Review Article

Safety and efficacy of ureteroscopy and stone fragmentation for pediatric renal stones: a systematic review

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Abstract: Flexible ureteroscopy (FURS) is now commonly used for the treatment of paediatric renal stones. We conducted a systematic review of literature looking at the outcomes of flexible ureteroscopy and laser lithotripsy (FURSL) for paediatric stone disease. A systematic review was conducted in a Cochrane style and in accordance PRISMA checklist using MEDLINE, CINAHL, EMBASE, Scopus, and Cochrane library for all English language articles in patients ≤18 years from 1990–2018 who underwent FURSL. A total of 11 studies reported on 431 patients, with a mean age of 8.5 years (range, 0.25–17 years). The mean stone size was 13 mm (range, 1.5–30 mm). The overall stone free rate (SFR) was 87% (58–100%) with a mean complication rate of 12.6% (n=55) (range, 0–31.3%) and 76% needing a post-operative ureteric stent insertion. Of the complications, Clavien I/II complications included fever and urinary tract infection (UTI) (n=19), haematuria (n=7), stent discomfort/stent symptoms/post-operative pain (n=8), voiding disturbance (n=2) and post-operative nausea and vomiting (n=1). Clavien III complications included ureteral injury which included perforation (n=6), urinoma (n=1), and acute urinary retention secondary to stone fragmentation (n=1). Clavien IV complications were urinoma (n=2) and no Clavien V complications were noted. Our review suggests that ureteroscopy and laser stone fragmentation for paediatric population is a safe and effective treatment with good SFR and a low risk of complications.

Keywords: Flexible ureteroscopy (FURS); laser fragmentation; pediatric stone disease; pediatric ureteroscopy

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Introduction

There has been a rise in the incidence of kidney stone disease (KSD) globally (1-4). The overall lifetime prevalence of KSD in the UK now stands at 14% (2). Furthermore, of those patients that are known to have stone disease, there is a recurrence rate of 50–75% at 10 years (3). Although paediatric stone disease remains proportionally much lower than in the adult population, it is thought that the number of cases diagnosed worldwide is on the rise (1,3).

Flexible ureteroscopy (FURS) has long been an established treatment for adult stone disease and its use is becoming increasing popular in the paediatric population (4). Richie *et al.* first used URS to extract lower ureteric stones in children in 1988 and since then it has been an exciting and developing field of surgery (5,6). With ongoing and emerging advancements in technology, the URS equipment continues to be adapted for paediatric use whilst training opportunities for surgeons have made this a safe intervention. Ureteroscopy can therefore now be used as a treatment for both ureteric and renal paediatric stone disease of varying and increasing complexion. It is

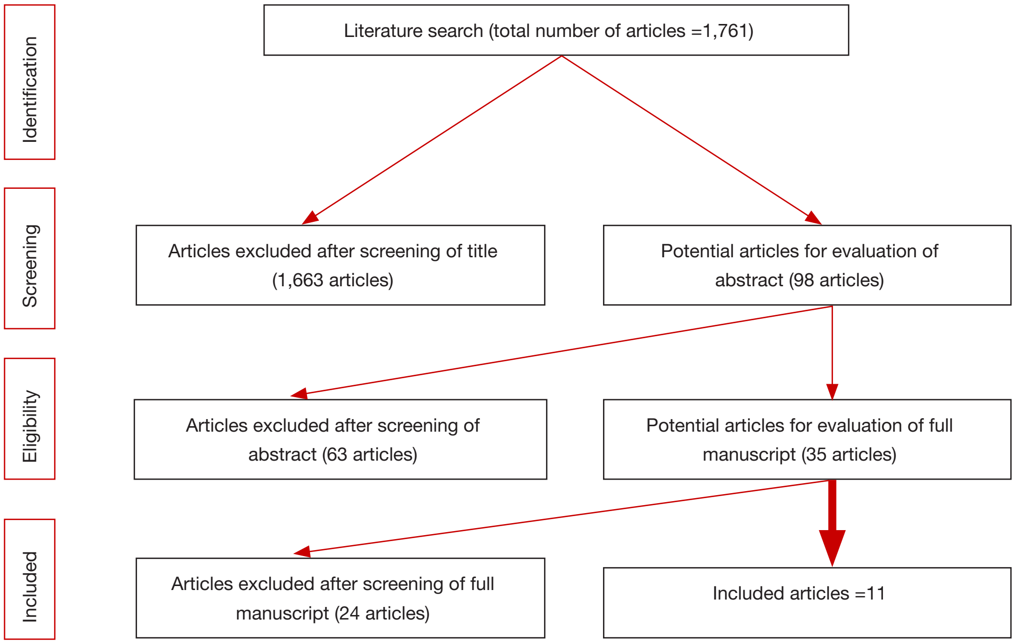

Figure 1 PRISMA flowchart of the included studies.

fast becoming the mainstay of treatment, meaning that the prolonged hospital stays and long open operations that were previously required, are thankfully increasingly rare (7). However, as this is relatively new practice, there is currently limited evidence with regards the efficacy and safety of its use within specifically the paediatric population. The current evidence suggests that ureteroscopy could be a viable treatment option for paediatric stone disease (8-13).

