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Original Article

Characteristics and factors influencing treatment outcome of renal and perinephric abscess — a 5-year experience at a tertiary teaching hospital in Taiwan

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Background and Purpose: Diagnosis of renal or perinephric abscess is still a challenge for physicians. This study investigated the effect of location and size of abscess and the time of diagnosis on treatment outcomes.
Methods: This retrospective analysis enrolled 159 adult patients with renal, perinephric or mixed-type (renal plus perinephric) abscess hospitalized between June 2001 and June 2006. The outcomes of these patients were classified into "poor" and "success" in order to elucidate associated risk factors. 106 patients had clear information of the timing of diagnosis and were categorized into "early" and "delayed" diagnosis groups, depending on whether the diagnosis was made within or after 5 days of admission.
Results: Compared with the early diagnosis group (n = 78), the delayed diagnosis group (n = 28) were older (59.9 ± 15.9 vs 50.9 ± 14.9 years, *p*=0.005) and had less costovertebral angle knocking pain (85.7% vs 51.3%, *p*=0.021), a higher rate of renal insufficiency (57.1% vs 15.4%, *p*<0.001) and hospital stay over 22 days (71.4% vs 24.4%, *p*<0.001). There was no significant difference between these two groups in clinical outcomes. Compared with renal abscess, both perinephric and mixed-type abscess had higher rates of larger abscess (>5 cm in diameter) [84.1% vs 25.6%, *p*<0.001; and 55.6% vs 25.6%, *p*=0.012, respectively] and lower rates of *Escherichia coli* infection (24.4% vs 59.4%, *p*<0.001; and 26.7% vs 59.4%, *p*=0.021, respectively). Among all culture-positive patients, the proportion of *Klebsiella pneumoniae* was 25.6%. Perinephric abscess had higher rates of percutaneous (56.3% vs 31.5%; *p*=0.005) and surgical drainage (29.2% vs 7.6%; *p*=0.001) than renal abscess. In multivariate analysis, age ≥65 years (*p*=0.006; odds ratio [OR], 7.008; 95% confidence interval [CI], 1.75-28.141), thrombocytopenia (*p*=0.002; OR [95% CI], 10.434 [2.344-46.444]), and abscess without drainage (*p*=0.001; OR [95% CI], 9.984 [2.640-37.758]) were independent factors for poor outcome (mortality or nephrectomy).
Conclusion: Old age, renal insufficiency and lack of costovertebral angle knocking pain may contribute to delayed diagnosis of renal or perinephric abscess, and prolonged hospital stay. The location and size of abscess did not affect clinical outcome in this study, which might be due to adequate abscess drainage. *K. pneumoniae* is not uncommon in renal or perinephric abscess in Taiwan.

Key words: Abscess; Kidney disease; Retrospective studies; Risk factors; Treatment outcome

Introduction

Renal or perinephric abscess is a diagnostic challenge to physicians. A delay in diagnosis may lead to higher morbidity and mortality [1]. Renal or perinephric abscess most often occurs in patients with diabetes mellitus (DM), urinary tract calculi or urinary tract obstruction [1,2]. Most of the causative pathogens are *Enterobacteriaceae*, such as *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus mirabilis*, *Staphylococcus aureus* and anaerobes [2-8]. Early diagnosis via appropriate diagnostic tools and aggressive therapy might improve the outcome [2-4,9]. However, the diagnosis of renal or perinephric abscess is usually difficult to make from

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history and physical examination findings alone, because the findings may be nonspecific. The presenting symptoms are usually of insidious onset with variation that prevents early diagnosis [2,10].

Recent advances in imaging have been helpful for diagnosis. Computed tomography (CT) has an important role in establishing the diagnosis in clinically equivocal cases of renal infections and related complications [4,11,12]. The mainstay of treatment for renal or perinephric abscess is adequate drainage and optimal antibiotic regimens [5,6]. Previous studies have mostly focused on the indications for abscesses drainage, particularly abscess size [5,13,14] and location [15]. In small abscesses, antibiotic therapy alone and close follow-up can provide successful treatment, but in large renal or perinephric abscesses, surgical intervention, such as incision and drainage, is usually necessary. Successful percutaneous drainage of renal or perinephric abscess was as effective as surgical drainage, even in severe emphysematous abscesses [16,17].

