



Emphysematous pyelonephritis treatment strategies in correlation to the CT classification: have the current experience and prognosis changed?

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Abstract

Purpose In view of the differences in early and late management experiences based on Huang and Tseng CT classification of emphysematous pyelonephritis (EP), our study included 34 patients aimed to re-correlate the current management plans with CT classification.

Methods A retrospective review from January 2009 to December 2018, in patients with primary or final diagnosis of EP. Data included; patients' demographics, routine laboratory and imaging work-up. CT was performed for all, and images were classified based on Huang and Tseng classification. The CT classification was correlated to the laboratory parameters and the final treatment plans. Data were collected and analyzed using SPSS[®].

Results Complete data for 34 patients were analyzed. The majority (70%) had positive urine culture, and Carbapenems and Ureidopenicillin were the most commonly used antibiotics. Based on CT classification, 75% (26/34) of the patients were in class I and II, 6 cases with class IIIa, and only two with class IIIb, with no cases of class IV. All patients in class I and II responded well to the medical therapy, and eight required PCN/DJ. Four required nephrectomy in class III, with zero mortality.

Conclusion Patients in class I and II comprise the majority of EP patients, and respond well to medical treatment with excellent outcome. Insertion of PCN and DJ are not required routinely, but with urinary obstruction requiring drainage, and a few cases who required nephrectomy—all with class III. Our data show improvement in the overall survival in patients for EP.

Keywords Emphysematous pyelonephritis · Huang and Tseng CT classification · Treatment

Introduction

Emphysematous pyelonephritis (EP) is a serious infection of the kidney with previous reports of high rate of nephrectomy and mortality that reached up to 40% [1]. CT has been known as the gold standard in the diagnosis, and Huang and Tseng classification is the most-commonly used tool [2].

When first reported by Huang et al. in 48 patients [2], all patients in class I and II required PCN or DJ stents, 8% required nephrectomy and mortality reached 18% in those patients. Moreover, the mortality rate was 40% in those who were treated with antibiotics only. However, with recent advances in antibiotics and medical care, the recent series reported differently; most of patients in class I and II were managed by antibiotics only, without nephrectomy required, and a mortality rate of zero in some series [3–5]. Even, bilateral EP, treated by medical therapy, was reported [6].

In view of the differences in the early and late management experiences based on CT classification, further studies were recommended to re-correlate the current management plans with Huang and Tseng CT classification. Our study, including 34 patients who were managed at a single tertiary-care hospital, aimed to address this purpose.

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Material and methods

After institutional board approval, we completed a retrospective review of the electronic database, from January 2009 to December 2018. All patients who were admitted with a primary or final diagnosis of EP were retrieved for further analysis. The data sheet included patients' demographics, such as age, gender, and BMI. Routine laboratory investigations included complete blood count (CBC), renal function test (RFT), random blood sugar (RBS), and HbA1c, in addition to urine analysis, culture and blood culture.

All patients had routine imaging studies that included ultrasonography (US), X-ray (KUB), and CT. All CT reports and films were reviewed and reclassified based on Huang and Tseng [2]; Class 1: Gas in the collecting system only, Class 2: Gas in the renal parenchyma without extension to extrarenal space, Class 3A: Extension of gas or abscess to perinephric space, Class 3B: Extension of gas or abscess to pararenal space, and Class 4: Bilateral EPN or solitary kidney with EPN.

All patients received the initial standard management, including intravenous fluids and antibiotics. The diabetic status was controlled by internist/endocrinologist. Patients were kept in the ordinary wards, unless their conditions required a high dependency bed or intensive care unit.

All obstructed kidneys were managed either by percutaneous nephrostomy (PCN) or double J (DJ) stents, and nephrectomy was reserved for those with advanced disease with no response to the medical treatment.

Data were collected using SPSS[®], version 21. Frequency and percentage were used for nominal and categorical variables. For normally distributed data, mean (standard deviation) were used to express data. For non-normally distributed data median (range) were used for expression and Mann–Whitney test was used for analysis.

Results

In the study period, 34 patients were admitted and treated for EP. The median age was 55 (range, 31–82 years), female outnumbered male (24/34, 70%), 26/34 (75%) had DM which was a major risk factor for EP, however, only (10/34, 30%) of our patients had urinary obstruction. The other patients' demographics are shown in Table 1.

