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ORIGINAL ARTICLE

Non-Enhanced Computed Tomography as a Predictor for Spontaneous Passage of Ureteral Stone

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ABSTRACT

Background: renal stone is one of the commonest causes of loin pain and leads to multiple visits to the urology emergency department with increasing costs for health systems. this study to assess the accuracy of the NECT technique in the prediction of whether ureteral stones will pass spontaneously or not.

Methods: In a prospective cohort study including 36 participants (age range, 18-70 years) having a ureteral stone, referred for NECT examination at the Radio-Diagnosis Department of Zagazig University Hospitals.

Results: our study revealed two groups of patients according to the stone passage, group 1 (stone passed spontaneously) and group 2 (stone not passed). in which, there is a significant relationship between the two study groups according to the stone location ($p < 0.05$). However, we found a statistically highly significant relationship between the two groups regarding the stone size ($p < 0.001$), but it is a statistically insignificant relation between outcome and other signs like (density, TRS, PFS and degree of hydronephrosis)… ($P > 0.05$). Our study demonstrated a method based on stone size and location can predict the probability of stone passage within a short time (8 wks.).

Conclusions: That NECT is a good predictor for spontaneous passage of ureteral stones.

Keywords: Renal colic, Ureteral Stone, hydronephrosis,, spontaneously**,** Non-Enhanced Computed Tomography

INTRODUCTION

Renal stone is one of the commonest causes of loin pain and leads to multiple visits to the urology emergency department with increasing costs for health systems. [1].The stone burden is clinically called algorithms [2, 3], leading to the requirement for accurate stone detection.

Usually, Ultrasound is the first modality of choice in detecting the renal stone (49-60 %), by using a Transabdominal protocol with a higher percentage in the detection of kidney and proximal part of ureter more than distal part of the ureter.[4] Since 1923 intravenous urogram (IVU) has been used to analyze the symptoms of acute loin pain. Today, NECT of kidneys, ureters and the bladder (CTKUB) replace IVU and remodeled the imaging approach for patients with acute loin pain presenting to the emergency medical department. The diagnostic utility of CTKUB was initially represented by Niemann T et al.[4] and has shown a higher rate of detecting ureteric calculi in terms of diagnostic accuracy, sensitivity, and specificity in comparison with IVU[4,5]. This was confirmed after by alternative printed series for CTKUB versus IVU with sensitivities of 94-100 versus 66-87% and specificities of 94-100 versus 92-94%, respectively [6].The main goal of managing a patient who presented in an emergency who complaining of signs and symptoms of obstructing ureteral stone depends partially on stone size. Small stones (less than five mm) are seemingly to pass spontaneously, whereas big stones (more than five mm) mainly need intervention [3].If the stone predicted to pass spontaneously among an affordable time and the patient can tolerate pain, the initial approach is conservative follow up, with or without concomitant medical expulsive treatment (MET) [7].The outcome either the stone will pass spontaneous or not it strongly depends on stone location and size [8].Historically stone size has been outlined, the most diameter perpendicular to the long axis of the ureter at excretory urography.

Using NECT, the stone measured by one of two ways the first one is transversally within the axial plane and the second is the axis in the coronal plane [9].However, there is no fixed methodology for measuring the ureteric stone size, with the foremost wide used methodology is (NECT) .A meta-analysis revealed within the 2007 guidelines from the European Association of urogenital medicine (EAU) and the American Urological Association (AUA) has big intervals up to 68% of stones less than 5-millimeter most likely to pass spontaneously. Therefore, according to guidelines, conservative management is the best way of the management approach for ureteral stones less than 5 mm. These guidelines not modified within the most up-to-date guidelines from EAU [10].

METHODS

This is a prospective cohort study including 36 patients (age range, 18-70 years) having a ureteral stone during the period from April to September 2018, referred for NECT examination at the Radio-Diagnosis Department of Zagazig University Hospitals. Patients with absolute indications of surgery (septicemia, high grade of obstruction, abnormal renal function test or severe pain), pregnant patients and patients with renal transplantation or underlying anatomical abnormality were excluded.