In our clinical experience, more and more cases of renal or perinephric abscesses can be successfully treated with antibiotics alone or a combination of antibiotics and abscess drainage, despite a delay in establishing the correct diagnosis. Thus, we conducted a retrospective study to investigate whether the location and size of abscesses and the time of diagnosis would influence treatment outcomes.

Methods

Patients and study design

We reviewed the charts of all patients over 18 years old with a diagnosis of renal, perinephric or mixed-type (renal plus perinephric) abscess at Chang Gung Memorial Hospital-Linkou Medical Center, between June 2001 and June 2006. The diagnosis was confirmed by surgical exploration, percutaneous needle aspiration, or image studies, such as abdominal CT, magnetic resonance imaging or ultrasound. The following information from the enrolled cases was collected: demographic characteristics, comorbid illness (such as DM, urinary tract calculi, hydronephrosis, previous urologic procedure, urinary tract infection history and other immunocompromised status), clinical features, location of abscesses and drainage methods, laboratory data, bacteriology, antibiotic regimens, image studies, duration between admission and diagnosis, length of hospital stay, and outcomes. Malignancies, liver cirrhosis and chronic renal disease in uremic stage (serum creatinine level ≥5 mg/dL) were included in "other immunocompromised status".

The location of abscess was determined based on the findings of image studies or surgery. Abscess confined in the cortex, central medulla or internal calices was considered as renal abscess, and that localized between the capsule of the kidney and Gerota fascia was identified as perinephric abscess [18]. Abscess involving both spaces was defined as mixed-type abscess. The size of renal and perinephric abscess was measured as the largest diameter, and the size of mixed-type was measured according to the sum of the diameters of renal and perinephric abscess. Abscess ≤5 cm was defined as "small abscess" and size >5 cm was defined as "large abscess" [13]. In cases of acute pyelonephritis, fever usually subsided within 4 days after effective antibiotic treatment [19], and therefore the cut-off period to distinguish between simple pyelonephritis and complicated renal infection was defined as 5 days. Diagnosis of renal, perinephric or mixed-type abscess being made within 5 days of admission was defined as "early diagnosis", and diagnosis made after 5 days of admission was defined as "delayed diagnosis". Patients were assigned to either group according to the time of establishing diagnosis. Hydronephrosis was defined as renal pelvis dilatation with or without thinning of cortex by imaging findings, such as ultrasound or CT scan.

Outcomes

Patient outcomes were classified into "poor" and "success", in order to elucidate the associated risk factors. Poor outcome was defined as either death or subsequent nephrectomy despite effective antibiotic treatment and/or abscess drainage. Treatment success was defined as successful treatment with antibiotics alone or a combination of antibiotics and abscess drainage [20].

Statistical analysis

The primary endpoint of the analysis was poor outcome. Comparisons between categorical variables were performed using the chi-squared or Fisher's exact test, as appropriate. Continuous variables were compared by Student's *t* test. Odds ratio (OR) and 95% confidential interval (CI) were calculated to evaluate the strength of any association, as well as the precision of the estimate of effect in the outcome analysis. Univariate analysis was conducted first to determine the association between potential risk factors and treatment outcomes. Variables with a 2-tailed p value <0.05 were then included in a forward stepwise multiple logistic regression analysis to determine the independent risk factors for the poor outcome in patients with renal, perinephric or mixed-type abscess. Statistical calculations were done using the Statistical Package for the Social Sciences (SPSS) for Windows (Version 12.0; SPSS, Chicago, IL, USA) software package.

Results

159 patients were included in this study. Percutaneous drainage was performed in 65 patients, of which 3 had surgical drainage and 6 later received nephrectomy. Among 47 patients without previous percutaneous drainage, 18 received surgical drainage, and the other 29 received nephrectomy. The remaining 47 patients without any drainage were diagnosed by clinical presentation and image findings, of which 41 were diagnosed by CT, 2 by magnetic resonance imaging, and 3 by ultrasound. Seventy eight patients had both CT and ultrasound examination in this study, and in 33 of them (42.3%) the diagnosis was missed by ultrasound. Smaller abscess size was found to be a contributing factor leading to misdiagnosis (mean ± standard deviation [SD], 3.72 ± 2.15 vs 5.33 ± 2.55 cm; p=0.005).

