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Review Article

Analysis of 17 children with renal abscess

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Abstract: Purpose: This study's aims to analyze the clinical characteristics of children with renal abscess and improve its diagnosis and treatment. Methods: The clinical data of children diagnosed with renal abscess in our hospital from 2007 to 2016 were retrospectively analyzed, including clinical manifestations, laboratory tests, imaging examinations, and treatment measures. Results: 17 children with renal abscess were enrolled with median age was 15 (1.5-163) months old. There were 7 girls and 10 boys. Fever was the most common symptom (82.4%). 58.9% of children suffered from abnormal urogenital function before onset, mainly manifested as ureteral abnormalities (41.2%), renal dysplasia, or non-functioning kidneys (17.6%). Acute C-reactive protein and erythrocyte sedimentation rate (ESR) were increased in more than 85% patients, but the elevation of procalcitonin was not significant (10%). 41.2% of the children had anemia, and 64.7% exhibited markedly elevated leukocytosis. All cases were negative by blood culture. The pathogen was mainly Gram-negative bacteria (47.1%), including Escherichia coli. The detection rate of Enterococcus and Candida albicans was 23.5%. Mycobacterium tuberculosis was found in 1 case. B-ultrasound and magnetic resonance imaging were most commonly used. All cases received anti-infective treatment. 10 cases were ineffective and underwent surgical treatment. There was a significant difference in the treatment outcome between abscesses larger and smaller than 4 cm ($P < 0.05$). Conclusion: For children with fever, abdominal pain, or flank pain, together with elevated white blood cell count, CRP, ESR, and IL-6, especially when anti-infective effect is poor, renal abscess should be considered. The initial anti-infective treatment of renal abscess can use a step-down scheme. The regimen needs to strengthen the anti-Gram positive bacteria and fungal treatment, and consider the possibility of renal tuberculosis infection. Conservative anti-infective treatment can be used in children with abscess size smaller than 4 cm, while surgery is recommended in abscesses larger than 4 cm not responsive to drug therapy.

Keywords: Renal abscess, children, management

Introduction

Renal abscess, which is extremely rare in pediatrics, has a long treatment period and is highly destructive to the kidneys. It is an extremely serious type of kidney infectious disease. The clinical manifestations are non-specific, including fever, abdominal pain, nausea, vomiting, and hematuria [1-3]. There is often a history of cold or surgery before the onset of the disease. The most common pathogens are Escherichia coli and Staphylococcus aureus [1, 3, 4], which may be retrograde or hematogenous. Potential susceptibility factors include diabetes, vesicoureteral reflux, pelvic ureteral duplication malformation, and nephrolithiasis [3-6]. With the development of imaging technology, renal abscess can be diagnosed by B-ultrasound, CT, and MRI. Conservative anti-infective therapy is recommended first. However, abscess puncture drainage or even single nephrectomy can be used in children with initial treatment failure [7, 8].

Limited by a lack of clinical data, the diagnosis and treatment of children's renal abscess are similar to the adult. However, children with renal abscess are unique. The main purpose of this study was to provide a reference for the clinical features, diagnosis, and treatment of children with renal abscess.

Materials and methods

Subject information

From 2007 to 2016, a total of 20 children with renal abscess were enrolled with mean age

Table 1. Clinical manifestations

Clinical symptoms and signs	Cases (n = 17)	Ratio (%)
Fever	14	82.4
Reduced appetite	6	35.3
Urinary changes*	5	29.4
Vomiting	5	29.4
Bladder irritation	4	23.5
Oliguria	2	11.8
Abdominal pain	1	5.9
Puffiness	1	5.9
Abdominal mass	1	5.9
Abdominal tenderness or cramps	1	5.9

*Including turbid urine, foamy urine, and gross hematuria.

Table 2. Urogenital abnormality

	Cases (n = 17)	Ratio (%)
Urogenital abnormality	10	58.9
Abnormal ureteral morphology (stenosis, dilation, or distortion)	7	41.2
Repeated urinary tract infection	4	23.5
Non-functional kidney or dysplasia	3	17.6
Bladder ureteral reflux	2	11.8
Renal stone	2	11.8
Renal cyst	1	5.9

26.4 (1.5-163) months old. There were 7 girls and 10 boys.

Statistical analysis

Enumerated data were compared using the Fisher exact test. $P < 0.05$ was considered significant.

Results

17 children with renal abscess were enrolled with median age 15 (1.5-163) months old. There were 7 girls and 10 boys. According to the WHO growth curve, the mean percentiles of height and weight were 29% and 39%, respectively. There was relatively retarded growth and development. Seven patients had a history of extrarenal infection recently, mainly respiratory infections (5 cases). Two patients had a history of kidney surgery.

