Percutaneous cystolithotripsy in the management of pediatric bladder stone

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Background

Bladder stones in children represent up to 15% of all pediatric urolithiasis. Variant methods of managing vesical stones in children are available now with comparable success rates. Percutaneous cystolithotripsy (PCCL) was introduced to our department to be offered for male children on a routine basis.

Aim

To evaluate our experience in managing bladder stones in male children less than 14 years of age via PCCL regarding safety and efficacy.

Patients and methods

A total of 37 children underwent PCCL for their bladder stones in the period between November 2016 and November 2017 in Assiut Urology and Nephrology Hospital. Their median age was 36 (12–144) months and median stone size was 11 (7–26) mm. Initial diagnosis was urethral stones in 26 (70.3%) patients and bladder stones in 11 (29.7%) patients. Patients were followed up for periods ranging from 5 to 33 months (median 18 months).

Results

The median operative time was 14 (5–45) min. Twenty-one (56.8%) patients underwent direct stone extraction without disintegration of their bladder stones. Sixteen (43.2%) patients needed disintegration of their stones, of which 13 (81.25%) had pneumatic disintegration of their stones, whereas three (18.75%) had laser disintegration. Success was achieved in 36 (97.3%) patients. Complications were reported in three (8.1%) cases, and prolonged catheterization was reported in two (5.4%) patients.

Conclusion

PCCL is a safe and effective minimally invasive method for treating bladder stones in children.

Keywords:
bladder, children, percutaneous, stones

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Introduction

Bladder stones represented a serious problem to the ancient Egyptians; the oldest stone on record was a bladder calculus found in 1901 by the English Egyptologist Sir Grafton Eliot Smith in a prehistoric Egyptian tomb in the pelvis of a 16-year-old boy's mummy in Egypt [1]. Urinary bladder stones are more common in male children, with a male to female ratio of 10: 1. This is presumably owing to the differences in the anatomy of the male and female urethras [2]. Girls can pass fragments of stones more frequently without retaining nuclei in the bladder [3–5].

The size and composition of the stone, underlying comorbidity, previous surgery, patient morphology and compliance, operative costs, surgical expertise, and available instrumentation should be considered before definite treatment. Open cystolithotomy has been the traditional modality to treat bladder stones in children. Open surgery has the inherent problems of a long hospital stay, being cosmetically bad from the suprapubic scar, prolonged catheterization, need for analgesics, and the risk of wound infection [6].

The advents of improved endoscopic techniques and related technology have made endoscopic management of bladder stones feasible. Vesical calculi in children can be treated endoscopically with disintegration of the stones using pneumatic lithotripsy or holmium: yttrium–aluminum–garnet laser lithotripsy. Transurethral disintegration for urinary bladder stones is a common method; however, in children, especially in boys, a smaller caliber urethra limits effective transurethral treatment of large bladder stones. Transurethral endoscopic removal of stone fragments is difficult and fraught with iatrogenic urethral stricture. Percutaneous cystolithotripsy (PCCL), however, is now used worldwide. It has less morbidity than open surgery and fewer limitations than the transurethral endoscopic route [7].

On the contrary, PCCL has some disadvantages, such as the presence of an incision, the need to dilate a tract, the insertion of a suprapubic tube, and the need for a urethral catheter [7]. There are other reported complications, including paralytic ileus, abdominal distention from the escape of irrigating fluid into the abdominal cavity, fever, and urine leakage [7]. Herein we evaluated the safety and efficacy of PCCL in managing bladder stones in male children less than 14 years.

Patients and methods

Between November 2016 and November 2017, 37 children had PCCL for their bladder and urethral stones. Any male child less than 14 years old age with single bladder or urethral stones was included in the study. Those with neurogenic bladder, augmented bladder, upper urinary tract stones requiring simultaneous ureteroscopy, percutaneous nephrolithotripsy or ureteral stent insertion, urethral stricture, stone in fossa navicularis that could be extracted after meatotomy, previous suprapubic procedures, multiple urethral/bladder calculi, severe skeletal malformation that prevents lithotomy position, and bleeding tendency were excluded. All patients were subjected to thorough history, clinical examination, and surgical fitness. Abdominal ultrasonography and kidney, ureter and bladder radiograph film were performed in all patients. Noncontrast computed tomography scan was performed in cases with radiolucent stones.