All selected patients were subjected to full history, physical examination, laboratory evaluation (complete urine analysis, complete blood picture, renal functions, and coagulation profile) and non-enhanced computed tomography imaging.

Examination Technique: NECT examination of the abdomen and pelvis was done for all patients included in this study with imaging follow up within eight weeks. NECT scanning is performed in the area above the kidneys up to the area below the base of the urinary bladder in the 20s and asks the patient to hold his breath using a **128-MDCT scanner (Philips Healthcare).**

The factors that were assessed on the NECT of all included patients are The side of the stone whether right or left, The site of the stone either upper, mid or lower position according to the sacroiliac joint, plus the position at the (UVJ) ureterovesical junction. Size of stone: measured in (axial cuts, coronal and sagittal reformate) relative to the main axes of the patients' body, And reported in millimeter to one decimal point. The length of the stone is the largest measurements and the smallest one is the width in three measurements every time.

NECT can also detect any abnormalities in renal anatomy, presence of hydronephrosis and its degree (None, mild, moderate and severe), and site of obstruction, presence of soft tissue rime sign (TRS), presence of Perinephric fate stranding sign (PFS), and determination of the density of the stone in the Hounsfield unit.

Outcome measures: radiological examinations were reviewed up to 8 weeks after the diagnostic NECT. The observed stone passage was defined as the presence of follow-up NECT where a ureteral stone was not present anymore. Any intervention was recorded as the non-spontaneous passage of the stone.

Written informed consent was obtained from all participants, the study was approved by the research ethics committee of the Faculty of Medicine, Zagazig University. The study was done according to The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

STATISTICAL ANALYSIS

Data has been presented in tables, prose, graphs and pie charts. Statistical analyses were performed using the Statistical Package for Social Scientists (SPSS USA Inc) Version 25 .0. Data has been analyzed using descriptive statistics to display the characteristics of the patient i.e. Mean value, standard deviation (SD), median, and frequencies has been used to describe data distribution. A chi-square test has been used to generate a bivariate association between independent and dependent variables. Correlation regression has been used to show an association between independent and dependent factors.

RESULTS

A total of 24 men and 12 women (mean age, 40.4 years) were identified with urolithiasis Table 1.

According to the stone position, there are four subgroups: upper in 14 patients (38.9%), mid in 3 patients (8.3%), lower in 11 patients (30.6%) and UVJ in 8 patients (22.2%).

Hydronephrosis was grouped into mild in 13 patients (36.1%), moderate in 18 patients (50%) and severe in two patients (5.6%), but hydronephrosis was not present in three patients (8.3%). According to spontaneous stone passage, there are two groups of patients: the spontaneous stone passage is observed in 22 patients (61.1%) and not observed in 14 patients (38.9%). The mean time of passage (20 - 42) days with a mean ± SD of 31.5 ± 5.8.

There was a statistically significant difference between the two studied groups according to the spontaneous passage of stone regarding age ($p < 0.05$), but there was a statistically insignificant difference regarding gender ($p > 0.05$).

Besides, The stone position at the level of the lower part of the ureter and UVJ, Show a significant predictor for spontaneous passage of

calculi in two study groups (p <0.05). However, we found a statistically highly significant relationship between the two studied groups regarding the size (P< 0.001), but there was a statistically insignificant relation regarding the side (P > 0.05). Table 2, 3

It was statistically high significant relations between outcome and width & length (p < 0.001), but there were statistically insignificant relations between outcome and density, TRS, PFS and degree of hydronephrosis (P > 0.05). Table 4, 5

A multivariate logistic regression analysis was performed. The width is a highly significant predictor of spontaneous passage of the ureteral stones and had an odds ratio (OR 0.43) which meaning low probability relation between the increase in width with spontaneous passing. The length had an odds ratio of (OR 0.67) indicating a minimal influence on the probability of spontaneous passage with width. The stone position (lower and UVJ) Shows a significant predictor for the passage of calculi. Table 6