The demographic and clinical features and laboratory data of these patients are summarized in Table 1. Patient age ranged from 19 to 91 years (mean, 55.08 ± 14.53 years). Women outnumbered men (121:38). Of 159 patients, 140 (88.1%) had comorbidities, including DM (78 patients, 49.1%), urinary tract calculi (51, 32.1%) and hydronephrosis (38, 23.9%). Seventeen patients were immunosuppressed, including 7 with malignancies, 6 with liver cirrhosis and 4 uremic patients. Forty six patients (28.9%) had preceding urologic procedures and 32 (20.1%) had previous urinary tract infections. The length of hospital stay ranged from 3 to 86 days (mean, 22.50 ± 15.16 days). The duration from hospitalization to the diagnosis of renal, perinephric or mixed-type abscess was 5.25 ± 5.70 days. The duration of symptoms before hospitalization was 15.67 ± 20.66 days. The duration of fever after starting effective antibiotics was 7.11 ± 7.52 days.

The mean size of abscesses was 4.95 ± 2.99 cm (range, 1.00 to 15.00 cm) in longest diameter. The mean leukocyte count was 13,189 ± 8195/μL (range, 1800 to 82,200/μL). The mean serum creatinine level was 1.85 ± 1.87 mg/dL (range, 0.5-11.3 mg/dL). Forty patients (25.2%) had serum creatinine level over 2.0 mg/dL. 107 patients (67.3%) had pyuria and 72 (45.2%) had hematuria (Table 1). Twenty three patients had complicated septic metastases, including psoas muscle abscess (6 patients), abdominal wall involvement (4), concurrent liver abscess (3), splenic abscess or perisplenic abscess (2), pelvic muscle abscess (3), concurrent adrenal abscess (1), peripancreatic abscess (1), mycotic aneurysm (1), septic embolism (1) and renal vessel thrombosis (1).

Only 125 patients had positive culture results, and 24 (19.2%) had at least 2 kinds of pathogens abscess culture results were available in 103 patients and the positive culture rate was 75.7% (78/103). Blood cultures were available in 129 patients and the positive culture rate was 39.5% (51/129). Urine culture results could be traced from 137 patients and the positive culture rate was 42.6% (61/143). The isolated pathogens are summarized in Table 2. The three most common pathogens isolated were *E. coli* (55 patients, 44.0%), *K. pneumoniae* (32, 25.6%) and *P. mirabilis* (13, 10.4%) [Table 2]. Of the 9 patients with anaerobic infections, monobacterial isolates included *Bacteroides fragilis* (3), *Veillonella* spp. (3), and *Peptostreptococcus* spp. (1). Polymicrobial isolates included *Peptostreptococcus* and *Prevotella* spp. (1) and *Fusobacterium mortiferum* and *Prevotella melaninogenica* (1). Except for renal or perinephric abscess, no other focus of infection could be traced from the medical records of these 9 patients.

In total, 106 patients with clear information of the timing of diagnosis were categorized into the "early" or "delayed" diagnosis group. The remaining 53 patients were diagnosed at other hospitals and had inadequate information for classification. Patients with delayed diagnosis (n = 28) tended to be older (59.89 ± 15.90 vs 50.88 ± 14.94 years, p=0.005) and had a higher rate of renal insufficiency (57.1% vs 15.4%, p<0.001), pyuria (92.9% vs 61.5%, p=0.006), hematuria (67.9% vs 38.5%, p=0.025) and hospital stay over 22 days (71.4% vs 24.4%, p<0.001) than patients with early diagnosis (n = 78). Patients with early diagnosis had a higher rate of costovertebral knocking pain (14.3% vs 48.7%, p=0.001) than those with delayed diagnosis. There was no significant difference between these two groups in clinical outcomes (Table 3).

