Treatment of pediatric renal calculi between 1990 and 2006 in Henan province

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Abstract

Objective. To evaluate the efficacy and safety of different modalities for pediatric renal calculi in Henan province in the last 17 years, namely before and after advent of minimally invasive surgery. *Methods.* We retrospectively reviewed the records of 542 children (589 renal units) younger than 16 years (mean age 8.9 years) treated with different modalities during a 17-year period. From 1990 to 1998, 214 and 77 renal units were treated with open surgery, and minimally invasive surgery respectively. Between 1999 and 2006, 42 renal units were received open surgery, 108 renal units were extracorporeal shock wave lithotripsy (ESWL), and 148 renal units were percutaneous nephrolithotomy (PCNL). *Results.* A total of 240 children (256 renal units) underwent 291 open surgery. Calculi size ranged from 8 to 97 mm. The overall calculi-free rate was 90.2%. A total of 167 children (185 renal units) underwent 287 ESWL sessions. Calculi size ranged from 6 to 84 mm. Calculi-free rate was 92.8% for calculi smaller than 20 mm, and 75.0% for calculi 20 mm or greater. For complex calculi or staghorn calculi 57.3% of patients were calculi-free. An overall complication rate was 23.5% in ESWL. A total of 135 children (148 renal units) underwent 166 PCNL. Calculi size ranged from 12 to 123 mm. The overall calculi-free rate was 92.7%, and with an overall complication rate of 18.2%. *Conclusion*. Open surgical methods has given way to ESWL and PCNL in management of pediatric renal calculi. The use of minimally invasive surgery has resulted in treating a large number of children with a short hospital stay. Open surgery is reserved only for severe complications or some complex calculi. [Life Science Journal. 2008; 5(1): 25 – 29] (ISSN: 1097 – 8135).

Keywords: minimally invasive; urinary calculi; pediatrics; surgical procedures

1 Introduction

Urolithiasis in children is rare in the developed world, representing 1% to 3% of all urinary tract calculi[1]. However, the occurrence of pediatric urolithiasis is 2% – 12% of all urinary tract calculi in our country[2]. Technological advancements and miniaturization of endourologic instruments have significantly altered the management of pediatric renal calculi disease[3,4]. Open surgical methods were used in the early period of our study, giving way to minimally invasive surgery, extracorporeal shock wave lithotripsy (ESWL) and percutaneous nephrolithotomy (PCNL), or combination of these modalities. At present, open surgery is only necessary in a few selected cases.

Henan province is situated in the middle of China that owns a total population of 100 millions. The prevalence of urinary calculi in this region is high in adults and children. In this study, we evaluated the efficacy and safety of different modalities for pediatric renal calculi in the last 20 years in our hospital. To our knowledge, this is the largest reported series on the management of pediatric renal calculi disease in central China.

2 Materials and Methods

We restrospectively reviewed the records of all children up to age 16 years in whose renal calculi was treated at our hospital from 1990 to 2006. Analysis was divided into 2 periods, namely 262 children (291 renal units) in 1990 to 1998, which was the era of open surgery before minimally invasive surgery, and 280 children (298 renal units) in 1999 to 2006, when the new modalities such as

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ESWL and PCNL were offered. Pretreatment investigations were arranged by the referring center and included history, physical examination, renal function tests, urinalysis, renal ultrasound, intravenous pyelography (IVP) and/or CT. Followup was performed by the referring center 3 to 6 months after operation, with plain abdominal X-ray (KUB). Success was determined as being completely calculi-free or having clinically insignificant residual fragments (CIRFs) on KUB obtained during the early postoperative days. A CIRFs was determined as a calculus fragment with a largest diameter of ≤ 3 mm.

Of the children, 469 were boys and 73 were girls (male/female ratio 6.4 : 1). The age ranged from 4.1 to 16 years old, with the mean age was 8.9 years old (mean age stratified by procedure: open surgery, 6.9; ESWL, 7.4; PCNL; 7.9). Of these, 94 had bilateral, 69 had multiple, 47 had semistaghorn (involving the renal pelvis and at least one infundibulum) or staghorn, and 29 had solitary renal calculi. The mean calculi diameter was 34 mm, 32 mm, and 39 mm for open surgery, ESWL and PCNL respectively. Presenting symptoms were pain in 214 patients, hematuria in 109 patients, nausea and vomiting in 31 patients and infection in 167 patients. Twenty-one patients were diagnosed incidentally while being examined for bowel symptoms. At IVP, anatomical abnormalitis were noted in 64 children (11.8%).

2.1 Open surgery

Open operative procedures can be categorized as ablative surgery or as simple or extensive calculi removal procedures. Ablative procedures include nephrectomy and partial nephrectomy for nonfunctioning kidneys associated with urolithiasis. Calculi removal procedures are divided according to calculi diameter and location. Pyelolithotomy and radial nephrolithotomy were indicated for a small to moderate calculi. For staghorn calculi, more extensive procedures were required, including anatrophic nephrolithotomy (ANL), extended pyelolithotomy combined with radial lithotomies, and bench surgery with autotransplantation. In the minimally invasive surgical era, the main indications for open surgery were age less than 4 years, multiple renal calculi or staghorn calculi, failed ESWL or PCNL, anatomical abnormalitis and parents' requirement.

