Accuracy of emergency radiological tools in guiding renal stones surgical treatment

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ABSTRACT

Objectives: Ultrasonography is becoming the first imaging option in emergency rooms for detecting renal stones to decrease the costs and the radiological exposure of computed tomography. This study will aim to reinforce this role.

Methods: A collected data from (1014) files of patients who were diagnosed by either Ultrasonography or computed tomography in the emergency room of King Hussein Hospital between (September 2014 and July 2017) as a case of Urolithiasis, was used in our retrospective study. Patients were classified into three groups according to the modality used (emergency US, elective US, CT) to show the effect of initial emergency room radiological modalities on initial or subsequent urologists' evaluation of these patients, the treatment choices and timing of procedures.

Results: 841 (83%) patients out of 1014 patients underwent consultations in our urology clinics at Prince Hussein urology institute, while 132 (13%) were evaluated by a urologist in the emergency room, 41 (4%) patients were discharged without follow-up and 233 (23%) underwent urological procedures. The timing and type of operations did not differ significantly when Ultrasonography was an initial modality. Still a significant number of patients had a CT to confirm the diagnosis that was reached by Ultrasonography prior to any management either conservative or surgical.

Conclusion: Ultrasonography is a reliable initial study in the emergency department to diagnose Urolithiasis with a significant accuracy, and it does not delay the urological intervention or alter its type significantly; also the evaluation of patients by urologists was not influenced. But computerized tomography before surgery is essential.

Key Words: Computed Tomography, Renal stones, Ultrasonography, Urinary tract stones, Urolithiasis

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Introduction

The renal stone disease prevalence in different age groups has markedly increased in the last couple of years in the united states [1,2,3] with a recurrence rate up to 50% [4]; Therefore Nephrolithiasis has become increasingly the commonest urological issue that warrants treatment. Regarding the Radiologic assessment of urinary tract stones, CT scan has the highest sensitivity of all imaging options in the diagnosis of renal calculi.[5,6] Renal Ultrasonography is replacing computerized tomography as being the first line option to diagnose urinary tract stones in emergency rooms since CT has a high cost and delivers a considerable amount of ionizing radiation to the patients. It is also noted that the use of Ultrasonography as a first radiological study in the emergency room will not significantly alter the treatment outcomes in patients with renal stones.[7, 8,9,10]

Furthermore, due to the high sensitivity and specificity of renal US in detecting urinary tract stones and hydronephrosis especially in renal failure patients and female renal colic patients (whether pregnant or not), thus the use of US alone or with x-ray KUB abdomen over non contrast CT has increased recently.[11,12,13]

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This study aims to verify if the type and planned time of the procedures of the renal stones patients who were diagnosed in the ER by ultrasound as an initial radiological imaging tool instead of other modalities, was affected or not.

Methods

The medical records of (1014) patients were reviewed. Patients were aged between (18-65) years, and were diagnosed of having urinary tract stones using US or CT, which were available all of time in the ER (done by ER doctor with the radiologist being on call) and the radiology departments of King Hussien Medical Centre. They were referred to the urology clinics of Prince Hussien Urology Institute or were actually assessed by our urologists at the ER before undergoing subsequent surgical management. The duration of the collected data was between (September 2014 and July 2017). Data were reviewed retrospectively and patients with any other diseases like appendicitis, acute cholecystitis, renal diseases apart from the stones were excluded from this study, pregnant ladies were also not included in this study. We reviewed the medical files of the patients who underwent surgeries due to renal stones and analysed the timing and types of the procedures that were done from the first visit to the ER or clinic and during the follow-up period. The records were filtered into 3 groups according to the imaging modalities that were used to diagnose the renal stones (ER US, elective US, CT whether in the ER or in the radiology department). This classification aimed to clarify the efficacy of the initial ER US in detecting Urolithiasis and guiding the timing and types of the surgical management options. We classified the procedures as they got more invasive and complex from double –j catheter placement, Nephrostomy tube insertion, ESWL (Extracorporeal Shock Wave Lithotripsy), URS (Ureteroscopy) to PCNL (Percutaneous Nephrolithotomy). So, we mentioned only the name of the more difficult procedure for the patients who did multiple procedures. Also, we defined the timing of the procedures according to whether the procedure was done urgently or electively. Therefore, when the patients had undergone the procedures after an urgent admission, then the procedure was considered an urgent procedure, while the elective procedures were defined as that procedure which was done after follow up in the clinic. On the other hand, if the urgent admission was after the first visit to the ER, so the consults were considered urgent, while the clinic or elective consults could be followed by an urgent admission if the patients came to the ER as a second visit after the referral to the urology clinics.