Compared to renal abscess, mixed-type abscess had a male predominance (47.4% vs 17.4%, p=0.012), a higher rate of urinary tract calculi (63.2% vs 26.1%, p=0.002) and a greater proportion of *K. pneumoniae* isolates (46.7% vs 17.4%, p=0.035). Both perinephric and mixed-type abscesses had a higher rate of large abscess (size >5 cm in diameter) [84.1% vs 25.6%,

Table 1. Comparison of clinical characteristics in patients with renal, perinephric and mixed-type (renal and perinephric) abscess

Variable	Renal (n = 92) No. (%)	Perinephric (n = 48) No. (%)	Mixed (n = 19) No. (%)	p^a	p^b
Age (years; mean ± SD)	53.2 ± 15.0	56.7 ± 13.8	60.2 ± 13.1	0.17	0.001
≥65 years	24 (26.1)	12 (25.0)	9 (47.4)	0.89	0.07
Gender					
Male	16 (17.4)	13 (27.1)	9 (47.4)	0.18	0.012
Female	76 (82.6)	35 (72.9)	10 (52.6)		
Comorbid condition					
Diabetes mellitus	40 (43.5)	30 (62.5)	8 (42.1)	0.033	0.91
Urinary tract calculi	24 (26.1)	15 (31.3)	12 (63.2)	0.52	0.002
Hydronephrosis	23 (25.0)	8 (16.7)	7 (36.8)	0.26	0.29
Previous urologic procedure	23 (25.0)	16 (33.3)	7 (36.8)	0.27	0.29
Previous urinary tract infection	21 (22.8)	7 (14.6)	4 (21.1)	0.25	0.99
Immunocompromised	11 (12.0)	6 (12.5)	0 (0.0)	0.93	0.21
Symptoms and signs					
Fever	56 (60.9)	23 (47.9)	10 (52.6)	0.14	0.51
Costophrenic angle knocking pain	36 (39.1)	20 (41.7)	10 (52.6)	0.77	0.28
Abdominal pain	16 (17.4)	5 (10.4)	4 (21.1)	0.27	0.75
Dysuria	35 (38.0)	15 (31.3)	10 (52.6)	0.43	0.24
Consciousness disturbance	5 (5.4)	4 (8.3)	1 (5.3)	0.49	0.99
Hypotension	3 (3.3)	4 (8.3)	3 (15.8)	0.23	0.06
Laboratory data					
Leukocyte count >12.0 × 10^3 or <4.0 × 10^3/μL	43 (46.7)	29 (60.4)	8 (42.1)	0.12	0.71
Platelet count <140 × 10^3/μL	20 (21.7)	6 (12.5)	4 (21.1)	0.18	0.99
Creatinine ≥2.0 mg/dL	27 (29.3)	9 (18.8)	4 (21.1)	0.19	0.43
Pyuria[c]	61 (66.3)	33 (68.8)	13 (68.4)	0.39	0.99
Hematuria	39 (42.4)	26 (54.2)	7 (36.8)	0.07	0.63
Abscess features[d]					
Abscess size (cm; mean ± SD)	3.12 ± 2.50	6.84 ± 2.52	6.01 ± 3.53	<0.001	0.008
>5 cm	22 (25.6)	37 (84.1)	10 (55.6)	<0.001	0.012
Septic metastases	10 (10.9)	9 (18.8)	4 (21.1)	0.20	0.26
Treatment					
Percutaneous drainage	29 (31.5)	27 (56.3)[f]	9 (47.4)	0.005	0.19
Surgical drainage	7 (7.6)	14 (29.2)[f]	0 (0.0)	0.001	0.60
Microbiology					
Escherichia coli	41 (59.4)	10 (24.4)	4 (26.7)	<0.001	0.021
Klebsiella pneumoniae	12 (17.4)	13 (31.7)	7 (46.7)	0.08	0.035
Proteus mirabilis	6 (8.7)	4 (9.8)	3 (20.0)	0.99	0.20
Positive blood culture[e]	36 (45.6)	8 (21.1)	7 (58.3)	0.008	0.74
Course and outcome					
Fever >7 days	15 (16.3)	3 (6.3)	4 (21.1)	0.21	0.45
Hospital stay (days; mean ± SD)	21.24 ± 14.79	24.06 ± 15.65	24.58 ± 15.27	0.30	0.38
≥22 days	32 (34.8)	19 (39.6)	8 (42.1)	0.58	0.58
Nephrectomy	21 (22.8)	6 (12.5)	8 (42.1)	0.14	0.09
Mortality	7 (7.6)	4 (8.3)	1 (5.3)	0.99	0.99

Abbreviation: SD = standard deviation

[a]Comparison of patients with renal and perinephric abscess.

