KIDNEY ABSCESS AS A RARE COMPLICATION OF THE URINARY TRACT INFECTIONS IN CHILDREN – 20 YEARS OF SINGLE-CENTER OBSERVATIONS

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Abstract:

Introduction and objective

Kidney abscess is one of the complications of the urinary tract infection. Gram (-) intestinal flora is considered the most common etiological factor in development of kidney abscess. The spreading of bacteria usually occurs via an ascending route. Currently, in the era of antibiotic therapies, the kidney abscess is a relatively rare complication.

Material and methods

The study aimed to analyse the prevalence, risk factors, clinical course of the disease, results of treatment, and the long-term consequences in pediatric patients with kidney abscess diagnosis.

Results

The renal abscess was diagnosed in 8 out of 32,000 hospitalized children (0.00025%) (5 girls, 3 boys, average age 6 years). In 7 cases, the association with urinary tract infection was confirmed (87.5%). In all patients, the abscess was limited to the renal parenchyma and its diameter was below 50 mm; two patients had multiple abscesses. Three children (37.5%) had a history of urinary tract disease. All patients had increased levels of the inflammation markers but the renal function parameters were within the reference values. Five children (62.5%) presented clinical symptoms (fever, pain, dysuria); in 2 children (25%) the clinical course was chronic and oligosymptomatic. The sensitivity and specificity of ultrasound examinations (US) were 100% accurate in the diagnosis and monitoring of treatment. In all cases, antibiotic therapy was effective. Post-antibiotic treatment renoscintigraphy showed persistent post-inflammatory scars in 62.5% of cases.

Conclusions

During 20 years of observations, kidney abscess was a rare complication of urinary tract infection. Most patients did not have any underlying risk factors. Ultrasound examination had high sensitivity and specificity in the diagnosis and monitoring of the treatment. Broad-spectrum, prolonged antibiotic therapy proved to be an effective treatment in all patients. However, after the abscess has been successfully healed, most patients required permanent nephrology care due to the presence of the post-inflammatory scars.

Keywords: kidney abscess, children, urinary tract infection, ultrasound examination, renoscintigraphy.

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Introduction

Kidney abscess is a relatively rare medical condition, it occurs with a frequency of about 1-10: 10,000 hospitalized patients [1, 2]. It is one of the complications of urinary tract infections. Bacterial spread and abscess formation usually occur via the ascending route [2, 3]. In such cases, Gram (-) bacteria of the intestinal flora such as *Escherichia coli*, *Klebsiella sp*., and *Proteus sp*. are the etiological factor [2-4]. Urinary tract obstruction is one of the risk factors contributing to kidney abscess formation [5]. In the pre-antibiotics era, a lot of renal

abscesses formed as a result of secondary, hematogenous spread of Gram (+) bacteria, most often from the infections located in the skin, bones or endocardium. In such cases, multiple abscesses located in the renal cortex were observed. Currently, drug addiction, diabetes mellitus, and dialysis are the main risk factors for the development of renal abscesses [4, 6].

Abscesses classification by the location:
- an intrarenal abscess (located in the renal parenchyma, single or multiple abscesses),
- a perinephric abscess (purulent material outside the renal capsule but within the renal fascia),
- a paranephric abscess (extends out of the renal fascia – may spread under the skin to the iliopsoas, to the groin, and even to the scrotum) [3].

Perinephric and paranephric abscesses are a serious complication of acute tubulointerstitial nephritis. They are caused by extension of the intrarenal abscess to the perirenal space. Occasionally, they are complications of some urological procedures [3].

Clinical symptoms of kidney abscess are usually the same as symptoms of acute tubulointerstitial nephritis. Patients present fever, lumbar pain, and dysuria [2]. Making an accurate diagnosis can be difficult at the beginning of the abscess formation. For this reason, as well as due to insufficient access to imaging examination in the past, the incidence of delayed diagnosis, uncontrolled spread of infection, and death as a consequence of sepsis, have been relatively common [2]. Therefore, in the presence of symptoms of severe urinary tract infection, and poor response to standard therapy, imaging tests of kidneys and urinary tract should be performed [2, 6]. Although currently, access to ultrasound examination (US) is good, the subjective interpretation of the ultrasound, in the case of renal abscess suspicion, requires the confirmation of diagnosis by computed tomography (CT) or magnetic resonance imaging (MRI) [2, 3, 6].

