

## **FIVE YEARS EXPERIENCE OF USING ULTRAPORTABLE SONOGRAPHY FOR UROLOGICAL EMERGENCIES**

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### **Abstract**

This study aimed to evaluate the use of ultraportable sonography in the emergency department for urological emergency conditions by one urologist. The results were compared to the final diagnosis after performing a second sonography, computed tomography and cystoscopy so to calculate the specificity and sensitivity of this test and outline its advantages and disadvantages for the emergency department and the examining urologist.

This prospective study was done between 2010 and 2015. A 217 patients with either flank pain or hematuria were included. An ultraportable sonography was used to examine all patients at the emergency department and the results were compared to the final diagnosis after evaluating those patients with another ultrasound, contrast study, computed tomography and cystoscopy.

The statistical analysis of the results showed a very high sensitivity of 97%, with a specificity of 75%, the false positive ratio was 25% which is high but the false negative result rate is 3.0% which was low, there was a high predictive value of 98% for positive, and only 66.7% for negative with a likelihood ratio of 3.881 for positive results.

In conclusion, ultraportable sonography can be used with high efficacy and accuracy in emergency urological conditions, it carry a lot of satisfaction for both the patient and the physician, it can improve patient management by reducing the time needed for diagnosing and assessing the patient condition. It is strongly recommend for primarily use in the emergency department.

### **Introduction**

Urological emergencies represent one of the major causes for admission to emergency departments all over the world, this might include acute flank pain (including urolithiasis and infection), obstructive uropathies, hematuria, trauma and testicular torsion. It has a high incidence rate, for example over one million patients with upper tract stones are admitted annually to the emergency department in the united states. With the increase in the prevalence of urolithiasis, there is a simultaneous increase in the

need to diagnosis, evaluate and treat those patients<sup>1-3</sup>. The evaluation of emergency urological conditions depend on proper history and physical examination with necessary laboratory investigation and imaging techniques by ultrasound, intravenous urography and computed tomography. The advantage of the ultrasound is in its low cost, more available, noninvasive, non-ionizing radiation, no need for preparation and no need for injecting or ingestion of contrast. For all these reasons, sonography might

be readily done as a first line investigation in a patient with a urological emergency. The development of an ultraportable or what is called recently a pocket ultrasound machine make it a more satisfactory method for both the patient and the physician, shortening the time needed for performing ultrasound image at the radiology department and saving precious time in reaching the diagnosis and starting the appropriate treatment thus relieving patients pain and suffer in shorter time. The name urologist stethoscope was given to this ultrasound machine for its advantages in practice. These probes can be attached to small sized laptops, tabs or even smartphones<sup>4</sup>. The first clinical application of ultrasound was in the 1940s, with the first endourological ultrasound dependent endourological procedure was in the 1970s. The most common and familiar type used is the two dimensional ultrasound in which the reflected echoes appear as bright spots which depends on the intensity of the signal<sup>5,6</sup>. The process of development of ultrasonography over the last few years was rapid and it involved both the technology and the size, improving the resolution and reducing the size till reaching the pocket size ultrasound.

This study utilizes ultraportable ultrasound probe to evaluate patients with flank pain and hematuria as examples of common urological emergencies in the emergency department and to compare our results to those obtained after full work up of the patient in the urology department, in order to estimate the specificity and sensitivity. There is no doubt that ultrasound machines are mandatory equipment in every urological department, cutting short diagnosis time and improving outcomes<sup>7</sup>, but this study tried to show its importance in emergency departments and compare it to computerized tomography and

intravenous urography in terms of specificity, sensitivity and practicality.