In terms of clinical symptoms, fever was the most common (82.4%), followed by decreased appetite (35.3%), changes in urinary (29.4%, including urine turbidity, foamy urine, and gross hematuria), vomiting (29.4%), and bladder irritation (23.5%) (**Table 1**). Ten patients (58.9%) had an abnormal urogenital system before onset. Among them, 7 patients (41.2%) had abnormal ureteral morphology, including ureteral or ureteral pelvic stenosis, ureteral dilatation, or ureteral distortion; 4 patients (23.5%) had recurrent urinary tract infections, 3 cases had renal dysplasia or no functional kidney (17.6%), 2 cases had vesicoureteral reflux (11.8%), and others had kidney stones (11.8%) and kidney cyst (5.9%) (**Table 2**).

In terms of laboratory data, the proportion of children with increased white blood cell count was 70.5% (**Table 3**). More than 85% of children had significantly upregulated acute C-reactive protein and erythrocyte sedimentation rate (ESR), but the elevation of procalcitonin was not obvious (10%) (**Table 4**). Anemia was present in 41.2% of children. Routine urinalysis showed that 64.7% of children had a significant increase in urinary white blood cells, and the positive rate of urinary protein was 29.4%.

In terms of pathogen examination, pathogens were detected in 12 children (70.6%) (**Table 5**). There was no positive result by blood culture. The positive rate of urine culture was 41.2%, and the positive rate of pus culture was 90%. The pathogens were mainly Gram-negative bacteria (8 cases, detection rate was 47.1%), including Escherichia coli as the most (3 cases, 17.6%). In addition, the detection rate of Enterococcus genus and Candida albicans were also high, with 4 cases (23.5%). Mycobacterium tuberculosis was found in 1 case. Among them, 5 cases were mixed infection (29.4%), which was Gram-negative bacteria combined with Gram-positive bacteria or fungi (**Table 6**).

Table 3. Lab testing

Lab test	Cases (n = 17)	Ratio (%)
Increased white blood cell count*	12	70.5
CRP (> 8 mg/L)	15	88.2
ESR (> 20 mm/h)	7 (7)	100
PCT (> 0.46 ng/ml)	1 (10)	10.0
IL-6 (> 16.6 pg/ml)	7 (9)	77.8
Anemia**	7	41.2
Positive urinary protein	5	29.4
Increased urinary leukocytes***	11	64.7
Increased urinary red blood cells****	5	29.4

Ps: * < 8 years old, white blood cell count > $12*10^9$/L; ≥ 8 years old, white blood cell count > $10*10^9$/L. **1~4 month old < 90 g/L, 4~6 month old < 100 g/L, 6 month~6 years old < 110 g/L, 6~14 years old < 120 g/L. ***Urinary leukocyte microscopy > 4/HP or urinary leukocyte count > 16.9/ul. ****Urinary red blood cell microscopy > 5/HP or urinary blood cell count > 22.7/ul.

Table 4. Cases with CRP, PCT, and IL-6 elevation

	Elevation	No elevation	*P* value
Acute CRP	15	2	0.591
IL-6	7	2	0.000
PCT	1	9	0.005

In the imaging examination, all patients underwent urinary B-ultrasound examination, 14 patients underwent magnetic resonance imaging (MRI), 8 patients underwent CT examination, and 4 patients underwent urinary retrograde angiography.

For treatment, all cases received anti-infective treatment mainly as third-generation cephalosporins. Due to the multi-drug resistant bacteria found in the bacterial culture, the antibiotics were upgraded to meropenem or imipenem in 10 cases. Because of drug-resistant positive bacteria, broad-spectrum anti-Gram positive bacteria drugs vancomycin or nafcillin were added to 5 cases. 4 cases received fluconazole for the treatment of Candida albicans. 1 case received anti-tuberculosis treatment. Ten patients received surgical treatment because of poor anti-infective therapy effect. Due to the specificity of anti-tuberculosis treatment, we excluded it and divided the remaining cases (16 cases) into two groups according to the size of abscess, including 9 cases with > 4 cm and 7 cases with ≤ 4 cm (**Table 7**). Anti-infective combined surgery was used in children with > 4 cm abscess, mainly abscess puncture drainage, 2 of whom received were nephrectomy due to non-functioning kidney.

Discussion

Renal abscess is very rare in pediatrics. Clinically, its diagnosis and treatment based on adult or small sample size data, which can cause a missed diagnosis, misdiagnosis, or inappropriate treatment measures. Therefore, analysis of children's renal abscess cases can greatly improve the diagnosis and treatment. We conducted a retrospective analysis of children diagnosed with renal abscess in our hospital from 2007 to 2016, aiming to describe clinical characteristics and improve diagnosis and treatment.

