ORIGINAL ARTICLE

Effectiveness of ultrasonography in the postoperative follow-up of pediatric patients undergoing ureteroscopic stone manipulation

Berkan Resorlu · Cengiz Kara ·
Eylem Burcu Resorlu · Ali Unsal

Abstract

Objectives To evaluate the effectiveness of ultrasonography and to determine whether ionizing radiation is necessary in the postoperative follow-up of children undergoing ureteroscopy.

Methods We reviewed the charts of 49 children who underwent 51 ureteroscopic procedures for ureteral calculi. Renal ultrasound and intravenous urography were performed in all patients at 3 months after surgery for postoperative evaluation.

Results In three cases, stones migrated to the kidney. Retrograde intrarenal surgery was performed in two patients and one patient required shockwave lithotripsy to become stone-free. Fourty-six children were completely stone-free and 3 had residual fragments on plain film in the postoperative 3 month. The sensitivity, specificity, negative and positive predictive values of ultrasonography for detecting hydronephrosis were 85.7, 100, 97.7 and 100%, respectively. Two patients under observation and three patients under medical expulsive therapy had resolution of hydronephrosis on follow-up. One patient required ureteroscopy for residual obstructing fragments.

Conclusions Ultrasonography has limited accuracy for detecting residual ureteral stones, but it is a highly specific and reasonably sensitive test for detecting hydronephrosis. A combination of ultrasonography and plain film is a safe and effective imaging procedure in postoperative follow-up of children undergoing ureteroscopy.

B. Resorlu (✉) · C. Kara · E. B. Resorlu · A. Unsal
Ministry of Health, Kecioren Training and Research
Hospital, Ankara, Turkey
e-mail: drberkan79@gmail.com

Introduction

Evolution of technique and miniaturization of instruments have changed the management of stone diseases. Ureteroscopy (URS) has gradually become a major technique for the treatment of ureteral stones in children and adults [1]. Introduction of smaller ureteroscopes, graspers, and baskets and safer intracorporeal lithotriptors has reduced the complication rates. Although rarely encountered, stricture formation and obstruction are significant complications after URS stone removal [2]. To detect these potential complications, many urologists include routine intravenous urography (IVU) or non-contrast computed tomography (CT) scan in postoperative monitoring. However, routine imaging for follow-up has recently been questioned, and studies regarding follow-up after this procedure are controversial. Some authors have concluded that routine postoperative imaging is crucial in all patients, whereas others recognize specific high-risk features that make postoperative imaging for obstruction and pain necessary for select patients only [3–6].

Radiological studies have improved with the emergence of the non-contrast CT as the gold standard for stone diagnosis [7–10]. Ultrasonography (US) has limitations compared with CT scan, as it has less sensitivity and specificity. However, US has clear advantages of convenience and lack of radiation exposure over CT scan and IVU. This is important especially in children. Although there have been a number of clinical series assessing the effectiveness of imaging procedures for follow-up after ureteroscopic lithotripsy in adult patients, to our knowledge

no study has been reported in pediatric patients about this topic. We reviewed our experience using URS for pediatric stone disease, and identified the effectiveness of renal US in the postoperative follow-up of pediatric patients.

Patients and methods

Patients

We retrospectively reviewed the medical records of 49 pediatric patients with ureteral stones, aged 16 years or younger, who underwent URS. Data were collected from the retrospective reviews of hospital and physician's office records, and by contact with the patients. Pretreatment evaluation included a careful medical history, clinical examination, routine blood tests, urinalysis, urine culture, plain abdominal film (KUB), renal USG and IVU. Renal scintigraphy and CT were not done routinely, but were performed whenever needed. Stone burden was measured by maximum additive linear diameter per stone or stones. All of the patients underwent renal US to determine the status of the renal parenchyma and the presence of hydronephrosis. The degree of hydronephrosis was evaluated in four categories as described previously: No, mild (blunting of calyces, normal thickness of renal parenchyma, and bandlike dilatation of renal sinus), moderate (dilatation outside calyces, dilatation of pelvis, renal contour enlargement, and compression of renal parenchyma), and severe hydronephrosis (severe dilatation of calyces, cystic appearance of pelvis, and markedly thin parenchyma) [10]. A primary metabolic workup was performed in all patients. Medical therapy and dietary planning were provided postoperatively in the outpatient setting when appropriate. Prophylactic perioperative wide-spectrum antibiotics were administered to patients with sterile urine, and patients with bacteriuria were treated according to the antibiogram results. Operative notes were reviewed to determine operative technique and intraoperative complications. Clinic charts were reviewed to determine stone-free status and postoperative complications.

