

Republic of Iraq  
Ministry of Higher Education and Scientific Research

University of Diyala  
College of Medicine  
Department of Physiology



# Comparison between the clinical provisional diagnosis and clinical ultrasound findings: Exploring the subclinical findings

Done by : Noor Abdulrazzaq Mustafa

Supervised by : Prof.Dr.Suad Muslih Al-deen Abdalmajeed

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## Certification

This is to certify, that the research paper submitted by Noor Abdulrazzaq Mustafa under my supervision to the department of physiology-Diyala university college of medicine

Signature.....

*Dr. Suad Musleh Alden Abd AL-Majed*

I submit this study for discussion by the examining committee based on the available recommendations.

Signature.....

### Committee Certification

After reading this research and considering the students' responses on its substance, we, the examination committee, believe it to be a suitable research project.

.

Signature.....

## Dedication

This study is wholeheartedly dedicated to my beloved parents, who have been my source of inspiration and gave me strength when I thought of giving up, who continually provide their moral, spiritual, emotional, and financial support. To my sisters & friends who encouraged me to finish this work. All the thanks to almighty God, thank you for the guidance, strength, power of mind, protection and skills and for giving us a healthy life. For all of these I am grateful to you.....

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They are the ultimate role models. Also my sisters who provide unending inspiration

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## Abstract

Ultrasonography has long been a valuable method of imaging the body with several distinct advantages over other modalities. One of the most important features is its lack of ionizing radiation. Sonography can provide clinically useful information without clinically significant biologic effects on the patient. This is critical in obstetrics, very important in the pediatric patient population, and becoming increasingly important in adults due to radiation dose concerns associated with other imaging modalities.

A hundred patients who had sonographic examinations at Baqubah's teaching hospital and Albatool teaching hospital were studied retrospectively between September 2022 and February 2023 following a questionnaire that demonstrate the age, gender, refereed doctor , provisional diagnosis and full ultrasound report to difference between the doctor's diagnosis and the ultrasound finding , All of the reports were taken by Hitachi Aloka ultrasound device with C251 probe and frequency of 2.5MHz , without contrast, and sonographic results were compared with findings at operation or findings made using other diagnostic methods. With a variety of lesions, the overall accuracy of diagnosis by sonography was 69%. In the remaining 31% of studies, false-positive or false-negative results were observed.

The hundred reported cases had errors and false positive reviews and the reason that lead to these results could be due to several reasons , these reasons returning to published reports are due to sonographers skills, the organs themselves and the patients' conditions that may interfere with good imaging.

Each type of abdominal disease has pros and cons when it comes to ultrasound. It helps to be familiar with the limitations of each, and make an educated choice depending on the diseases on your initial list of differential diagnoses.

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## Abbreviations

ED :Emergency department

CT :Computed tomography

US :Ultrasonography

SD :Standard deviation

CI :Confident interval

Rt :Right

Lf :Left

Yrs :Years

M :Male

F :Female

# **Chapter 1**

## 1.1.Introduction

Ultrasound application allows for noninvasive visualization of tissue structures. Real-time ultrasound images are integrated images resulting from reflection of organ surfaces and scattering within heterogeneous tissues. Ultrasound scanning is an interactive procedure involving the operator, patient, and ultrasound instruments. Although the physics behind ultrasound generation, propagation, detection, and transformation into practical information is rather complex, its clinical application is much simpler. Because ultrasound imaging has improved tremendously over the last decade, it can provide anesthesiologists opportunity to directly visualize target nerve and relevant anatomical structures. .

Sonography is known for its real-time nature of the examination. This makes it possible to evaluate rapidly moving structures such as the heart and easier to examine the moving fetus and structures in patients unable to suspend respiration or cooperate with the examination. Its multi-planar imaging, real-time equipment, and three dimensional (3D) capabilities enable flexibility in the selection of imaging planes and the ease of altering these planes, allowing rapid determination of the origin of pathologic masses and analysis of spatial relationships of various structures. The portable nature of the

equipment is an advantage over other cross-sectional modalities such as CT and magnetic resonance imaging (MRI).

Doppler techniques add the advantage of qualitative and quantitative evaluation of blood flow.

Development and continuing refinement and experience with ultrasound micro bubble contrast agents now allow sonography to rival and/or exceed CT and MRI in detecting and characterizing soft-tissue and vascular lesions.

