

1.1 Introduction:

Diabetes mellitus (DM) has been frequently associated with cholelithiasis and inflammation of biliary tract , but the exact causes of gallstone (GS) in diabetics has not been completely clarified . it known that contraction of gallbladder (GB) is poor in diabetic patients , especially with autonomic neuropathy often referred to as diabetic neurogenic gallbladder . on the other hand , obesity frequently with DM , may also affect cholesterol saturation in bile , which is significant factor in gallstone formation.

Diabetes mellitus is not a single disease entity but rather the a group of metabolic disorders sharing the common underlying feature hyperglycemia. Hyperglycemia in diabetes results from defect in insulin secretion , insulin action , insulin action or most commonly both . the chronic hyperglycemia and attendant metabolic dysregulation may be associated with secondary damage in multiple organ systems , especially the kidneys , eyes , nerves , blood vessels . According to the American Diabetes Association , diabetes affect over 20 million children and adult. (Robbin ,2014)

1.2 Problem Of Study:

This study was conducted in order to estimate the risk factors for DM and detect if there any relation between DM and gall stone because the DM is widely distribute in Sudanese popularity .

1.3 Objectives:

1.3.1 General objective:

To determine the prevalence of gallstone in diabetic patients by using ultrasonography .

1.3.2 Specific objectives:

to determine the prevalence of gall stone in diabetic patients in sudan .

to determine the prevalence of gall stone in diabetic patients related to age .

to determine the prevalence of gall stone in diabetic patients related to gender .

1.4 Overview of the study:

This study will falls into five chapters, with chapter one is an introduction which include background concerning the Diabetes mellitus and it is diagnosis ,classification , clinical feature and gallbladder and biliary tract sonography, problem of study and objectives. While chapter two which include theoretical background (anatomy, physiology and pathology) and literature review, it will present the previous study that carried out by the scholar in the field of the study. In the same essence chapter three methodology which includes material used to collect the data, design of the study population of the study, sample size and type, place and duration of the study, method of data collection , method of data analysis, chapter four include result presentation (tables and figures) write an introduction about the results at the end of the results write summary or conclusion about the main points of the results, and chapter fine which include discussion, conclusion and recommendation.

2.1 Anatomy and physiology of the gallbladder:

The gallbladder is part of the digestive system. It is a small, pear-shaped organ on the right side of the body, under the right lobe of the liver. The body can function without the gallbladder . If doctors need to remove it because of disease, there are no serious long-term effects and the body can still digest food. (Martini, 2009)

2.1.1 Structure:

The gallbladder is about 7.5 -10 cm (3 -4 inches) long and about a 2.5 cm (1 inch) wide. (Martini, 2009)

The gallbladder is made up of layers of tissue:

2.1.2 Mucosa :

the inner layer of epithelial cells (epithelium) and lamina propria (loose connective tissue). (Martini, 2009)

A Muscular Layer:

a layer of smooth muscle. (Martini, 2009).

Perimuscular Layer:

connective tissue that covers the muscular layer. (Martini, 2009)

Serosa:

the outer covering of the gallbladder.

The gallbladder, liver and small intestine are connected by a series of thin tubes or ducts, The common hepatic duct drains bile from the liver through the left and

right hepatic ducts, The cystic duct joins the gallbladder to the common bile duct, The common bile duct is where the hepatic and cystic ducts meet and connect to the small intestine, The gallbladder and bile ducts are also called the biliary system or biliary tract. (Martini, 2009)

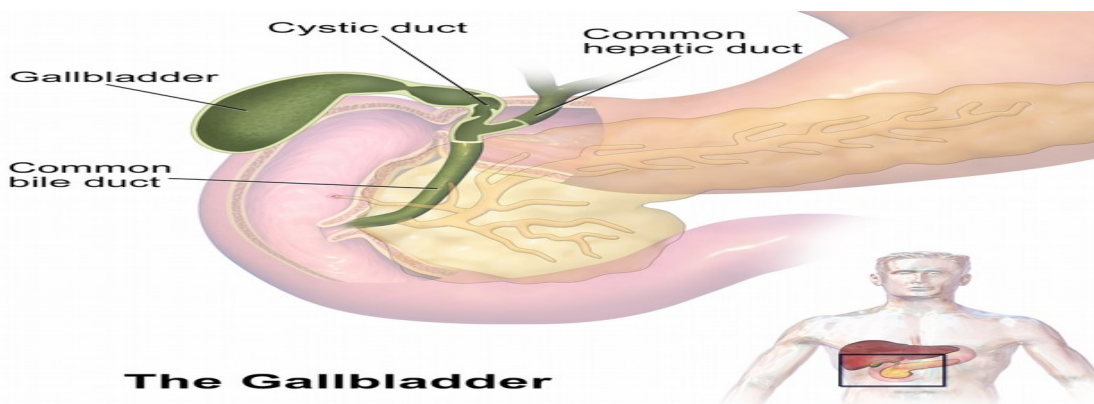


Figure: (2-1) show anatomy of gallbladder

([https://en.wikipedia.org/wiki/Gallbladder#/media/File:Gallbladder_\(organ\).png](https://en.wikipedia.org/wiki/Gallbladder#/media/File:Gallbladder_(organ).png))

2.2 Gall bladder & biliary tract sonography:

Sonographic evaluation of the biliary tract is one of most appropriate and efficacious uses of the ultrasound examination . the cystic nature of both the gall bladder and bile duct , particularly when dilated, provided an inherently highly contrast resolution in comparison to the adjacent tissues this factor the excellent spatial resolution of sonography , and acoustic window provided by the liver allow for a high-quality examination in the majority of patients . currently, sonography remain the modality of choice for detection of gall stone . The classic appearance of CBD stones is rounded echogenic lesion with posterior acoustic shadowing . (Carol, 2011)