Follow-up

The follow-up period ranged from 3 to 28 months (average 13.4 months). Postoperative evaluation included a KUB radiograph on day 1 in patients who has residual fragments intraoperatively. A urinary ultrasonography was also obtained on postoperative day 10 in all patients. Then the first follow-up evaluation was performed 3 months after the operation after which patients were seen every 3 months during the first year, and every 6 months thereafter. At first visit, urinalysis, urine culture, serum creatinine, renal US,

and IVU were performed. The success rate, is defined as stone-free and no obstruction. During follow-up, the patients subjectively reported the presence or absence of pain as persistent flank pain related to the same side treated with ureteroscopy. Hydronephrosis was observed for a period of time and followed with renal US for resolution. Persistent hydronephrosis prompted additional imaging with either CT scan or IVU and they were treated accordingly with additional surgery or medical expulsive therapy.

Results

Preoperative findings

A total of 49 children (27 boys and 22 girls) underwent a total of 51 ureteroscopic procedures for ureteral calculi at our institution. Mean patient age at the time of the procedure was 8.2 years (range 9 months–16 years) and mean stone size was 8.5 mm (range 5–17 mm). The location of stones was the distal ureter in 22 (43.1%) patients, mi-dureter in 12 (23.5%) patients, and proximal ureter in 14 (27.4%) patients. Three patients (5.9%) had multiple ureteral stones and they were treated primarily with URS. Six (12%) patients had failed ipsilateral shock wave lithotripsy (SWL) in their history. All six ureteral stones that failed to be cleared by SWL were successfully treated by URS.

The most common presenting symptom was flank or abdominal pain in 39 (79.6%) patients. The other common symptoms were hematuria in 29 (59.2%) and fever in 5 (10.2%) patients. Eleven (22.5%) patients had urinary-tract infection at presentation confirmed by urine culture. Three children had preoperative serum creatinine levels >1.5 mg/dL. Two of these patients had bilateral ureteral calculi. Single session bilateral URS was performed for these patients. The other patient, a 9-month-old infant, presented with anuria secondary to bilateral renal and ureteral calculi. Right percutaneous nephrolithotomy (PCNL) and left ureteroscopic stone treatment were performed for this patient. Creatinine levels reached normal values in these patients, and they were discharged home with stable creatinine levels. The preoperative characteristics of the patients are summarized in Table 1.

Operative findings

The surgical technique is similar to that in adults [11]. Balloon dilatation of the ureteral orifice was used in 10 (19.6%) procedures, while the remaining 41 (80.4%) cases did not require dilatation. In 4 (7.8%) patients, stones were extracted only by basket catheter. The holmium laser was used in 20 (39.2%) patients and pneumatic lithotripter was used in 27 (52.9%). Average operative time was 32.5 min

Table 1 Demographic and stone-related parameters

No. of patients	49
Mean age (range)	8.2 years (9 months–16 years)
Male/female	27/22
Clinical presentation (%)	
Hematuria	29 (59.2%)
Abdominal pain	39 (79.6%)
Urinary-tract infection	11 (22.5%)
Fever with chills	5 (10.2%)
Anuria	1 (2%)
Stone side (%)	
Left	23 (45%)
Right	26 (51%)
Bilateral	2 (4%)
Stone location	
Proximal ureter	22 (27.4%)
Middle ureter	12 (23.5%)
Distal ureter	14 (43.1%)
Multiple	3 (5.9%)
Stone size (range)	8.5 mm (5–17 mm)
Hydronephrosis (%)	
No	8 (15.7%)
Mild	16 (31.4%)
Moderate	18 (35.3%)
Severe	9 (17.6%)

