

Original Article

## Serum Procalcitonin in Childhood Urinary Tract Infections

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### ABSTRACT

**Background:** The early differentiation of upper urinary tract infection (UTI) from lower UTI in infants and children is essential, because renal parenchymal involvement in UTI has the greatest potential for causing irreversible renal damage. Commonly used inflammatory markers can not be used reliably for such differentiation. Dimercaptosuccinic acid (DMSA) renal scintigraphy is the gold standard for the diagnosis of upper UTI (acute pyelonephritis); but it is expensive, not readily available in all centers and exposes the patients to radiation. There is a great need for a quick and accurate diagnostic test for renal involvement in UTI. Procalcitonin (PCT), a recently described marker of bacterial infection, has not been fully studied in relation to UTI in children.

**Objectives:** We conducted this research to study the ability of serum PCT to predict renal involvement in UTI (acute pyelonephritis) in comparison with the other commonly used inflammatory markers in these cases.

**Methods:** The serum PCT, C-reactive protein (CRP), total leukocytic count (TLC), band cells percent (BC%) and erythrocyte sedimentation rate (ESR) were studied in 25 children with UTI diagnosed by positive urine cultures and significant colony counts. They included 10 cases with acute pyelonephritis and 15 cases with lower UTI. Acute pyelonephritis was diagnosed by the presence of pyelonephritic changes in renal DMSA scans. Patients who received antibiotics within the previous week of admission or having extrarenal infection known to affect PCT level were excluded. Ten healthy children matched for age and sex served as a control group. A semiquantitative immunochromatographic rapid test (PCT-Q) was used for measurements of PCT.

**Results:** The mean values of serum PCT, CRP, TLC, BC% and ESR were significantly higher in patients with acute pyelonephritis than in those with lower UTI and controls ( $p < 0.005$ ). Serum PCT in upper UTI was mildly elevated in six cases ( $\geq 0.5$ -2 ng/mL), moderately elevated in three cases ( $> 2$ -10 ng/mL) and markedly elevated in one case ( $> 10$  ng/mL). The mean of CRP was  $54 \pm 69$  mg/L in cases with acute pyelonephritis versus  $5.1 \pm 2.9$  mg/L in lower UTI ( $p = 0.004$ ). The mean TLC was  $15420 \pm 4130$  /mm<sup>3</sup> in acute pyelonephritis compared to  $10273 \pm 2099$  /mm<sup>3</sup> in lower UTI ( $p = 0.000$ ). Band cells had a mean value of  $2.2 \pm 1.8\%$  in cases with acute pyelonephritis which was significantly elevated than the other two groups ( $p = 0.001$ ). Cases with lower UTI, had normal serum PCT and CRP levels, while mean values of TLC and ESR were significantly elevated versus controls ( $p < 0.001$ ). Although BC% was higher in lower UTI compared to controls, this difference did not reach statistical significance. The sensitivity, specificity and predictive values of PCT for the detection of acute pyelonephritis were 100% each. All of CRP, TLC and ESR had sensitivity of 100% but a specificity of 93%, 87% and 40%, and positive predictive value of 91%, 83%, 53% respectively while negative predictive value was 100% for each of them.

**Conclusions:** Serum PCT is a valuable new infection marker with the highest sensitivity, specificity and predictive values for the detection of renal involvement in UTI compared to the other commonly used inflammatory markers in those cases. It allows early differentiation between acute pyelonephritis and lower UTI equal to dimercaptosuccinic acid (DMSA) renal scintigraphy.

### INTRODUCTION

Urinary tract infection (UTI) is a common pediatric problem. Acute pyelonephritis (upper UTI) represents the most severe type of UTI in children<sup>(1,2)</sup>. It

not only results in greater acute morbidity but also has the greatest potential for causing irreversible renal damage. It requires more aggressive therapy, investigations, and follow up than does lower UTI<sup>(3,4)</sup>.

The nonspecific nature of the signs and symptoms of UTI in infants and children makes the clinical differentiation between acute pyelonephritis and lower UTI a difficult challenge.