Finally, in the era of medical cost containment, ultrasonography is an attractive imaging study for many clinical problems, especially in situations in which multiple sequential examinations are necessary or when screening of large patient populations is desired.

All of these factors make ultrasonography an extremely valuable tool in the investigation of a vast array of disorders.

Any individual who performs diagnostic ultrasonography must have an understanding of the physical principles of this technique and the instrumentation available for detecting and displaying the acoustic information.....(1)

## 1.2. Historical background of US

In 1880, French physicists Pierre Curie and his elder brother, Paul-Jacques Curie, discovered the piezoelectric effect in certain crystals. Paul Langevin, a student of Pierre Curie, developed piezoelectric materials, which can generate and receive mechanical vibrations with high frequency (therefore ultrasound).

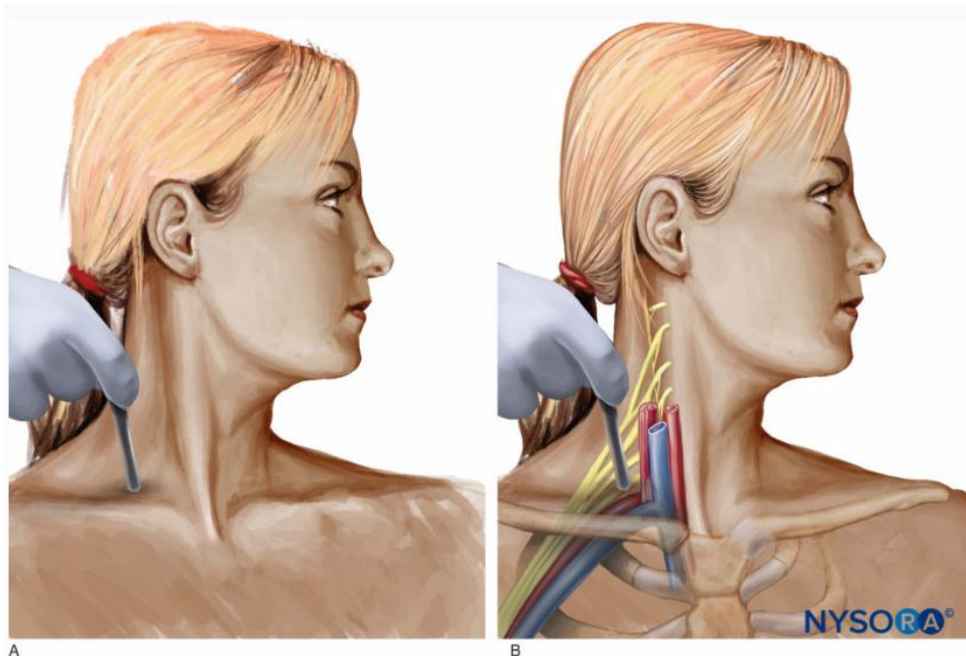
During World War I, ultrasound was introduced in the navy as a means to detect enemy submarines. In the medical field, however, ultrasound was initially used for therapeutic rather than diagnostic purposes.

In the late 1920s, Paul Langevin discovered that high-power ultrasound could generate heat in bone and disrupt animal tissues. As a result, throughout the early 1950s ultrasound was used to treat patients with Ménière disease, Parkinson disease, and rheumatic arthritis.

Diagnostic applications of ultrasound began through the collaboration of physicians and sonar (sound navigation ranging) engineers. In 1942, Karl Dussik, a neuropsychiatrist, and his brother, Friederich Dussik, a physicist, described ultrasound as a medical diagnostic tool to visualize neoplastic tissues in the brain and the cerebral ventricles. However, limitations of ultrasound instrumentation at the

time prevented further development of clinical applications until the mid-1960s.

The real-time B-scanner was developed in 1965 and was first introduced in obstetrics. In 1976, the first ultrasound machines coupled with Doppler measurements were commercially available. With regard to regional anesthesia, as early as 1978, La Grange and his colleagues were the first anesthesiologists to publish a case series report of ultrasound application for peripheral nerve block. They simply used a Doppler transducer to locate the subclavian artery and performed supraclavicular brachial plexus block in 61 patients (Figures 1A and 1B). Reportedly, Doppler guidance led to a high block success rate (98%) and absence of complications such as pneumothorax, phrenic nerve palsy, hematoma, convulsion, recurrent laryngeal nerve block, and spinal anesthesia. In 1989, Ting and Sivagnanaratnam reported the use of B-mode ultrasonography to demonstrate the anatomy of the axilla and to observe the spread of local anesthetics during axillary brachial plexus block.



