Hounsfield unit attenuation value can distinguish pyonephrosis from hydronephrosis in parents with upper urinary tract stones

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Research Article

Keywords: upper urinary tract stones, Hounsfield unit, renal pyonephrosis, urogenic sepsis, hydronephrosis,

Posted Date: April 6th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1526164/v1

Abstract

Objective: To evaluate the attenuation value [Hounsfield unit (HU)] in non-contrast CT for distinguishing pyonephrosis from hydronephrosis in parents with upper urinary tract (UTS) stones and to identify factors predicting the development of sepsis in patients with pyonephrosis.

Methods: Between October 2019 and October 2021, patients with hydronephrosis or pyonephrosis secondary to upper urinary tract stones (UTS) were retrospectively searched in our study. All patients with UTS were treated with either percutaneous nephrostomy (PCN) or surgical management (percutaneous nephrolithotomy / transurethral ureteroscope lithotripsy). We excluded patients treated with extracorporeal shock-wave lithotripsy or patients with bilateral upper urinary tract stones. Patients whose CT was not performed in our hospital or treated in another hospital were also excluded. Clinical data regarding basic information, clinical feature, co-morbidities, previous intervention, infection-related indicators, Calculi-related indicators, HU values of the renal pelvis, the thick wall of the renal pelvis on CT were collected. Univariate and multivariate logistic analyses were performed. ROC curves were drawn to predict pyonephrosis and sepsis.

Results: Two-hundred-forty patients with UTS were included in our study, 191 patients had hydronephrosis without pyonephrosis (Group 1), and 49 patients had hydronephrosis with pyonephrosis (Group 2). The HU value of the renal collecting system in Group 2 (mean, 15.46; range, +1/+30) was significantly higher than that in Group 1 (mean, 5.5;5 range -6/+24) (P = 0.02); the ROC curve analysis revealed that the HU value (AUC = 0.613) of 9.5 was the best cut-off value to predict calculi-related obstructive pyonephrosis, with 71.4% sensitivity and 70.2% specificity. But it cannot predict the development of sepsis in patients with postoperative pyonephrosis (p = 0.11). Multivariate analysis showed that age (P = 0.041), sex (p = 0.036), herpes labialis (p = 0.018), and serum albumin (p = 0.027) were significant predictors for the development of sepsis in patients with postoperative pyonephrosis.

Conclusions: The HU attenuation value of the renal collecting system can distinguish pyonephrosis from hydronephrosis, but it cannot predict sepsis in patients with pyonephrosis postoperative. Older, low-serum albumin female patients with renal pyonephrosis caused by UUT stones are more likely to develop urogenic sepsis.

Introduction

Calculi-related obstructive pyonephrosis (COP) is a common disease occurring in about 3. 2% of patients with upper urinary stones in urology, and it is a serious suppurative and infectious lesion in the renal collecting system caused by calculi (1). COP is considered a urological emergency, and it can cause a rapid loss of renal function and can quickly progress to sepsis and even septic shock (2). Previous studies have suggested that urinary tract obstruction combined with infection significantly increases the risk of urosepsis and shock, with a high morbidity and mortality rate (1–3). So early diagnosis and treatment of COP are particularly important to protect renal function and prevent septic shock.

In such cases, urine leukocyte and urine bacterial cultures usually do not accurately reflect the infection status in the kidney because of urinary tract obstruction. Several studies have shown that more than 50% of patients with pyonephrosis had negative urine culture results (4–6). Primary drainage, including percutaneous nephrostomy or retrograde ureteral intubation, is the principal treatment for pyonephrosis. The gold standard diagnosis of pyonephrosis is pyogenic fluids during endoscopic surgery or primary drainage (2, 9, 12).