The choice ultrasound scanning (USS) in gall bladder evaluation is ideal as it is cheap, non-invasive , safe , and repeatable without known adverse effect to patient in clinical scenarios . X-ray may fail to identify non – calcify GS , but USS is highly discriminatory as all stone appear echogenic . USS can detect GS as small as 3mm in diameter. (Carol, 2011)

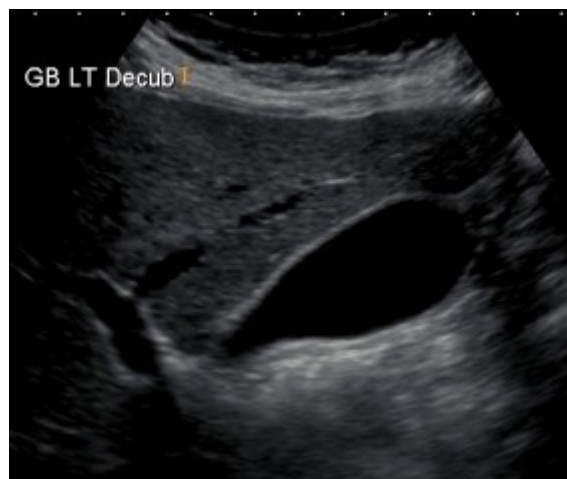


Figure {2-2} sagittal sonographic image show Normal sonographic appearance of gallbladder

(<http://www.ultrasoundpaedia.com/normal-gallbladder/>)

2.3 Function:

The gallbladder stores and concentrates bile, a yellowish-green fluid made by the liver. Bile helps the body digest fats. Bile is mainly made up of:

bile salts

bile pigments (such as bilirubin)

cholesterol

water

The liver releases bile into the hepatic duct. If the bile is not needed for digestion, it flows into the cystic duct and then into the gallbladder, where it is stored. The gallbladder can store about 40–70 mL (8–14 teaspoons) of bile. The gallbladder absorbs water from the bile, making it more concentrated. When bile is needed for digestion after a meal, the gallbladder contracts and releases it into the cystic duct. The bile then flows into the common bile duct and is emptied into the small intestine, where it breaks down fats.(Martini, 2009)

2.4 Gallbladder pathology:

Gallbladder disease is common and must be considered in the differential diagnosis of upper abdominal pain and jaundice. The most common disorder in the gallbladder is the presence of calculi. Gallstones are commonly accompanied by some degree of chronic cholecystitis, and predispose to the development of acute cholecystitis. Cholesterol from the bile is sometimes absorbed and stored in macrophages in the lamina propria of the gallbladder. This may be seen grossly as pale spots or ridges in the gallbladder mucosa. This

is a variation of normal physiology and not a disease. Cholesterosis is sometimes an incidental finding in surgically removed gallbladders. (Daniel, 2010)

2.4.1Cholecystitis:

Cholecystitis is inflammation of the gallbladder. The stimulus is sometimes bacterial and sometimes due to vascular, mechanical or chemical factors. The inflammation may be acute or chronic. (Daniel ,2010)

2.4.2.Acute cholecystitis:

the gallbladder wall is thickened because of edema and inflammatory infiltrate. Bouts of acute cholecystitis are marked by right upper quadrant colicky pain. Gallstones are typically present, often obstructing the neck of the gallbladder or cystic duct. In chronic cholecystitis, the gallbladder wall is commonly thickened by scarring, and there may be distortion of the gallbladder wall architecture with formation of Aschoff-Rokitansky sinuses. An Aschoff-Rokitansky sinus probably reflects distension with herniation of the mucosa between muscle bundles of the wall. The result is that gallbladder mucosa can lie deep in the muscularis of the gallbladder. (Daniel ,2010)

2.4.3.Chronic cholecystitis:

Gallbladder (opened) showing numerous multifaceted calculi and marked thickening of the wall. The mucosa is pale suggesting that there is no acute inflammation so the thickening of the wall probably reflects scarring due to chronic cholecystitis. Chronic cholecystitis is usually present in gallbladders that contain calculi. (Daniel ,2010)

2.4.4.Gallstones and hydrops :

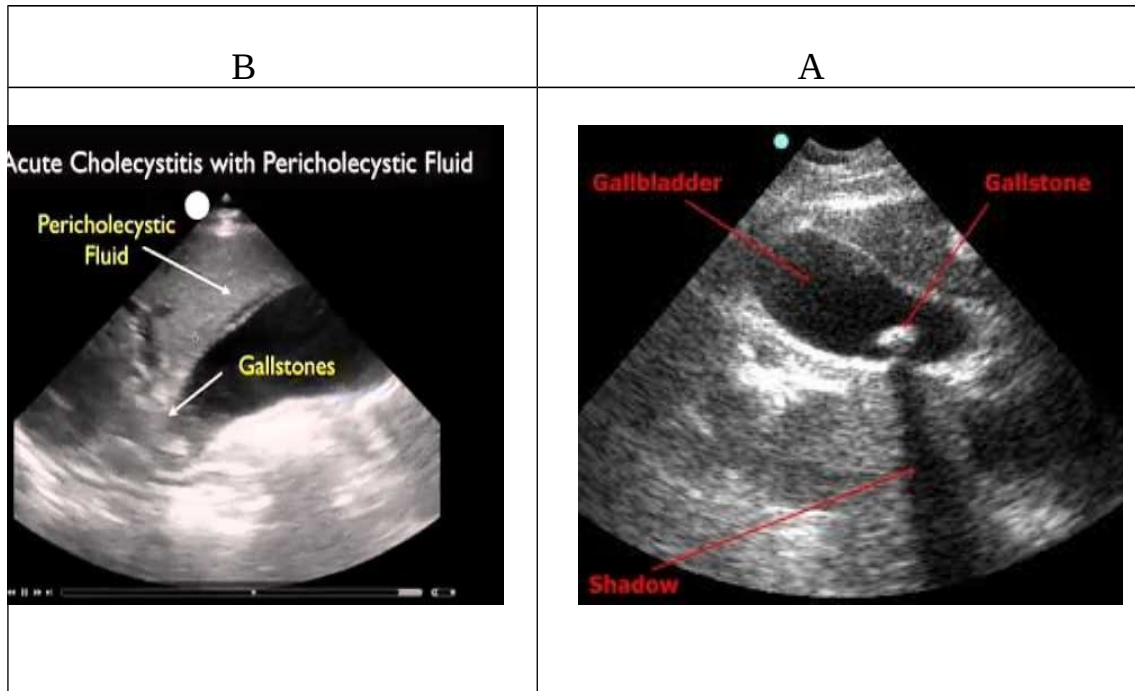
Gallstones have a high prevalence. They are usually diagnosed by imaging studies. The cystic duct may become obstructed by a gallstone so that the bile and mucoid secretions of the gallbladder mucosa distend the gallbladder. Sometimes the bile is reabsorbed and replaced by watery mucoid liquid. This is called hydrops. (Daniel ,2010)