[b]Comparison of patients with renal and mixed-type abscess.

[c]Before September 2002, pyuria was defined as urine white blood cell (WBC) count ≥10 cells/high power field (HPF). After that, pyuria was defined as urine WBC count over 30/μL. Hematuria was defined as red blood cell count ≥5 cells/HPF before September 2002; after that, it was defined as over 20/μL.

[d]Data on abscess size were not available for six patients with renal abscess, four with perinephric abscess and one with mixed-type abscess.

[e]Blood culture data were available for 79 patients with renal abscess, 38 with perinephric abscess and 12 with mixed-type abscess.

[f]Of 41 patients with perinephric abscess, 3 received percutaneous drainage followed by surgical drainage.

Table 2. Organisms isolated from abscess (78 patients), blood (51) and urine (61) in patients with renal, perinephric and mixed-type (renal and perinephric) abscess

Organism[a]	Number of isolates (%)		
	Abscess	Blood	Urine
Gram-negative organisms	57 (73.1)	44 (86.3)	53 (86.9)
Escherichia coli	24 (30.8)	28 (54.9)	33 (54.1)
Klebsiella pneumoniae		14 (27.5)	12 (19.7)
Proteus mirabilis	10 (12.8)	2 (3.9)	2 (3.3)
Other *Enterobacteriaceae*			
Enterobacter spp.	1 (1.3)	0 (0.0)	1 (1.6)
Morganella spp.	3 (3.8)	0 (0.0)	0 (0.0)
Citrobacter spp.	2 (2.6)	1 (2.0)	2 (3.3)
Serratia marcescens	1 (1.3)	0 (0.0)	0 (0.0)
Salmonella spp.	2 (2.6)	1 (2.0)	0 (0.0)
Klebsiella oxytoca	1 (1.3)	0 (0.0)	0 (0.0)
Pseudomonas aeruginosa	3 (3.8)	0 (0.0)	5 (8.2)
Gram-positive organisms	18 (23.1)	6 (11.8)	6 (9.8)
Staphylococcus aureus	4 (5.1)	3 (5.9)	1 (1.6)
Other Gram-positive cocci			
Coagulase-negative staphylococci	1 (1.3)	0 (0.0)	1 (1.6)
Enterococcus spp.	4 (5.1)	1 (2.0)	3 (4.9)
Viridans streptococci and other			
Streptococcus spp.	9 (11.5)	2 (3.3)	1 (1.6)
Anaerobes	9 (11.5)	1 (2.0)	
Bacteroides fragilis	3 (3.8)	1 (2.0)	0 (0.0)
Veillonella spp.	3 (3.8)	0 (0.0)	0 (0.0)
Peptostreptococcus spp.	2 (2.6)	0 (0.0)	0 (0.0)
Prevotella spp.	2 (2.6)	0 (0.0)	0 (0.0)
Fusobacterium mortiferum	1 (1.3)	0 (0.0)	0 (0.0)
Candida spp.	1 (1.3)	0 (0.0)	4 (6.6)

[a]Polymicrobial isolates were present in one patient or one specimen.

$p<0.001$; and 55.6% vs 25.6%, $p=0.012$, respectively] and a lower rate of *Escherichia coli* infection (24.4% vs 59.4%, $p<0.001$; and 26.7% vs 59.4%, $p=0.021$). Perinephric abscess had a higher rate of percutaneous drainage (56.3% vs 31.5%, $p=0.005$) and surgical drainage (29.2% vs 7.6%, $p=0.001$) than renal abscess. The location and size of abscess did not affect clinical outcome in this study. DM was seen more commonly in patients with perinephric abscess than in those with renal abscess (62.5% vs 43.5%, $p=0.033$). The renal abscess group had a higher positive blood culture rate than the perinephric abscess group (45.6% vs 21.1%, $p=0.008$) [Table 1].