Our study was carried on by a group of qualified consultants and urology specialists who actually did treat and follow up those patients between day (1) and (90) from the first visit to the urology clinic or first day of admission. A checklist was designed for each patient and included all investigations and procedures that were done.

We got a formal approval from our institution of ethical committee in Royal Medical Services to carry on this research till publication.

Statistical analysis: was done using the SPSS computer program version 22. Results were expressed as mean ± SD or number. Comparison between the mean values of all groups was done by using Mann-Whitney U test. Whereas the comparison between the categorical data (N (%)) was done by chi-square test. P-value < 0.05 was considered statistically significant.

RESULTS

This study showed that out of (1014) patients who were diagnosed with renal stones in the emergency room of King Hussein Hospital, there were 679 (67%) patients had undergone CT scan in the emergency room or in the radiology department of the same hospital during follow-up clinic (CT scan was used to confirm the US findings or when US was suspicious and cannot give a definitive diagnosis of stone disease), 941 (93%) patients did emergency US in the ER, and in contrast 193 (19%) patients had elective US in the radiology department. (Table I) showed the demographic data (age groups, gender) of all patients in relation to the type of the imaging tool that were used for the diagnosis of renal stones. Mean values and SD or numbers of patients were inserted in this table, it was noticed that male to female ratio was (1.5: 1) in all radiology modalities. All percentages were calculated in relation to the total number of all patients.

Table I: The demographic data of the population:

N ® (%) **Mean ± SD€**	**ER \US** **N= 941 (93%)** **Mean ± SD**	**Elective\ US** **N= 193 (19%)** **Mean ± SD**	**CT (ER or RD)** **N= 679 (67%)** **Mean ± SD**
Males N= 608 (60%)	N=584 (58%)	N=118 (12%)	N=401 (40%)
Females	N=357 (35%)	N=75 (7%)	N=278 (27%)

N= 406 (40%)			
Age (18-25) n=154 (15%)	21.68±2.33	21.41±2.41	21.6±2.347
21.75±2.265			
Age (26-35) n=217 (21%)	30.3±2.86	29.5±2.69	30.1±2.82
30.39±2.857			
Age (36-45) n=339 (34%)	39.8±2.86	40±2.96	39.5±2.80
39.8±2.87			
(46-55) n=203 (20%)			
50.2±3.04	50.2±3.03	49.8±3.07	50.1±3.32
(56-65) n=101 (10%)			
60.46±2.85	60.4±2.87	61±3.14	60.7±2.94

®The number of the patients, € Standard deviation.

Out Of (1014) patients who were diagnosed with renal stones, 841 (83%) patients were referred to our urology clinics, while 132 (13%) patients were assessed by a urologist in the ER, in contrast 41 (4%) patients were discharged from the ER without follow-up (these patients had a severe colicky pain that resolved after a history of tiny stone passage out of the urinary tract or to the urinary bladder and documented adequately with a normal whole or upper urinary tract by the US). Out of all patients only 233 (23%) patients had undergone at least one urological procedure.

In (Table II), a comparison was made between the Urologic procedures according to the time of the surgery (urgent or elective) in relation to the kinds of the imaging modalities that were used for the diagnosis of renal stones. Therefore, we got the following results:

1- The number of the patients who underwent urgent procedures was (83) (35.6 %). This number was distributed among the three radiology imaging modalities as follows: ER US (70) (30%), elective US (6) (2.5%) and CT (54) (23%), with an estimated P-value for each imaging tool (0.0435, 0.0678, 0.0487, respectively).

