and general anesthesia. J Urol 152(3):976–977. https://doi.org/10.1016/S0022-5347(17)32634-4
21. Rassweiler M-C, Michel M-S, Ritter M (2014) Black-Star®—magnetic DJ removal. J Urol 191(4S):e949–e950
22. Oonnell L, Broe MP, Rooney D, Elhag S, Cheema I, McGuire BB (2018) Magnetic stent removal in a nurse Led Clinic; a nine month experience. Iran Med J 111(2):687
23. Singh KM, Goel A, Shankhwar SN, Dalela D (2004) Confirmation of the correct placement of lower end of DJ stent during open surgery: point of technique. Int Urol Nephrol 36(3):335–336. https://doi.org/10.1007/s11255-004-0924-z
24. Kurien T, Price KR, Pearson RG, Dieppe C, Hunter JB (2016) Manipulation and reduction of paediatric fractures of the distal radius and forearm using intranasal diamorphine and 50% oxygen and nitrous oxide in the emergency department: a 2.5-year study. Bone Jt J 98-B(1):131–136. https://doi.org/10.1302/0301-620X.98B1.36118
25. Mehrabi A et al (2019) Surgical outcomes after pediatric kidney transplantation at the University of Heidelberg. J Pediatr Urol 15(3):221.e1–221.e8. https://doi.org/10.1016/j.jpurol.2019.01.007
26. Administration UFaD (2016) FDA Drug Safety Communication: FDA review results in new warnings about using general anesthetics and sedation drugs in young children and pregnant women. https://www.fda.gov/drugs/drug-safety-and-availability/fda-drug-safety-communication-fda-review-results-new-warnings-about-using-general-anesthetics-and. Accessed 3 Aug 2018