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Paediatric cystolitholapaxy through the Mitrofanoff/Monti channel

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Summary

Introduction
Bladder calculi are a known complication of bladder augmentation. Open cystolithotomy remains the preferred option for treating large or multiple stones. Increasingly, however, minimal access techniques have been used. Reports of Mitrofanoff cystolitholapaxy are rare and have been limited to adults. This study presented a two centre series of children treated by cystolitholapaxy via the Mitrofanoff/Monti channel.

Materials and methods
With institutional approval the current study retrospectively reviewed and identified 14 patients, on a prospective database, who underwent Mitrofanoff cystolitholapaxy to treat bladder calculi at two independent institutions in the UK and Chile between 2004 and 2016. It looked at patient demographics, surgical technique, stone clearance and recurrence, as well as leak or catheterisation difficulties of the Mitrofanoff/Monti channel post-procedure.

Results
Fourteen patients underwent Mitrofanoff cystolitholapaxy during the period 2004—2016. One patient was excluded due to lack of follow-up. The remaining 13 patients were aged 5—22 (median 14) years at the time of the procedure. Their underlying diagnoses were four neuropathic bladders, four bladder exstrophy, four cloacal exstrophy and one posterior urethral valve. Patients underwent augmentation cystoplasty at a median age of 5 (range 1—15) years, using ileum in 10 and sigmoid colon in three. The channel for clean intermittent catheterisation was an appendix Mitrofanoff in nine and a Monti channel in four. An Amplatz sheath was placed through the Mitrofanoff to allow safe access to the bladder for treating the stones (see Summary Table). Recurrent stones were treated using the same technique. Stone and channel outcomes were analysed for each procedure. There were 22 procedures in 13 patients; five (38%) patients had recurrent stones. Median time to recurrence was 6 months. There were no immediate complications. Stone clearance was confirmed by ultrasound and abdominal x-ray at 3—6 months after the procedure. Median follow-up was 15 (range 3—53) months. There were no leaks or difficulties catheterising the channel on follow-up.

Discussion
This was the first series of Mitrofanoff/Monti cystolitholapaxy for the treatment of calculi in augmented bladders of paediatric patients. Previous concerns about damaging the continence mechanism of the conduit appeared to be unwarranted. The use of an Amplatz sheath protected the continence system from repeated instrumentation, and permitted free backflow of irrigation and rapid clearance of stone fragments. Recurrence of stones occurred in 38%, which was in keeping with rates reported in the wider literature.

Conclusion
Mitrofanoff cystolitholapaxy was safe, and with appropriate care did not result in leakage or difficulty catheterising.

Summary Table

Amplatz sheath	**Number**
No sheath	4
18 Ch	13
20 Ch	3
26 Ch	1
28 Ch	1
Fragmentation method	**Number**
Swiss Lithoclast	12
Grasper	6
Laser	1
No fragmentation (lift-out)	3
Retrieval method	**Number**
Grasping forceps	18
2.4 Ch basket	4

Operative details.

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Introduction

Bladder calculi are a known complication of bladder augmentation; they affect 12–52% of patients after enterocystoplasty [1,2]. Risk factors include poor compliance with bladder washouts, need for CIC, presence of foreign bodies, recurrent UTIs, type of bowel segment used for augmentation, immobility, and bladder neck closure [3–5]. Various surgical techniques have been described to treat these stones. Open cystolithotomy remains the preferred option to treat large or multiple stones. Increasingly, however, minimal access techniques are used such as percutaneous surgery, urethral cystolitholapaxy, and extracorporeal shockwave lithotripsy.

Reports of Mitrofanoff cystolitholapaxy are rare [6,7]. This may reflect concern that stone surgery via the channel may risk damaging the continence mechanism of the channel [3,4]. The current study is a two centre case series of 13 paediatric patients treated by cystolitholapaxy via the Mitrofanoff/Monti channel. It focused on stone clearance, recurrence, and leak or catheterisation difficulties of the Mitrofanoff/Monti channel after the procedure.

Material and methods

With institutional approval, the current study retrospectively reviewed and identified 14 patients, on a prospective database, who underwent Mitrofanoff cystolitholapaxy to treat bladder calculi at two independent institutions in the UK and Chile between 2004 and 2016. Data analysed were patient demographics, underlying pathological condition, age at augmentation, bowel segment used for augmentation and channel, bladder neck repair and closure, age at first stone occurrence, stone burden, stone composition, concomitant UTI, compliance with bladder washouts, size of Amplatz, technique for stone fragmentation and retrieval, stone clearance (ascertained by ultrasound and abdominal x-ray), complications including recurrence of stone, and any issues relating to the Mitrofanoff channel after the procedure.