**Figure 1.1.** A: Early application of Doppler ultrasound by LaGrange to perform a supraclavicular brachial block. B: Relationship of the brachial plexus of nerves and the subclavian artery.

In 1994, Stephan Kapral and colleagues systematically explored brachial plexus with B-mode ultrasound. Since that time, multiple teams worldwide have worked tirelessly to define and improve the application of ultrasound imaging in regional anesthesia. Ultrasound-guided nerve block is currently used routinely in the practice of regional anesthesia in many centers worldwide.....(2),(3),(4)

## 1.3.Types of ultrasound

The common types of ultrasound scan are:

- Abdominal ultrasound, which examines the internal organs of the abdomen, such as the liver, gallbladder, pancreas and spleen
- Obstetric/pregnancy ultrasound, which is a routine scan to assess the growth and health of the baby
- Female pelvis ultrasound, which may use transvaginal ultrasound (with the transducer in the vagina) or external pelvic ultrasound to look at the female pelvis, uterus, cervix, fallopian tubes and ovaries
- Breast ultrasound, which is used to assess breast symptoms such as lumps, and also to screen for breast cancer in women with dense breast tissue



Fig.1.2 Illustration of abdominal ultrasound



Fig.1.3 Illustration of pelvis ultrasound



Fig.1.4 Illustration of breast ultrasound



- Renal ultrasound, which is used to scan the urinary tract including the kidneys and bladder

- Transrectal ultrasound, which provides images of the prostate gland

- Doppler ultrasound, which monitors blood flow in the major arteries and veins

- Echocardiogram, which examines the heart

- 3D ultrasound, which shows a three-dimensional picture of the inside of the body

- 4D ultrasound, which creates a three-dimensional picture in motion....(5),(6)

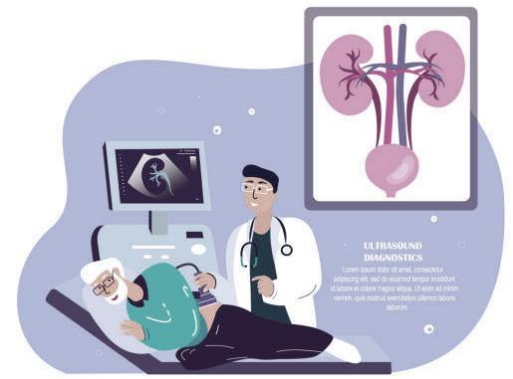


Fig.1.5 Illustration of renal ultrasound

## **1.4.Diagnostic validity of Ultrasound**

Ultrasonography is the most widespread imaging technique used in the diagnostics of the pathologies concerning the organs in the abdominal cavity. It is a modality that has seen more and more application in recent years. It's different from radiographs in that the picture you see on the screen is only a few millimeters in thickness, so that depth dimension compression is negligible. You are actually looking at thin slices of the abdomen one after the other, displayed in "real time". This is great because you can look at a thin slice of an organ, for example a kidney, without the averaging. Ultrasound physics also allows you to see many more "shades" of echogenicity, while radiographs are limited to air, fat, soft tissue, mineral and metal. So the mass that you couldn't see in the kidney on a radiograph is very visible on ultrasound. Ultrasound does not always detect focal lesions such as masses though, especially in the liver.

Similarly to other diagnostic tools, errors may occur in ultrasound examinations. They generally result from inappropriate techniques, which do not conform to current standards, or erroneous interpretation of obtained images. A significant portion of mistakes is caused by inappropriate quality of the apparatus, the presence of sonographic imaging artifacts, unfavorable anatomic variants or improper preparation of the patient for the examination.