Successful treatments for kidney abscess are still being researched and discussed. Usually, the treatment begins with a broad-spectrum intravenous antibiotic therapy. Only in the case of the lack of no improvement after such a therapy, and in case of patients with large or perinephric abscess, it is necessary to perform surgery. The most commonly used treatment among surgical techniques is percutaneous drainage. Major surgical procedures such as surgical drainage (open surgery), heminephrectomy, or nephrectomy are reserved only for large abscesses causing permanent renal insufficiency, or the severe general condition of the patient [2, 6, 7].

Aim of the study

The aim of the study was analysis of demographic data, risk factors, clinical course, treatment results, and long-term consequences of the disease in children with a kidney abscess, treated in our department during the last 20 years.

Material and methods

We performed retrospective analysis of the medical records of all children hospitalized at the Department of Paediatrics, Paediatric Nephrology, and Allergology in Military Institute of Medicine in Warsaw between 2000 and 2019, and identified the data of children hospitalized due to urinary tract infection.

Data of children with kidney abscess diagnosis were analysed in detail. Age, gender, risk factors, clinical symptoms, course of infection, laboratory results (white blood cells – WBC, C-reactive protein – CRP, erythrocyte sedimentation rate – ESR, urea, creatinine, urinalysis, urine culture), imaging results (ultrasonography – US, computed tomography – CT, magnetic resonance imaging – MRI), type and duration of treatment, as well as long-term consequences of the disease were analysed.

The abscess size was determined by measuring its largest dimension.

All patients after recovery remained under the care of a nephrologist Blood pressure was regularly measured, parameters of renal function and urinalysys were periodically assessed, and abdominal ultrasound, as well as renoscintigraphy, were performed in order to recognize possible consequences of the disease.

The results of the analyses are presented as the average and percentage value. Data were analysed using Microsoft Excel.

Results

Between 2000 and 2019 32,000 patients at the age of 0-18 years were hospitalized at the Department. Urinary tract infection was the reason for the hospitalization of 2148 (6.71%) children. In 8 patients (5 girls and 3 boys) kidney abscess was diagnosed, which constituted 0.00025% of all hospitalizations. In 7 cases, this diagnosis was associated with urinary tract infection (0.032% of all diagnosed urinary infections). In one patient, the abscess was a complication of peritonitis. The average age of patients with kidney abscess diagnosis was 6 years. In three cases, the pathology was localized in the left (37.5%), and in five cases in the right (62.5%) kidney. In all patients parenchymal abscesses were diagnosed: in 6 cases single, in 2 cases – multiple abscesses. The size (diameter) of abscesses in the analysed material ranged from 10 to 33 mm, an average 21.6 mm (Table 1).

A history of urinary tract diseases was recorded in 3 patients (37.5%). One patient had urolithiasis, the second had recurrent urinary tract infections and a complex kidney cyst, and the third had recurrent urinary tract infections and vesicoureteral reflux. Appendicitis complicated by perforation and peritonitis was also an important pathology outside the urinary tract, contributing to kidney abscess.

All observed patients had increased inflammatory markers (WBC: range 7.0 - 21.94 x 109/l, average 14.31 x 109/l; CRP: range 1.2-22.5 mg/dl, average 9.7 mg/dl, ESR: range 14-109 mm/h, average 71.5 mm/h). In 7 children (87.5%) in urinalysis the features of urinary tract infection were found (leukocyturia). In all children, the parameters of renal function were normal (creatinine: range

0.3-0.7 mg/dl, average 0.4 mg/dl; urea: range 17-32 mg/dl, average 22.4 mg/dl) (Table 1).

Table 1. Summary of analyzed variables: characteristic of a group, risk factors, course of the disease.

Variable	Value
Sex	
Girl	5 (62,5%)
Boy	3 (37,5%)
Age	
< 1 year old	0 (0%)
2-6 years old	6 (75%)
> 6 years old	2 (25%)
Location	
Right kidney	5 (62,5%)
Left kidney	3 (37,5%)
Multiplicity	
Abscess of kidney parenchyma	8 (100%)
Single abscess	6 (75%)
Multiple abscesses	2 (25%)
Size	
<30mm	6 (75%)
30-50mm	1 (12,5%)
No data	1 (12,5%)
Risk factors	
Positive history of urinary tract diseases	3 (37,5%)
Other (peritonitis)	1 (12,5%)
Course of illness	
Severe (sepsis, multi-organ failure)	1 (12,5%)
Moderate-severe (urosepsis, dehydration)	1 (12,5%)
Moderate (fever, pain, dysuria)	3 (37,5%)
Mild (no clinical symptoms, chronic course)	2 (25%)
No data	1 (12,5%)
Laboratory test results	
Elevated inflammation markers	8 (100%)
Leukocyturia in urinalysis	7 (87,5%)
Elevated kidney function parameters	0 (0%)
Urine culture	
Escherichia coli	3 (37,5%)
Enterococcus faecalis	2 (25%)
Proteus mirabilis	1 (12,5%)
Sterile culture	1 (12,5%)
No data	1 (12,5%)

In urine culture, the most common isolated pathogen was *E. coli* (37.5%). Table 1 presents the results of the urine culture.