Regarding the measurement of width, NECT had 86.4% and 85.7% in sensitivity and specificity respectively, the PPV about 90.5%, and NPV about 80% at a cutoff value of five as a predictor of spontaneous passage of ureteric calculi. Table

Table (1): Comparison of demographic data according to the spontaneous passage of stone

	Not pass	Pass	t	p
Age (years)			3.27	0.002 (S)
Mean ± SD	48.3 ± (14.8)	35.3 ± (9.1)		
Range	25-70	20-51		
Gender			X^2 = 0.72	0.39 (NS)
Male	11 (78.6%)	13 (59.1%)		
Female	3 (21.4%)	9 (40.9%)		

Table (2): Side and size

N = 36		No.	%
Side	Left	19	52.8%
	Right	17	47.2%
Size (mm)	Mean ± SD	4.69 ± 5.65	
	Range	1-26.1	
Location	Upper	14	38.9%
	Mid	3	8.3%
	Lower	11	30.6%
	UVJ	8	22.2%

Table (3): Side and size in relation to the passage of stone

	Not pass		Pass		X2	p
	No.	%	No.	%		
Side						
Left	7	50%	12	54.5%	0.07	0.7 (NS)
Right	7	50%	10	45.5%		
Size (mm)						
Mean ± SD	8.88 ± (7.22)		2.03 ± (1.32)		t = 4.37	< 0.001 (HS)
Range	2.0-26.1		1-4.9			
Location						
Upper	10	50%	4	31.8%	X^2 = 10.61	0.014 (S)
Mid	1	7.1%	2	9.1%		

	Not pass		Pass		X2	p
	No.	%	No.	%		
Lower	2	35.7%	9	27.3%		
UVJ	1	7.1%	7	31.9%		

Table (4): Characteristics of lesion and outcome

	N = 36
Density	
Mean ± SD	780.4 ± 324.9
Range	231-1423
TRS	
No	27 (75%)
Yes	9 (25%)
PFS	
No	34 (94.4%)
Yes	2 (5.6%)
Hydronephrosis	
Non	3 (8.3%)
Mild	13 (36.1%)
Moderate	18 (50%)
Severe	2 (5.6%)
Passage	
No	14 (38.9%)
Yes	22 (61.1%)
Time of passage (days)	
Mean ± SD	31.5 ± 5.8
Range	20-42

Table (5): Relation between outcome and other parameters

	Not pass	Pass	t	p
Density				
Mean ± SD	879.5±332	717.4±311.4	1.4	0.14
Range	343-1423	231-1277		(NS)
TRS				
No	11 (78.6%)	16 (72.7%)	X^2 =	1
Yes	3 (21.4%)	6 (27.3%)	0.16	(NS)
PFS				
No	12 (85.7%)	22 (100%)	X^2 =	0.2
Yes	2 (14.3%)	0 (0%)	1.16	(NS)
Hydronephrosis				
None	0 (0.0%)	3 (13.6%)	X^2 =	0.16
Mid	5 (35.7%)	8 (36.4%)	5.05	(NS)
Moderate	7 (50%)	11 (50%)		
Severe	2 (14.3%)	0 (0%)		
Time of passage				
Mean ± SD	-	31.5 ± 5.8		
Range	-	20-42		
Length				

	Not pass	Pass	t	p
Mean ± SD	11.6 ± 6	4.8 ± 1.8	4.87	< 0.001 (HS)
Range	5-29	1-7		
Width				
Mean ± SD	6.7 ± 2.7	3.8 ± 1.5	4.3	< 0.001 (HS)
Range	4-12	1-7		

Table (6): Multivariate logistic regression with all independent variables as a predictor for spontaneous passage of ureteral stones