2.4.5.Gallstones (Cholelithiasis):

Acholelithiasis involve the presence of gallstone which concretion that from in the biliary tract , usually in gallbladder cholelithiasis refer to the presence one or more gallstones in the common bile duct (CBD) . (Daniel ,2010)

2.4.6.Adenocarcinoma of the gallbladder:

Adenocarcinomas of the gallbladder are rare cancers. They characteristically occur in a gallbladder with chronic cholecystitis. These are usually well differentiated or moderately differentiated adenocarcinomas. Carcinoma of the gallbladder is a serious disease because it does not cause biliary obstruction or pain until late in the disease. Often, the carcinoma has invaded the liver by this time so that resection is difficult or impossible. The 5-year survival is very low. Gallstones are present in many patients who develop this carcinoma, but most patients with gallstones do not develop carcinoma. Adenocarcinomas of the gallbladder are rare cancers. They characteristically occur in a gallbladder with chronic cholecystitis. These are usually well differentiated or moderately differentiated adenocarcinomas. Carcinoma of the gallbladder is a serious disease because it does not cause biliary obstruction or pain until late in the disease. Often, the carcinoma has invaded the liver by this time so that resection is difficult or impossible. The 5-year survival is very low. Gallstones are present in many patients who develop this carcinoma, but most patients with gallstones do not develop carcinoma. (2010 Daniel ,2010)



Figure[2-3]

(A)Sagittal sonographic image show gallbladder contain stone (<http://www.stefajir.cz/?q=gallbladder-sonography>) . (B) sagittal sonographic image show acute cholecystitis (<https://www.youtube.com/watch?v=FY3dBuQV03w>)



Figure (2-4) assagittal sonographic image show a denocarcenoma of gallbladder (<http://emedicine.medscape.com/article/368497-overview>)

2-5 Ultrasound Physics:

2-5-1 Nature of the sound:

Sound is mechanical energy transmitted by pressure waves in a material medium. This general definition encompasses all types of sound, including audible sound, low-frequency seismic waves, and ultra sound used in diagnostic imaging. This definition describes sound firstly as a form of energy, that means when sound travels from one location to another it carries energy; that is, it can cause slight back and displacement of objects in its path.

Sound energy is said to be mechanical, meaning it exists in the form of physical movement of the molecules and particles in the medium. This distinguishes sound energy from other forms of energy such as electromagnetic.

Another important idea in the definition of sound is that it involves propagation through a material medium, that means sound waves cannot travel through a vacuum.

2-5-2 Sources of sound:

Sound production requires a vibrating object. A tuning fork in air is a good example, as a tuning fork vibrates it pushes and pulls against adjacent air molecules, causing them to vibrate as well. These vibrations cause still further molecules to vibrate, and so forth. Thus this disturbance spreads through the air as a wave.

2-5-3 Periods and frequency:

A useful way of expressing the temporal behavior of a sound wave is to plot the pressure versus time at a single point in the medium. The resultant curve traces out a sine wave. The number of times per second the disturbance is repeated at any point is called the frequency, which is determined by the number of oscillations per second made by the sound source.

The time it takes for the disturbance to repeat itself, that is to go through one complete cycle, is the period.

$$T = 1/f$$

T expressed the period

F expressed the frequency.

((Period is the inverse of the frequency)). (James ,1996)

2-5-4 Speed of sound:

The speed of sound in any medium is determined primarily by the characteristics of the medium (there are slight dependencies on other factors, such as the ultrasonic frequency, but these are so small that they can generally be ignored). Specifically, for longitudinal sound waves in either liquids or body tissues, an expression for the speed of sound “c” is:-

$$C = \sqrt{B/P}$$

B, represent property of the medium called the bulk modulus; it is a measure of the stiffness of the material that is the resistance of the material to being compressed.

Symbol P is the density, given in grams per cubic centimeter (g/cm³).

The average speed of sound in soft tissue (excluding the lung) is 1540 m/s, and range - measuring circuits on most diagnostic ultrasound instruments are calibrated on this basis. (James , 1996)

2-5-5 Wave length:

The wave length is the distance between two peaks, valleys, or other corresponding point on the wave .it is the distance which the sound wave travels during one complete cycle of the wave.

It is usually designated by the symbol λ and depends on the frequency and the speed of sound in the medium it is given by the following relationship:-

$$\lambda = c/ f$$

2-5-6 Acoustic impedance:

It is acoustic pressure divided by the resultant particles velocity, which is equal to the product of the medium's density (ρ) and its speed of the sound " c " that is

$$Z = \rho c$$

The units for expressing these are kilograms per square meter per second ($1\text{kg/m}^2/\text{s}$).