Five children presented clinical symptoms of urinary tract infection, such as fever, chills, vomiting, lumbar pain, and dysuria. In two children clinical symptoms were not observed at the time of diagnosis (chronic course – asymptomatic) (Table 1). These were patients under constant nephrological care due to recurrent urinary tract infections. In one of them, a complex kidney cyst had been observed for several years.

In each case, ultrasound examination was performed in the diagnostic process, and during monitoring of the treatment. To confirm the diagnosis, magnetic resonance imaging was used in four cases, and computed tomography in three. In one case, due to the patient's severe condition and multi-organ failure, all three imaging methods were used for diagnosis and monitoring (Table 2).

In each case, at the beginning of the treatment, a combination of broad-spectrum, intravenous antibiotic therapy was used, followed by an oral antibiotic therapy. The average duration of intravenous antibiotic therapy was 18 days and the average duration of total antimicrobial treatment – 45 days. The duration of treatment was chosen individually, depending on the severity of the disease and the degree of recovery. In the acute phase of the disease satisfactory treatment results were obtained in all patients. None of the patients required surgical treatment. Detailed data on the used antibiotics are presented in Table 3.

Table 3. Antibiotic therapy.

Patient	Before and during hospitalization	After discharge from the Department
1.	cefuroxime axetil p.o. (6 days) –> amikacin i.v. (10 days) –> metronidazole i.v. (10 days) –> ceftriaxone i.v. (21 days)	sulfamethoxazole/ trimethoprim p.o. (21 days) –> trimethoprim p.o.(5 weeks)
2.	ceftazidime i.v. (10 days), ampicillin i.v. (10 days) –> amikacin i.v. (10 days), ceftriaxone i.v. (14 days), linezolid i.v. (10 days)	no antibacterial treatment was used
3.	ceftriaxone i.v. (21 days) netromycin i.v. (10 days)	ciprofloxacin p.o. (10 days)
4.	ceftriaxone i.v. (16 days)	sulfamethoxazole/ trimethoprim p.o. (5 weeks)
5.	cefuroxime i.v. (14 days) amikacin i.v. (10 days)	cefuroxime axetil (7 days)
6.	ceftazidime i.v. (21 days) amikacin i.v. (10 days) –> metronidazole i.v. (10 days)	clindamycin p.o. (5 weeks)
7.	cefuroxime axetil (6 days) –> ceftazidime i.v. (14 days)	sulfamethoxazole/ trimethoprim p.o. (6 weeks)
8.	No data	No data

i.v. – intravenously, p.o. – orally

During nephrological follow-up, five patients (62.5%) were found to have persistent post-inflammatory renal

Table 2. Diagnostic imaging.

Method	Number of cases in which an examination was performed to diagnose or confirm a diagnosis	Number of cases in which a kidney abscess was visualized	Number of cases in which the course of the disease was monitored
USG	8	8	8
MRI	5	5	2
CT	4	4	1

scars visualized by ultrasound and renoscintigraphy. The other 3 patients had normal renal parenchyma. Deterioration of kidney function and chronic kidney disease were not observed in any of the children.

Discussion

Our study analysed etiology, risk factors, clinical course, and results of treatment of kidney abscess in the pediatric population.

Kidney abscess was a rare complication in the examined material. The prevalence was 8 out of 32000 of all hospitalized patients, and 7 out of 2148 patients with urinary tract infections, which is consistent with the published data [1, 2]. In 87.5% of analysed cases, an association between the formation of an abscess and urinary tract infection was confirmed. In the literature, this correlation was estimated to be above 75% [6]. Our study showed that the pathology was slightly more common in girls (62.5%). This observation can be explained by the fact that urinary tract infections are more common in female population, but the small number of analysed cases makes it impossible to draw definite conclusions. Similar results were obtained by Lee et al. [8]. In their study, which analysed the course of the disease in 56 adults, women constituted 75% of patients. However, Willard et al. [1] found that kidney abscesses occurred with the same frequency in both sexes.

In our study, the abscesses were more often diagnosed in younger children (<6 years of age).