Ultrasound is operator dependent. Definitive diagnosis in abdominal diseases has always been challenging because of its non-specific symptoms, signs, and laboratory findings, which can mimic several different pathologies, However, to avoid the negative abdominal surgery rate of emergency surgeries, and to have a complete picture about any abdominal diseases while reaching the definitive diagnosis Several reports were done to rule out the efficacy of abdominal ultrasound in diagnosing vague cases of abdominal pathologies in all age groups. Ultrasound can lead to misdiagnosis, especially in young women, children, and elderly patients. The reports were a systematic update from 2010 to 2021, and a total of 18 articles were selected to rule out the sensitivity, specificity, PPV, NPV, and Diagnostic odd ratios. When correlated with histopathology, these reports showed an overall sensitivity of 77%

Only the histopathology record of the taken specimen and samples served as the reference standard in theses researches.

The limitation of most of the present studies and what is affecting the ultrasound report accuracy is that the variability in the type of sonographer as skilled and experienced radiologists can reduce the chance of false-negative results.

The diagnostic accuracy of the US could be compared with other methods of imaging to see the variability. Analysis of studies showing accuracy based on techniques using Color Doppler to ultrasound examination and various scoring systems based on patient's history, physical examination, and laboratory tests can further improve the diagnostic accuracy rate of ultrasound abdominal pathologies.

US can be a useful bedside screening test for not only patient with abdominal pathologies but also in patients with pleural manifestation of certain lung diseases. This was shown in a pilot study that physicians with previous US experience after a short training could recognize US signs of with a good accuracy and inter- and intra-observer agreement. Furthermore, this pilot study suggests that sensitivity of US could be superior to abdominal radiography and that a 2 fast-scan exam could be as accurate as full abdominal examination; however, more studies are needed to confirm these preliminary findings in a larger ED population.....(7),(8),(9)

## **1.5.Errors in U/S application**

US diagnostic errors can be classified into three groups as follows:

Errors dependent on:

1. Environmental factors;
2. Patients;
3. Technical skills of the operator

### **1. Environmental Factors**

A common malpractice claim scenario takes place in an emergency room. Overcrowding in emergency rooms, a large number of investigations of differing appropriateness, and quick diagnosis and management all contribute to a high-risk setting. These variables can affect the quality of US examinations, by putting the medical operator under stress when performing US and interpreting results.

## **2. Patients**

Patients in the emergency room are unlikely to be adequately prepared for unanticipated US examinations, such as fasting status and bladder distention. Some patients may be unwilling to cooperate, suffer extreme pain from the probe's pressure, or be under the influence of alcohol or drugs. These factors can complicate the performance of the US examination, especially by providing a poor panoramic view

## **3. The Technical Skills of the Operator**

The accuracy of the US examination is directly related to the operator's skill, training, and experience. The medical operator's responsibilities include fully exploiting the diagnostic capability of US, knowing what to look for, and having the competence to interpret the findings based on understanding the physiology and pathological changes of the examined organs. Furthermore, the interpretation of US examinations requires a subjective judgment that is heavily influenced by the operator and cannot be achieved only on the basis of the images.

Unlike other imaging procedures, US examination is a real-time test that cannot be delegated, although in many countries across Europe and North America it is usually performed by a specialized non-medical technical operator such as a sonographer,

followed by a delayed report by a physician; in this way it loses its special value—facilitating real-time imaging. The increased number of devices and operators devoted to US influence a large number of examinations; interpretational doubts create the need for further diagnostic imaging confirmations and a consequent increase in healthcare costs, diagnostic delays and medico-legal disputes .

US is often wrongly considered as an imaging modality that needs short training, in the mistaken belief that it is, due to the widespread diffusion of the method, a very simple procedure to perform. Errors of ignorance are due to inadequate knowledge, whereas errors of implementation occur during the application of knowledge

.Furthermore, knowing the intrinsic US limits also represents at the same time the achievement of a good awareness of US imaging, the so-called “right measure”, so as to be able to better combine this imaging modality with others in order to achieve good diagnostic performance, and at the same time, make US a concrete diagnostic opportunity.

The training and advanced study of US techniques, thorough knowledge of human anatomy, the study of US artifacts, and ultrasonography semiotics are all crucial tools, and according to the increase in the supply of US performance and its clinical use in emergency scenarios, the need to implement universally accepted guidelines of US training courses appears imperative.....(10),(11),(12)



## **1.6.Patient's condition that interfere with** **good image resolution**

Image resolution determines the clarity of the image. Such spatial resolution is dependent of axial and lateral resolution. Both of these are dependent on the frequency of the ultrasound. Axial resolution is the ability to see the two structures that are side by side as separate and distinct when parallel to the beam. Lateral resolution is the image generated when the two structures lying side by side are perpendicular to the beam. Narrower the beam better is the resolution. The width of the beam is inversely related to the frequency. If the beam is wide the echoes from the two adjacent structures will overlap and the image will appear as one.