So, some scholars have proposed that preoperative imaging examinations, such as ultrasound, Magnetic resonance imaging (MRI), and computed tomography (CT), may help to determine the status of renal infection and diagnose pyonephrosis as soon as possible (12–18). CT is the most commonly used method for preoperative diagnosis of upper urinary calculi; it can quickly determine the location and size of stones in patients and the severity of hydronephrosis of the affected kidney. Some scholars have used CT attenuation values of bladder and renal pelvis urine to predict the positivity results of urine culture, and they found it is high sensitivity and specificity (15). Boeri et al. (6) reported that Hounsfield unit (HU) attenuation could differentiate pyonephrosis from hydronephrosis. But few studies have examined the risk factors of calculi-associated obstructive pyonephrosis, and the development of pyonephrosis in COP is unfamiliar. Therefore, we performed a retrospective study to evaluate the prevalence and risk factors of COP and the role of CT attenuation values in predicting calculi-related obstructive pyonephrosis.

Materials And Methods

Data collection

After ethical approval from the institutional ethical committee, the clinical data of patients with Calculi-related obstructive hydronephrosis in our hospital between October 2019 to October 2021 were retrospectively reviewed. A total of 240 patients admitted with upper urinary tract stones (UTS) were included in the study. Patients without pyonephrosis presented during the study period were included in Group 1, and patients with pyonephrosis presented during the study period were included in Group 2.

Inclusion and exclusion criteria

Inclusion criteria were: having complete clinical information; abdominal CT of patients must have been performed in our hospital, and all UTS patients must have been treated with either percutaneous nephrostomy (PCN) or surgical management (percutaneous nephrolithotomy/transurethral ureteroscope lithotripsy).

The exclusion criteria were: patients without complete clinical information or abdominal CT not performed in our hospital; the patient who had been treated for calculi in another hospital before admission; patients treated by extracorporeal shock-wave lithotripsy (ESWL); patients have bilateral UTS; and abnormal urinary tract anatomy.

clinical data collection and criteria

The clinical data of patients were collected in three categories (patient-related, infection-related, and calculus-related). The patient-related data included age, sex, BMI, fever, hematemesis, co-morbidities (hypertension, diabetes, tuberculosis, HBV, HCV, HIV, malignancy), and previous same-side renal surgery details. The infection-related data included White Blood Cells (WBC), neutrophils, serum CRP, urine leukocyte, urine culture, and serum creatinine. The calculus-related data included stone size, location and number of stones, stone density, grade of hydronephrosis, duration of symptoms, HU values of the renal pelvis, and the thick wall of the renal pelvis.

Pyonephrosis was diagnosed by the presence of pyogenic fluids during endoscopic surgery or primary drainage (PCN and PCNL). Hydronephrosis was diagnosed by ultrasound based on Onen Grading System (24).

Grade 1 = renal pelvic dilation alone; Grade 2 = pelvic + caliceal dilation, renal parenchyma are normal; Grade 3 = pelvic + caliceal dilation, the medulla is short and thin, the cortex is normal; Grade 4 = pelvic + caliceal dilation, there is no medulla, the cortex is thin.

Two physicians calculated the HU values of the renal pelvis and determined whether the wall of the renal pelvis was thickened. Stone size was measured on KUB; urine was taken for culture on the first day in the hospital for all patients; in Group 2, the pyogenic urine in the renal pelvis during endoscopic surgery or primary drainage was also taken for culture.

Blood cultures were performed on patients with high fever (max body temperature ≥ 38.5°C) or chills before or after the operation; Urosepsis was defined as a quick increase in SOFA (Sepsis-related Organ Failure Assessment) score of 2 or higher (25).

Statistical analysis

SPSS 22 software (SPSS Inc., Chicago, IL, USA) was used for all statistical analyses. Continuous data were tested with Student’s t-test, categorical data were processed by the Chi-Square test, the clinical information of all patients was analysed by univariate logistic analysis, and the variables that were statistically significant in univariate analyses were entered into the multivariate logistic regression analyses. Independent risk factors were found, and the ROC (receiver operating characteristic) curves that evaluated the accuracy were described. A value of $p < 0.05$ was considered to be significant.