In the studied group of patients, the coexisting urinary tract pathologies (recurrent urinary tract infections, vesicoureteral reflux, urolithiasis) were the main risk factor for renal abscess. This association was found in 37.5% of patients. According to the literature, other risk factors for the formation of renal abscesses are urinary tract defects, diabetes, liver cirrhosis, cancer, and congenital or acquired immunodeficiency [2, 4, 8]. Yen et al. [9] and Hung et al. [10] described the risk factors for poor prognosis and increased mortality among adults with renal abscesses. Poor prognosis positively correlated with the high values of C-reactive protein [10] and urea nitrogen [9] in blood serum, and with the advanced age of patients [10]. According to various studies, mortality in renal abscesses was between 0-7% in adults [8, 11, 12]. In our observations of pediatric patients, no impairment of renal function was found in any child. However, elevated inflammatory markers were observed in all of them. In two children with a septic level of markers of inflammation, the use of antibiotic therapy normalized the parameters. In our observation, high WBC, CRP, and ESR values did not correlate with worse prognosis. None of the studied children were found to have a serious chronic diseases, including immunodeficiencies.

As already mentioned, in studies analysing patients before 1960, most of the renal and perirenal abscesses were the result of hematogenous spread of *S. aureus* from other foci of infection. Currently, the widespread use of antimicrobial drugs has almost completely eliminated this phenomenon. Today, most of the renal abscesses are caused by Gram (-) bacilli originating from the urinary tract, which is confirmed by the results of our study, as well as the results from other centers. *E.coli* is the main pathogen causing the abscesses [8, 13, 14].

In all cases of patients with abscess of renal parenchyma described in our study early diagnoses and implementation of broad-spectrum antibiotic therapy prevented serious complications, such as perinephric abscess or extension out of the renal fascia. However, in the study of Lee et al. [8] of the population of adults with many coexisting chronic diseases, the percentage of abscesses extending beyond the renal parenchyma was 45% [8].

According to our observations attention should be paid to the usefulness of ultrasound examinations in initial diagnostics and in monitoring the course of the disease. US is a widely available and non-invasive test. According to the literature, its sensitivity in abscess detection ranges from 70 to 86% [9, 15]. In our study sensitivity and specificity of ultrasound imaging were 100%. Computed tomography and magnetic resonance imaging were used to confirm the diagnosis. Computed tomography enables the diagnosis of a kidney abscess with accuracy at 90-100% [9]. This method is particularly useful in the case of equivocal US results. It is also useful in accurate assessment of the abscess size, its extension, and renal parenchyma failure [2]. Magnetic resonance imaging has the highest sensitivity and specificity. However, due to limited availability and high cost, it is primarily used to differentiate abscesses with malignant tumors [2, 8, 16]. In our observations, CT and MRI were used with the same frequency to confirm the diagnosis. In one of the cases, both imaging tests were performed because of the atypical course of the disease and severe general condition of the patient. To monitor the treatment, the ultrasound examination has been used in all children, while MRI scans were performed in 2 patients, and CT scan in one patient. Radiological protection should be the key aspect in the choice of imaging methods in pediatric population [2, 16].

In empirical treatment, combined broad-spectrum antibiotic therapy was used, such as second and third-generation cephalosporins, aminoglycosides, and metronidazole. Similar drugs were used in many other studies described in the literature [2, 8, 17]. Adult patients were also treated with fluoroquinolones [2, 17]. In all examined children a good therapeutic effect of antibiotic therapy was observed, none of the patients required surgical intervention. In all cases, the abscess size did not exceed 50 mm. The size of the abscess which is a definite indication for surgical treatment, is still the subject of discussion. In 1996, Siegel et al. proposed an algorithm for the treatment of renal abscesses depending on their size. Renal abscesses were divided into small (<3 cm), medium (3-5 cm) and large (>5 cm) [17]. Broad-spectrum intravenous antibiotic therapy was recommended for small abscesses, whereas a more invasive treatment was the preferred option for large abscesses. In the case of medium abscesses, the indication for surgical interventions depended on the response to antimicrobial treatment and the patient's clinical condition [2, 17, 18]. This scheme was accepted in the majority of studies, which described

the positive outcome [2, 7, 8, 15, 19]. In the case of perinephric abscesses, their size is less important. In most of these cases, conservative treatment was ineffective [19].

After recovery, each of the patients analysed by us remained under nephrological care. In the available literature, there are no results of long-term observations on possible renal dysfunction or other long-term consequences after recovery in adults [8, 15, 16]. In our observations in 62.5% of cases, persistent post-inflammatory scars were found by renoscintigraphy. Therefore, continuous nephrological care seems to be justified in this group of patients.