Commonly used inflammatory markers, such as C-reactive protein (CRP), total leukocytic count (TLC), and erythrocyte sedimentation rate (ESR) can not be reliably used for such differentiation, especially in infants and young children<sup>(2,3,5)</sup>. Dimercaptosuccinic acid (DMSA) renal scintigraphy is considered by many investigators as the gold standard for the diagnosis of acute pyelonephritis<sup>(6-9)</sup>. However, the DMSA scan is expensive, not readily accessible in all centers and exposes the patients to radiation<sup>(6,7)</sup>. A quick and readily available diagnostic test for renal involvement in UTI would be a valuable tool for early diagnosis and management of acute pyelonephritis.

Procalcitonin (PCT) a recently described specific marker of bacterial infection is a 116 amino acid propeptide of calcitonin devoid of hormonal activity<sup>(10)</sup>. Serum PCT levels are correlated with the severity of bacterial infection<sup>(11-13)</sup>. They are highly elevated in patients with invasive bacterial infections, mildly elevated in localized bacterial infections and are normal in non-infectious inflammatory conditions and viral infections [Table 1]<sup>(14-16)</sup>. Reviewing the literature revealed only few studies investigating the diagnostic role of this marker in UTI<sup>(17-19)</sup>.

#### AIM OF THE WORK

We conducted this prospective research to study the ability of serum PCT to predict

renal involvement in UTI (acute pyelonephritis) in comparison with the commonly used inflammatory markers in these cases.

#### SUBJECTS AND METHODS

The present prospective study was conducted on 25 children with UTI diagnosed by positive urine cultures and significant colony counts [Table 2]. They included ten cases with renal scintigraphic evidences of acute pyelonephritis and 15 children with lower UTI. Patients who received antibiotics within the previous week of admission or had extrarenal infection known to affect PCT level were excluded. Ten healthy children matched for age and sex served as a control group.

All patients were subjected to the following:

- (1) Thorough history taking with special emphasis on:
  - Symptoms suggestive of upper UTI as unexplained fever  $\geq 38.5^{\circ}\text{C}$ , toxic look and loin pain.
  - Symptoms suggestive of lower UTI as dysuria, frequency and urgency.
  - History of previous attacks of UTI.
- (2) Thorough clinical examination with special emphasis on the renal system, palpation of the abdomen for renal masses and tenderness of renal angles.
- (3) Laboratory tests on admission before the start of antibiotic therapy.<sup>(20-23)</sup>
  - Urine analysis, urine culture and colony count. Urine samples were obtained by clean-void midstream catch in toilet trained children or by suprapubic aspiration or urinary catheter in the infants and young children.

The following laboratory tests were done to all studied cases and controls:

- Blood urea and serum creatinine<sup>(21)</sup>.
- Quantitative estimation of C-reactive protein (High sensitivity CRP)<sup>(22)</sup>.
- Total and differential leukocytic counts including the band cells %.
- Erythrocyte sedimentation rate (ESR).
- Measurement of serum procalcitonin (PCT) levels by PCT-Q<sup>®(23)</sup>, which is an immunochromatographic rapid test for the semiquantitative detection of PCT. Serum samples which were not used for the assay within 4 hours after taking the blood sample were frozen and stored at -20°C. The individual test packaging was opened immediately prior to measuring the samples. Six drops of the serum were pipetted into the round cavity of PCT-Q. Then, incubated for 30 minutes at room temperature. The validity of the test and interpretation of its results were based on checking the clearly visible control and test bands (Fig. 1). At a PCT concentration of  $\geq 0.5$  ng/mL, a reddish test band is seen, its color intensity is directly proportional to the PCT concentration of the sample. The PCT concentration range was determined by comparing the color intensity of the test band with the color blocks of the reference card:  $< 0.5$ ,  $\geq 0.5-2$ ,  $> 2-10$  or  $> 10$  (ng/mL)<sup>(23)</sup>.