Results

A total of 240 patients with UTS were included in our study, 191 patients had hydronephrosis without pyonephrosis (Group 1), and 49 patients had hydronephrosis with pyonephrosis (Group 2); the preliminary analysis showed no significant difference between the two groups in duration of symptom, associated co-morbid condition, hematemesis, and body mass index and age ($p > 0.05$). But there were significant differences in sex ($P = 0.01$), fever ($P = 0.001$), and history of same-side urological surgery ($P = 0.001$) (Table 1).

Table 1
Data regarding patient-related factors

	Hydronephrosis	Pyonephrosis	p value*
No. of patients [No. (%)]	191(79.6)	49(20.4)	
Age(years)			0.62
Mean ± SD	51.8 ± 12.16	56.82 ± 11.55	
Range	16–80	23–77	
Sex (Male/female)	134/57	25/24	0.01
Body mass index			0.37
Mean ± SD	23.18 ± 3.78	22.65 ± 3.18	
Range	16.5–30.8	16.6–32.5	
Associated co-morbid condition(n/N)			
Diabetes mellitus	41/191	7/49	0.26
Hypertension	74/191	14/49	0.18
DM with HTN	13/191	3/49	0.86
HBV	5/191	1/49	0.81
HCV	1/191	0	
Tuberculosis	2/191	0	
Duration of symptom (day)			0.29
Mean ± SD	5.37 ± 4.52	4.53 ± 6.38	
Range	1–30	1–30	
Fever(n/N)	15/191	26/49	0.001
Hematuresis(n/N)	73/191	13/49	0.08
History of same-side urological surgery(n/N)	52/191	25/49	0.001
Herpes labialis	0	26/49	

*p value according to the Mann–Whitney test for continuous data and the Chi Square Test for categorical variables, as indicated.

In addition, we compared infection-related and calculus-related factors between the two groups. The HU value of hydronephrosis in Group 2 was higher than that in Group 1 (P = 0. 02), and there were significant differences between the two groups in WBC count, neutrophils, serum CRP (P < 0.001), serum albumin (P

= 0. 004), urine leukocyte ($P = 0.029$), WBCC ($P < 0.001$), urine culture in midstream urine ($P < 0.001$), grade of hydronephrosis ($P = 0.02$), and thick wall of the renal pelvis ($P = 0.01$) (Table 2 and Fig. 1).

Table 2
Data regarding infection-related and calculus-related factors

	Hydronephrosis	Pyonephrosis	p value*
No. of patients [No. (%)]	191(79.6)	49(20.4)	
WBC (*10^9/L)	7.63(2.73–17.32)	12.97(2.14-30)	< 0.001
Neutrophils (*10^9/L)	5.30(1.37–14.03)	11.02(2.01-27)	< 0.001
Serum CRP (mg/L)	14.25(0.28-252.12)	102.82(0.77–309)	< 0.001
Serum albumin	42.15(12.25–53.6)	34(19.9–43.5)	0.004
Urine leukocyte (/ul)	178.94(0-9433)	461.98(0-5320)	0.029
WBCC	0.26(0–4)	3.18(0–43)	< 0.001
Urine culture			< 0.001
Positive	15(8.4%)	18(36.7%)	
Negative	164(91.6%)	31(63.3%)	
Location of stone(n/N)			
Ureteral calculus	161/191	45/49	0.18
Renal calculus	100/191	23/49	0.49
RC with UC	72/191	19/49	0.89
Stone size (mm)	10.28(6–28)	10.31(6–27)	0.38
Stone density (HU)	919.4(150–1669)	793(198–1559)	0.23
Grade of hydronephrosis (n/N)			0.02
Grade 1/2	94/191	15/49	
Grade 3/4	97/191	34/49	
CT value of hydronephrosis (HU)	5.55(-6-24)	15.46(1–30)	0.02
Staghorn calculi (n/N)	26/191	6/49	0.8
Thick wall of the renal pelvis(n/N)	60/191	25/49	0.01
Definitive surgery(n/N)			
PCNL	56/191	17/49	0.46
URL	145/191	34/49	0.62
PCNL and URL	10/191	2/49	0.74