The limitation of research presented here is the small study group, which does not allow statistical analyses and definitive conclusions. However, in the available literature, there are no sufficient descriptions and analyses of kidney abscesses in pediatric population. Thus, further observations are necessary to make recommendations for the management of renal abscesses in pediatric patients. Due to the rare occurrence of such a complication, the thorough analysis will require the multi-centre studies.

Conclusions

1. During 20 years of observation of our patients renal abscess was a rare complication of urinary tract infection.
2. Most patients did not have any underlying risk factors.
3. The clinical course in the majority of children was mild, they mostly demonstrated fever and elevated inflammatory markers.
4. Ultrasound examination showed high sensitivity and specificity for the diagnosis and monitoring of treatment.
5. Broad-spectrum prolonged antibiotic therapy proved to be a sufficient method of treatment in all patients.
6. Due to the presence of post-inflammatory scars in the majority of observed patients, they required constant nephrological care after the abscess has been healed.

References

1. Willard BT, Lynn J, Steinbecker K, et al. Renal Corticomedulary Abscess. eMedicine. Eds. Jong M. Choe, et al. 27 Jul. 2004; Medscape, 13 Jan. 2005
2. Rubilotta E, Balzarro M, Lacola V, et al. Current clinical management of renal and perinephric abscesses. Urologia 2014; 81 (3): 144-147
3. Campbell-Walsh, et al. Urology. 10th ed. International Edition, 2012; Elsevier
4. Yu M, Robinson K, Siegel C, et al. Complicated Genitourinary Tract Infections and Mimics. Curr Probl Diagn Radiol. 2017 Jan - Feb; 46 (1): 74-83
5. Vourganti S, Agarwal PK, Bodner DR, Dogra VS. Ultrasonographic evaluation of renal infections. Radiol Clin North Am 2006 Nov; 44 (6): 763-75
6. Dubbs S, Sommerkamp S. Evaluation and Management of Urinary Tract Infection in the Emergency Department. Emerg MedClin North Am, 2019 Nov; 37 (4): 707-723
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; 4 :569-7
8. Lee BE, Seol HY, Kim TK, et al. Recent clinical overview of renal and perirenal abscesses in 56 consecutive cases. Korean J Intern Med, 2008 Sep; 23 (3): 140-8
9. Yen DH, Hu SC, Tsai J, et al. Renal abscess: early diagnosis and treatment. Am J of Emerg Med, 1999; 17 (2): 192-7
10. Hung CH, Liou JD, Yan MY, Chang CC. Immediate percutaneous drainage compared with surgical drainage of renal abscess. Int Urol Nephrol, 2007; 39 (1): 51-5
11. Choi JY, Kim MS, Kim YK, Lee KS, Chang KH, Huh AJ, Yeom JS, Song YG, Kim JM. Recent clinical trend of renal and perirenal abscess. J Korean Soc Chemother, 2002; 20: 91-100
12. Jin WY, Lee JH, Lee YJ, Jang IC, Jo DH. A clinical review of 16 cases of renal of perirenal abscess. Korean J Urol, 1988; 29: 761-765
13. Schrier RW, Gottschalk CW. Diseases of the kidney. 6th ed. Boston: Little brown and company, 1997; pp. 947-959
14. Jung UY, Kim DH. A clinical survey on perinephric abscess. Korean J Urol, 1985; 26: 7-12
15. Coelho RF, Schneider-Monterio ED, Mesquita JL, Mazzucchi E, Marmo Lucon A, Srougi M. Renal and perinephric abscesses: analysis of 65 consecutive cases. World J Surg, 2007; 31: 431-436
16. Capitan Manjon C, Tejido Sanchez A, Piedra Lara JD, Martinez Silva V, Cruceyra Betriu G, Rosino Sanchez A, Garcia Penalver C, Leiva Galvis O. Retroperitoneal abscesses: analysis of a series of 66 cases. Scand J Urol Nephrol, 2003; 37: 139-144
17. Grabe M, Bjerklund-Johansen TE, Wullt B, et al. Guidelines on Urological Infections, EAU, 2013; 4.4.2; 30-1
18. Siegel JF, Smith A, Moldwin R. Minimally invasive treatment of renal abscess. J Urol, 1996; 155 (1): 52-5
19. El-Nahas AR, Faisal R, Mohsen T, Al-Marhoon MS, Abol-Enein H. What is the best drainage method for a perinephric abscess? Int Braz J Urol, 2010; 36 (1): 29-7