(4) Imaging studies:

- Renal ultrasonography (US) was done within the first 2 days of admission using a 3.5 - 5 MHz sector scanner.
- Renal cortical scintigraphy using Technetium<sup>99m</sup> dimercaptosuccinic

acid (Tc<sup>99m</sup> DMSA)<sup>(6,7)</sup> was performed within the first week of admission in 16 children with febrile UTI (rectal temperature  $\geq 38.5^\circ\text{C}$ ) suspected to have acute pyelonephritis. Ten cases of them showed renal scintigraphic evidences of acute pyelonephritis in the form of areas with defective uptake of Tc<sup>99m</sup> DMSA without volume loss (Fig. 2a). The other six cases had normal DMSA scan and were considered as having lower UTI (Fig. 2b).

- Voiding cystourethrogram (VCUG) was carried out as soon as urine was bacteria-free or in some cases after 3-6 weeks<sup>(5)</sup>.

**Statistical Methods**

The results were tabulated and analyzed using the appropriate statistical methods with the level of statistical significance at ( $p \leq 0.05$ ). Values were expressed as percentage or mean  $\pm$  SD. Statistical analysis was done by SPSS computer program (Statistical Package for Social Science) version 10, using student's t test and F test whenever needed. Considering DMSA renal scan as the gold standard for diagnosis of acute pyelonephritis, the studied variables were tested for sensitivity, specificity, and predictive values using the following equations:<sup>(24)</sup>

$$\text{Sensitivity (\%)} = \frac{\text{True positives}}{\text{True positives} + \text{False negatives}} \times 100$$

$$\text{Specificity (\%)} = \frac{\text{True negatives}}{\text{True negatives} + \text{False positives}} \times 100$$

$$\text{Positive predictive value (\%)} = \frac{\text{True positives}}{\text{True positives} + \text{False positives}} \times 100$$

$$\text{Negative predictive value (\%)} = \frac{\text{True negatives}}{\text{True negatives} + \text{False negatives}} \times 100$$

**Sensitivity** is the probability that the test will be positive in a diseased person. **Specificity** is the probability that the test will be negative in a non-diseased person. **Positive predictive value (PPV)** is the

probability of having the disease if the test result was positive. **Negative predictive value (NPV)** is the probability of the disease to be absent with negative test result. **False positives** are individuals without the disease having positive test result. **False negatives** are individuals with the disease having negative test result<sup>(24)</sup>.

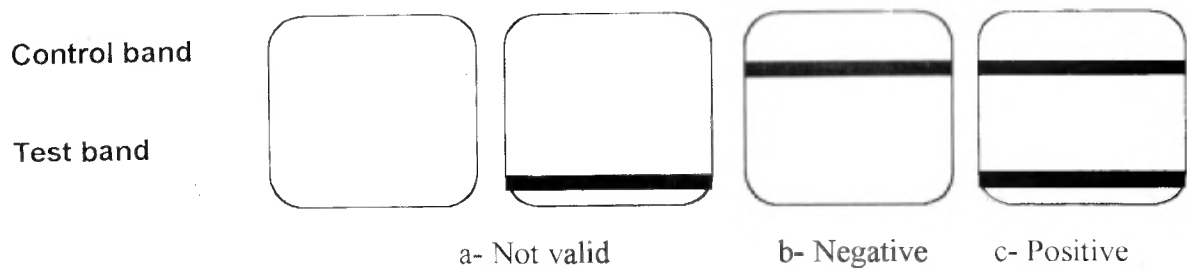
**Table 1: Procalcitonin levels in different conditions<sup>(14,15)</sup>**

Condition	PCT (ng/mL)	PCT level
Normal subjects Viral infections Auto-immune diseases	< 0.5	Normal
Localized bacterial infections	≥ 0.5 – 2	Mild elevation
Severe bacterial infections	> 2 – 10	Moderate elevation
Septicemia or septic shock	> 10	Marked elevation