Seventy percent (24/34) of our patients had UTI on routine urine analysis; 60% percent of cultures reported *E. coli*, 15% *Klebsiella aeruginosa*, 10% *proteus mirabilis*, 7% *pseudomonas* and others organisms were reported in 8%. Most of the patients responded to medical treatment

Table 1 Patients' demographics

Variables	Number (%) ^a	
Age , median (range)	55 (31–82)	
Gender		
Male	10	(30)
Female	24	(70)
Presentation		
Flank pain	8	(23)
Flank pain with fever	10	(30)
Disturbed level of consciousness	8	(23)
Others	8	(23)
Diabetes Mellitus		
Yes	26	(75)
No	8	(25)
Urinary obstruction		
Yes	10	(30)
No	24	(70)
Urine analysis		
Nitrate, positive (+)	24	(70)
Nitrate, negative (–)	10	(30)
Urine culture		
Positive	22	(65)
Negative	12	(35)
Blood culture		
Positive	16	(47)
Negative	18	(53)

^aDecimals were removed for simplification

with broad-spectrum antibiotics. Carbapenems (meropenem, imipenem) and Ureidopenicillin (piperacillin, tazobactam) were the most commonly used antibiotics either empirically or culture directed. Urinary obstruction was found in 10 (30%) patients, which was relieved by PCN or DJ stent.

Based on Huang and Tseng classification [2], 75% (26/34) of the patients were in class I (Fig. 1) and II (Fig. 2), six cases in class IIIa (Fig. 3), two in class IIIb (Fig. 4), while no cases in class IV were recorded.

Abdominal pain with or without fever were the commonest clinical presentation 18/34 (53%), and eight of our patients presented with disturbed level of consciousness. Patients in class III (in comparison to class I and II) were associated with higher serum glucose, acute renal impairment, high WBCs count, and low Hb level and thrombocytopenia, and the laboratory parameters are correlated with the CT classification in Table 2. Serum glucose and platelet count are the only statistically significant parameters ($p=0.04$, and 0.02 , respectively) in-between the two groups (class I, II and class IIIa, IIIb).

All patients with class I and II with no obstruction responded well to medical treatment and none of them

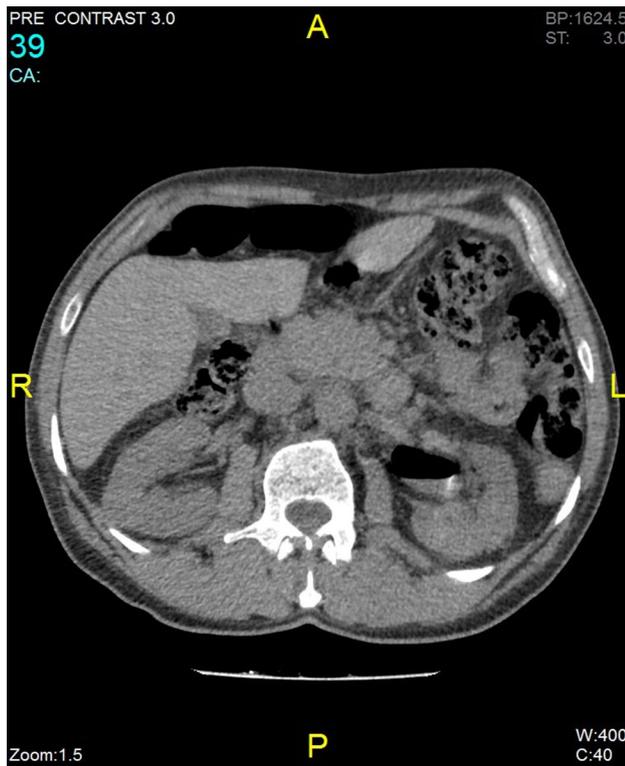


Fig. 1 Non contrast axial CT of the abdomen showing air locules on left PCS and ureter: EP class I



Fig. 2 Stone left renal pelvis (1.5×1 cm), and multiple air locules on the left PCS and renal parenchyma: EP class II

required nephrectomy, however, nephrectomy was required in 2/6 (33%) in class IIIa, and 2/2 (100%) in class IIIb. Table 3 shows the CT classification in correlation to the treatment strategies received by the patients and we have no patients in class IV nor bilateral EP in our series.

All of the patients were discharged with a median hospital stay of 10 days (range, 4–25 days) in good general condition; fully-conscious, no fever, stable vitals, WBCs within range, and resolution of the acute inflammatory stage. Either oral ciprofloxacin or cefuroxime was given to all patient for 14 days. Eleven patients were seen in the follow-up visits, and showed disappearance of air from renal parenchyma.

Discussion

With improving medical care and changing trends in managing EP, when we classified patients based on Huang and Tseng [2], which is the most-commonly used classification. Our study confirmed recent changes in the treatment trends of EP in correlation to CT classification if compared to the early and initial experiences.