Table 2 Perioperative and postoperative findings of patients

Mean operative time (range)	32.5 min (20–90 min)
Instrumentation	
Ureteral balloon dilatation	10 (19.6%)
Only basket catheter	4 (7.8%)
Holmium laser	20 (39.2%)
Pneumatic lithotripter	27 (52.9%)
Postoperative stent	15 (29.4%)
Mucosal edema	7
Failed surgery	1
Mucosal injury	4
Tight ureter	3
Complete stone fragmentation	49 (96.1%)
Completely stone-free	46 (90.2%)
Postoperative hydronephrosis	6 (12.2%)

(range 20–90 min). In three (5.8%) cases, stones migrated to the kidney. Retrograde intrarenal surgery was performed in the same session with URS in two patients and one patient required shockwave lithotripsy to become stone-free. In a patient, stone was large (17 mm) and impacted in the iliac region, and URS ended in failure, so open ureterolithotomy was carried out. A Double-J catheter was inserted in 15 (29.4%) patients. Indication of Double-J stenting included significant mucosal edema (7 patients), tight ureter (3 patients), failed surgery (one patient), and mucosal injury (4 patients) (Table 2).

Follow-up in postoperative 3 month

Of 49 procedures with perioperative complete stone fragmentation (96.1%), 46 were completely stone-free (90.2%), while fragments were observed on the KUB radiograph in 3 patients. Flank pain was accepted as a criteria for symptoms. A total of 42 patients were asymptomatic, while 7 (14.3%) patients complained of symptoms after URS. Symptoms were related to residual ureteral stone fragments in 3, urinary-tract infection 1 patient, and idiopathic in 3 patients. Renal US detected hydronephrosis in six (12.2%) cases; five patients were symptomatic, whereas one patient had asymptomatic hydronephrosis. Asymptomatic patient deemed to have chronic hydronephrosis. US showed the

presence of mild hydronephrosis in three patients, moderate hydronephrosis in two patients, and severe hydronephrosis in one patient. All of them were found to have ureteral obstruction by IVU (three patients had residual ureteral stones, and the other three children had persistent hydronephrosis). Forty-three children did not have hydronephrosis in US, but one of them had mild hydronephrosis without ureteral obstruction in IVU. The sensitivity, specificity, negative and positive predictive values of US for detecting hydronephrosis were 85.7, 100, 97.7 and 100%, respectively. In three cases who had persistent hydronephrosis after URS had impacted ureteral stones (10 mm proximal, 8 mm distal, and 9 mm distal) and ureteral edema preoperatively. A ureteral D-J stent has been placed to these three patients postoperatively. The other Double-J stenting patients with indication of mucosal injury and tight ureter did not have hydronephrosis postoperatively. The presence of stone impaction and ureteral edema can be the risk factors associated with postoperative hydronephrosis. Balloon dilation was performed in ten cases, with one patient (10%) having hydronephrosis postoperatively. The remaining 41 (80.4%) cases did not require dilatation, with 5 patients (12%) having hydronephrosis postoperatively. The preoperative stone burden was similar in patients with (9.2 mm) and without (8.4 mm) hydronephrosis. Two patients under observation and three patients under medical expulsive therapy had resolution of hydronephrosis on follow-up. One patient required URS with laser and Double-J stent insertion for residual obstructing fragments.

Discussion

Ureteral stones can be managed with observation, SWL or URS in children. Van Savage et al. showed that most of the

stones <3 mm in diameter in the distal ureter of children would pass spontaneously. Stones of 4 mm or greater in diameter are likely to require treatment [11]. In the 1980s the advent of SWL revolutionized pediatric stone management, and it is currently the procedure of choice for treating most of the urinary stones in industrialized nations [12]. However, the long-term effects of shock waves on developing kidneys and on contiguous viscera are not clear and many studies have shown that the success rate of SWL decreases significantly with increasing stone size. Lam et al. compared the efficacy of SWL with URS using holmium laser lithotripsy in 67 patients with proximal ureteral calculi. The stone-free rates in patients with calculi of >1 cm were 93% with URS and 50% with SWL, while for calculi of <1 cm, the stone-free rates were 100 and 80% for URS and SWL, respectively [13]. Due to significant improvements in the miniaturization and durability of endoscopic equipment, URS has become standard first line therapy for large, impacted, and distal-ureteral stones in children [14]. In present study, using the pediatric ureteroscopes, we cleared 90.2% of the ureteral stones in a single procedure, and with secondary procedures, this rate improved to 100%. In a patient, stone was large (17 mm) and impacted in the iliac region, and URS ended in failure, so open ureterolithotomy was carried out.