2- The number of patients who underwent elective procedures were (150) (64.4%), distributed in the different types of the radiology modalities as follows: ER US (120) (51.5%), elective US (47) (20.1%) and CT (89) (38.2%), with an estimated P-value for each modality (0.0261, 0.0876, 0.0325, respectively). (The percentages in the (Table II) relate to the total number of the patients who underwent surgery (233)).

3- Time of surgery in patients who underwent ER US was not affected significantly when compared to the same time in the patients who had undergone urgent or elective CT scan, (P-value in the ER US groups for urgent and elective procedures = 0.0435, 0.0261, respectively), approximately the same P-values were seen in the CT groups for urgent and elective procedures, (P-value = 0.0487, 0.0325, respectively). (Significant P-value was considered < 0.05).

Table II: A comparison between the procedures according to the time (urgent or elective) in relation to the imaging modalities.

	N* (%)	**ER\ US n (%)**	**RD\ US n (%)**	**CT n (%)**
Urgent procedure	83 (35.6%)	70 (30%)	6 (2.5%)	54 (23%)
Elective procedure	150 (64.4%)	120 (51.5%)	47 (20.1%)	89 (38.2%)

*The number of the patients.

(Table III) showed the variation among the imaging groups according to the type of the Urologic consultation (urgent or not (clinic consultation)) either for three categories:

1-admission and conservative management, 2- admission for urgent operation or 3- for follow up as outpatient elective surgery. In all, the total number of the Urologic consults was (973) (96 % of all patients). Urgent consults form (13.6%) (132 patients) of the total number, distributed (urgent, elective) and the number of the urgent admissions among the imaging groups as was shown in (Table III). While clinic or elective consults form (86.4%) of the total number, with the distribution among the imaging groups according to the same variables in the urgent consults, (Table III). The estimated P-value among radiology tools (ER\US, RD\US, CT) in urgent consults was (0.0384, 0.0859, 0.0497, respectively), while in elective consults the P-value for the same previous radiology modalities was (0.0245, 0.0683, 0.0134, respectively). So, when we made a comparison between ER US and CT in relation to the P-values which were close in the two types of the urology consults, we found that the evaluation of the patients after ER US was close to the CT evaluation and was affected significantly in a positive way. (The percentages were calculated in relation to the total number of consultations, (973)). (Significant P-value was considered < 0.05).

Table III: A comparison among imaging groups in relation to the type of the consultation.

	Variables	Number (%)	ER \US n (%)	RD \US n (%)	CT n (%)
ER consults 13.6% Number = 132	Urgent procedure.	72 (7.4%)	63 (6.5%)	0 (0%)	47 (4.8%)
	Elective procedure.	96 (9.9%)	89 (9.1%)	31 (3.1%)	66 (6.8%)
	Urgent admission.	85 (8.7%)	82 (8.4%)	13 (1.3%)	52 (5.4%)
Clinic consults 86.4% Number = 841	Urgent procedure.	11 (1.1%)	7 (0.7%)	6 (0.6%)	7 (0.7%)
	Elective procedure.	54 (5.5%)	31 (3.1%)	16 (1.6%)	23(2.2%)
	Urgent admission.	21 (2.1%)	19 (2%)	12 (1.2%)	17(1.7%)

Regarding the effectiveness of the ER US on the type of the surgical intervention, we reviewed this feature in (Table VI), which illustrated the close relationship between the ER US and the renal CT scan in the selection of the proper type of the surgery for the patients who were diagnosed with urinary tract stones either in the ER or later in the post follow up clinic. In this table the numbers of all types of the surgeries were done for the patients were shown, the percentages were calculated according to the total number of the procedures (233), the P-values of the ER US and the CT scan was made between the different types of the surgical interventions for each imaging modality, (P-value = 0.0125, 0.0167, respectively). (Significant P-value was considered < 0.05).
Most of the emergency procedures were a double-j-catheter insertion, whereas, the elective ones were the Uretroscopies. The average time for surgery was within 21 days (3 weeks).

Table VI: Comparison between the radiology imaging groups in relation the different types of the surgical intervention.