Previous studies found that the proportion of girls with renal abscess was higher than that of boys [1-3, 9, 10]. Our data showed that the proportion of boys was higher than that of girls (10/7), indicating that there is no obvious gender tendency in children renal abscess. The median age of children with renal abscess in our study was 15 months old, which was younger than the overall age of previous studies. Moreover, their height and weight were significantly lower than their peers, suggesting that renal abscess may affect children's growth and development.

We observed that 58.9% of children had urogenital abnormalities before the onset of renal abscess, mainly due to ureteral abnormalities (41.2%), renal dysplasia or non-functioning kidney (17.6), or vesicoureteral reflux (11.8%). It was demonstrated that children with an abnormal urogenital system might be a high risk factor for renal abscess. At the same time, 23.5% of children had repeated lower urinary tract infections before onset, revealing that they may also be at high risk for renal abscess. In addition, the median age was young (15 months old) and immune dysfunction was common in our series, suggesting that young age and immune dysfunction may be high risk factors for renal abscess in children.

There is lack of specificity in clinical signs and symptoms. Fever is the most common manifes-

Table 5. Etiological examination

	Cases (n = 17)	Ratio (%)
Total pathogen detection#	12	70.6
Positive blood culture	0	0
Positive urine culture	7	41.2
Positive pus culture	9 (10)	90
Positive acid-fast bacilli test	1 (6)	16.7

#Positive in either blood culture, urine culture, pus culture, or acid-fast bacilli test.

Table 6. Pathogen species

	Cases (n = 17)	Ratio (%)
Gram-negative bacteria	8	47.1
Escherichia coli	3	17.6
Xanthomonas	2	11.8
Pseudomonas aeruginosa	2	11.8
Alcaligenes	1	5.9
Enterobacter cloacae	1	5.9
Enterobacter aerogenes	1	5.9
Gram-positive bacteria	4	23.5
Enterococcus	4	23.5
Candida albicans	1	5.9
Tubercle bacillus	5	29.4

Table 7. Abscess size and treatment

	Anti-infection (%)	Anti-infection + surgery (%)	
> 4 cm	1 (11.1)	8 (89.9)	P = 0.035
≤ 4 cm	5 (71.4)	2 (28.6)	

tation (82.4%), and can be manifested as turbid urine, foamy urine, hematuria, nausea and vomiting, urinary frequency, urinary urgency and other bladder irritative symptoms. For older children, there may be abdominal pain, flank pain and other manifestations [1-3, 9, 10]. Abdominal tenderness or abdominal mass could be found on physical examination.

In laboratory data, it was found that more than 70% of children suffered from elevated white blood cell count, erythrocyte sedimentation rate, C-reactive protein, and interleukin-6, while most of the procalcitonin was normal (90%). We demonstrated that CRP and IL-6 could be used as inflammatory markers for the diagnosis and evaluation of renal abscess. The routine application of PCT is not recommended in the diagnosis and treatment of renal abscess. In summary, renal abscess needs to be considered in children with fever, abdominal pain, or flank pain, accompanied by elevated white blood cell count, CRP, ESR, and IL-6, especially in case of poor anti-infective effect.

In terms of imaging examination, B-ultrasound is the first choice because of its low price, high reproducibility, and no radioactivity. Therefore, all of our patients were routinely undergoing B-ultrasound examination. Considering radioactivity, only half of the patients (8 cases) underwent CT examination to further confirm the diagnosis. However, we did not find superiority of CT in the diagnosis of renal abscess compared to ultrasound. In addition, in order to better understand the overall appearance of the urinary tract system in children with renal abscess, 14 cases received magnetic resonance imaging (MRI) examination. As a non-invasive and contrast-free examination method, it displayed the urinary tract anatomy, which is better than the invasiveness and complications of bladder retrograde angiography or renal angiography.

Our patient did not develop pathogenic bacteria in the blood. Previous research demonstrated that in children with renal abscess, the blood culture positive rate was extremely low, suggesting that hematogenous dissemination may not be the main mechanism of childhood renal abscess [3, 8, 9]. Urinary routine tests revealed that 11 patients (64.7%) suffered from significantly elevated leukocytosis, and 7 (41.2%) presented with positive urine culture, which was similar to the previous studies [3, 8], suggesting that the ascending infection should be the main mechanism of children's renal abscess. The positive rate of pus culture was 90%. The pathogens were mainly Gram-negative bacteria (8 cases, detection rate was 47.1%), including Escherichia coli most commonly (3 cases, 17.6%). In addition, the detection rates of Enterococcus genus and Candida albicans were also high with 4 cases in each type (23.5%), suggesting that anti-Gram-positive bacteria and antifungal treatment could be used in patients with poor treatment effect. Wang *et al.* found that in premature infants,

especially low birth weight infants, urinary fungal infections are common, leading to renal abscesses and repeated fungal infection [11]. There were 4 premature infants in our study, all of whom were low birth weight infants. Three of them exhibited positive Candida albicans culture. Thus, it was recommended that for premature infants with renal abscess, a course of antifungal therapy should be extended if the culture suggests fungal infection.