### Patients and Methods

This study was conducted between February 2010 and January 2015, at Basrah General Hospital, emergency department. A 217 patients with two important urological complaints were studied those with frank macroscopical hematuria and patients with acute flank pain (testicular torsion and trauma were excluded). The study involved examination by an ultraportable sonography performed by the same consultant urologist for all the patients at admission, they were followed later and the results were compared to the results of subsequent investigations in the form of sonography, computerized tomography and cystoscopy performed later. The idea was to compare the primary results to the final outcome diagnosis, in order to figure out the accuracy of this procedure in detecting the cause of these urological emergencies. The reason for this limited number of patient was the infrequent emergency room duties for that specific urologist so as to conduct all exams by the same person in an attempt to minimize the multi-operator error.

All patients were assessed by a thorough history and physical examination, there was no personal selection of patients for enrollment in the study i.e. random selection, they were examined using a state of the art ultraportable 3.5MHz probe, with 20cm scan depth, 7.5 cm focal point and 90° scan angle the probe was connected to mini laptop, tablet or a smart phone (Fig.1), examination of kidneys for evidence of hydronephrosis and its degree was assessed, cortical thickness was measured and stone or renal masses were looked for and measurement taken. The ureter caliber was measured reporting any dilatation of

the ureter, the bladder was also examined looking for capacity, wall thickness, prostate size, stone or tumors. The patients data after admission to the hospital was collected regarding investigation in the urology department

and the final diagnosis was compared to the primary diagnosis at the emergency department by the ultraportable sonography. The data collected was statistically analyzed using SPSS version 15 software.



Figure 1: Ultrasonographic probe connected to smart phone.

## Results

Two hundred seventeen patients were enrolled in this study, 61 females (28.1%) and 156 males (71.9%) (table I). The age ranged from three to 93 years with a mean of 38.44 years (table II).

Table I: Gender distribution

	Frequency	Percent	Valid Percent	Cumulative Percent
female	61	28.1	28.1	28.1
male	156	71.9	71.9	100.0
Total	217	100.0	100.0	

Table II: Age distribution

	N	Minimum	Maximum	Mean	Std. Deviation
age	217	3.00	93.00	38.4424	23.04721

Seventy-eight patient were admitted to the emergency department because of frank hematuria the remaining 139 patients had flank pain as the cause of admission to the emergency department. The ultraportable ultrasound examination of patients who had hematuria revealed (table III) stones in 33 patients (15.2%),

benign prostatic hyperplasia in 17 patients (7.8%), hydronephrosis in 11 patients (5.1%), tumor in seven patients (3.2%) and it did not detect a cause in 10 patients (4.6%), while in patients admitted for flank pain it revealed (table IV) stones in 76 patients (35%), hydronephrosis in 45 patients (20.7%),

renal cyst in seven patients (3.2%), tumor in three patients (1.4%) and it did not detect a cause in eight patients (3.7%). Comparing these results to the final diagnosis on discharging the patient after performing ultrasonography, contrast study, computerized tomography and cystoscopy and by using a statistical software (biocalculation) the results came

up with the following figures regarding ultraportable ultrasonography, the specificity is 75%, the sensitivity is 97%, the false positive result rate is 25%, the false negative result rate is 3.0%, the predictive value is 98% for positive and 66.7% for negative, the likelihood ratio is 3.881 for positive and 0.040 for negative (tables V & VI).

Table III: Pathologies diagnosed by ultrasound in patients with hematuria

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	139	64.1	64.1	64.1
no pathology	10	4.6	4.6	68.7
stone	33	15.2	15.2	83.9
tumor	7	3.2	3.2	87.1
BPH	17	7.8	7.8	94.9
hydronephrosis	11	5.1	5.1	100.0
Total	217	100.0	100.0	

Table IV: Pathologies diagnosed by ultrasound in patients with flank pain

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	78	35.9	35.9	35.9
no pathology	8	3.7	3.7	39.6
stone	76	35.0	35.0	74.7
tumor	3	1.4	1.4	76.0
renal cyst	7	3.2	3.2	79.3
hydronephrosis	45	20.7	20.7	100.0
Total	217	100.0	100.0	