Emphysematous pyelonephritis is a serious necrotizing infection that is characterized by a presence of air inside the renal parenchyma that may extend to the perinephric or

paranephric spaces [1, 7]. Seventy-five percent (26/34) of our patients had uncontrolled diabetes mellitus, and it was poorly controlled in patients in class III. Uncontrolled DM has been reported to be the primary risk factor for EP, and high percentages are reported (96% [2], 100% [8]). Seventy percent (24/34) of our patients had UTI on routine urine analysis; 22 and 16 had positive urine and blood culture, respectively. The majority (60%) revealed *E. coli* and this is in agreement with most of the published series [9, 10]. Because UTI is more common in females, this explains why EP is prevalent female than male [4, 5].

The pathogenesis of EP is well-understood. Uncontrolled DM induces diabetic nephropathy which decreases tissue perfusion and immune response. Glucosuria nourishes the growth of glucose-fermenting microbes that ultimately leads to necrotizing infection with gas formation [2]. The condition gets worse with urinary obstruction, which must be relieved. It also decreases the renal blood flow and tissue perfusion. Initial reports showed less response to medical therapy with more intervention and nephrectomy rates with ultimately high mortality [1, 2, 7].

Abdominal pain and fever are the commonest clinical presentation, but in sever sepsis, patients may present with disturbed level of consciousness. Eight of our patients presented with disturbed level of consciousness, the majority

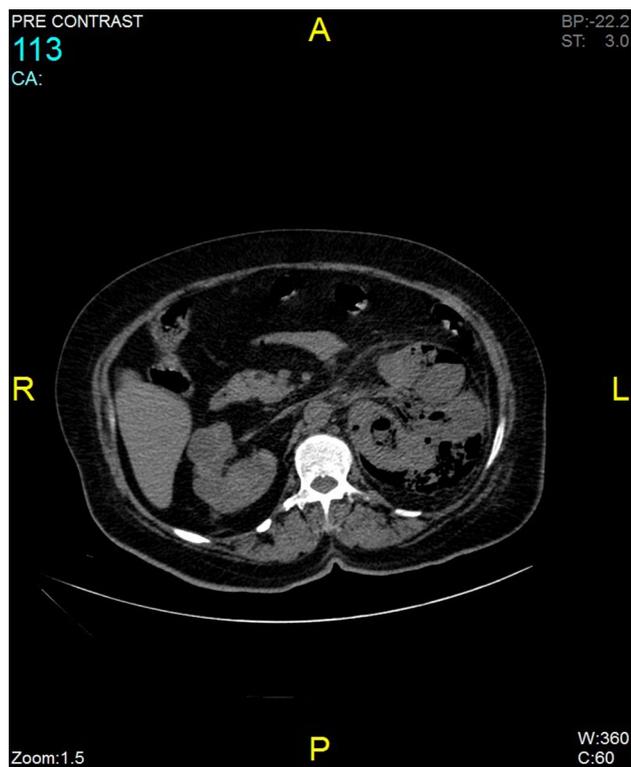


Fig. 3 Distorted shape of the left kidney with multiple air locules inside the PCS, renal parenchyma and the perinephric space: EP class IIIa

(6/8) were in class III. All were managed adequately with no mortality. Different studies were tried to stratify patients based on the clinical presentation, laboratory indices and CT classification. Disturbed level of consciousness, shock, acute renal impairment, thrombocytopenia and class IV were all reported frequently to have bad prognosis [1, 2, 11].

In our series, all patients with class I and II with no obstruction responded well to medical treatment. However, we agree that patients with class III (IIIa and IIIb) may require more risk-stratification. Huang et al. reported that patients in class III with fewer than two risk factors (thrombocytopenia, acute renal impairment, and disturbed level of consciousness) had 85% survival rate with medical treatment and PCN, where those who had more than two risk factors had 93% failure rate with PCN and medical treatment [2]. Our results showed that serum glucose and platelet counts are the only statistically significant laboratory parameters between class I, II and class IIIa, IIIb. Kumar et al. [11] divided the patients in his series into responders to medical treatment and non-responders who required nephrectomy; low Hb, low platelet count and severe proteinuria in laboratory work up were independent risk factors. In contrast, a few studies revealed no difference in the prognosis between patients with less or two or more prognostic factors [9]. We had no cases in class IV nor bilateral EP, which