Then univariate and multivariate analyses of significant factors were performed for predicting pyonephrosis. The univariate analysis showed significant differences in sex, fever, history of urological surgery, WBC count, neutrophils, serum CRP, serum albumin, urine leukocyte, WBCC, grade of hydronephrosis, CT value of hydronephrosis, and thick wall of the renal pelvis ($P < 0.05$) between two groups. So, these 12 factors were included in the multivariate logistic regression analysis. In the multivariate logistic analysis, we found the history of urological surgery, WBC count, neutrophils, serum CRP, serum albumin, WBCC, grade of hydronephrosis, CT value of hydronephrosis were statistically significant for pyonephrosis (Table 3).

Table 3
Univariate and multivariate analysis of significant factors for predicting pyonephrosis before operation

Variable	**Univariate analysis**		**Multivariate analysis**	
	OR (95% CI)	p-value	OR (95% CI)	p-value
Sex (Male/female)	0.206(0.105–0.404)	< 0.001	0.522(0.098–2.775)	0.446
Diabetes mellitus	1.122(0.793–1.587)	0.262		
Hypertension	0.938(0.647–1.359)	0.184		
Duration of symptom (day)	1.193(0.613–2.322)	0.293		
Fever(n/N)	10.020(4.936–20.340)	< 0.001	2.447(0.332–18.004)	0.380
Hematuresis(n/N)	0.453(0.213–0.964)	0.078		
History of urological surgery	6.292(3.152–12.559)	0.001	5.786(1.041–32.148)	0.045
WBC (*10^9/L)	0.116(0.058–0.232)	< 0.001	0.074(0.011–0.480)	0.006
Serum CRP (mg/L)	0.035(0.008–0.149)	< 0.001	0.018(0.001–0.329)	0.007
Serum albumin	0.039(0.015–0.105)	0.004	0.128(0.018–0.902)	0.039
Urine leukocyte (/ul)	0.213(0.080–0.564)	0.002	5.915(0.535–65.407)	0.147
WBCC	0.100(0.042–0.237)	< 0.001	0.052(0.004–0.624)	0.020
Urine culture	0.132(0.059–0.298)	< 0.001	1.063(0.131–8.618)	0.954
Stone density (HU)	0.550(0.281–1.076)	0.233		
Grade of hydronephrosis (n/N)	0.388(0.204–0.738)	0.021	0.134(0.024–0.733)	0.020
CT value of hydronephrosis (HU)	0.019(0.006–0.055)	< 0.001	0.050(0.007–0.343)	0.002
Thick wall of the renal pelvis	4.810(2.457–9.416)	0.012	4.867(0.805–29.411)	0.085

Receiver operative characteristic (ROC) analysis revealed that WBC count (AUC = 0. 713), history of urological surgery (AUC = 0. 713), serum CRP (AUC = 0. 712), and HU value of hydronephrosis (AUC = 0. 613) had a good ability to differentiate pyonephrosis from hydronephrosis (Fig. 2). A HU value of 9.5 was the best cut-off value to predict calculi-related obstructive pyonephrosis, with 71. 4% sensitivity and 70. 2% specificity.

Of the 49 patients with pyonephrosis, 18 patients developed urogenic sepsis. Those factors were compared between the group Py with Sepsis and Py without Sepsis; we found significant differences in age, sex, herpes labialis, serum albumin, and urine leukocyte between the two groups (Table 4, 5). And univariate and multivariate analysis showed that age, sex, herpes labialis, and serum albumin were statistically significant for sepsis (Table 6).