	OR (95% CI)	p
Width	0.43 (0.23-0.8)	0.003 (S)
Length	0.67 (0.36-1.21)	0.15 (NS)
Position versus upper		
Mid	1.5 (0.82-2.73)	0.15 (NS)
Lower	2.25 (1.23-4.13)	0.004 (S)
UVJ	1.91 (1.03-3.56)	0.028 (S)
Hydronephrosis versus no		
Mild	1.33 (0.76-2.451)	0.31 (NS)
Moderate	1.56 (0.83-2.92)	0.13 (NS)
Severe	1.62 (0.87-3.04)	0.1 (NS)
Age	1.22 (0.67-2.21)	0.47 (NS)
Gender (female versus male)	0.67 (0.37-1.21)	0.15 (NS)
Side (left versus right)	1.24 (0.67-2.29)	0.46 (NS)

Table (7): Validity of width measured by NECT as a predictor of spontaneous passage of ureteric stones

Width (mm)	Passage		Sensitivity	Specificity	PPV	NPV
	Yes	No				
≤ 5	**19**	**2**	**86.4%**	**85.7%**	**90.5%**	**80%**
> 5	**3**	**14**				

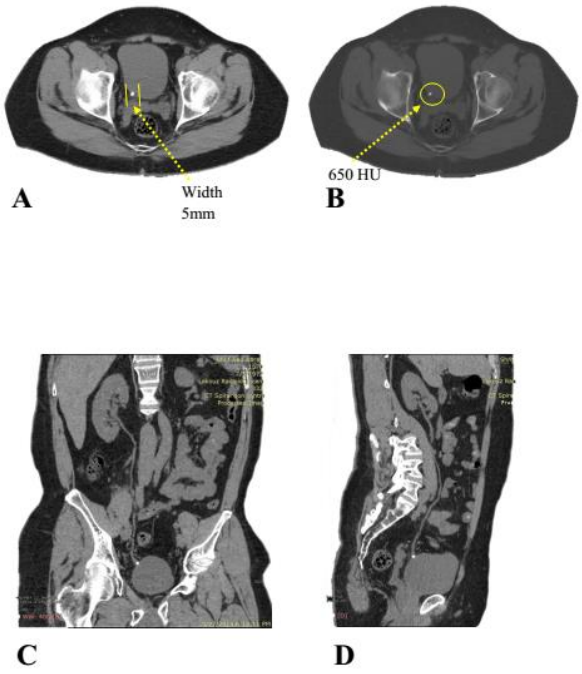

Figure 1A

(A) Axial soft tissue image, (B) Axial bone window image,(C) coronal reconstruction image, and (D) sagittal reconstruction image for a male aged 45 years old referred to our department for CTU NECT was performed, show: There is 5 mm Rt. VUJ stone (650 HU density) with no significant Rt. side hydroureteronephrosis.

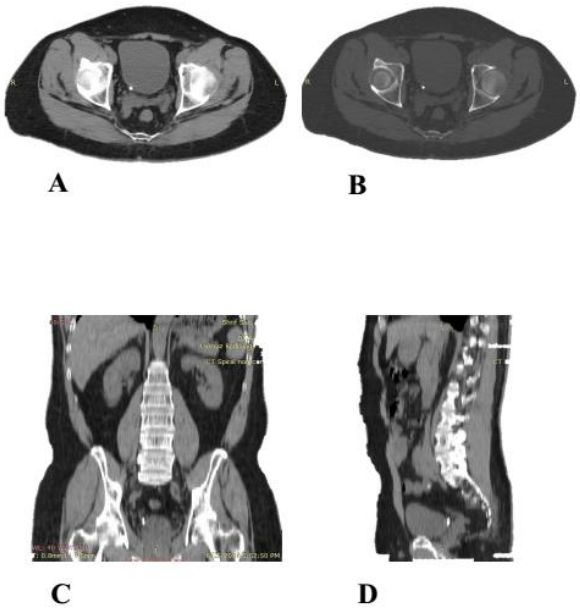

Figure 1B: Follow up after 8 wks NECT was performed **(Figure 1B**) (A) Axial soft tissue image, (B) Axial bone window image, (C) Coronal reconstruction image, and (D)Sagittal reconstruction image show: Compared to the previous study there are no time interval changes. There is 5 mm Rt. VUJ stone (730 HU density).