This stone fragmentation technique was chosen for patients who had a small stone burden and a working Mitrofanoff channel, and whose stones were unable to be accessed via the urethral route because of previous surgery or anatomical difficulties. Percutaneous cystolitholapaxy was offered to patients with a larger stone burden.

For the procedure, a 0.035-inch straight guide wire (for example Sensor guidewire, Boston Scientific®) was placed by initial endoscopy (Storz® (UK) 0°/30° 9.5 Ch) of the Mitrofanoff/Monti channel. The channel was serially dilated using progressively larger Jacques/Nelaton catheters (12–16 Ch Rusch® (Teleflex medical, UK)) before passage of the Amplatz (Cook Medical, US) sheath (range 18–28 Ch, median 18 Ch) with an introducer. To visualise the stone an R. Wolf® (Richard Wolf GmbH, Knittlingen, Germany) 18 Ch mini nephroscope or R. Wolf® 9.8 Ch STING scope was used. Stones were fragmented using either a SwissMaster® Lithoclast, Holmium YAG laser (Cook Medical, Bloomington, USA) or grasping forceps. Stones were removed with grasping forceps or Boston Scientific® (Boston Scientific Corporation, Natick, MA, USA) Zero-tip 2.4 Ch basket. A Nelaton catheter was placed through the Mitrofanoff channel after the procedure.

Statistical analysis

As the numbers of patients was small, significance testing was not appropriate. Therefore, raw data are presented with the mean, median and range.

Results

Fourteen patients underwent Mitrofanoff cystolitholapaxy during the period 2004–2016. One patient was excluded due to lack of follow-up. The remaining 13 patients (eight males, five females) were aged 5–22 years (median 14) at the time of the procedure. Their underlying diagnoses were four neuropathic bladders, four bladder exstrophy, four cloacal exstrophy, and one PUV. Patients underwent augmentation cystoplasty at a median age of 5 years (range 1–15), using ileum in 10 and sigmoid colon in three, accompanied by a Young-Dees-Leadbetter bladder neck reconstruction in four and bladder neck closure in two patients. The CIC channel was an appendix Mitrofanoff in nine and a Monti channel in four. The time period between continence surgery and treatment of first stone was a median of 7 (range 1–15) years. All patients had positive urine culture at the time of surgery. Non-compliance with bladder washouts was reported in five patients. All patients were using 10–12 Ch catheters to drain their bladders via the Mitrofanoff/Monti channel.

Recurrent stones were treated using the same technique via the Mitrofanoff/Monti channel. Stone and channel outcomes were analysed separately for each procedure. There were a total of 22 procedures in 13 patients, as five (38%) had recurrent stones. Total calculated stone surface area (diameter $\times$ width $\times$ π $\times$ 0.25) ranged from 58 to 707 mm^2 (median 176 mm^2). Stone composition was available for 11 patients (see Table 1).

In all but four procedures, cystolitholapaxy was through an Amplatz sheath (Cook®, Cook Medical , Indiana, USA). Size of Amplatz sheath ranged from 18 to 28 Ch (median 18 Ch). In the four procedures where an Amplatz sheath was not used, a Stinger Scope (Richard Wolf GmbH, Germany) was inserted via the Mitrofanoff and graspers were used to lift out the stone, and no fragmentation occurred. The stone surface area in these four procedures was between 28 and 176 mm^2. In all but three procedures, stones were fragmented by: grasper-crushing in six, ultrasound $\pm$ pneumatic energy using the SwissMaster® Lithoclast in 12, and Holmium YAG laser (0.8 J, 5 Hz, total 2.96 kJ) in one. Stone fragments were removed either by

Table 1 Stone composition.

Stone composition	Number of stones
Calcium phosphate	1
Calcium phosphate and calcium oxalate	2
Ammonium urate/uric acid/calcium phosphate	1
Struvite and ammonium urate stones	4
Struvite and calcium oxalate	1
Struvite and calcium phosphate	2

vortex through the Amplatz sheath, by grasping forceps, or by a Boston Scientific® (Boston Scientific Corporation, Natick, MA, USA) Zero-tip 2.4 Ch basket until the patient was visually stone-free. A size 12—16 Ch catheter was left through the Mitrofanoff/Monti channel at the end of the procedure in all but one patient. Using their usual size catheter (10—12 Ch) CIC was recommenced after 48 h; it was recommended straight after the procedure in the one remaining patient. Two patients kept indwelling catheters through the Mitrofanoff/Monti channel as they had been unable to tolerate CIC of the channel prior to the procedure. Antibiotics were given to all patients at induction and continued postoperatively for 2—7 days. Intravenous fluids were given until full enteral intake was established. There were no immediate complications. All patients were discharged the next day. Stone clearance was confirmed by ultrasound and abdominal x-ray at 3—6 months after the procedure (see Table 2).