**Table 2: Diagnosis of UTI<sup>(3)</sup>**

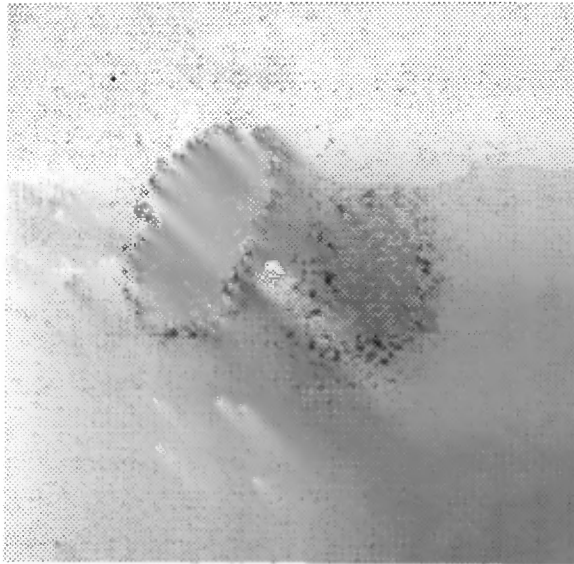
Method of urine collection	Criteria for diagnosis of UTI
Suprapubic aspiration	Growth of urinary pathogens in any number.
Catheterization	≥ 50 x 10 <sup>3</sup> CFU/mL of a single urinary pathogen.
Midstream clean-void	≥ 10 <sup>5</sup> CFU/mL of a single urinary pathogen in symptomatic patients.
	In asymptomatic patient: at least 2 specimens on different days with ≥ 10 <sup>5</sup> CFU/mL of the same organism.

CFU = Colony forming unit.

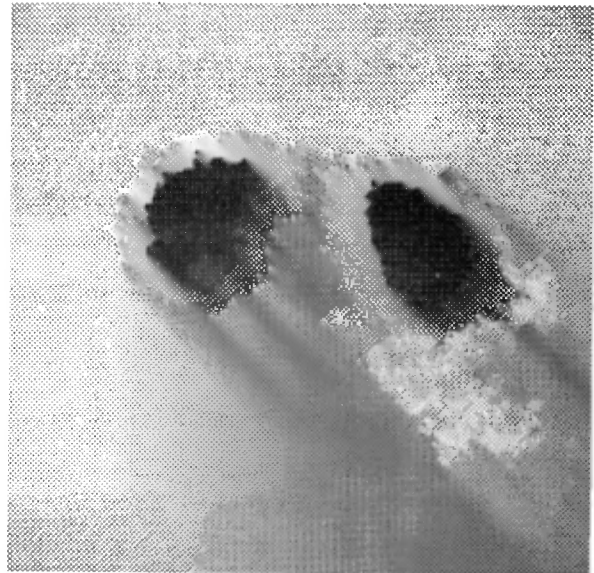


a- No control band or only test band visible: test not valid and was excluded.  
 b- Only control band visible: test is negative (PCT < 0.5 ng/mL).  
 c- Control and test bands visible: test is positive (PCT ≥ 0.5 ng/mL).

**Fig. 1: Interpretation of PCT-Q rapid test<sup>(23)</sup>.**



**Fig. 2a: Abnormal DMSA renal scan in upper UTI showing pylonephritic changes as areas of defective uptake of the dye by the right kidney.**



**Fig. 2b: Normal DMSA renal scan with good uptake of the dye bilaterally in lower UTI.**

## RESULTS

Thirty-five children were studied, 21 females and 14 males with an age range between 1-132 months. Ten cases had upper UTI (Group I) and 15 children had lower UTI (Group II). Acute pyelonephritis was diagnosed by the presence of pyelonephritic changes in renal DMSA scans. No statistically significant difference was present between both groups as regards age, blood urea [Table 5]. Urine cultures revealed klebsiella in 60% of patients with upper UTI and in 46.7% of patients with lower UTI. However, *E. coli* was isolated in 40% of patients with upper UTI and in 46.7% of patients with lower UTI. *Proteus* was found in 6.7% of patients with lower UTI [Tables 3 and 4] and (Fig. 3). Upper UTI presented with toxic look in 90% of cases, loin pain in 60% and fever ( $\geq 38.5^{\circ}\text{C}$ ) in 100% of them.

The mean values of serum PCT, CRP, TLC, BC% and ESR were significantly higher in patients with acute pyelonephritis than in those with lower UTI and controls ( $p < 0.005$ ) [Table 5] and (Fig. 4). On the other hand, cases with lower UTI, had normal serum PCT and CRP values, while TLC and ESR were significantly elevated versus controls ( $p < 0.001$ ). Although BC% was higher in lower UTI compared to controls, this difference did not reach statistical significance.