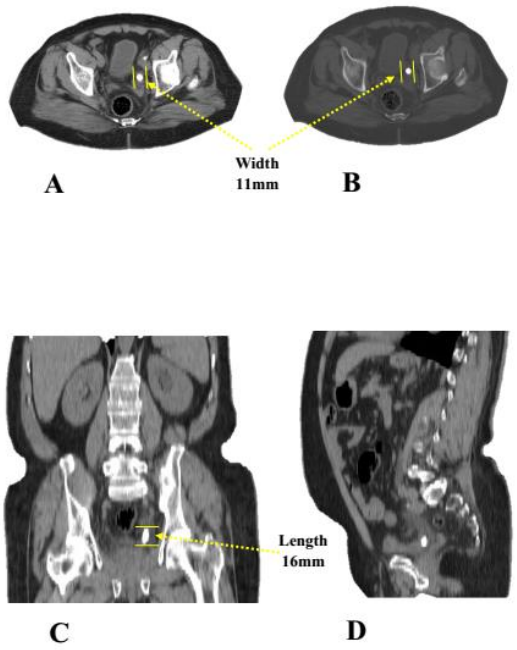

Figure 2:A male aged 64years old complaining of left flank pain radiating to groin one week from the presentation. NECT was performed (A) Axial soft tissue image, (B) Axial bone window image, (C) Coronal reconstruction image, and (D) Sagittal reconstruction image show: Lt. Lower ureteric stone (16X11 mm of about 1156 HU density) just prior to VUJ with minimal hydronephrotic changes & dilated ureter down to the distal end. The patient underwent ESWL after 4 weeks, so the stone did not pass spontaneously.

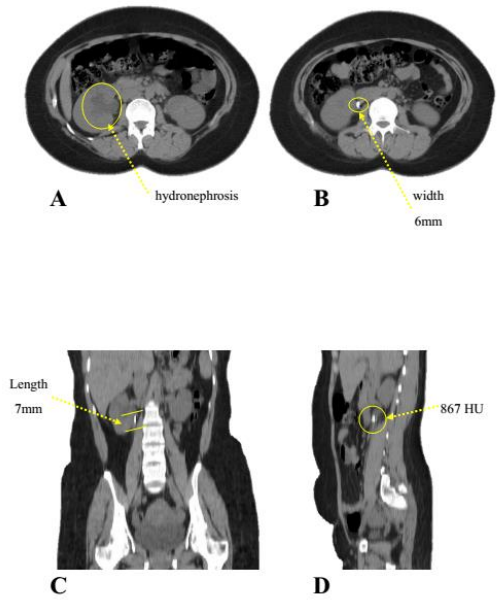

Figure 3A:A female patient aged 20 years old complaining of 4 days back of Right-side loin pain associated with nausea and vomiting tow times since the presentation. NECT was performed; (A)& (B) Axial soft tissue image, (C) Coronal reconstruction image, and (D) Sagittal reconstruction image shows: Impacted Rt. upper ureteric stone, just below Rt. PUJ measuring about 7x6 mm with a density of 867 HU exerting a mild Rt. side hydroureteronephrosis