Which result after multiplying density times speed, and some times given in Rayls, one Rayl is the same $1\text{ kg/ m}^2/\text{sec}$. (James , 1996)

2-5-7 Interaction of sound wave with matter:

When an ultra sound beam is incident on an interface formed by two materials having different acoustic impedances some of the energy is reflected as an echo and the some is transmitted, the proportions of energy reflected and transmitted depend on the acoustic impedances (Z) of a material.

The fraction of sound energy that is reflected at the interface between two materials depends on the angle of incidence. When the beam strikes the surface at or nearly at right angles, the fraction of sound energy that is reflected(R) at the interface between two materials of acoustic impedances (Z_1), (Z_2). Is given by

$$R = \frac{(Z_1 - Z_2)^2}{(Z_1 + Z_2)^2}$$

It is the same whether the sound is travelling from material "1" to material "2" or vice versa. (James , 1996)

2-5-7-1 Reflection:

It is return of sound toward the source; there are two types of reflection:

(A)Specular reflection:

This occurs when a beam strikes a large smooth interface at an angle, the same laws of reflection and refraction apply as with light.

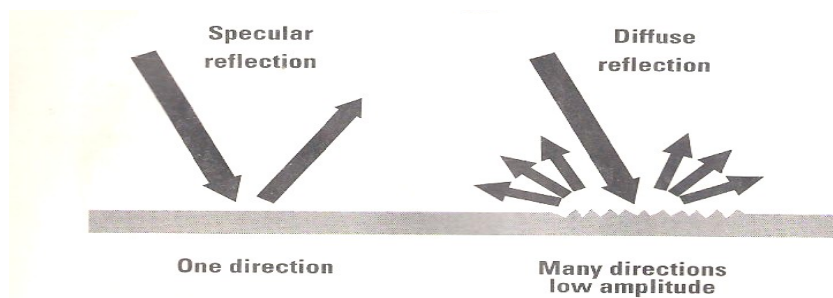
- Here the angle of reflection equals the angle of incidence.
- The ratio of the sines of the incident and refraction angles is equal to the ratio of the sound velocities in the two materials

$$\sin \theta_i / \sin \theta_r = C_1 / C_2$$

This is known as Snell's law

(B) Diffuse reflection:

This occurs when the tissue interface is rough and undulations equal to a wave length or so, the reflected beam spreads out over an angle. (James, 1996)



Figure

(2-5). Shows a comparison

between specular and diffuse reflection

2-5-7-2 Scatter:

This occurs when sound encounters a structure that is smaller than a wave length (such as a red blood corpuscle).

This effect allows even small structures to be visualized, as some scatter will reach the transducer. (James , 1996)

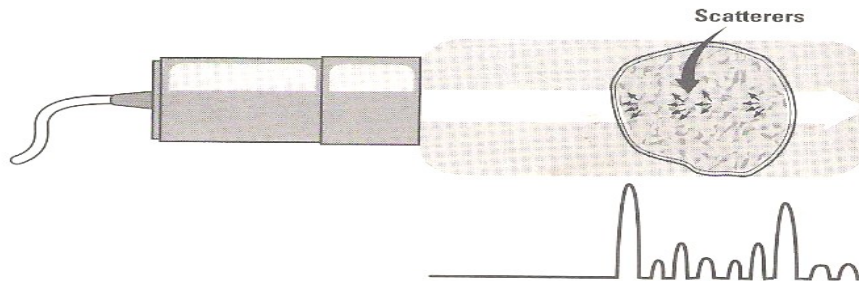


Figure (2-6). Shows the scattering by small reflector

2-5-7-3 Refraction:

It is a bending of the sound beam, that is, a change in the direction of the transmitted beam emerging in different direction from the incident beam. (James , 1996)

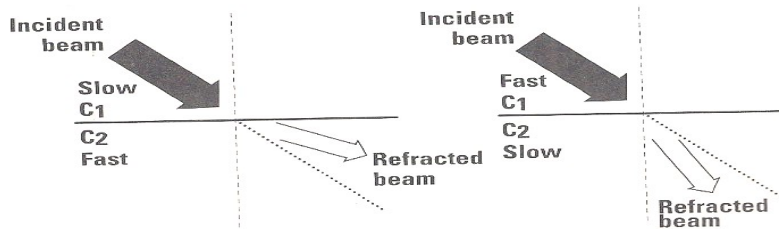


Figure (2-7). Shows the refraction of fast and slow beam speed

2-5-7-4 Absorption:

Is the conversion of the sound energy to the other form of energy. (Penelope , 2008)

2-5-8 Attenuation of ultra sound:

When travelling through a material, sound is attenuated exponentially with the depth of travel for the following reasons :

- Energy is absorbed and converted into heat.
- Energy leaves the forward - travelling beam due to scattering and to partial reflection by the multitude of interfaces that the beam encounters on route.
(The higher the frequency, the greater the attenuation).