It's accounted for by minor differences in acoustic characteristics of organs. For e.g intra-abdominal organs like the pancreas, liver, spleen, and kidney, all listed in increasing hypoechogenicity, a sonographer rely on capsular outlines and peritoneal reflections which are hyperechoic for tissue differentiation.

When it comes to patient's condition fat and air are the main factors affecting quality by causing interference in ultrasound.

Deterioration in resolution with increasing thickness of overlapping fat has been verified experimentally.

The following factors have provided better resolution in experimental studies: large aperture transducers; compound technique (good axial resolution compensates for poor lateral resolution); compression of fat and location of the fat in the focus of the transducer; large beam width of the ultrasound signal. In a clinical study with 663 patients the influence of compression and compound technique on visualisation of abdominal structures was tested with a Combison 100 real-time scanner, Combison 202 compound scanner and the Octoson system. The retroperitoneal space was not demonstrated in 66 patients. Compression with the real-time transducer improved demonstration in 50% of studies, as compared to 20% with the compound technique. Resolution was affected by velocity errors and reflection in 30% of cases examined with the compound technique.

“Another experimental studies verify a deterioration of lateral and axial resolution with increasing thickness of overlapping fat. This is due to attenuation and phase distortion of ultrasound in fat. Experimental studies about how the fat is one of the main disturbance factors in ultrasound showed a lesser deterioration of resolution behind fat (better results) with the following factors: .large aperture transducers, compoundtechnique (the good axial resolution improves the wordes lateral resolution), great bandwidth of the ultrasound signal, compression of the fat and position of the fat in the focus of the transducer”....(13)

## **Chapter2**

## **2.1.Purpose**

To compare between the clinical provisional diagnosis and clinical ultrasound findings

## **2.2.Material and method**

A hundred patients visited Albatool teaching hospital and Baqubah's teaching hospital (Diyala, Iraq) whom had an abdominal ultrasound report between September 2022 and February 2023 were enrolled in the study , following a questionnaire that demonstrate the age, gender, refereed doctor , provisional diagnosis and full ultrasound report

47 patients' ultrasound reports were taken from department of internal medicine in Baqubah's teaching hospital , 51 patient's ultrasound reports were taken from department of general surgery in Baqubah's teaching hospital , and only 2 patient's ultrasound reports were taken from department of pediatric medicine in Albatool teaching hospital

All of the reports were taken by Hitachi Aloka ultrasound device with C251 probe and frequency of 2.5MHz , without contrast



Fig.2.1. Hitachi Aloka Ultrasound device

The definitive diagnosis was made based on the specialist doctor's decision depending on the findings found during the operation or findings made using other diagnostic methods, including additional radiological evaluations (e.g. CT-scan, MRI..etc) ,biopsies and laboratory evaluation

## **Chapter3**

### 3.1.Results

The study enrolled 100 report, M:F rate are 1.4:1.1 , (fig 3.1) 43% of the cases were between 40-60 years old and 32% were below 30 years old 2 of them were from pediatric age group and the rest were above 60 years old .

More than 50% of the cases were admitted for surgical management , and about 47% of the cases were at hospital stay in the internal medicine floor.