2.2 ESWL

ESWL was done using a Piezolith 2300 lithotriptor with a storage shock wave of 35 to 45 W, and power of 1200 bars. The younger children less than 12 years required general anesthesia, while older children received alfentanil and diclofenac for pain control if required. Before ESWL 3 – 4 Fr stents were placed when the calculi diameter was more than 12 mm, or in a single functioning kidney with calculi. Lead shields and lung shields were used to protect the gonads and lung. No patient received bilateral synchronous ESWL treatments.

2.3 PCNL

All of the operations were performed using general anesthesia and preoperatively prophylactic antibiotics were administered. After induction of anesthesia, ureteral catheters (4 or 5 Fr) were inserted in the retrograde fashion for the ipsilateral ureter and kidney. Patients were placed in a prone position and using B-type ultrasound guidance a puncture was made in the most suitable kidney site with an 18 G percutaneous access needle and guidewire. The tract was dilated to the proper size (14 – 16 Fr) with an Amplatz semi-rigid dilator and a Teflon sheath was placed. A 9.8 Fr rigid ureteroscope was used for working. Sterile saline (35 – 36 ºC) was used for irrigation. Using video guidance, though the ureteroscope, a pneumatic lithotripter was used for disintegrating the calculi. Grasper forceps were used to remove the small fragments. A 5 – 6 Fr double-J stent was left in place for 6 to 8 weeks. A nephrostomy tube (16 Fr Nelaton catheter) was placed at the completion of the procedure and removed 2 to 5 days later when there was no hematuria, pain and/or fever. The endopyelotomies were carried out at the end of PCNL to resolve ureteropelvic junction obstruction with a cold knife. Indications for PCNL include a large calculi, significant renal obstruction, urinary infection, failure of ESWL, an anomalous kidney anatomy unsuitable for ESWL, significant volume of residual calculi after open surgery and parents' requirement.

3 Results

3.1 Open surgery

A total of 240 children (256 renal units) underwent 291 open surgery. Calculi size ranged from 8 to 97 mm. Before minimally invasive surgery 214 renal units (73.5%) were treated with open surgery, and in the minimally invasive surgery era only 42 renal units (14.1%) were treated with open surgery. Of the 256 renal units that underwent open surgery pyelolithotomy was done through a posterior lumbar incision in 51 (19.9%), while extended pyelolithotomy in 103 (40.2%) and radial nephrotomy in 39 (15.2%) were performed via a flank incision. Anatrophic nephrolithotomy was done in 37 (14.5%) and nephrectomy was done in 26 (10.2%). After open surgery, complete calculi clearance was achieved in 231 renal units (90.2%), while

other methods were performed for residual calculi in the rest 25 (9.8%). Mean hospital stay was 10 days (range 8 to 13 days). Complications after open surgery included prolonged urinary extravasation in 24 renal units (9.4%), wound infection in 19 (7.4%), fever in 39 (15.2%), postoperative bleeding in 5 (2.0%) and residual calculi in 25 (9.8%) and so on.

3.2 ESWL

A total of 167 children (185 renal units) underwent 287 ESWL. Calculi size ranged from 6 to 84 mm. Of the patients 151 (90.4%) were treated on an outpatient basis, while 16 (9.6%) were hospitalized overnight, mostly those who were young or had complications. Overall 164 renal units (88.6%) became calculi-free by 3 months. Calculi-free rates were 92.8% for calculi smaller than 20 mm, and 75.0% for calculi 20 mm or greater, and for complex calculi or staghorn calculi 57.3% of patients were calculi-free. The remaining 21 renal units (11.4%) without clearance underwent PCNL or open surgery. Table 1 summarized the results for all calculi treated with ESWL.

3.3 PCNL

A total of 135 children (148 renal units) underwent 166 PCNL. Calculi size ranged from 12 to 123 mm. The PCNL cleared calculi in 112 renal units (75.7%) after monotherapy. The overall calculi-free rate was 92.7%. However, 17 renal units (11.5%) needed ESWL after PCNL for complete calculi clearance. In 11 cases (7.4%) PCNL were abandoned and were converted to open surgery due to excessive bleeding. Mean procedure time was 112 minutes (range 58 to 234 minutes). Eleven patients with ureteropelvic junction obstruction (UPJO) and four with infundibular narrowing were treated with PCNL procedures. During PCNL 17 patients (11.5%) needed blood transfusion. Mean hospital stay was 4.2 days (range 3 to 7 days). Table 2 summarized the results for all calculi treated with PCNL.

4 Discussion

Open surgical lithotomy was traditionally the basis for the management of most symptomatic upper urinary tract calculi[5]. Between 1990 to 1998, open surgery was the mainstay of treatment, and 73.5% were this procedures. But it appears from our review that technological advances in ESWL and PCNL have made a substantial impact on the treatment of pediatric urolithasis. Between 1999 to 2006, fewer children required open surgery in which only 14.1% were open surgical procedures. However, our opinion is that open surgery still provides an opportunity to clear stones in complex calculi, and patients with a calculus that the surgeon thinks about multiple PNL and ESWL procedures may be candidates for open surgery[6].