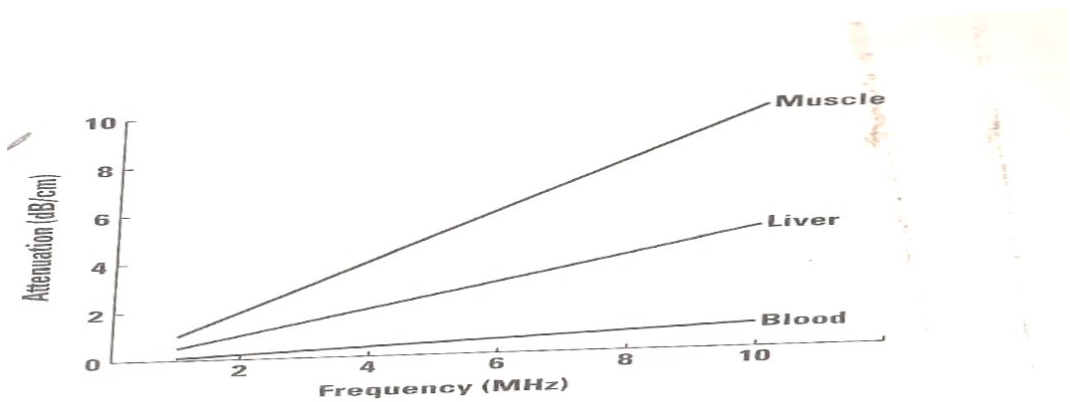
Attenuation is usually measured in decibels (dB) as this enables a wide range of power or intensity ratios to be expressed in a compact way by using a logarithmic scale as follows:

$$10 \log (\text{power or intensity ratio}) = \text{number of decibel ((James , 1996)$$

- **Calculating attenuation:**

To determine the amount of attenuation occurring when a sound beam passes through a given thickness of tissue, simply multiply the attenuation coefficient (in dB / cm) by the distance traveled (cm) thus:

Attenuation (dB) = α (dB/ cm) X d (cm) where α is the Attenuation coefficient and d



distance (James , 1996)

Figure (2-8). Shows ultrasound attenuation versus frequency for several tissues

2-5-9 wave interference:

When wave produced by more than one source, they may overlap and produce interference. The effect at any point is a wave whose amplitude may be greater or less than that of either wave alone, depending on the relative phase of the two waves.⁽²⁵⁾ If they have one phase, the amplitude is greater, while they have different phase the amplitude is less.

2-5-10 Piezoelectric Effect and Piezoelectric Elements:

The active element of most acoustic transducers used today is a piezoelectric ceramic. When piezoelectric ceramics were introduced, they soon became the dominant material for transducers due to their good piezoelectric properties and their ease of manufacture into a variety of shapes and sizes. They also operate at low voltage and are usable up to about 300°C. The first piezoceramic in general use was barium titanate, and that was followed by lead zirconate titanate compositions, which are now the most commonly employed ceramic for making transducers. New materials such as piezo-polymers and composites are also being used in some applications.

The thickness of the active element is determined by the desired frequency of the transducer. A thin wafer element vibrates with a wavelength that is twice its thickness. Therefore, piezoelectric crystals are cut to a thickness that is 1/2 the desired radiated wavelength. (The higher the frequency of the transducer, the thinner the active element). (Auld, 1990)

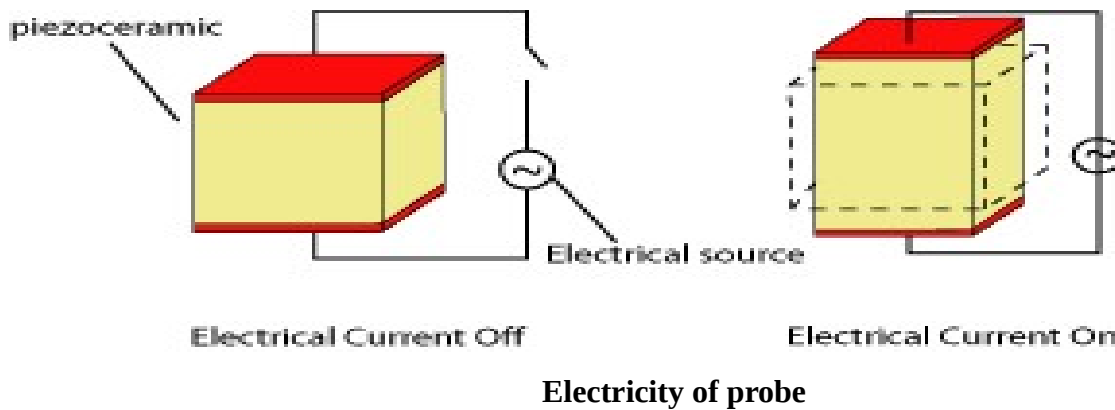


Figure (2-9). Shows

2-5-11 probe molding (man made probe):

Ceramic elements, such as lead zirconate titanate (PZT) consist of mixtures of microscopic crystals randomly oriented throughout the volume of element. Mechanically these materials are somewhat brittle and may be damaged if dropped or pounded. During manufacturing they can be shaped into various configurations such as rectangular slabs, planer disks, or concave disks, the shape can be optimized for the scan head frequency, size, and type to be use full for transmitting and receiving ultrasound waves. These ceramics must first be polarized. This is done by heating the material above to degree what is called curie temperature (365 c for PZT), which frees the microscopic crystals, allowing them to move.

A high voltage is then applied across the element producing particle alignment or polarization, of the microscopic crystals.

The element is then cooled with the voltage still applied .it will now remain polarized and exhibit the desired piezoelectric properties.

The element can lose it is piezoelectric properties (become depolarized) if it is inadvertently heated above the Curie temperature. (James , 1996)

2-5-12 Transducer constriction:

In single element non focused transducer (figure 2-10) the piezoelectric element is a flat circular disk, the element is mounted coaxially in a cylindrical case. Acoustic insulation such as rubber or cork is necessary to avoid coupling ultra sonic energy to the case. A metal electrical shield prevents pickup of extraneous electrical noise signals by the transducer leads. Such signals are undesirable because they contribute to excessive noise in a display during echo detection. Wires that connect to attuning coil and then to the external connectors provide electrical contact between the transducer element and the instrument.

(James , 1996)

- **Resonance frequency:**

A piezoelectric transducer has a resonance frequency at which it is most efficient, in converting electrical energy to acoustic energy and vice versa. The resonance frequency is determined mainly by the thickness of the piezoelectric element. Analogous to strings on a guitar, thin element have high resonance frequencies.