Only 6% of the cases had a previous history of abdominal ultrasound

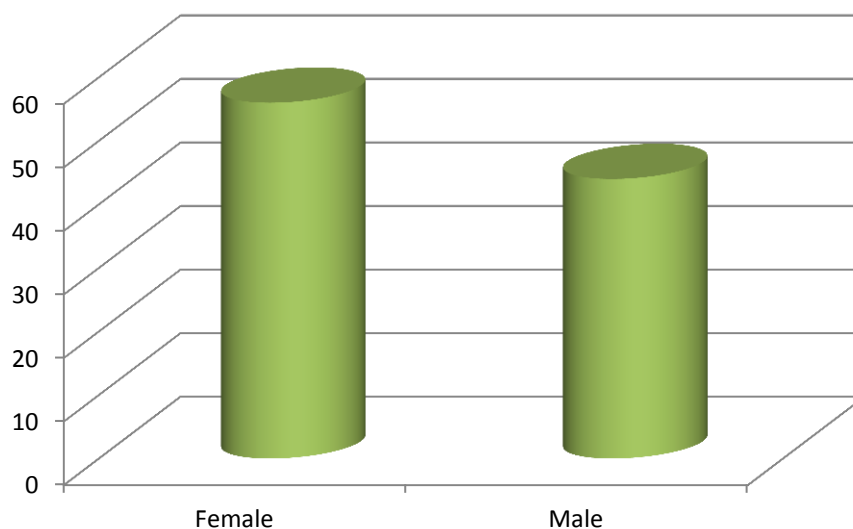


Fig.3.1. The Male;Female ratio in the reported cases

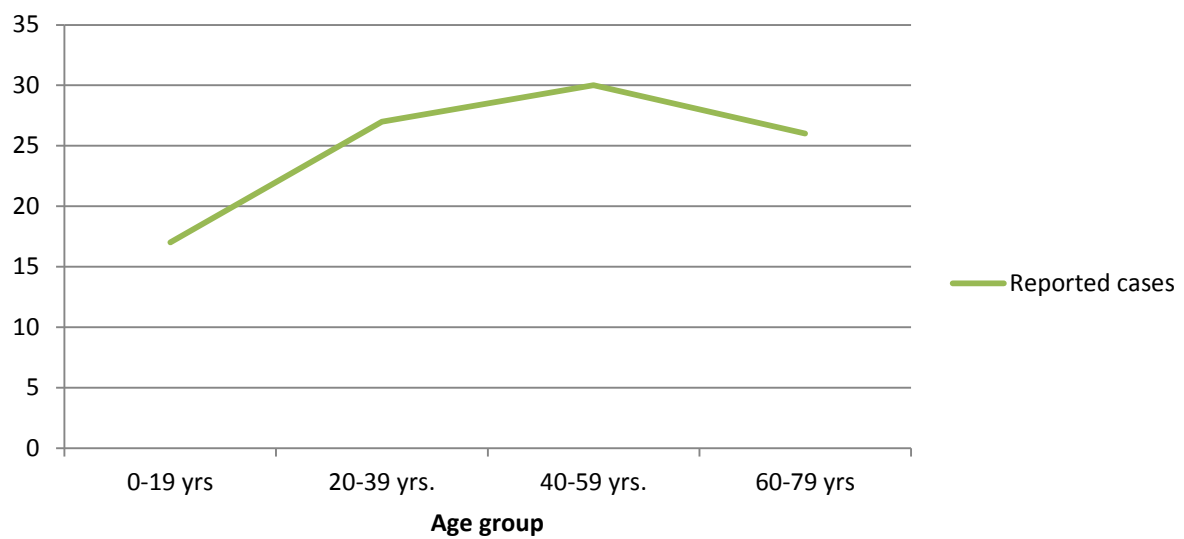


Fig.3.2. Different age groups in the reported cases

The report showed that 53% of internal medicine cases were referred by Dr.Ahi Thamer , Dr.Ali Quais & Dr.Abdullah Shehab . And 43% of general surgery cases were referred by Dr.Nazar Salih , Dr.Ahmmed Quasim & Dr. Mohammed Shakir



When it comes to the comparison between the diagnosis that the doctors made depending on the clinical signs and symptoms and the usage of other diagnostic methods and the findings that has been shown in the ultrasound report , it had been found out that 31% of the cases whom had an abdominal ultrasound and despite having certain clinical findings came out with false negative result , around one third of these false negative reports were to patients with acute appendicitis...(Table3.1) ,

Appendix					
			Appendix		Total
			Normal	Inflammatory signs	
Provisional diagnosis	Acute appendicitis	Count	11	15	26
		% within Provisional diagnosis	42.3%	57.7%	100.0%
		% within Appendix	42.3%	100.0%	63.4%
		% of Total	26.8%	36.6%	63.4%

**Table 3.1,-Provisional diagnosis \* Appendix**

The ratio of acute appendicitis with normal ultrasound report  
and with report showing inflammatory signs

yet 69% of the cases have had positive findings in the ultrasound report correlating to their medical condition.