Perioperative minor complications were observed in five (9.8%) patients in our series, which was consistent with previously published series. All of these complications were managed conservatively. None of our children developed ureteral stricture. Introduction of smaller ureteroscopes, graspers, and baskets and safer intracorporeal lithotriptors has reduced the complication rates after URS stone removal. Most contemporary series report a rate of stricture formation of <1% [15]. Nevertheless, because of the concern for ureteral stricture development and subsequent renal deterioration, many urologists order routine IVU or CT scan in postoperative follow-up. IVU exposes the patient to ionizing radiation and, contrast-related nephrotoxicity can occur in patients with renal impairment. It also carries a small but definite risk of anaphylaxis [16]. Radiological studies have improved with the emergence of the non-contrast CT as the gold standard for stone diagnosis [7, 8]. However, CT involves higher radiation doses than the conventional X-ray imaging procedures. More recently, reports have been published on the theoretic increased risk of fatal cancer in adults and children as a result of a single CT examination, based on data from similar low levels of exposure to ionizing radiation during the atomic bombings of Nagasaki and Hiroshima [17, 18]. US has limitations compared with CT scan, as it has less sensitivity and specificity. Catalano et al. compared helical CT and sonography in the clinical setting of acute flank pain. The combination of KUB and sonography, when

compared with CT, has a 77.1 versus 92.4% sensitivity, 92.7 versus 96.4% specificity, 95.3 versus 98% positive predictive value, 68 versus 86.9% negative predictive value, and 82.5 versus 93.7% accuracy in patients who underwent all three techniques [19]. However, US has clear advantages of convenience and lack of radiation exposure over CT scan and IVU. It is important particularly in children.

Routine imaging for follow-up has recently been questioned, and studies regarding follow-up after this procedure are controversial. Some authors have concluded that routine postoperative imaging is crucial in all patients, whereas others recognize specific high-risk features that make postoperative imaging for obstruction and pain necessary for select patients only. Weizer et al. [6] suggested that postoperative pain was a poor predictor of obstruction because asymptomatic obstruction occurred in 3% of the patients. They advocated routine postoperative follow-up with imaging for all patients because they have identified patients who have progressed to decrease or loss of renal function after ureteroscopy. In contrast, in our series, there were no patients with obstruction on renal US who experienced decrease or loss of renal function. In another study, Karod et al. reviewed 183 patients, and obstruction was not seen in any of asymptomatic patients at the time of the routine follow-up of radiologic procedure. They recommended no follow-up imaging for asymptomatic patients [20]. Beiko et al. published their experience with upper tract imaging after ureteroscopic holmium:YAG laser lithotripsy. They emphasize that routine postoperative upper tract imaging is not necessary in all patients undergoing uncomplicated ureteroscopic lithotripsy. They suggested that routine postoperative imaging should be considered in cases of chronic stone impaction, significant ureteral trauma, preexisting renal function impairment, endoscopic evidence of stricture, and postoperative flank pain or fever [21]. Bugg et al. [7] examined 87 patients with follow-up imaging and concluded that imaging was unnecessary in the absence of pain and preoperative obstruction. These studies evaluated for obstruction using primarily IVU and CT in adult patients, whereas in our study postoperative imaging was conducted with renal US and in children. In our data, we have similar findings in pediatric patients, 85% of our patients reported no postoperative pain, and only one of these patients displayed obstruction at the time of the 3 month follow-up. Of the patients who experienced flank pain subsequent to URS, 85% had ureteral obstruction secondary to ureteral calculus or ureteral edema.

We recommend that routine radiologic studies with IVU or CT are not necessary in the asymptomatic post URS patients. Renal US is highly accurate in detecting mild to severe hydronephrosis [10, 22]. A combination of renal US

and plain film is a safe and effective imaging procedure in postoperative follow-up of children. We believe that, IVU or CT delineate the cause of obstruction only if hydronephrosis is present on US. However, in patients with persistent pain after ureteroscopy, non-contrast CT or IVU might be more reliable in establishing a diagnosis according to the US.