Transducers usually are operated at or near the resonance frequency of element.

Some broad band width transducers are designed to be operated at more than one frequency. With these transducers, the operator chooses the examination frequency by selecting a control on the instrument. This causes the instrument's transmitter to shape the electrical pulse applied to the transducer for the frequency selected; the amplifiers in the receiver also may be turned to this frequency. (James ,1996)

2-5-12-1 Backing material:

This material present posterior to element and reduce the pulse duration by damping the vibration of the transducer as quickly as possible.

2-5-12-2 Matching layer:

This present anterior to the element and it provide efficient transmission of sound waves from the transducer element to soft tissue and vice versa. They do this by reducing reflection at the transducer (Tissue interface). (James ,1996)

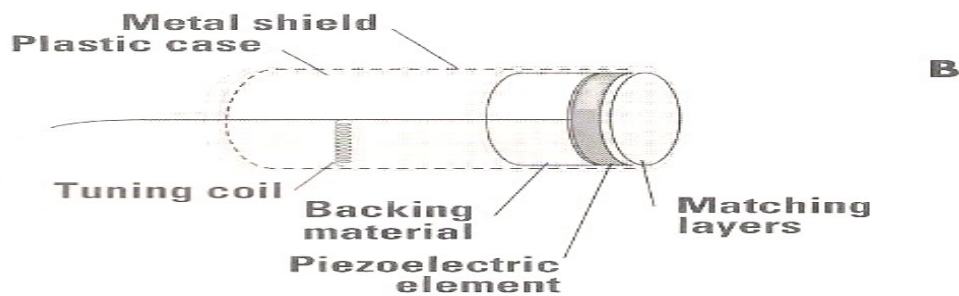


Figure (2-10). Shows the components of a single element transducer

2-5-13 Focused transducer

Single element transducer is focused by an acoustic lens attached to a planar piezoelectric element or by using an element that is curved, which is the more common approach.

Focusing has the effect of narrowing the beam profile and increasing the amplitude of echoes from reflectors over a limited axial range in comparison to an equivalent.

The focal distance corresponds to the Plane where the beam width is narrowest.

The focal zone corresponds to the region over which the width of beam is less than two times the width at the focal distance. (James , 1996)

2.5.14. Beam Field

(1) Near field:

Also called the fresnel zone. It is characterized by fluctuations in the amplitude and intensity from one point in the beam to another

(2) Far field:

It is the region of the beam beyond the near field of a single element transducer, in which the beam is diverges . Also called fraunhofer zone

2-5-15 Transducer array:

It is simply consist of group of closely spaced piezoelectric elements, each with it is own electrical connection to the ultra sound instrument. This enables element to be excited individually or on groups to produce ultra sound beams.

(Penelope , 2008)

2-5-15-1 Advantage of array:

- (1) They enable electronic beam steering.
- (2) They enable electronic focusing and beam forming.

2-5-16 Probes types:

There are three types of probes Linear, Curvilinear and Sector. For abdominal ultrasound curved type scanners are used as the best compromise of two other standard type probes the linear and the sector scanner. (Penelope , 2008)

2-5-17 Image resolution:

The ultimate goal of any ultrasound system is to make like tissues look a like and unlike tissues look different.

Resolving capability of the system depends on:

axial/lateral resolution ,spatial resolution , contrast resolution and temporal resolution Resolution depends mainly on the frequency and beam shape which relate to crystal shape and ultrasonic beam focusing.

(A) Axial resolution:

Specifies how close together two objects can be along the axis of the beam, yet still be detected as two separate objects. Frequency (wavelength) affects axial resolution

(B) Lateral resolution:

The ability to resolve two adjacent objects that perpendicular to the beam axis as separate objects. Beam width affects lateral resolution

(C) Spatial resolution also called "detail resolution":

It is the combination of Axial and Lateral resolution.

(D) Contrast resolution:

The ability to resolve two adjacent objects of similar intensity (reflective properties) as separate objects. (Harsh Mohan, 2002)

Increase frequency	Reduce wave length and penetration	Improve resolution
Decrease frequency	Increase wavelength and penetration	Worse the resolution

Table (2-1). Shows relation between transducer frequency, wavelength, penetration and resolution

2-5-18 Image display:

Ultra sound signals may be displayed in several ways:

(I) A- mode: “amplitud”:

In this form of display, the strength or amplitude of the reflected sound is. indicated by the height of the vertical deflection displayed on the oscilloscope. With A-mode ultra sound represents the position and strength of the reflecting structure is recorded

It is usually used in ophthalmology and for showing midline displacement in the brain. (Penelope , 2008)

(II) M- mode “motion mode:

This display echo amplitude and shows the position of moving reflectors .To day the major application of M- mode display is in echo- cardiography.

“brightness” (III) B-mode:

In this mode the variations in display intensity or brightness are used to indicate reflecting signals of differing amplitude to generate a two dimensional image. (Penelope , 2008)

Any reflected echo-represents in the screen by brightness dot.