Since the first clinical report of ESWL on children

Table 1. Results of ESWL procedures

	The calculi diameter		Total
	< 20 mm	≥ 20 mm	
Kidney (*n*)	69	116	185
Mean size (mm)	14.1	42.6	32
Total sessions	1.2	1.8	1.5
Stone-free (*n*)			
ESWL one session	64 (92.8%)	87 (75.0%)	164 (88.6%)
ESWL two/three sessions	4 (1.4%)	9 (7.8%)	
Ancillary procedures (*n*)			
PCNL	0	9	9
Open surgey	1	11	12
Complications			
Hematuria	7	30	37
Fever	4	22	26
Colic	3	15	18
Steinstrasse	0	7	7
Urosepsis	1	3	4
Others	3	11	14

Table 2. Results of PCNL procedures

	The calculi diameter		Total
	< 20 mm	≥ 20 mm	
Kidney (*n*)	50	98	148
Mean size (mm)	13.4	48.2	39
Stone-free (*n*)			
PCNL monotherapy	37 (94.9%)	75 (76.5%)	
PCNL re-treatment	2 (5.1%)	6 (6.1%)	137 (92.6%)
PCNL + ESWL	0 (0%)	17 (11.7%)	
Procedure time (minute)	67	131	112
Mean hospital stay (day)	3.5	4.8	4.2
Complications			
Fever	4	19	23
Hematuria	4	17	21
Urine extravasation	3	11	14
Hypothermia	0	4	4
Urosepsis	2	5	7
Blood transfusion	3	3	6
Others	2	6	8

by Newman[7] and associates in 1986, many studies on ESWL have reported calculi-free rates of 67% – 99%[8,9]. Today, ESWL is considered to be the first line of treatment in the absence of obstructive uropathy in children[10]. It represents a successful and safe modality of treatment for the calculi but not the cause in children[11]. We performed ESWL in 167 children (185 renal units) . The calculi diameter was 6 to 84 mm. The overall calculi-free rate was 88.6% after an average of 1.5 sessions. Rizvi *et al*[12] reported a similar calculi-free rate of 84.2%. There was a highly significant correlation between calculi-free rate and calculi diamater. Our calculi-free rates of 92.8% at 3 months with ESWL for calculi smaller than 20 mm compared favorably with other reported series[13], but calculi-free rates for calculi larger than 20 mm or greater decreased to 75%. From our experience we concluded that proper selection of calculi size (less than 20 mm) represented a safe and efficacious option for ESWL in children, but large calculi (more than 20 mm) was associated with poor results of ESWL. ESWL in children is well tolerated with minimal morbidity. Several factors affected results of ESWL, including large calculi, calculi within dependent or obstructed portions of the collecting system, calculi composition, obesity or a body habitus that inhibits imaging, and unsatisfactory targeting of the calculi. For these calculi we no longer use ESWL as primary treatment, perferring PCNL instead.

Since the first pediatric series reported by Woodside[14] and associates in 1985, PCNL has become an established technique in children as monotherapy, or as part of a multimodal approach for children with large calculi burdens[15]. Indications for PCNL in children include a large calculi burden, significant renal obstruction, urinary infection, and failure of ESWL and significant volume of residual calculi after open surgery. Desai *et al*[16] noted that intraoperative hemorrhage during PCNL in children is related to the calibre and number of tracts and emphasized the need of technical modifications. Zeren *et al*[17] also noted significant association of intraoperative bleeding with operative time calculi burden and sheath size. Restricting the calibre of the percutaneous tract to 14 – 16 Fr compared to the conventional 30 Fr tract reduce significantly morbidity[18,19]. In 148 renal units, we achieved a calculus-free rate of 75.7% using PCNL monotherapy. The overall calculi-free rate was similar (92.7% and 90.2% for PCNL and open surgery, respectively) and no severe complications occurred. However, PCNL offered a shorter hospital stay, a lower narcotic requirement, greater patient satisfaction, reduced hospital costs and a shorter recovery period. And anatomical abnormalities such as UPJO and infundibular stenosis can be corrected by combining PCNL with other endourological procedures. Although open pyeloplasty remains the gold standard for UPJO, endopyelotomy achieves similar success rates with a lower morbidity and thus can be a good treatment alternative. In our series, eleven patient with UPJO and four with infundibular nar-

rowing were treated with PCNL procedures. PCNL was not associated with complications typical for open surgery such as wound infection, flank bulge, or prolonged pain and discomfort. Eleven of these patients, PCNL was converted into open surgery due to excessive bleeding.

5 Conclusion

Pediatric urolithsiasis is relatively common and poses a specific technical challenge to the urologist in our region. The goal of surgical calculi management is to achieve maximal calculi clearance, minimal morbidity to the patient, preservation of renal function and prevention of recurrence. The advent of ESWL, as well as the continuing technical and technologic improvements in endourology, has enabled most renal calculi to be treated in a minimally invasive fashion. Although open surgical procedures are now rarely necessary, they still play a role in the management of certain calculi patients in whom other methods fail.

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