Type of the Surgery	Number (%)	ER US (%)	RD US (%)	CT (%)
DJC	126 (54%)	103 (44.2%)	20 (8.6%)	75 (32.2%)
PCN	10 (4.3%)	9 (3.9%)	1 (0.4%)	7 (3%)
ESWL	21 (9%)	19 (8%)	8 (3.4%)	10 (4.3%)
URS	70 (30%)	54 (23.1%)	22 (9.4%)	45 (19.3%)
PCNL	6 (2.6%)	5 (2.1%)	2 (0.9%)	6 (2.6%)

Discussion

We noticed that the ER US resulted in accurate diagnosis of renal calculi, which did not differ significantly from such diagnosis was made by the CT use. Furthermore, the ER US assisted to take a proper decision of the modality of the treatment without delaying the timing for such intervention. Ultrasound has the benefit of being cost effective and no radiation exposure hazard or contrast hazard compared to a CT scan. Similar results were reported by Metzler and colleagues in (September 2016).[10]
Marcia L Edmonds et al reported that, when the ER Ultrasonography detected renal stones, there was a significant positive influence in the urologists' evaluation and the urological intervention.[14,15] These findings support our results that were mentioned before. On the other hand, Salinawati Bakin and associates reported in a literature that was published in Kuala Lumpur, Malaysia, that the accuracy of the radiology department US, that was done by master of radiology, in revealing urinary tract stones, did not add a significant influence over the ER US regarding the accuracy of the detecting of Urolithiasis, making the need for an experienced radiologist to confirm the diagnosis of a renal stone that was made by ER US unnecessary and for such purpose CT scanning is better for such a diagnosis.[16]
Urinary tract calculi management, depending on the size of the stone, the location of the stone and of the obstruction, the degree of the renal pain apart from the type of the obstruction, can be achieved by either a conservative manner through a trial of spontaneous stone passage or by active urological interventions such as: (ESWL), (URS) and (PCNL) selectively or more simply via decompression of the urinary tract through double j catheter or nephrostomy tube insertion urgently.[17] Our study supports this idea by showing that urgent double j catheter or nephrostomy tube insertions were commonly applied to those who were decided upon for urgent intervention. Opposite findings were shown in the article by Papa L, et al that aimed to predict mode of

intervention in renal colic patients after urgent evaluation in the ER. This article showed that the Ureteroscopy, ESWL and percutaneous nephrostomy had been the commonest in use for urgent cases.[18] Whereas (SWL), (URS) or (PCNL) were used much more in elective cases in our study. Such findings were obvious in the research that was done in the United States (in 2015) by Sivalingam Sri et al regarding variable practice patterns of Obstructive Uropathy, where the Ureteroscopy was preferable over the double catheter insertion in the management of the selected cases.[19]

Many literatures confirmed that, considering an Ultrasonography as an initial imaging tool, if available, in the diagnosis of renal stones in renal colic patients who presented to the emergency department, should be done with no significant misdiagnosed cases if there is a restriction to the use of renal CT.[20, 21, 22]

A. Andrew Ray and colleagues had reported that, the ultrasound overestimates the renal stone size, especially in the sized stone less than (5 mm) due to the inaccurate measurement of the skin-stone distance.[23] On the other hand, Renal CT is important and more sensitive than US for diagnosing renal stones despite of the reliability, safety and dependency on US as being first imaging tool in ER.[24] So the use of renal non enhanced CT to get an accurate size of the urinary tract stone before any intervention is recommended, not to make the decision for the timing of the surgery, to delay the intervention or changing the type of the planned procedure, but just to confirm the positive findings of US and to locate the site of the stone. Keeping in mind that the period of the operation depends on the location and the size of the renal stone. Therefore, we found that most of the patients in our research 679 (73%) had undergone renal CT for follow-up or before exposed to any procedure.

Conclusion

Ultrasonography as an initial study to diagnose urinary tract stones in the emergency room is of great value for an accurate diagnosis of renal stones. It provides a positive influence regarding the timing and the proper selection of the treatment mode without any significant delay in the diagnosis or in the timing of the intervention. ER US is cost effective, widely available in the emergency rooms and has no hazard of radiation exposure.

Recommendations: in patients with a clinical diagnosis of renal stones, the first imaging modality for investigation should be ultrasonography. And if in doubt of diagnosis, CT maybe a second option.

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