Serum PCT was elevated in 100% of cases with acute pyelonephritis. It was

mildly elevated in six patients ( $\geq 0.5$ -2 ng/mL), moderately elevated in three patients ( $> 2$ -10 ng/mL) and markedly elevated in one patient ( $> 10$  ng/mL). The mean of CRP was  $54 \pm 69$  mg/L in cases with acute pyelonephritis versus  $5.1 \pm 2.9$  mg/L in lower UTI ( $p = 0.004$ ). The mean TLC was  $15420 \pm 4130$  /mm<sup>3</sup> in acute pyelonephritis compared to  $10273 \pm 2099$  /mm<sup>3</sup> in lower UTI ( $p = 0.000$ ). Band cells had a mean value of  $2.2 \pm 1.8\%$  in cases with acute pyelonephritis which was significantly elevated than the other two groups ( $p = 0.001$ ).

The sensitivity, specificity and predictive values of PCT for the detection of acute pyelonephritis were 100% each. The CRP, TLC and ESR had a sensitivity of 100% but a specificity of 93%, 87% and 40% respectively. They had PPV of 91%, 83% and 53% respectively while NPV was 100% for each of them. Band cells had 70% sensitivity, 40% specificity, 80% PPV and 93% NPV [Table 6]. Renal US reported renal structural abnormalities in 60% of cases with upper UTI in the form of slight enlargement and/or dilatation of pelvicalyceal system. Voiding cystourethrogram (VCUG) revealed vesicoureteral reflux (VUR) in 70% of cases with acute pyelonephritis, two cases had bilateral VUR (grade IV), two cases had unilateral VUR (grade III) and the remaining three cases had unilateral VUR (grade II) [Table 3].

**Table 3: Laboratory, bacteriological and radiological data of patients with acute pyelonephritis (upper UTI).**

No.	Age*	Sex	Previous attacks	Causative Organism	Blood Urea (mg/dL)	Serum Cr (mg/dL)	ESR (mm/hr)		TLC (/mm <sup>3</sup> )	BC (%)	CRP (mg/L)	PCT#	US	VCUG		DMSA
							1 <sup>st</sup> hr	2 <sup>nd</sup> hr						Rt	Lt	
1	7	F	1	E. coli	18	0.5	80	115	13600	2	25	2	+	+	+	+
2	5	F	0	Klebsiella	24	0.5	40	50	12200	1	20	1	+	-	+	+
3	48	F	0	Klebsiella	25	0.6	110	130	17200	2	48	1	-	-	-	+
4	120	F	0	Klebsiella	21	0.6	33	55	14600	1	28	1	-	-	-	+
5	60	M	2	Klebsiella	80	2.8	110	150	22000	7	244	3	+	+	+	+
6	54	F	0	E. coli	22	0.6	50	70	14900	1	82	1	-	-	-	+
7	60	F	0	E. coli	18	0.6	88	116	12500	2	21	1	-	-	+	+
8	18	M	1	Klebsiella	26	0.9	100	110	23200	2	28	2	+	-	+	+
9	72	M	1	E. coli	25	0.8	80	100	12000	2	23	2	+	-	+	+
10	36	M	1	Klebsiella	25	0.5	60	80	12000	2	24	1	+	+	-	+
Mean ± S.D.	48 34				28.4 18.4	0.84 0.7	75 28	98 33	15420 4130	2.2 1.8	54 69					

Age\*: Age in months, M: Male, F: Female, Cr: Creatinine, hr: Hour, - : Absent, + : Present

#: PCT code [0 : normal (< 0.5 ng/mL), 1: mild (≥ 0.5-2 ng/mL), 2: moderate (> 2-10 ng/mL), 3: Marked (> 10 ng/mL)]

US: Presence or absence of renal structural abnormalities by US.

VCUG : Presence or absence of VUR by VCUG.

DMSA: Presence or absence of pyelonephritic changes by renal DMSA scan.