(IV) Real time “ gray scale”:

In modern B-scanners, the image is automatically scanned in a succession of frame sufficiently rapidly to demonstrate the motion of tissues with all degrees of densities. (Penelope ,2008)

2.6.Previous study:

A study done by (Pagliarulo M) In North Italian centers wide survey were considered (332/1337 (24.8%) versus (2469/18091 (13.6%) . A total off 332 diabetics (25%) had gallstone disease : 261 had stone and 71 previously under gone cholecystectomy for gall stone disease after diagnose of diabetes mellitus . the prevalence of gall stone disease was higher in female (29% versus 22%) and increase with age (13, 20 and 30% in patients $\leq 40, 41 -65$ and > 65 years respectively) , body mass index (24%) in patients with a body mass index ≤ 30 and 30% in those with body mass index of $>30\text{Kg/ m}^2$ and apposite family history of gallstone disease (31% versus 23%) . gallstone disease was not significantly related to type of diabetes, plasma total and HDL cholesterol and triglyceride levels , alcohol intake , smoking habits , physical activity , weight reduction in last year's , the use of oral contraceptive , parity or menopause . At multivariate analysis , increase age , a higher body mass index and a positive family history maintained their statistical significance . (Pagliarulo , 2004)

A study was performed in Nigeria, GS was found in 70 (17.5%) of 400 patients . positive cases had a male to female ratio of 3:4 and 59 (51.92%) were above the age of 40 years with type 2 DM . body mass index (BMI) greater 25 Kg/m^2 was seen in 56 (48.3%) patients ; smoking and alcohol intake were insignificantly implicated . jaundice is recorded in 8 (11.4%) while abdominal pain in 24 (34.3%) patients . and 52 (74.3%) patient of those gall stone disease had had diabetes for More than 4 years . (Agunloye , 2013)

A study was performed in Sweden. The prevalence of gall stone disease was analyzed in 360 diabetic patients and 359 control subjects. In 61 (17%) of diabetic patients and 50 (14%) of control subjects gall stone disease was verified by previous cholecystography, ultrasonography, or cholecystectomy. The remaining 608 with no history of gall stone disease were invited to have an ultrasound scan of gall bladder; the prevalence of cholelithiasis was similar among diabetic patients (14.4% n=28) and control subjects (12.5% n=26). (Persson, 1991)

A study done in Iraq. Gallstones were found in 33% of diabetic and 17% of non-diabetic patients. There was no significant difference in age and family history of gall stone between diabetic and non-diabetic groups. However, gall stone was higher in diabetic patients with BMI $> 25 \text{ Kg/m}^2$ with increase duration of DM, with increased HbA1C and multiparous female. (Sabeha Al-bayati, 2008)

A study was performed in western Siberia. Change in human behavior and life style over the last century have resulted in a dramatic increase in incidence of DM and GSD world wide, many risk factors are common to these disease (over weight, age, arterial hypertension, dyslipidemia, etc). In some studies it was shown. A higher prevalence of gall stone among patients with DM compared with persons without DM, in other – there were no association between GSD and DM. In epidemiological study in frame of the WHO "MONICA" In the urban organization population of Novosibirsk in western Siberia (1994 – 1995 years) it was shown, that in male population aged 35-54 years found no relationship between GSD and DM, in female the female population aged 25-64 the prevalence of GSD was 10.5% and among women with DM the frequency of GSD showed 37.5%. (Reshetnikov, 2002)

A study was undertaken to compare the prevalence of gall stone disease (gall stones observed on ultrasound or history of cholecystectomy). In 308 diabetics and 318 controls there was prevalence of gall stone disease (GSD) in diabetics (32.7%) compare to controls (20.8%; $p < 0.001$ chi-squared test). However , when gender was taken into account , the difference was only significant in females (diabetics 41.8% versus controls 23.1%; $p, 0.001$). analysis by type of diabetes revealed that subject with non- insulin –depended diabetes mellitus (NIDDM) had a higher prevalence of GSD than controls for both genders: males- control 18.1% NIDDM 33. ($p < 0.05$), IDDM 15.6% ns; females –controls 23.1%, 23.1%NIDDM 48.6% ($P < 0.001$), IDDM 36.3% ($P < 0.05$) . on univariate analysis the following risk (BMI) .triglycerides , LDL cholesterol . decreased HDL cholesterol , alchole intake , family history of GSD , and female parity > 3 . Using stepwise multiple . logistic regression . the following variables were identified as independently predictive of gall stones for each gender /diabetic combination: males – NIDDM (N=54), increased age and decreased HDL ; IDDM (N=90) age and family history ; females –NIDDM (N=74) , increased age , diabetes , increase BMI , and decrease alcohol ; IDMM (N= 91) , increased BMI , age , decrease alcohol and family history . the proportion of subject who underwent cholecystectomy was higher In females (46.7%) compare to males (21.7% $p < 0.01$) but there were no difference between diabetics and controls in either sex . in conclusion , there was a higher prevalence of GSD in diabetics compare to controls . however GSD is multifactorial and only in NIDDM females was diabetes an in depended risk factor . the proportion of diabetics and controls with GSD how underwent cholecystectomy was equivalent . (Chapman ,1996)

Material & methods:

3-1 Patients and sampling:

One hundred and fifty two patients were screened, from hospital in Al khartoum state, they are of age between (15 to90years).The sample group consists of one hundred and two have diabetes mellitus and fifty patients controlled .

Firstly ultrasound scanning was done for patients to to determine the prevalence of gall stone in diabetic patients

3-2 Area and duration of the study:

This study was started in June 2016 and continued up to November 2016. The study was carried out in Khartoum states hospitals (modern medical center, yastabshiron hospital , Alribat hospital , almaunora hospital)

3-3 Equipment used:

(A)An ultrasound machines of facilities as shown in the following table:

U/S machine name	Aloka	Honda	General Electric
Model	SSD 500	HS 2000	LOGIQ 5
Movement	Portable	Portable	Mobile
Type of probe	Curvilinear	Curvilinear	- Curvilinear - Linear - Transvaginal
Energy of probe	3.5 MHz	3.5 MHz	- 3.5 MHz - 10 MHz - 7.5 MHz

- All these machines have Printer with thermal paper.



Figure (3.1). Shows General electric LOGIQ 5 which used in this study



Figure (3.2). Shows Honda 2000 Machine which used in this study



Figure (3.3). Shows ALOKA SSD 500 machine which used in this study

(B) TOSOH AIA 200 PACK UCPA design of following features:

- Throughput of 200 tests/hour.
- 576 tips (6 tip racks).
- 2 substrate bottles.
- Walk away time approx. 4 hours.
- 960 tests (48 trays) can be loaded at any time.
- 3 incubators.
- 2 sampling arms.