Table 4
Data regarding patientrelated factors

	Py - Sepsis	**Py + Sepsis**	**p value***
No. of patients [No. (%)]	31(63.3)	18(36.7)	
Age(years)			
Mean ± SD	53 ± 10.99	62.56 ± 8.19	0.006
Range	37–77	47–73	
Sex (Male/female)	23/8	3/15	0.04
Body mass index			0.319
Mean ± SD	23.42 ± 1.82	18.33 ± 2.74	
Range	20.3–26.5	16.5–26.2	
Associated co-morbid condition			
Diabetes mellitus	6/31	4/18	0.81
Hypertension	7/31	8/18	0.48
DM with HTN	2/31	3/18	
HBsAg	2/31	0	
HCV	0	0	
Tuberculosis	0	0	
Duration of symptom (day)	5.61 ± 7.2	2.66 ± 4.52	0.18
Hematuresis	7/31	2/18	0.327
History of same-side urological surgery	20/31	7/18	0.086
Herpes labialis	11/31	17/18	0.002

Table 5
Data regarding infection-related and calculus-related factors

	Py - Sepsis	Py + Sepsis	p value*
No. of patients [No. (%)]	31(63.3)	18(36.7)	
WBC (*10^9/L)	12.76 ± 5.22	14.95 ± 7.69	0.242
Neutrophils (*10^9/L)	10.69 ± 5.12	13.16 ± 7.45	0.181
Serum CRP (mg/L)	116.24 ± 86.99	127.15 ± 78.22	0.655
Serum AST	43.62 ± 22.78	66.16 ± 60.44	0.131
Serum Y-GGT	64.54 ± 79.80	72.08 ± 55.03	0.719
Serum albumin	35.52 ± 4.19	30.95 ± 6.08	0.003
Urine leukocyte (/ul)	802.61 ± 1156.23	74.94 ± 81.06	0.063
WBCC	3.22 ± 8.11	2.33 ± 3.74	0.661
Urine culture			0.535
Positive	11/31	8/18	
Negative	20/31	10/18	
Location of stone			
Ureteral calculus	27/31	16/18	0.854
Renal calculus	19/31	7/18	0.130
RC with UC	15/31	5/18	0.157
Stone size (mm)	10.27 ± 6.13	10.8 ± 3.91	0.383
Stone density (HU)	796.36 ± 377.9	780.54 ± 381.68	0.915
Grade of hydronephrosis			0.553
Grade 1/2	8/31	2/18	
Grade 3/4	23/31	16/18	
CT value of hydronephrosis (HU)	13.85(6–30)	13.44(6–20)	0.11
Thick wall of the renal pelvis	12/19	10/8	0.25

Table 6
Univariate and multivariate analysis of significant factors for predicting Sepsis

Variable	**Univariate analysis**		**Multivariate analysis**	
	OR (95% CI)	p-value	OR (95% CI)	p-value
Age(years)	0.090(0.018–0.463)	0.004	0.856(0.737–0.993)	0.041
Sex (Male/female)	0.227(0.066–1.157)	0.048	0.040(0.002–0.813)	0.036
History of same-side urological surgery	0.350(0.105–1.162)	0.086	0.057(0.000-7.974)	0.255
Herpes labialis	30.909(3.612-264.501)	0.002	8.755(3.160–4.470)	0.018
Serum albumin	1.198(1.048–1.369)	0.008	1.149(0.864–1.529)	0.027
Urine leukocyte (/ul)	1.007(1.000-1.015)	0.063	1.242(1.024–1.505)	0.339

Discussion

UUT stones are among the most common diseases in urology, which often cause hydronephrosis or even renal pyonephrosis. And calculi-related obstructive pyonephrosis (COP) occurs in about 3.2% of patients with UUT stone (1). COP is considered a urological emergency, and it can cause a rapid loss of renal function and can quickly progress to sepsis and even septic shock (2). In recent years, the incidence of sepsis caused by UUT stone has increased, and the associated mortality rate is still high, although the management of the patients has improved (2, 3). So early diagnosis and treatment of COP are particularly important to protect renal function and prevent septic shock.