References

1. Jaidane M, Hidoussi A, Slama A et al (2010) Factors affecting the outcome of ureteroscopy in the management of ureteral stones in children. Pediatr Surg Int 26:501–504
2. Karadag MA, Tefekli A, Altunrende F et al (2008) Is routine radiological surveillance mandatory after uncomplicated ureteroscopic stone removal? J Endourol 22:261–266
3. Smith RC, Levine J, Rosenfeld AT et al (1999) Helical CT of urinary tract stones. Epidemiology, origin, pathophysiology, diagnosis, and management. Radiol Clin North Am 37:911–952
4. Jackman SV, Potter SR, Regan F et al (2000) Plain abdominal x-ray versus computerized tomography screening: sensitivity for stone localization after nonenhanced spiral computerized tomography. J Urol 164:308–310
5. Adiyat KT, Meuleners R, Monga M et al (2009) Selective postoperative imaging after ureteroscopy. Urology 73:490–493
6. Weizer AZ, Auge BK, Silverstein AD et al (2002) Routine postoperative imaging is important after ureteroscopic stone manipulation. J Urol 168:46–50
7. Bugg CE, El-Galley R, Kenney PJ et al (2002) Follow-up functional radiographic studies are not mandatory for all patients after ureteroscopy. Urology 59:662–667
8. Manger JP, Mendoza PJ, Babayan RK et al (2009) Use of renal ultrasound to detect hydronephrosis after ureteroscopy. J Endourol 23:1399–1402
9. McAchran SE, Dogra V, Resnick MI (2005) Office urologic ultrasound. Urol Clin North Am 32:337–352
10. Ellenbogen PH, Scheible FW, Talner LB et al (1978) Sensitivity of gray scale ultrasound in detecting urinary tract obstruction. Am J Roentgenol 130:731–733
11. Van Savage JG, Palanca LG, Andersen RD et al (2000) Treatment of distal ureteral stones in children: similarities to the American Urological Association guidelines in adults. J Urol 164:1089–1093
12. Smaldone MC, Corcoran AT, Docimo SG et al (2009) Endourological management of pediatric stone disease: present status. J Urol 181:17–28
13. Lam JS, Greene TD, Gupta M (2002) Treatment of proximal ureteric calculi: holmium: YAG laser ureterolithotripsy versus ESWL. J Urol 167:1972–1976
14. Desai M (2005) Endoscopic management of stones in children. Curr Opin Urol 15:107–112
15. Geavlete P, Georgescu D, Nita G et al (2006) Complications of 2735 retrograde semirigid ureteroscopy procedures: a single-center experience. J Endourol 20:179–185
16. Cheung MC, Leung YL, Wong BBW et al (2002) Prospective study on ultrasonography plus plain radiography in predicting residual obstruction after extracorporeal shock wave lithotripsy for ureteral stones. Urology 59:340–343
17. Brenner DJ, Elliston CD (2004) Estimated radiation risks potentially associated with full-body CT screening. Radiology 232:735–738
18. Brenner D, Elliston C, Hall E et al (2001) Estimated risks of radiation-induced fatal cancer from pediatric CT. AJR 176:289–296
19. Catalano O, Nunziata A, Altei F et al (2002) Suspected ureteral colic: primary helical CT versus selective helical CT after unenhanced radiography and sonography. AJR 178:379–387
20. Karod JW, Danella J, Mowad JJ (1999) Routine radiologic surveillance for obstruction is not required in asymptomatic patients after ureteroscopy. J Endourol 13:433–437
21. Beiko DT, Beasley KA, Koka PK et al (2003) Upper tract imaging after ureteroscopic holmium: YAG laser lithotripsy: when is it necessary? Can J Urol 10:2062–2067
22. Baumgartner BR, Steinberg HV, Ambrose SS et al (1987) Sonographic evaluation of renal stones treated by extracorporeal shock wave lithotripsy. Am J Roentgenol 149:131–135