Abscess size could be established from the medical records and imaging studies in 148 patients. Of these, 69 had large abscesses and 79 had small abscesses. Table 4 shows the characteristics of abscesses without percutaneous or surgical drainage. In patients with renal abscess, 38 were successfully treated with antibiotics alone. In contrast, only 3 patients with perinephric abscess and 3 with mixed-type survived with antibiotics alone. Of the 21 patients with large abscess but without drainage, 11 had perinephric space involvement, but only one of them (9.1%) was successfully treated with antibiotics alone. Of the 10 patients with large renal abscess, 6 of them (60.0%) had successful therapy with antibiotics alone.

Of 79 patients with small abscess, 52 had no abscess drainage, of which 37 (71.2%) were treated successfully with antibiotics alone, while 24 of 27 patients with abscess drainage (88.9%) had treatment success. Drainage of small abscesses seemed to have better treatment outcome, but this effect did not reach statistical significance ($p=0.08$). Among 69 patients with large abscesses, 21 had no abscess drainage, of which 7 (33.3%) were treated successfully with antibiotics alone, and 40 of the 48 patients with abscess drainage (83.3%) had treatment success. Drainage of large abscess was associated with better treatment outcome ($p<0.001$).

Table 3. Demographic and clinical features of patients with early diagnosis (within 5 days of admission) and delayed diagnosis (after 5 days of admission) of renal, perinephric and mixed-type (renal and perinephric) abscess

Variable	Early (n = 78) No. (%)	Delayed (n = 28) No. (%)	*p*
Age (years; mean ± SD)	50.9 ± 14.9	59.9 ± 15.9	0.008
≥65 years	15 (19.2)	13 (46.4)	0.005
Male gender	18 (23.1)	5 (17.9)	0.57
Costovertebral angle knocking pain	38 (48.7)	4 (14.3)	0.021
Leukocyte count >12.0 × 10^3 or <4.0 × 10^3/μL	41 (52.6)	12 (42.9)	0.38
Platelet count <140 × 10^3/μL	14 (17.9)	8 (28.6)	0.23
Creatinine ≥2.0 mg/dL	12 (15.4)	16 (57.1)	<0.001
Pyuria	48 (61.5)	26 (92.9)	0.006
Hematuria	30 (38.5)	19 (67.9)	0.025
Abscess size >5 cm[a]	32 (42.7)	10 (40.0)	0.82
Septic metastases	11 (14.1)	4 (14.3)	0.99
Hospital stay ≥22 days	19 (24.4)	20 (71.4)	<0.001
Nephrectomy	17 (21.8)	5 (17.9)	0.66
Mortality	5 (6.4)	5 (17.9)	0.12

Abbreviation: SD = standard deviation

[a]Data on abscess size were available for 75 patients in the early diagnosis group and 25 patients in the delayed diagnosis group.

Forty five patients had poor outcome, comprising nephrectomy in 35 and death in 12 patients. Two patients with nephrectomy later died. From the outcome analysis in Table 5, age over 65 years (p=0.006), thrombocytopenia (p=0.002) and abscess without drainage (p=0.001) were independently related to poor outcome.

Discussion

Of 78 patients with both CT and ultrasound examination in this study, diagnosis was missed by ultrasound in up to 42.3%. We strongly suggest that CT scan examination should be considered in those patients with suspicion of renal or perinephric abscesses.

Nearly 50% of the patients enrolled in this study had DM, which could predispose patients to infections because of diabetic nephropathy, diabetic cystopathy and impaired phagocytosis and chemotaxis [21]. Patients with perinephric abscess had a higher rate of DM than those with renal abscess (62.5% vs 43.5%, p=0.033). This could explain why the perinephric abscess group had a borderline higher rate of *K. pneumoniae* infection (31.7% vs 17.4%, p=0.083), as *K. pneumoniae* is the common pathogen associated with liver abscess, meningitis, and endophthalmitis in Taiwan [22].

In previous studies in western countries, *E. coli* has been the predominant strain contributing to renal or perinephric abscess, and *K. pneumoniae* was responsible for 1% to 14% of cases [3,4]. In this study, the ratio of *K. pneumoniae* was 25.6% of all culture-positive patients, and is thus a predominant pathogen in renal and perinephric abscess in Taiwan. Urolithiasis, previous urologic procedure, hydronephrosis and previous urinary tract infection were the most common underlying urologic problems predisposing to renal or perinephric abscess. The most common symptoms and signs were fever, flank pain, and dysuria. These are similar to previous studies [1,2,4,6].