The evolution of renal pyonephrosis has not been exactly investigated. Obstruction caused by UUT stone and infection is two vital etiological mechanisms of COP (4, 5). This study found that patients with renal pyonephrosis had a higher degree of hydronephrosis than those without pyonephrosis. And the grade of hydronephrosis is an independent predictor of COP in multivariate logistic analysis. Luca Boeri et al. (6) analysed a cohort of 46 patients with renal pyonephrosis and 76 individuals without renal pyonephrosis treated at a single centre. These authors also found that the grade of hydronephrosis is an independent predictor of COP, and they think patients with grade III-IV hydronephrosis are three times more at risk of renal pyonephrosis than patients with grade I-II. Hydronephrosis increases pressure in the renal pelvis and reduces urine formation, so the risk of retrograde infection by bacteria is significantly increased.

Escherichia coli is the most common infecting organism in urinary tract infection (UTI) due to retrograde infections (6, 7, 8). In our study, *E. coli* was also the most common infecting organism (32.5% of cases).

So, the preoperative urine leukocyte count and WBBC were higher in patients with pyonephrosis than in the hydronephrosis group. But the positive rate of mid-stream urine culture (MUC) was only 36.4% in patients with pyonephrosis, and 33.3% of patients' renal pelvis urine cultures were positive, and preoperative mid-stream urine cultures were negative in patients with pyonephrosis. Similar results were also found in a recent study; Madhusudan et al. (9) found the positive rate of midstream urine culture below 50% in patients with pyonephrosis. Liu et al. (10) also found preoperative urine culture played a role in predicting SIRS after PCNL, but it was unable to prevent the occurrence of SIRS. Because of the urinary obstruction, the infection may persist in the upper system when the MUC is negative. Although far higher than that in patients with hydronephrosis, we believe the MUC cannot be a good predictor of COP because of the low positive rate.

Previous studies have observed that UTIs are more common in women than men, and males are more likely to suffer from urolithiasis (4, 10, 11). In this study, there were twice as many men as women; 24 of 49 patients with pyonephrosis are women. Therefore, we propose that female patients with UUT are more likely to suffer from renal pyonephrosis because of the high risk of UTI. In addition, 15 of 24 female patients with pyonephrosis developed urogenic sepsis, and only three males developed urogenic sepsis. We believe that the difference between genders is significant, especially in those who are older and with low serum albumin; female patients with renal pyonephrosis caused by UUT stones are more likely to develop urogenic sepsis.

Primary drainage, including percutaneous nephrostomy or retrograde ureteral intubation, is the principle for diagnosing and treating pyonephrosis (9, 12, 20). A percutaneous nephrostomy or retrograde ureteral intubation is a necessary and effective surgical procedure, but they are invasive. So, we are looking for a non-invasive method to identify pyonephrosis from hydronephrosis.

Radiological examinations, such as ultrasound, magnetic resonance imaging (MRI), and computed tomography (CT), are important in the diagnosis of pyonephrosis because they can achieve a rapid result and help determine the status of renal infection. Ultrasound is a conventional diagnostic method for upper urinary calculi. It has been reported that renal pyonephrosis may be suggested when strong echo points, uneven density, and blurred images occur in the renal collecting system (12). However, ultrasound is highly subjective and has no quantitative indicators, limiting the value of renal pyonephrosis diagnosis. Magnetic resonance (MR) is a reliable tool to differentiate pyonephrosis from hydronephrosis but is not widely used in the diagnosis of upper urinary calculi due to its low efficiency in diagnosing calculi (13, 14). CT is by far the most commonly used method for diagnosing upper urinary calculi, and the diagnostic rate of calculi is as high as 95–100%. Meanwhile, it can clearly show the renal parenchyma, renal collecting system, and perirenal conditions(15).