Under general anesthesia, sterilization was done, and parenteral third-generation cephalosporin was given to all patients. All patients had initial diagnostic urethrocystoscopy in lithotomy position using an operating compact 7-Fr cystourethroscope to evaluate stone burden and to exclude any anatomical abnormality. Urethral stones were pushed back to the bladder. A Foley's urethral catheter was fixed for continuous irrigation. Mild traction on urethral catheter was done for prevention of escape of stone fragments through the bladder neck. Then, the bladder was filled with 100–200 ml of normal saline. Access to the distended bladder was obtained by a 10 G needle in the midline, 1–2 cm above the pubic bone. Once suitable placement was confirmed with the return of bladder fluid, a guide wire was passed through the needle to the bladder. Dilatation was done using 8–10-Fr coaxial dilator. Then, a single fascial dilator 20 Fr in diameter with placement of a suitable sheath as a working tract was then introduced. No ultrasonic or fluoroscopic guidance was used to gain access to the bladder. Placement of a 12-Fr pediatric nephroscope through the sheath was done. Stone basket was used to extract the stone. If the stones were too large to be extracted through the used sheath, disintegration was performed with a pneumatic lithotripter or holmium: yttrium–aluminum–garnet laser. Stone retrieval then was done using stone basket. Primary skin closure of the suprapubic stab wound by a single 3–0 polyglycolic acid stitch was done. The urethral catheter was left for 48 h under coverage of antibiotics and analgesics. Later follow-up was done after 1 week by abdominal ultrasonography and plain kidney, ureter and bladder radiograph to confirm stone-free state and to exclude the presence of any complications. Success after procedure was defined as no residual stone fragments with no need to shift to other modality. Complications were graded according to the Uro-Clavien-Dindo classification system (2012).

Results

In this study, the median age was 36 (12–144) months and median stone size was 11 (7–26) mm. Initial diagnosis was urethral stones in 26 (70.3%) patients and bladder stones in 11 (29.7%) patients. Noncontrast computed tomography scan was ordered in seven (18.9%) patients with radiolucent stones. The median operative time was 14 (5–45) min. Sixteen (43.2%) patients needed disintegration of their stones, of which 13 (81.25%) had pneumatic disintegration of their stones, whereas three (18.75%) had laser disintegration. Patients were followed up for periods ranged from 5 to 33 months (median 18 months).

Success was achieved in 36 (97.3%) patients. Failure of procedure was reported in only one case of a 66-month-old boy with a bladder stone 20 mm in diameter with trial of pneumatic disintegration. Development of intraperitoneal collection occurred that shifted the procedure to open cystolithotomy with retrieval of all stone fragments and drainage of collection.

Complications were reported in three (8.1%) cases, and prolonged catheterization was reported in two (5.4%) patients. One patient had subcutaneous fluid collection in the scrotum and suprapubic region owing to escape of irrigation fluid during percutaneous management of the stone. After scrotal skin release incision, the catheter was left for 1 week with antibiotic coverage over this period to guard against secondary infection until swelling subsided. One patient had prolonged catheterization because of failed percutaneous extraction of stone and intraperitoneal fluid collection owing to escape of irrigation fluid into the peritoneum that needed open cystolithotomy for stone delivery and drainage of free intraperitoneal collection. Another patient had his bladder stone entrapped in the subcutaneous tract that was managed by widening of skin incision and extraction of the stone.

Discussion

Bladder stones represent 5% of all pediatric urolithiasis, reaching up to 15% in developing countries, with 1–5% incidence in developed world [8]. The need for an effective method for management of bladder stones in male children with sparing of the delicate, growing urethra led to the development of variant techniques aiming to extract bladder stones with the least morbidity.

Open suprapubic cystolithotomy was the procedure of choice for treating not only vesical calculi, but it also was the preferred method for managing posterior urethral stones after being pushed back to the bladder [6]. Being simple, cheap, achieving stone-free rate up to 100% in a single session, and sparing the urethra from manipulation had made open cystolithotomy the preferred method till now in some centers [6,9]. A lot of modifications had been applied to the traditional open cystolithotomy aiming at decreasing hospital stay and morbidity [10]. Yet, this technique had the problem of prolonged catheterization, relative long hospital stay, suprapubic scar, and the risk of wound infection [6]. PCCL offers an alternative method for managing bladder calculi in children, with less operative time and morbidity compared with open cystolithotomy, with high success rates. Another advantage of PCCL is that it spares the delicate narrow-calipered urethra in children [11,12]. It is the preferred method in treating stones in augmented bladder and in cases of bladder neck reconstruction [13].

Table 1 shows the comparison between our case series and previous studies done by Ahmadnia *et al.* [12], Gan *et al.* [14], and Salah *et al.* [15] regarding managing bladder stones in children via PCCL.

In their case series, Gan *et al.* [14] and Salah *et al.* [15] fixed a suprapubic tube and a urethral catheter at the end of their PCCL procedures. Agrawal *et al.* [7] fixed a suprapubic tube only at the end of their case series of PCCL. In this study, we fixed a urethral catheter without a suprapubic tube to reduce patient morbidity and the need for further intervention and maneuver.