Table 4. Abscess characteristics in patients who did not receive percutaneous or surgical drainage

	Renal No. (%)[a]	Perinephric No. (%)[a]	Mixed-type No. (%)[a]	Total No. (%)[a]
Small abscess (≤5 cm)	32/43 (74.4)	2/4 (50.0)	3/5 (60.0)	37/52 (71.2)
Large abscess (>5 cm)	6/10 (60.0)	1/6 (16.7)	0/5 (0.0)	7/21 (33.3)
Total	38/53 (71.7)[c]	3/10 (30.0)	3/10 (30.0)	44/73 (60.3)
p[b]	0.44	0.50	0.17	0.003

[a]Number of patients successfully treated with antibiotics alone/total number of patients without percutaneous or surgical drainage.
[b]Comparison of successful treatment rate with antibiotics alone between small and large abscesses in different locations.
[c]Three patients were excluded because their abscess size was not available.

Table 5. Risk factors for poor outcome (mortality or nephrectomy) in patients with renal, perinephric or mixed-type (renal and perinephric) abscess

Variable	Patients		Univariate	Multivariate analysis	
	Poor (n = 45)[a] No. (%)	Success (n = 114)[b]	*p*	*p*	OR (95% CI)
Age ≥65 years	22 (48.9)	23 (20.2)	<0.001	0.006	7.008 (1.745-28.141)
Urinary tract calculi	21 (46.7)	30 (26.3)	0.013	0.07	3.796 (0.895-16.097)
Hydronephrosis	17 (37.8)	21 (18.4)	0.010	0.96	0.967 (0.238-3.930)
Fever	20 (44.4)	69 (60.5)	0.066	0.44	0.612 (0.177-2.113)
Costophrenic angle knocking pain	14 (31.1)	52 (45.6)	0.095	0.73	0.800 (0.222-2.883)
Consciousness disturbance	6 (13.3)	4 (3.5)	0.031	0.47	2.359 (0.226-24.661)
Leukocyte count $>12.0 \times 10^9$ or $<4.0 \times 10^4$/L	14 (31.1)	66 (57.9)	0.002	0.27	0.524 (0.165-1.664)
Platelet count $<140 \times 10^9$/L	14 (31.1)	16 (14.0)	0.013	0.002	10.434 (2.344-46.444)
Creatinine ≥2.0 mg/dL	18 (40.0)	22 (19.3)	0.005	0.82	1.165 (0.309-4.387)
Mixed type abscesses	9 (20.0)	10 (8.8)	0.049	0.17	3.788 (0.561-25.585)
Septic metastases	10 (22.2)	13 (11.4)	0.081	0.10	4.023 (0.773-20.935)
Proteus mirabilis isolate	8 (17.8)	5 (4.4)	0.010	0.16	3.698 (0.594-23.009)
No abscess drainage	31 (68.9)	44 (38.6)	0.001	0.001	9.984 (2.640-37.758)

Abbreviations: OR = odds ratio; CI = confidence interval
[a]Patients who died or received nephrectomy.
[b]Patients who were treated successfully with antibiotics alone or a combination of antibiotics and abscess drainage.

The mean duration of symptoms before hospitalization and the mean duration of fever after initiation of antibiotic therapy in any type of abscess were longer than in uncomplicated urinary tract infections [19]. This should alert physicians to the possibility of more severe and complicated urinary tract infections in this setting, as mentioned in previous studies [1,2]. In this study, abscess size over 5 cm in diameter might be the cut-off value to avoid misdiagnosis by ultrasound examination. CT should be mandatory in patients with high clinical suspicion of renal or perirenal abscess, even if the ultrasound study is negative [11]. Bamberger suggested avoidance of aggressive interventional or surgical treatment of renal and perinephric abscesses of 5 cm diameter or less, which can have complete remission after antibiotic therapy [13]. But another study suggested that aggressive drainage was appropriate in abscesses over 3 cm [5]. In this study, expected abscess size and location had an important role in clinical outcomes in patients without abscess drainage. For patients with large abscesses (over 5 cm) treated with antibiotics alone, abscess confined to the intranephric space had a better outcome than perinephric abscess. Aggressive abscess drainage is necessary in large perinephric abscess (Table 4).