The HU is the scale of tissue density at standard temperature and pressure, related to two predefined values: air defined as -1000 HU and water 0 HU (23). Physicians routinely use the HU attenuation value measured by computed tomography to assess the hardness of urinary calculi, helping to determine the stone treatment and define the nature of the kidney masses (16, 17, 21, 22).

Stunell et al. (18) reported no non-specific findings, such as thickening wall of the renal pelvis and blurring of perirenal fat, in computed tomography in patients with pyelonephritis. Also, the HU value of the renal collecting system was not measured in their study. However, Yuruk et al. (19) conducted a retrospective study of 105 patients with calculi-related obstructive hydronephrosis and revealed that the HU value of the renal collecting system in patients with pyonephrosis was significantly higher than in patients with hydronephrosis. The best cut-off value for predicting pyonephrosis in the renal collecting system was 9.21 (65.9% sensitivity and 87. 9% specificity). We also report similar results; HU values of the dilated renal collecting system of patients with pyonephrosis were higher than patients with hydronephrosis (p = 0. 02). The ROC curve analysis revealed that the HU value of 9.5 was the best cut-off to predict calculi-related obstructive pyonephrosis (71.4% sensitivity and 70. 2% specificity).

In a recent study, 11 patients with obstructive UTI and 22 patients with Calculi-related hydronephrosis were retrospectively evaluated, and percutaneous nephrostomy was performed in all patients; these authors report that patients in obstructed urinary systems with renal pelvis urine culture positivity had a higher HU value than negative patients (20). In another study, they found the HU values of the dilated renal collecting system can differentiate COP from COH and predict septic complications after surgery. The best cut-off value to predict septic complications in the renal collecting system was 7.3. Patients with HU values of more than 7.3 are 8-times more likely to progress to sepsis postoperative (6). In our study, we did not detect a was a significant difference between the patients with or without sepsis in HU value (p = 0. 11), and we found that there is a significant difference between the patients with or without sepsis in age, sex, and the level of serum albumin. We believe older, low serum albumin female patients with renal pyonephrosis caused by UUT stones are more likely to develop urogenic sepsis.

Limitation Of Study

A limited number of patients did not have the data for calculus component analysis, so we were unable to test the relationship between calculus components and pyonephrosis. There was no clear boundary between infective hydronephrosis and pyonephrosis, and there were certain deviations in the collected data. A large-scale case analysis is now needed to continuously confirm the conclusions.

Conclusions

In this study, we found that many factors, such as the history of urological surgery, lower serum albumin, and grade of hydronephrosis, are associated with the development of calculi-related obstructive pyonephrosis. The HU attenuation value of the renal collecting system can distinguish pyonephrosis from hydronephrosis, but it cannot predict sepsis in patients with pyonephrosis postoperative. Based on our findings, we believe that older, low serum albumin female patients with renal pyonephrosis caused by UUT stones are at increased risk of developing urogenic sepsis.

Statements And Declarations

Funding

No funding was obtained for this study

Competing interests

Authors have no conflict of interests.