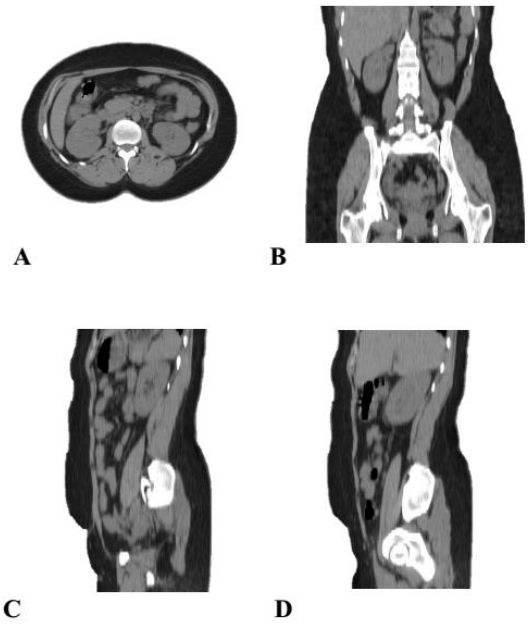

Figure 3B: Follow up after 5weeks. NECT was performed (Figure 3B) (A) Axial soft tissue image, (B) Coronal reconstruction image, (C) AND (D) Sagittal reconstruction image show: no stone (stone passed spontaneously after 38 days)

DISCUSSION

Renal stone is one of the commonest causes of loin pain and leads to multiple visits to the urology emergency department with increasing costs for health systems [1]. Demehri et al reported that The stone burden is clinically called algorithms [3], leading to the requirement for accurate stone detection. CT had the superiority of diagnosis as well as the detection of ureteric calculi, especially in the lower ureter as reported by Scales et al [11]. NECT is the gold modality in the evaluation of ureteric stone. NECT virtually shows most of the types of ureteric calculi unrespect to their composition like (uric acid calculi) which is radiolucent in routine plane X-Ray (KUB) [12]. According to previous studies [13], Coll et al, 75–90% of ureteric stones spontaneously passed in a short time and the patient can tolerate the pain. Ahmed et al mentioned that the management of a patient with ureteric stone can be one of two approaches: the first is conservative and careful waiting, with or without using analgesia. The second one if we expected that the stone not spontaneously passing, we managed with interventions like extracorporeal shock wave lithotripsy (ESWL), stone extraction percutaneous through the pelvis of kidney or laser lithotripsy[6]. The risks can be present in both the conservative and the invasive management, like systemic sepsis, which occur in both due to obstruction or as a post-operative complication also time-consuming without benefit if the stone not passing spontaneously. Exposing the patient to the anesthesia, UTI, and iatrogenic ureteral injury is the major risk of intervention. From this point, if we can predict the probability of stone to spontaneously pass is mandatory for choosing the type of management protocol as mentioned by Kambadakone et al [14].The study aims to know the value of the NECT technique in the prediction of whether ureteral calculi will pass spontaneously or not.

In our study, 24 male and 12 female (the mean of age, 40.4 years) were detected with urolithiasis. There was a statistically significant difference between spontaneous passage of stone and age of the patient ($P < 0.05$), and it was a statistically insignificant difference regarding gender ($P > 0.05$). In contrast, Jendeberg et al mentioned that age had a minimal probability of passage spontaneously[1].Our study determined the chance of stone spontaneous passage with the help of the diagnostic NECT. The spontaneous stone passage was noted in 22 patients (61.1%) and not observed in 14 patients (38.9%). The mean time of stone passage ranged from 20 to 42 days with a mean of 31.5 ± 5.8 days. Miller & Kane determined the interval to the stone passage and factors predictive of successful spontaneous ureteral stone passage[15]. They also concluded that the time interval to stone passage is highly variable. For example, ureteral stones 2 to 4 mm, 95% pass spontaneously but passage may take as long as 40 days. Similarly, [1] reported a mean outcome observation day in the short-term group was 31 ± 7. They agree that the position of the