We wanted to look at the outcomes of flexible ureteroscopy and laser lithotripsy (FURSL) in the paediatric population for stone disease. This would help to better understand its efficacy and safety and therefore its role within the treatment of stone disease in this age group. We conducted a systematic review of literature looking at the outcomes of FURSL for paediatric stone disease.

Methods

We conducted a Cochrane-style systematic review carried out in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) checklist. All major databases were searched including MEDLINE, CINAHL, EMBASE, Scopus, and the Cochrane library. Search terms included 'paediatric', 'ureteroscopy', 'flexible', 'stones', 'calculi', 'infants', 'retrograde intra renal surgery', 'RIRS', 'URS', 'FURSL' and 'ureterorenoscopy'. All English language articles published between January 1990-December 2018 on FURSL in patients ≤18 years of age were included. There were no additional exclusion criteria. Data was then pooled with an existing systematic review and analysed accordingly (14).

Results

A total of 11 studies (431 patients) were found to meet the criteria set for the review (*Figure 1*). Of these studies, 5 were published from Turkey, 2 from the USA, 2 from England and 1 each from France and Australia (*Table 1*). Of the patients included in the study, the male:female ratio was 1.1:1. Gender was not commented on studies by Suliman, Freton or Corcoran (15-17). The mean age of the patients was 8.5 years with a range of 0.25–17 years. Of the studies reported, the mean operating duration was 62 minutes with a mean length of stay of 1.3 days (range, 0–5 days). Nine studies commented on the mean stone size reported as 13 mm (1.5–30 mm), and a mean stone burden reported across 2 other studies of 10.2 mm (1.5–25 mm) (17,18).

Stone location was variable with majority (n=483) being renal stones. Of these locations, they were in the lower pole (n=141), renal pelvis (n=107), upper pole (n=73), middle pole (n=27) and other unspecified renal stones (n=85) (*Table 2*). The other stone locations were in the

Table 1 Patient demographics of the included studies

Author	Journal	Year	Country	Number of cases	Mean age (range)	Male:female	Stone free rate (%)	Stone size, mm (range)
Suliman *et al.* (15)	*Urolithiasis*	2018	England	36	10.6 (1.4–15.7)	NR	89.0	8 [3–23]
Freton *et al.* (16)	*J Endourol*	2017	France	46	9.1 (±0.9 SD)	NR	76.1	21.6 (±2.0 SD)
Corcoran *et al.* (17)	*J Urol*	2008	USA	30	9.7 (2.2–14.4)	NR	94.0	8.8 (1.5–25)—burden
Unsal and Resorlu (18)	*J Pediatr Surg*	2011	Turkey	16	4.2 (0.8–7)	9:7	88.0	11.5 [8–17]—burden
Yuruk *et al.* (19)	*J Pediatr Urol*	2017	Turkey	14	10.9 [7–15]	8:6	100.0	13.6 [10–18]
Baş *et al.* (20)	*J Endourol*	2016	Turkey	36	8.4 [1–16]	15:21	86.1	12.8 [10–19]
Erkurt *et al.* (21)	*Urolithiasis*	2014	Turkey	65	4.3 (0.5–7)	31:34	92.3	14.7 [7–30]
Yeow *et al.* (22)	*J Indian Assoc Pediatr Surg*	2009	Australia	26	8.2 (0.25–15)	14:12	88.5	10.3 [3–21]
Tanaka *et al.* (23)	*J Urol*	2008	USA	50	7.9 (1.2–13.6)	31:19	58.0	8.8 (1.5–25)
Resorlu *et al.* (24)	*J Urol*	2012	Turkey	95	9.3 [1–17]	53:42	92.6	14.3 [10–30]
Featherstone *et al.* (25)	*J Pediatr Urol*	2017	England	17	10.8 (3.9–15)	9:8	88.2	13.3 [10–25]

Table 2 Stone location in the included studies

Author	PUJ	RP	UP	MP	LP	Non-LP	Other renal	Ureteric
Suliman *et al* (15)	–	20	21	–	29	–	48	11
Freton *et al.* (16)	–	–	–	–	17	–	–	–
Corcoran *et al.* (17)	11	10	3	6	–	–	–	–
Unsal and Resorlu (18)	–	5	3	4	5	–	–	–
Yuruk *et al.* (19)	–	4	4	3	3	–	–	–
Baş *et al.* (20)	–	14	2	1	10	–	9	–
Erkurt *et al.* (21)	–	22	10	12	28	–	–	–
Yeow *et al.* (22)	–	–	–	–	–	–	17	7
Tanaka *et al.* (23)	27	–	–	–	13	9	2	–
Resorlu *et al.* (24)	–	29	28	–	29	–	9	–
Featherstone *et al.* (25)	3	3	2	1	7	–	–	2

PUJ, pelvicalyceal system; RP, renal pelvis; UP, upper pole; MP, mid pole; LP, lower pole.

ureteropelvic junction (n=41) and ureteric stones (n=20).