Rt: Right kidney, Lt: Left kidney

**Table 4: Laboratory and bacteriological data of patients with lower UTI.**

No.	Age*	Sex	Previous attacks	Causative Organism	Blood urea (mg/dL)	Serum Cr (mg/dL)	ESR (mm/hr)		TLC (/mm <sup>3</sup> )	BC (%)	CRP (mg/L)	PCT#
							1 <sup>st</sup> hr	2 <sup>nd</sup> hr				
1	26	F	0	E. coli	20	0.3	30	80	11000	2	8	0
2	1	F	0	Klebsiella	15	0.4	25	55	11800	1	3	0
3	72	F	1	E. coli	32	0.6	35	75	9800	1	2	0
4	3	M	0	E. coli	27	0.6	20	40	14000	2	9	0
5	78	F	1	Klebsiella	30	0.3	17	55	7000	1	2	0
6	84	M	0	E. coli	30	0.5	35	55	8500	1	9	0
7	132	F	0	Klebsiella	21	0.5	25	55	12000	2	3	0
8	6	M	2	Proteus	24	0.6	15	25	8600	0	3	0
9	36	F	3	Klebsiella	20	0.5	30	45	8100	0	8	0
10	54	M	1	Klebsiella	23	0.6	5	15	9300	1	2	0
11	72	F	1	Klebsiella	23	0.6	30	65	12500	2	3	0
12	9	M	0	E. coli	15	0.4	50	60	9900	2	4	0
13	60	F	0	E. coli	32	0.4	7	20	9000	0	8	0
14	72	M	0	E. coli	31	0.6	15	23	9000	1	9	0
15	7	F	1	Klebsiella	24	0.4	60	85	13600	0	4	0
Mean ± S.D.	47.5 39				24.5 5.7	0.49 0.11	27 15	50 22	10273 2099	1.1 0.8	5.1 2.9	

Age\*: Age in months, M: Male, F: Female, Cr: Creatinine, hr: Hour, #: PCT code [0: normal (< 0.5 ng/mL)]



**Table 5: Age, sex and laboratory data in the three studied groups.**

Variable		Group I (Upper UTI)	Group II (Lower UTI)	Group III (Controls)	F test p value
Number		10	15	10	-
Age (months)		48 ± 34	47.5 ± 39	49 ± 27	F = 0.0008 p = 0.9776
M / F		4 / 6	6 / 9	4 / 6	-
Blood urea (mg/dL)		28.4 ± 18.4	24.5 ± 5.7	18 ± 2.4	F = 2.502 p = 0.097
Serum Cr (mg/dL)		0.84 ± 0.7**	0.49 ± 0.11	0.22 ± 0.06	F = 6.687 p = 0.004
CRP (mg/L)		54 ± 69**	5.1 ± 2.9	4.8 ± 1.9	F = 6.405 p = 0.004
TLC (/mm <sup>3</sup> )		15420 ± 4130**	10273 ± 2099*	7240 ± 839	F = 24.85 p = 0.000
BC (%)		2.2 ± 1.8**	1.1 ± 0.8	0.2 ± 0.4	F = 8.455 p = 0.001
ESR	1 <sup>st</sup> hr	75 ± 28**	27 ± 15*	9 ± 4	F = 37.26 p = 0.000
	2 <sup>nd</sup> hr	98 ± 33**	50 ± 22*	19 ± 4	F = 29.91 p = 0.000

\* = significant versus control group, \*\* = significant versus all other groups.

**Table 6: Sensitivity, specificity and predictive values of the studied inflammatory markers.**

Test	Sensitivity	Specificity	PPV	NPV
PCT	100%	100%	100%	100%
CRP	100%	93%	91%	100%
TLC	100%	87%	83%	100%
ESR	100%	40%	53%	100%
BC%	70%	40%	80%	93%

PPV: Positive predictive value, NPV: Negative predictive value.