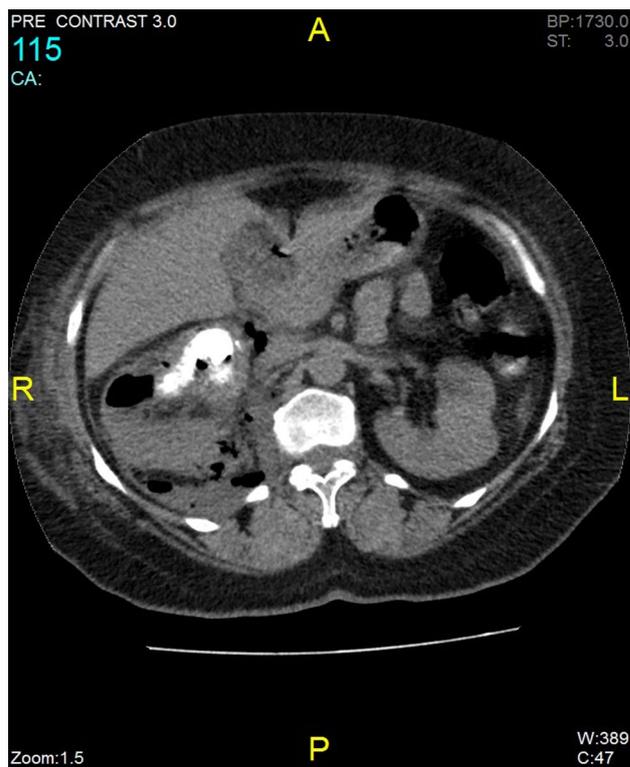


Fig. 4 The right kidney showed bizarre shaped, marked hydronephrosis proximal to large branching stone at renal pelvis, middle and lower calyces with gas density inside the PCS, perinephric and posterior pararenal space. Left perinephric collection related to the lower pole (displays mixed fluid and air densities): EP class IIIb

Table 2 Correlation between CT classification and laboratory parameters

Laboratory parameters (median)	CT classification		<i>p</i> value (Mann–Whitney test)
	Class I, II	Class IIIa, IIIb	
Blood glucose	13 mmol/L	20 mmol/L	0.04
Serum creatinine	244 mmol/L	350 mmol/L	0.07
WBCs	13 × 1000	19 × 1000	1.0
Platelets	244 × 1000	112 × 1000	0.02
Hb	10.4 g/dl	10 g/dl	2.0

Table 3 CT classification in correlation to the management strategies

CT classification (Huang and Tseng)	Management			Total number
	Medical treatment	PCN/DJ stent	Nephrectomy	
Class I	4	4	–	8
Class II	14	4	–	18
Class IIIa	–	4	2	6
Class IIIb	–	–	2	2

PCN percutaneous nephrostomy, DJ double J stent

were rarely reported in the literature [4–6]. In our study, we had eight cases in class III (six of class IIIa and two of class IIIb), but even those who had thrombocytopenia and impaired renal function survived. That reflects the changing trends in EP management.

Early experiences showed that it was a trend to insert DJ stent or PCN for the majority of the EP cases—even without obstruction, with poor response to antibiotics. In the initial report by Huang and Tseng [2] that included 48 patients, 28 (60%) had class I and II, and all required PCN and DJ. Currently and with more understanding of the pathogenesis of the disease, advances in medical care with more potent antibiotics, the figure was changed. In our series, 75% (26/34) were in class I and II, and all responded well to medical treatment with only four who required PCN. The pooled data in the literature supports that class I and II had an excellent outcome without insertion of PCN or DJ stent with no urinary obstruction [3–5, 12].

In addition, early experiences showed that nephrectomy was done early for many cases because it was thought it would be the best option for EP management. In the initial report by Huang and Tseng [2] that included 48 patients, the overall mortality was 18% and 40% with those who received antibiotics only. In our series, four patients required nephrectomy all in class III who did not respond to medical treatment. In addition, there were no mortality cases in our series, the same as reported by Saadi et al. [3], Das et al. [10]. Even the trend that emergent nephrectomy, associated with lower mortality, was denied by Aboumarzok et al. [13] in his study that showed that PCN and DJ stents had lower mortality than emergent nephrectomy.

In accordance with our results, Eswarappa et al. [4] and in a series of 51 patients, the majority of the patients were in class I and II (38 patients, 75%) and one case only in class IV, who died, 23 (45%) were treated by medical treatment but 27 (53%) required DJ stents. In addition, Sharma et al. [5] reported successful medical treatment in 14 patients, 3 requiring PCN, with only one mortality.

As in all the previous studies on EP, our review is a retrospective one, and that is due to the rarity of the disease. However, there was a considerable number for a rare disease which was treated at a single tertiary-care hospital. Moreover, our research paper updated the existing knowledge on EP treatment strategies and outcome that are different from the early experiences. This information will help in guiding decision-taking and improving patients' care.

Conclusion

In patients with EP, the correlation of the CT classification with the treatment plans reflects recent changes when compared to the initial reports. Patients in class I and II comprise

the majority of patients, and respond well to medical treatment with excellent outcome.

Insertion of PCN and DJ are not required routinely, but with urinary obstruction requiring drainage, and a few cases who required nephrectomy—all with class III. Our data show improvement in the overall survival in patients for EP.

Compliance with ethical standards

Conflict of interest None of the authors has conflict of interest.

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