stone is a crucial predictor of stone passage [13]. Our study divided the study population into four subgroups in keeping with the location of ureteric stone: upper in fourteen patients (38.9%), middle in three patients (8.3%), lower in eleven patients (30.6%) and UVJ in eight patients (22.2%). There was a major relationship between the spontaneous stone passage and the location of the stone ($P < 0.05$). In contrast, Jendeberg et al demonstrated that left-sided ureteral stones have superiority to pass considerably over right-sided stones in some analyses[1]. The results of earlier studies on hydronephrosis and side relating to stone passage are divergent [5] [15], within the current study, hydronephrosis was classified into mild in thirteen patients (36.1%), moderate in eighteen patients (50%) and severe in two patients (5.6%), and no hydronephrosis in three patients (8.3%). In the present study, there are no statistically significant relations between outcome and degree of hydronephrosis ($P > 0.05$). This finding is comparable to that of Jendeberg et al who declared that there was no significant distinction between the grades of hydronephrosis within the long-run outcome[1].

Coll et al Studied the relationship of stone size and location as determined by NECT to the rate of spontaneous passage. They ended that the rate of spontaneous passage of ureteral stones varies with stone size and location as determined by NECT[13]. Eisner et al showed that interobserver variability could be reduced well with an automatic volume measuring[16]. Many very different promising machine-driven reader-independent measuring ways are projected. In the present study, there was a statistically extremely significant relationship between the spontaneous stone passage and the size of the stone ($P < 0.001$). Miller & Kane Found that some variables not prognosticative for the predilection of stone passage like age, sex, and pain. Independently, side, position, and size approached significance, however on multivariate analysis, all three considerably prognosticative stone passages. They ended that interval to stone passage is very variable and dependent on stone size, location, and side. The degree of pain and patient gender and age do not have any concern on the time to stone passage[15]. In our study, we tend to created logistical regression models for prediction of the spontaneous passage employing a clear definition of the stone length and width. The width is very significant for a predictor of spontaneous of the ureteral stones associate degreed had an odds ratio (OR 0.43) that meaning low likelihood relation between the rise in width with spontaneous passing. The length had an odds ratio of (OR 0.67), indicating the least influence of spontaneous passage. The stone position (lower & UVJ) was a major predictor of stone passage. Therefore, the selection between the length and therefore the width as a variable quantity is less vital, whereas it is vital to pick the measure that is employed systematically. These findings are congruent with that revealed by Jendeberg et al, who performed the multivariate logistical regression analyses using the bone window measurements and ended that the length and width of the ureteral calculi were extremely related (correlation constant 0.96). However, the stone width took precedence over the stone length. Besides, it reported that the stone location was a major predictor of stone passage[1].

Regarding the measurement of width, NECT had 86.4% and 85.7% in sensitivity and specificity respectively, the PPV about 90.5%, and NPV about 80% at a cutoff value of five as a predictor of spontaneous passage of ureteric calculi. Finally, relating to the result of the stone passage, our study disclosed that there have been statistically high significant relations between outcome and width and length of stones ($P < 0.001$).Takahashi et al reported that the presence of soft tissue rim sign (TRS)(a renal fascia thickening) was not helpful in renal stone detection and prediction for its passage. In contrast, perinephric fat stranding (PFS)(curvilinear areas of soft tissue attenuation in the perinephric space) was proved to has high sensitivity (82%) and specificity (94%) in the presence of a renal stone.

however, in our study, there have been statistically insignificant relations between outcome and density, Soft-Tissue Rim Sign, Perinephric Fat Stranding and degree of hydronephrosis ($P > 0.05$).Our study incontestable a way for predicting the likelihood of stone passage within a short time supported stone size and location. Our results showed that spontaneous passage of a ureteral stone is often foreseen with high accuracy with the knowledge obtainable within the NECT, specifically stone width or length and whether the location of the stone concerning the sacroiliac joint (proximal or distal) and using standardized window settings and magnifications. Therefore, we can conclude that NECT may be a good predictor for spontaneous passage of ureteral stones and therefore the spontaneous passage.

CONCLUSION

Our study demonstrated a method based on stone size .and location can predict the probability of stone passage within a short time (8 wks.). So, NECT may be a good predictor of the spontaneous passage of ureteral stones.

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