20% of these cases were to patients diagnosed with cholecystitis with reports showing gallbladder with either inflammatory signs e.g. thick edematous wall , contraction & other signs of inflammation , or showing multiple small stones , mostly with normal biliary tree....(Table2.2)

Gallbladder						
			Gallbladder			Total
			Normal	Inflammatory signs with multiple stones	Removed	
<b>Provisional diagnosis</b>	Cholecystitis	Count	1	14	0	15
		% within Provisional diagnosis	6.7%	93.3%	0.0%	100.0%
		% within Gallbladder	4.0%	93.3%	0.0%	36.6%
		% of Total	2.4%	34.1%	0.0%	36.6%
<b>Total</b>		Count	25	15	1	41
		% within Provisional diagnosis	61.0%	36.6%	2.4%	100.0%
		% within Gallbladder	100.0%	100.0%	100.0%	100.0%
		% of Total	61.0%	36.6%	2.4%	100.0%

**Table 3.2,-Provisional diagnosis \* Cholecystitis**

The ratio of Cholecystitis with normal ultrasound report and with report showing inflammatory signs

16 % of the reported cases were to patients suffering from heart and renal failure , these cases were suspected to have either renal manifestation or any remarks on the kidneys that could show the progression of the disease , results demonstrated in table 3.3

Provisional diagnosis * Kidney Crosstabulation									
			Kidney						Total
			Normal	Single left kidney , signs of CKD	Both reduced CM dilitation	Rt. Cystic lesion LF.with stones	Both with increased echogenecity	Lf. Multiple cyst	
Provisional diagnosis	Heart failure	Count	10	0	0	0	2	1	13
		% within Provisional diagnosis	76.9%	0.0%	0.0%	0.0%	15.4%	7.7%	100.0%
		% within Kidney	100.0%	0.0%	0.0%	0.0%	100.0%	100.0%	81.3%
		% of Total	62.5%	0.0%	0.0%	0.0%	12.5%	6.3%	81.3%
	Renal failure	Count	0	1	1	1	0	0	3
		% within Provisional diagnosis	0.0%	33.3%	33.3%	33.3%	0.0%	0.0%	100.0%
		% within Kidney	0.0%	100.0%	100.0%	100.0%	0.0%	0.0%	18.8%
		% of Total	0.0%	6.3%	6.3%	6.3%	0.0%	0.0%	18.8%
Total		Count	10	1	1	1	2	1	16
		% within Provisional diagnosis	62.5%	6.3%	6.3%	6.3%	12.5%	6.3%	100.0%
		% within Kidney	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	62.5%	6.3%	6.3%	6.3%	12.5%	6.3%	100.0%

**Table 3.3,-Ultrasound report with renal manifestation**

The cases reported with heart or renal failure with renal manifestation

## **Chapter4**

## 4.1. Discussion

The hundred reported cases had errors and false positive reviews and the reason that lead to these results could be due to several reasons , these reasons returning to published reports are that some patients had factor interfering with good image resolution , poor positioning and time required despite having dozens of cases that need to be reported daily in the radiology department are also important factors that may lead to improper imaging

Other reasons that lead to these errors are due to organs themselves , with 26% of the cases being acute appendicitis as shown previously in the results , it had the greatest error rate , a meta-analysis in Nantong university-China....(9) reported that cases suspected with appendicitis should undergo all available investigations to avoid misdiagnosis that could lead to perforation and death because of the unclear nature of the disease and the different positions that the appendix could be found in , yet proved that CT-scan is the gold standard to avoid negative appendectomy rate that may occur due to overlapping signs and symptoms with other acute abdominal diseases

## **4.2. Conclusion**

Each type of abdominal disease has pros and cons when it comes to ultrasound. It helps to be familiar with the limitations of each, and make an educated choice depending on the diseases on your initial list of differential diagnoses. Positive US findings are useful for the diagnosis of multiple abdominal pathologies or any other disease with abdominal manifestation . US is highly predictive albeit not disease-specific. Negative US examinations, however, do not exclude pathologic abdominal diseases.

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اوصي باستلام و قبول بحث تخرج الطالبة نور عبد الرزاق مصطفى بعد اكمالها  
متطلبات البحث كاملة و دون اي نقص و اكمالها جميع الاحصائيات و التعديلات  
المطلوبة منها

د.سعاد مصلح الدين عبد المجيد