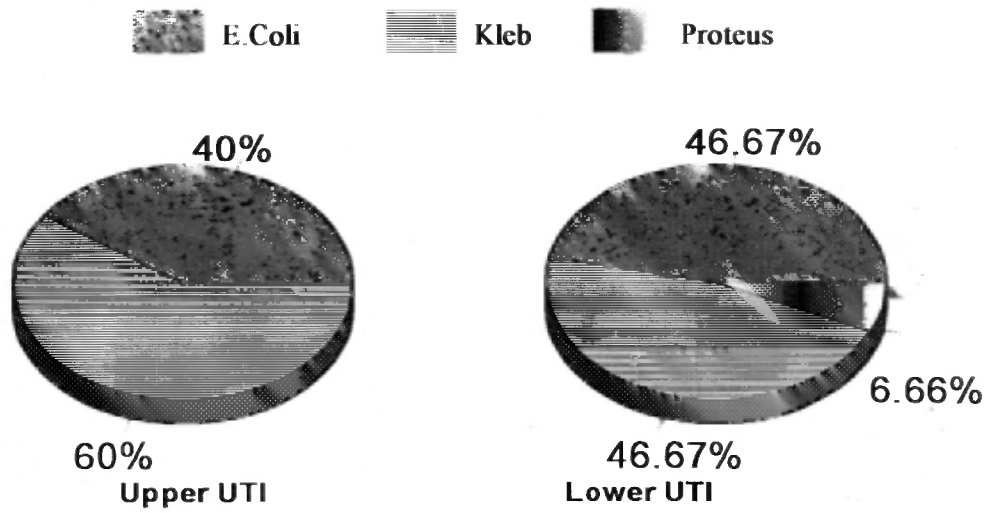


Fig. 3: Causative organisms in studied patients.

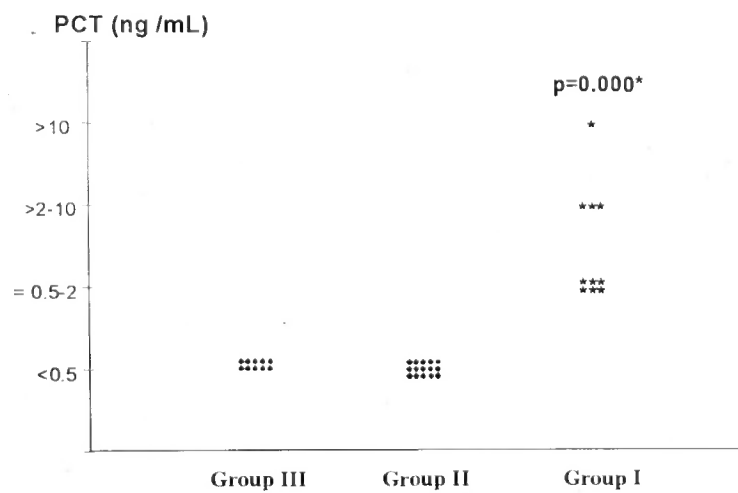


Fig.4: Serum PCT in the studied groups

## DISCUSSION

The early differentiation of acute pyelonephritis from lower UTI in infants and children is essential, because renal parenchymal involvement can induce renal scarring that may lead to arterial hypertension and chronic renal failure<sup>(3,4)</sup>. Renal cortical scintigraphy with DMSA scan is considered the best reference method for the diagnosis of renal involvement in UTI<sup>(6,7)</sup>, but it has the disadvantages of being expensive, not readily accessible in all centers and exposes the patient to radiation. A simple reliable and rapid test to diagnose acute pyelonephritis would be a distinct addition for proper management and consequently prevention of renal scarring.

Many non-specific infection markers have been suggested to differentiate between upper and lower UTI, like CRP, TLC, BC% and ESR<sup>(2,3,5)</sup>. In our study, the mean values of CRP, TLC, BC% and ESR were significantly higher in cases with acute pyelonephritis compared to lower UTI cases ( $p < 0.005$ ). On the other hand, cases with lower UTI had normal serum PCT and CRP values, while TLC and ESR values were significantly elevated versus controls ( $p < 0.001$ ). The BC% was higher in lower UTI than controls, but without statistical significance. The mean serum creatinine was significantly elevated in the upper UTI group compared to the other two groups due to the renal parenchymal insult in upper UTI. Gervaix et al.<sup>(17)</sup> and Smolkin et al.<sup>(18)</sup> reported similar results. They have shown that PCT was elevated in children with acute pyelonephritis and often normal in lower UTI.