Safwat *et al.* [6] performed cystoscopic guided percutaneous suprapubic stone extraction for management of posterior urethral stones after being pushed back to the bladder using a hemostat without fluoroscopy. Another similar technique was described by Gamal *et al.* [16] for managing bladder and urethral stones. Both techniques are minimally invasive and effective in cases of small stones. This technique has limitation in cases of large or multiple stones. Moreover, there is no stable percutaneous tract with possibility of missing the access to the bladder during stone extraction and loss of the stone in the parietal layers.

Similar to Agrawal *et al.* [7] case series, we did not use fluoroscopic guidance to gain access to the bladder to minimize exposure to ionizing radiation in our series of pediatric patients. Depending on the anatomy of the

Table 1 Comparison between our case series and other studies in managing bladder stones in children using percutaneous cystolithotomy technique

	Ahmadnia *et al.* [12]	Gan *et al.* [14]	Salah *et al.* [15]	Our case series
Number of patients	147	15	155	37
Age (years)	Mean 4.07 (1-12.5)	Mean 0.68 (0.25-0.96)	>14	Median 3 (1-12)
Number of stones	Single stone	Single stone	Single stone	Single stone
Stone size (cm)	Mean 2.74 (0.8-5)	Mean 1.4 (0.9-2.2)	Mean 2.3 (0.7-4)	Median 1.1 (0.7-2.6)
Need for fluoroscopy	No	Yes	Yes	No
Working tract diameter	30 Fr	16 Fr	30 Fr	20 Fr
Endoscope used	26 Fr nephroscope	8-9 Fr ureteroscope	26 Fr nephroscope	12 Fr pediatric nephroscope
Method of disintegration	Pneumatic Lithoclast	Pneumatic Lithoclast	Ultrasonic	Pneumatic Lithoclast 13 (81.25%), Ho-YAG 3 (18.75%)
Method of stone retrieval	Stone forceps	Stone forceps	Stone forceps	Stone basket
Duration of procedure (min)	Mean 29.7 (12-48)	Mean 25 (10-50)	Mean 20 (5-60)	Median 14 (5-45)
Urethral catheter duration (days)	2	2-3	2	2
Suprapubic tube (days)	No	1-2 (14 Fr)	1 (18-20 Fr)	No
Stone-free state (%)	100	100	99.3	97.3
Complications	Fever 16 (11%) Hematuria 6 (4%)	-	Ileus 15 (9.7%) patients Intraperitoneal extravasation 1 (0.68%)	3 (8.1%) patients

Ho-YAG, holmium: yttrium–aluminum–garnet.

Table 2 Complications during case series, their Uro-Clavien-Dindo classification, and management

Complication	#of cases	Uro-Clavien-Dindo classification	Management
Stone entrapped in subcutaneous tissue	1	Grade IIIb, i	Widening of skin incision and extraction of stone
Subcutaneous fluid collection	1	Grade IIIb, i	Prolonged catheterization and skin incision for drainage
Bladder perforation with intra-peritoneal collection	1	Grade IIIb, i	Shift to Open cystolithotomy and drainage of collection

bladder in children that it becomes an abdominal organ when it is full, we filled the bladder to its capacity by normal saline, and a puncture just 1–2 cm above pubic bone was done with a safe and satisfactory access to the bladder. Moreover, all patients had a urethral catheter for 48 h postoperatively (except two patients who had prolonged catheterization owing to complications).

Although transurethral cystolithotripsy has the advantage of short hospital stay and less morbidity compared with open cystolithotomy, concerns have aroused regarding the development of urethral stricture owing to prolonged operative time and multiple trials of stone fragment extraction [11]. The wide working tract in PCCL enabled us to extract stone easily with less operative time, and this favors PCCL in cases of large and multiple bladder stones. However, PCCL has the risk of bowel injury, paralytic ileus, and escape of irrigation fluid to the peritoneal cavity [7].

In Al-Marhoon *et al.* [11] case series of PCCL, complications were encountered in 3 patients in the form of intraperitoneal extravasation, which was managed by exploration. Table 2 show complications encountered in our case series, the Uro-Clavien-Dindo classification of these complications and the method of management. In this study, we had an acceptable overall success rate in 36 (97.3%) cases compared with other studies. We had three (8.1%) patients with complications. One patient with escape of the stone in the subcutaneous tissue during PCCL who was managed without alternation of the procedure by widening of the skin and successful stone extraction, one patient with intraperitoneal fluid collection who was managed by exploration, and repair of the bladder tear with smooth postoperative period. The tubal drain was removed 2 days postoperatively and the catheter was removed 7 days after the procedure. One patient developed subcutaneous extravasation during PCCL and was managed by small multiple release incisions in the scrotum and prolonged catheterization for 7 days.

Conclusion

PCCL is a safe and effective method in treating with bladder stones in male children. Less cost and morbidity can be achieved by using a urethral catheter only to drain the bladder effectively postoperatively and minimizing the use of fluoroscopy to gain access to the bladder. Another study to compare PCCL with other modalities of managing bladder stones in children, especially transurethral route, is recommended.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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