Median follow-up was 15 (range 3—53) months. All patients were asked about any difficulties with the Mitrofanoff channel at the 3-month follow-up. Leakage was defined as any report from the patient about their channel leaking. Whilst there were no leaks or difficulties catheterising the channel at follow-up, stone recurrence occurred in five of 13 (38%) patients (see Table 3). Median time to recurrence was 6 months. Three patients developed a single stone recurrence 12, 12 and 24 months later; one developed three further stone recurrences and one patient had four episodes of stone recurrence. In the patient who had four episodes of stone recurrence, these occurred within a short period of time (8, 4, 3, and 2 months). This was an index case of a conjoined twin with a reconstructed bladder, closed bladder neck, Monti channel and reconstructed abdominal wall. Treatment of the stones through the Monti channel was felt to be the safest option in this case, as stones kept reforming at the end of an indwelling Malekot catheter, which had been left through the Monti channel. Once the Malekot catheter was exchanged for a silicone catheter, no further stone recurrence was reported (further follow-up at 53 months).

Table 2 Equipment used for the 22 procedures.

Amplatz sheath	**Number**
No sheath	4
18 Ch	13
20 Ch	3
26 Ch	1
28 Ch	1
Fragmentation method	**Number**
Swiss Lithoclast	12
Grasper	6
Laser	1
No fragmentation (lift-out)	3
Retrieval method	**Number**
Grasping forceps	18
2.4 Ch basket	4
Size of postoperative catheter	**Number**
No catheter	2
12 Ch	1
14 Ch	12
16 Ch	7

Discussion

This was the first series of Mitrofanoff/Monti cystolitholapaxy for the treatment of calculi in augmented bladders in paediatric patients. Two earlier case reports in adults have described cystolitholapaxy via Mitrofanoff using either a Lawrence Add-a-Cath sheath or a mini-PCNL kit [6,7]. For those needing more than a simple stone lift-out, an Amplatz sheath was used, generally 18 Ch, after the initial endoscopy and gentle serial dilatation.

The Mitrofanoff principle was first described by Paul Mitrofanoff in 1980. He described a continence mechanism with the use of the appendix to make a flap valve. A submucosal tunnel is created within the bladder wall for the appendix, which allows for a supple and small-diameter conduit. As the bladder reservoir fills, the rise in intravesical pressure is transmitted through the epithelium and to the implanted conduit, coapting its lumen [8]. Mitrofanoff cystolithopaxy has not been widely reported in the literature. Concerns have been raised about damage to the continence mechanism of the Mitrofanoff conduit by instrumentation; these include placing the patient at risk of stomal stenosis or incontinence, especially if there is a high frequency of manipulations across the conduit [3,9].

Using the Amplatz sheath in the current series meant that there was a fixed channel in place across the delicate continence mechanism of the Mitrofanoff, through which fragmentation and removal of the stone could occur, thus protecting it. In four cases, no Amplatz sheath was used; in all of these cases, the procedure involved lifting the stone out without fragmentation and avoiding multiple manipulations through the Mitrofanoff channel. Another advantage of using the Amplatz sheath is that it allows open and free drainage of irrigation fluid around the working instrument, thus reducing the intravesical pressure within the augmented bladder and risk of rupture [9]. A larger Amplatz sheath is not just bigger but also stiffer than an 18 Ch sheath, which might be more traumatic for the channel but does facilitate extraction of stone fragments and drainage of irrigation fluid. None of the current patients, including those in whom a larger Amplatz was used, developed leak or difficulties with CIC after any of the 22 procedures on follow-up. Nevertheless, an 18 Ch Amplatz sheath is advocated for the procedure.

Recurrence of stones in augmentation cystoplasty is common. Cohen et al. reported a recurrence rate of 63% after 5-year follow up [10]. In the current series, the recurrence rate was 38% at the 3—53-month follow-up. In one patient, four recurrences were attributable to an indwelling Malekot catheter, which, after its removal, had no further stone recurrence 4 years later. It might be postulated that the risk of leaving a small fragment in a fold within the augment, acting as a nidus for recurrent stone formation, would be higher after fragmentation than after a single stone lift-out. However, Szymanski et al. examined the recurrence risk between open cystolithotomy, endoscopy via catheterisable channel or the urethra, and percutaneous surgery in 107 patients and found no link on

Table 3 Patients who developed stone recurrence after the original procedure.