Table V: Specificity and sensitivity

	cause present	cause absent	total
Ultrasound positive	195	4	199
Ultrasound negative	6	12	18
total	201	12	217
Specificity	75.0%		
Sensitivity	97.0%		

Table VI: Predictive values

	positive	negative
False result rate	25%	3%
Predictive value	98%	66.7%
Likelihood ratio	3.881	0.040

## Discussion

Sonography is an important diagnostic tool for physicians in general and urologists specifically and an ultraportable ultrasound is definitely more superior than the conventional machine by the fact that it can be easily carried to bed side, and the physician can carry it in his pocket as a urologist "stethoscope" adding this to the advantages an ultrasound can provide in the sense of cost comparing to other imaging modalities, it require no preparation, no ionizing radiation, rapid, safe and non-invasiveness<sup>8-10</sup>, the pocket ultrasound aid can be considered a very valuable tool in the urologist hands that is indispensable cutting short the time required to evaluate a patient and rapidly initiating management but at the same time it cannot replace other diagnostic tools in the urologist armamentarium .

The author evaluated ultraportable ultrasound machine in terms of sensitivity and specificity using special statistical software that determined both. This is done by comparing the false positive and false negative ultrasound results performed at the emergency department to the diagnosis at discharge of the patient from the urology department after full evaluation and management. The predictive value of the test and the likelihood ratio were estimated by the same software. The ultrasound was performed by a single consultant surgeon, it was done at the emergency department up on admission and after history and physical examination the ultrasound exam was done at bed side taking no more than five minutes. Patients evaluated were of two main complains, flank pain and frank hematuria. There was a positive finding by the ultraportable ultrasound in 91.705% in the remaining 8.29% there was no positive finding. The specificity of the test was 75%, while the sensitivity was 97%, several studies showed variable

results, one study by Nargund et al reported a sensitivity of 84% and a specificity of 97% which is relatively the reverse of our findings<sup>11</sup>, while another study by Meghan K et al reported a sensitivity of 92.7, a specificity of 81.4% and a positive likelihood ratio of 4.97 which is very close to our results, another study by Rosen C. et al<sup>12</sup> had low sensitivity and specificity rates of 72% and 73% respectively, Moak et al in 2012<sup>13</sup> also reported a sensitivity and specificity rate of 76.3% and 78.3% respectively these variations in results can be attributed to two main factors the machine and the operator, which definitely had a lot of versatility in type of the ultrasound machine and its accuracy ,while the physician skills and training in operating an ultrasound can also be another cause for these variable results, thus a highly trained physician will result in the high rates ,while less trained users can end with the previous low rates making it a user dependent procedure<sup>14-16</sup>. The overall good sensitivity and specificity of ultrasound cannot replace the doubtless better accuracy spiral computerized tomography but it can even make it more accurate i.e. increase the accuracy of other imaging modalities like the computerized tomography or even the traditional intravenous urography<sup>17</sup>.

The results obtained reflects only a single surgeon experience so the results reflect the sensitivity and specificity of the ultrasound under these conditions, there for changing the operator or multi-operators with different experience can definitely end with totally different results. The type of the ultrasound system can also play a role in changing the results.

Conclusion: The results of this study showed the high efficacy of ultraportable ultrasound in preliminary diagnosis of

urological emergencies in emergency departments, through its high sensitivity and specificity leaving no doubts about the necessity of providing ultrasonography for urologist and specially physician at emergency departments, as it shortens diagnosis time and it facilitate early initiation of management, it can be performed without the need to prepare the patient, without injecting contrast, easy, rapid cheap and safe no ionizing

radiation exposure. The test can add to the efficacy of the subsequent diagnosing tests increasing the specificity and sensitivity and improving the likelihood ratio of the test. The results by no means refer to substituting ultrasonography for CT or cystoscopy, it adds to the urologist tools a safe and handy tool. This tool is strongly dependent on the operator skills and training and the type of probe used.

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