Although the rate of nephrectomy was higher in patients with mixed-type abscess than in those with renal abscess (42.1% vs 22.8%), the rate of mortality and nephrectomy did not differ significantly between these groups. The small number of mixed-type abscess cases may have contributed to this statistical result. Perinephric abscess had a higher rate of percutaneous and surgical drainage than renal abscess. About 70% of patients (78/106) had early diagnosis of the presence of abscess (Table 3), which led to early abscess drainage. This could explain why the location and size of abscess did not affect clinical outcome in this study.

Patients with renal abscess had a higher rate of *E. coli* infection and a greater proportion of females (82.6%) than did those with perinephric or mixed-type abscess. This may be a result of the development of renal abscess via an ascending infection by organisms already isolated within the urinary tract. Patients with renal abscess had a higher rate of positive blood culture than those with perinephric or mixed-type abscess, but the incidence of septic metastasis did not differ between the groups. This might be related to the close proximity of renal abscess to the corticomedullary area. Renal abscesses were of smaller size than other abscess types, possibly because of earlier diagnosis of the former and thus a reduced likelihood of rupture into the perinephric space [11].

The mean duration from hospitalization to diagnosis was 5.25 days in this study, a result similar to previous studies [1,11]. In this study, the delayed diagnosis group had higher percentages of patients over 65 years old, patients without costovertebral angle knocking pain, patients with hematuria or pyuria, and patients with abnormal renal function. When facing a prolonged or atypical course of urinary tract infections, CT with contrast enhancement is crucial for the complete evaluation of patients with renal infection, in order to demonstrate the areas of altered nephrogram that occur as a result of the inflammatory process, and to identify complications [12]. Physicians might be more likely to hold or delay contrast-enhanced CT examination in those patients with older age or renal insufficiency, in order to avoid renal function decline, possibly contributing to delayed diagnosis in these groups.

Despite the delayed diagnosis group having a higher rate of pyuria and hematuria, these findings seemed nonspecific. Imaging studies to investigate complicated renal infection or other focus of infection should not be delayed once the patient has prolonged fever under antibiotic therapy.

Among abscesses treated with antibiotics alone, large abscesses had a lower rate of treatment success than small abscesses (33.3% vs 71.2%, $p=0.003$). Furthermore, regardless of abscess size, abscesses localized in the intranephric space had a higher rate of successful treatment than perinephric or mixed-type abscesses (Table 4). While drainage of small abscesses was associated with (non-significant) improvement in treatment outcome ($p=0.08$), drainage of large abscesses was significantly correlated with better treatment outcome ($p<0.001$). Thus, we suggest that patients with large abscesses, particularly those involving the perinephric space, should receive abscess drainage.

Delayed diagnosis, believed to be associated with poor outcome in previous studies [2,9], did not predict poor outcome (nephrectomy or mortality) in this study, although it did prolong the hospital stay. Early initiation of effective antibiotic therapy on admission and empiric use of broad-spectrum antibiotics might be the reason why there was no increased mortality and morbidity in our patients with delayed diagnosis. In a previous study, predictors of poor outcome in renal or perinephric abscess included old age, lethargy and elevation of blood urea nitrogen [2]. In this study, old age, thrombocytopenia and abscess without drainage were the major risk factors related to poor outcome in multiple regression analysis (Table 5).

In conclusion, *K. pneumoniae* is not uncommon in renal or perinephric abscess in Taiwan. Large abscesses should receive drainage, particularly those involving the perinephric space. Delayed diagnosis prolonged hospital stay, but was not associated with poor outcome in this study. Elderly patients, and those with renal insufficiency and lack of costovertebral knocking pain may have increased likelihood of delayed diagnosis. Physicians should be alert for those patients with a prolonged clinical course of urinary tract infection, and CT scan should be considered in patients with suspicion of renal or perinephric abscesses. In this study, age ≥65 years, thrombocytopenia, and abscess without drainage were factors independently associated with poor outcome (mortality or nephrectomy).

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