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5
Age (at time of procedure), years	7	5	22	10	11
Underlying pathology	PUV	Cloacal exstrophy	Conjoined twin, neuropathic bladder	Covered cloacal exstrophy variant	Bladder exstrophy
Bowel segment	Ileum	Ileum	Ileum	Ileum	Ileum
Bladder neck surgery	No	No	Bladder neck closure	Bladder neck closure	Bladder neck repair
Time between augmentation and procedure, years	8	1	8	9	4
Mitrofanoff	Monti	Monti	Monti	Appendix	Appendix
Regular bladder washouts	Yes	No	Yes	Yes	No
Time to recurrence, months	3, 4, 47	36	8, 4, 3, 2	12	24
Number of recurrences	3	1	4	1	1
Length of follow-up since last recurrence, months	3	49	53	12	34

univariate or multivariate analysis [8]. They reported an overall recurrence rate of 34% at 5 years and 50% at 9 years, with the greatest risk in the first 2 years after initial cystolitholapaxy. From current experience, use of an Amplatz sheath facilitates the wash-out of small stone fragments, although careful inspection of the augment is needed to ensure complete stone clearance.

Taking in consideration the high rate of recurrence in this group of patients, cystolitholapaxy via the Mitrofanoff/Monti is especially attractive [11,12]. It is less morbid than repeated open surgery or PCCL, and requires minimal postoperative analgesia and a single overnight hospital stay.

Conclusion

This case series shows that cystolitholapaxy via a Mitrofanoff/Monti channel is a safe procedure in children. It is recommended that this technique is used in patients where the stone burden is not high, for example in patients who have single stones, and where access through the native urethra is unfeasible. The use of an Amplatz sheath protects the continence system of the Mitrofanoff/Monti channel from repeated instrumentation, permits free backflow of irrigation, and rapid clearance of stone fragments.

Conflict of interest/funding

None.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jpurol.2018.02.024.

References

[1] Woodhouse RJC, Robertson WG. Urolithiasis in enterocystoplasties. World J Urol 2004;22:215—21.
[2] Kisku S, Sen S, Karl S, Mathai J, Thomas RJ, Barla R. Bladder calculi in the augmented bladder: a follow up study of 160 children and adolescents. J Paed Urol 2015;11:66.
[3] Okhunov Z, Duty B, Smith A, Okeke Z. Management of urolithiasis in patients after urinary diversions. BJUI 2011;108:330—6.
[4] Szymanski KM, Misseri R, Whittam B, Amstutz S, Kaefer M, Rink RC, et al. Cutting for stone in augmented bladders — What is the risk of recurrence and is it impacted by treatment modality. J Urol 2014;191:1375—80.
[5] Hernandez-Martin S, Lopez-Pereira P, Lopez-Fernandez S, Ortiz R, Marcos M, Lobato R, et al. Bladder neck closure in children: long-term results and consequences. Eur J Pediatr Surg 2015;25(1):100—4.
[6] Floyd Jr MS, Sakalis V, Davies M. Mitrofanoff cystolitholopaxy and bladder biopsy using mini-PCNL kit. JCU 2017;10(1):36—8.
[7] Floyd Jr MS, Stubington SR. Mitrofanoff cystolitholapaxy: an innovative method of stone clearance in a hostile abdomen with an inaccessible urethra. Urol J 2015;12:2115—8.
[8] Wein AJ, Kavoussi LR, Partin AW, Peters CA. Campbells urology. 11th ed.
[9] L'Esperance JO, Sung J, Marguet C, L'Esperance A, Albala DM. The surgical management of stones in patients with urinary diversions. Curr Opin Urol 2004;14:129—34.
[10] Cohen TD, Streem SB, Lammert G. Long-term incidence and risks of recurrent stones following contemporary management of upper tract calculi in patients with a urinary diversion. J Urol 1996;155:62—5.
[11] Palmer LS, Franco I, Kogan SJ, Reda E, Gill B, Levitt SB. Urolithiasis in children following augmentation cystoplasy. J Urol 1993;150:726.
[12] Metcalfe PD, Cain MP, Kaefer M, Gilley DA, Meldrum KK, Misseri R, et al. What is the need for additional bladder surgery after bladder augmentation in Childhood? J Urol 2006;176:1801.