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Figures

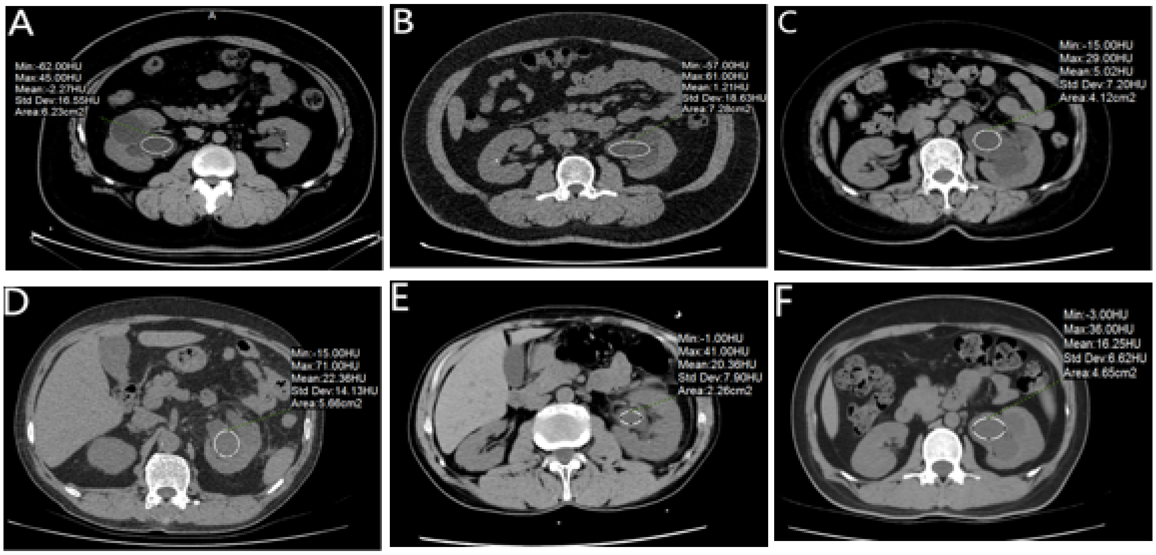

Figure 1

Hounsfeld units measurement of 3 different patients in pyonephrosis and Hydronephrosis group. A-C. Different patients in Hydronephrosis group; D-F. Different patients in pyonephrosis group.

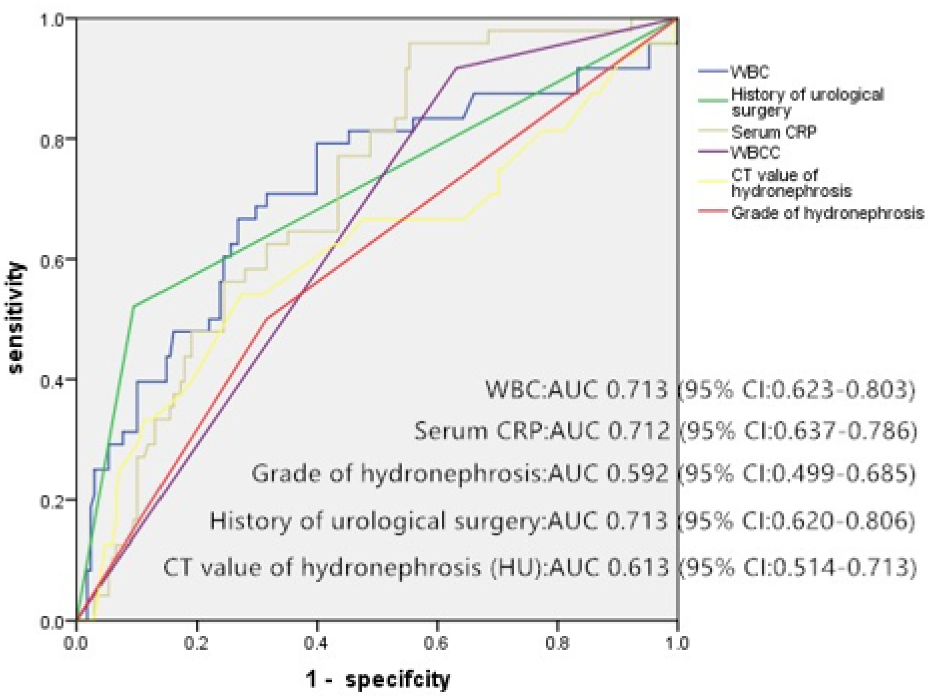

Figure 2

ROC analysis demonstrating the sensitivity and specifcity of independent risk factors in distinguishing pyonephrosis from hydronephrosis.