For years CRP had been suggested to be

one of the best available markers to indicate pyogenic tissue inflammation, but it should be emphasized that CRP has a slow kinetic profile, thus, early diagnosis of acute pyelonephritis could be missed<sup>(5,25-27)</sup>. Furthermore, it has the disadvantages of being induced by viral infections, minor inflammatory reactions and rejection reactions<sup>(26,27)</sup>. Hepatic CRP production may continue after the inflammatory stimulus has disappeared, so that improvement might be masked. Total leukocytic count, BC%, ESR are all indicators of inflammatory activity, they can be highly sensitive for any typical inflammation, however, they are rather non-specific and have no specific relation to kidney diseases<sup>(5,26)</sup>.

We evaluated the studied inflammatory markers as regards the sensitivity, specificity, and predictive values for the detection of renal involvement in UTI. The only test that had 100% sensitivity, specificity, and predictive values was PCT. Similarly, Smolkin et al.<sup>(18)</sup> reported sensitivity of 94% and specificity of 90% for PCT to predict renal involvement. Both CRP and TLC had 100% sensitivity and  $> 85\%$  specificity, while ESR had 100% sensitivity but only 40% specificity. All of them had 100% NPV; but only CRP had PPV of  $> 85\%$ , thus, CRP is a good infection marker but as mentioned previously has the disadvantages of having slow kinetic profile, prolonged production and being induced by viral infections and minor inflammation.

Since Assicot et al.<sup>(29)</sup> first proposed PCT as an early marker of bacteraemia, many descriptive reports of PCT in various diseases<sup>(11-16)</sup> have been published, but only

very few reports were related to UTI in children<sup>(17-19)</sup>. Our results plus the known rapid kinetics and short half life of PCT make it the best marker for the early differentiation between acute pyelonephritis and lower UTI. Its simplicity, accuracy and rapid availability of its results are remarkable distinct advantages.

Markedly elevated serum PCT was detected in one of the studied cases with impaired renal function, but this should not be attributed to renal impairment as renal excretion of PCT plays a minor role. Clinical data have shown that PCT does not accumulate in cases of severe renal dysfunction<sup>(28)</sup>.

Vesicoureteral reflux (VUR) is the most significant host risk factor in the etiology of childhood acute pyelonephritis and the subsequent renal scarring. In addition, the risk for acute pyelonephritis and renal scarring is related to the severity of VUR<sup>(2,5)</sup>. Vesicoureteral reflux was diagnosed in 70% of studied cases with acute pyelonephritis. Majd et al.<sup>(30)</sup> found that approximately 80% of patients with VUR had acute pyelonephritis.

In our study, *Klebsiella* was the predominant organism isolated from urine in upper UTI (60%). In contrast, Benador et al.<sup>(19)</sup>, reported that *E. coli* was responsible for 87% of UTI in their study. The predominance of *Klebsiella* in our study might be due to presence of VUR in 70% of studied cases with acute pyelonephritis. Predominance of *Klebsiella*, as a causative organism in UTI was reported in cases associated with VUR, instrumentation and/or obstruction of the urinary tract<sup>(3,5)</sup>.

In conclusion, our results indicate that serum PCT is a valuable new infection marker with the highest sensitivity, specificity and predictive values for the detection of renal involvement in UTI. It allows early differentiation between acute pyelonephritis and lower UTI equal to DMSA renal nuclear scanning. It has the advantage of early initiation of proper treatment that minimizes the chance of renal scarring. Moreover, measuring PCT by PCT-Q<sup>®</sup> has the advantages of being a rapid, easy, and accurate method that can be used at the bedside by physicians and nurses.

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*Geget* is the official publication of The Egyptian Society for Pediatric Nephrology and Transplantation (ESPNT). The Journal will consider papers that deal with diseases of the kidney and urinary tract and related subjects. *The Journal* will publish original articles, review articles, short communications, case studies and letters to the editor, all of which are referred to as papers in this "Information for Authors/Contributors." Papers must not have been submitted for publication to any other journal or bulletin. All original articles, review articles, short communications and case studies will be peer reviewed. The procedure followed and decisions made by the editor will be final. The overall objective would be to get diverse perspectives in all matters relating to the kidney and urinary tract in the healthy and the diseased.

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