Seven studies (15,16,19-23) commented on pre-operative stent insertion rates. Of these studies, the mean pre-operative stenting rate was 42.6% (7.1–96.20%). The laterality of the stones was not routinely commented on. The overall stone free rate (SFR) was 87% (58–100%). An average of 76% (60–98%) cases required post-operative stent insertion and three studies (20-22) did not comment on ureteric stent insertion rates.

The mean complication rate was 12.6% (n=55) (range, 0–31.3%) with two studies reporting no complications at all. The most frequently occurring complications were fever and urinary tract infection (UTI), haematuria and post-operative pain, including stent discomfort. The complications were

Table 3 Complication rates of the included studies

Author	Percentage complication rates, n (%)	Complication [n]
Suliman *et al.* (15)	2 (3.6)	Post-operative UTI [1], stent symptoms [1]
Freton *et al.* (16)	10 (21.7)	Stent discomfort [3], haematuria [1], post-operative UTI [3], urinoma [1], urinary retention secondary to stone fragmentation [1], urinoma [1]
Corcoran *et al.* (17)	3 (0.3)	Ureteral perforation [2], urinoma requiring percutaneous drainage [1]
Unsal and Resorlu (18)	5 (31.3)	Ureteral perforation [1], abdominal pain [2], voiding disturbances [2]
Yuruk *et al.* (19)	2 (14.3)	Post-operative fever [1], ureteral laceration [1]
Baş *et al.* (20)	6 (16.7)	Fever [2], colic [1], post-operative uti [2], stent insertion secondary to colic [1]
Erkurt *et al.* (21)	18 (27.7)	Post-operative haematuria [6], post-operative uti and fever [10], ureteral wall injury [2]
Yeow *et al.* (22)	0 (0)	–
Tanaka *et al.* (23)	1 (2.0)	Readmission due to nausea and vomiting [1]
Resorlu *et al.* (24)	8 (8.4)	Unspecified [8]
Featherstone *et al.* (25)	0 (0)	–

UTI, urinary tract infection.

classified according to the Clavien classification. Clavien I/II included fever and UTI (n=19), stent discomfort/stent symptoms/post-operative pain (n=8), voiding disturbance (n=2), haematuria (n=7), and post-operative nausea and vomiting (n=1). Clavien III complications included urinoma (n=1), ureteral injury which included perforation (n=6) and acute urinary retention secondary to stone fragmentation (n=1). Clavien IV included urinoma (n=2) and there were no Clavien V complications. The overall complication rate for Clavien I/II complications was 8.9% (n=35), the complication rate for Clavien III/IV complications was 2.5% (n=10). The complications encountered in the paper by Resorlu (24) were unspecified, however there was a reported complication rate of 8.4% (n=8) (*Table 3*).

Discussion

Meaning of our review

This review aimed to establish the efficacy and safety of FURS and laser stone fragmentation for the treatment of paediatric stone disease. A total of 11 studies were eligible for inclusion within the study and evidence appears to suggest that ureteroscopy for the management of paediatric stone disease is safe and effective with a low risk of major complications.

Over the past decade, the use of ureteroscopy for the treatment of stone disease has increased dramatically and could be considered the mainstay of initial treatment for both adult and paediatric stone disease. Advances in technology mean that we are now able to use ureteroscopy to treat stones that previously required open surgery. The use of ureteroscopy means that we are able to minimize operating times and cut the length of hospital stays. Only four papers commented on the length of hospital stay after ureteroscopy with a mean stay of 1.3 days (range, 0–5 days) (15,16,20,25). They also commented upon the mean length of operation which was 62 minutes.

Role of paediatric ureteroscopy in literature

Recently, a twin surgeon approach with a paediatric urologist and an experienced adult endourologist has been recommended and this seems to be a sensible approach for achieving good results in paediatric patients (25,26). The results also seem to be equally good in medium and high volume centres (27). Although there is also a rise in minimally invasive PCNL techniques, it seems that URS is also cost effective and is being performed in a wide cohort of patients (28-30). Compared to adult URS, paediatric URS is still performed in a much smaller cohort of patients with an overall risk of complications which is slightly higher than their adult counterparts (31). This slightly increased complication rate may be due to the fact that the paediatric population are surgically and technically more challenging (14). It may also be secondary to the fact that the use of ureteroscopy in the paediatric population is fairly new practice and therefore the equipment and techniques used are still evolving.

Strengths, limitations and areas of future research

Although there are still only a few studies on FURS for paediatric stone disease, our review provides is comprehensive and covers all aspects of this intervention. Clearly there is still a publication bias with only 3 of these studies with over 50 patients. Given that paediatric URS is not common, perhaps multi-centric prospective studies will help in standardised reporting and outcome measure to provide a better quality of evidence.

Conclusions

The use of ureteroscopy for the treatment of paediatric renal stones has increased. Paediatric ureteroscopy appears to achieve a good SFR with a low risk of morbidity when performed in tertiary centres with skilled and experienced surgeons.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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