In addition, one of our patients presented with urinary frequency, urgency, urinary incontinence, accompanied by hematuria, but no fever or weight loss. The conventional anti-infective treatment was ineffective, while PPD test, blood culture for acid-fast bacilli, and T-cells of Mycobacterium tuberculosis were positive. Thus, the patient was diagnosed with renal tuberculosis. Therefore, for children with atypical renal abscesses, the possibility of Mycobacterium tuberculosis infection should be considered in the case of poor therapeutic effects.

It was found that the main pathogen of renal abscess in children was Gram-negative bacilli, mainly Escherichia coli [1-3]. Therefore, initial treatment was mostly based on second or third generation cephalosporins. However, we observed that the pathogens were mostly multi-drug resistant, and the initial treatment effect was often poor. 12 patients (70.6%) adjusted their medications to hydrocarbonase-based antibiotics, such as meropenem and imipenem. Considering the harmfulness and destructiveness of renal abscess, step-down treatment plan is the preferred choice for children with renal abscess. The initial treatment can be ultra-broad spectrum antibiotics, and then the antibiotic level is reduced according to the treatment effect and drug sensitivity test.

In addition, our data emphasized the importance of Gram-positive bacteria and fungi in children with renal abscess, especially for children with poor treatment, young age, and low birth weight. If necessary, anti-Gram positive bacteria and fungal treatment should be strengthened.

Previous data mostly grouped the renal abscess based on diameter of 3 cm and recommended that renal abscesses larger than 3 cm can be treated with percutaneous abscess puncture, while those smaller than 3 cm can receive conservative anti-infective treatment [3]. Our patients were divided into two groups based on diameter at 4 cm. Considering the risk of surgical treatment, for children with renal abscess, surgical treatment can be performed on abscesses with diameter > 4 cm. The main surgical method was percutaneous drainage guided by B-ultrasound, and nephrectomy can be selected for non-functional kidney.

Our data spans ten years and is a good reference for appropriate treatment options. However, our research lacks randomized controls. The treatment plan is closely related to personal experience and the number of cases is small. Further multi-center randomized controlled research is needed to clarify the treatment regimen.

Disclosure of conflict of interest

None.

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References

[1] Linder BJ and Granberg CF. Pediatric renal abscesses: a contemporary series. J Pediatr Urol 2016; 12: 99, e1-5.

[2] Chen CY, Kuo HT, Chang YJ, Wu KH, Yang WC, Wu HP. Clinical assessment of children with renal abscesses presenting to the pediatric emergency department. BMC Pediatr 2016; 16: 189.

[3] Seguias L, Srinivasan K and Mehta A. Pediatric renal abscess: a 10-year single-center retrospective analysis. Hosp Pediatr 2012; 2: 161-6.

[4] Al-Taheini K, Leonard M and Pike J. Mp-16.21. Urology 2006; 68: 161.

[5] Ko MC, Liu CC, Liu CK, Woung LC, Chen HF, Su HF, Li CY. Incidence of renal and perinephric abscess in diabetic patients: a population-based national study. Epidemiol Infect 2011; 139: 229-35.

[6] Angel C, Shu T, Green J, Orihuela E, Rodriquez G, Hendrick E. Renal and peri-renal abscesses in children: proposed physiopathologic mecha-

nisms and treatment algorithm. Pediatr Surg Int 2003; 19: 35-39.
[7] Lee SH, Jung HJ, Mah SY, Chung BH. Renal abscesses measuring 5 cm or less: outcome of medical treatment without therapeutic drainage. Yonsei Med J 2010; 51: 569-73.
[8] Comploj E, Cassar W, Farina A, Gasparella P, Trenti E, Palermo S, Dechet CB, Caione P, Pycha A. Conservative management of paediatric renal abscess. J Pediatr Urol 2013; 9: 1214-7.
[9] Angel C, Shu T, Green J, Orihuela E, Rodriquez G, Hendrick E. Renal and peri-renal abscesses in children: proposed physio-pathologic mechanisms and treatment algorithm. Pediatr Surg Int 2003; 19: 35-9.
[10] Barker A and Ahmed S. Renal abscess in childhood. Aust N Z J Surg 1991; 61: 217-21.
[11] Wang GH, Dai CL, Liu YF, Li YM. Cerebral and renal abscess and retino-choroiditis secondary to Candida albicans in preterm infants: eight case retrospective study. Clin Exp Obstet Gynecol 2013; 40: 519-23.