Figure (3.4). Shows TOSOH machine which used

3-4 Source of data collection:

Using a special data collection sheet (questionnaire), a random sample of 152 patients were studied, the data collecting sheet was designed to cover if the patient had diabetic or none- diabetic and and if the patient had gallstone and diameter of gall bladder wall and CBD diameter .

3.5.Study design:

descriptive and analytical design

3.6. Study Variable :

-patient age. - gender. sonographic appearance of gall stone

3.7. Data Collection Tools &Techniques:

102 diabetic patients and 50 non-diabetic patients has abdominal ultrasound to diagnose or exclude the present of gall stone using data collection sheet from pervious hospitals

3.8. Technique used:

3.8.1. Patient position

Generally the gallbladder is best viewed in the left lateral decubitus position. However it can be viewed with the patient supine and erect.

Erect views may be useful to determine if stones are mobile or impacted in the neck.

3.8.2 Patient Preparation

Fast for 6 hours. No food or drink.

Preferably book the appointment in the morning to reduce bowel gas.

3.8.3. Equipment Selection

Use the low frequency probe to gain adequate penetration. This will be between a 3.5 to 7MHz range curved linear array or sector

Start with 5MHz and work down to 2 or 3 for larger patients.

Assess the depth of penetration required and adapt. The gallbladder should be able to be scanned using a 7MHz as it is so superficial. Paediatric and thin pts should be scanned with a 7MHz also.

Narrow the dynamic range

3.8.4. Scanning Technique

Patient in supine, left lateral decubitus and erect

the liver as a window especially when the patient onto their left side

Measure the wall <3mm

Is the gallbladder enlarged? >10cm in length

Check with colour Doppler for increased vascularity of the wall

Assess the cystic duct, neck, body and fundus.



Figure (3-5) explain scan technique of gallbladder

3.9. Statistical analysis:

All data were presented as mean \pm SD values. Data were analyzed by an independent t-test and by correlation analysis with the use of the SPSS (IBM SPSS version 21.0). A value of $P < 0.05$ was considered significant.

3.10. Ethical consideration :

Informed consent was obtain from the faculty technical and ethical research committee , addition al consent where obtained from the chief of radiology department where the patients privacy and confidentiality was monitored

4. Result :

(4-1) Distribution according to diabetic patients:

Percentage	Distribution	
67.1%	102	Diabetic
32.9%	50	None – Diabetic
100%	152	Total

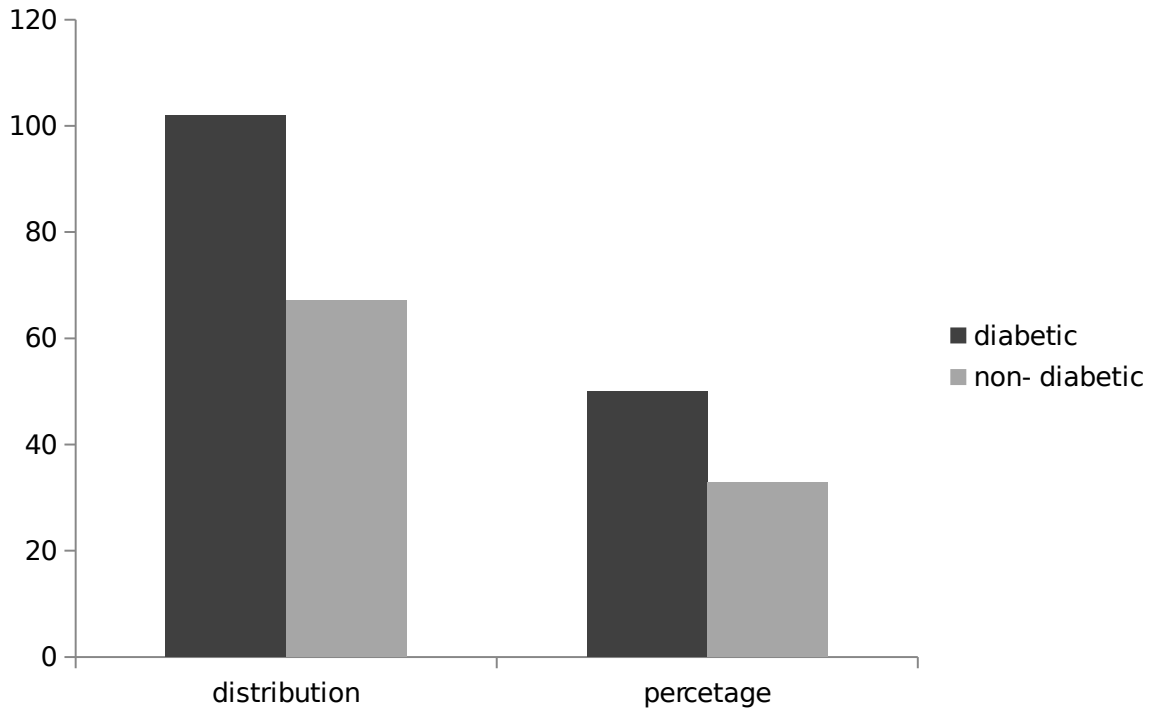


Figure 4-1 represent distribution according to diabetic patient

. Table – (4.2)

Prevalence of gall stone in diabetic and none –Diabetic patients:

%	Total	%	No Gall stone	%	Gall stone	Diabetic
67.1%	102	82.4%	84	17.6%	18	Yes
32.9%	50	96%	48	4%	2	No
100%	152	68.8%	132	13.2%	20	Total

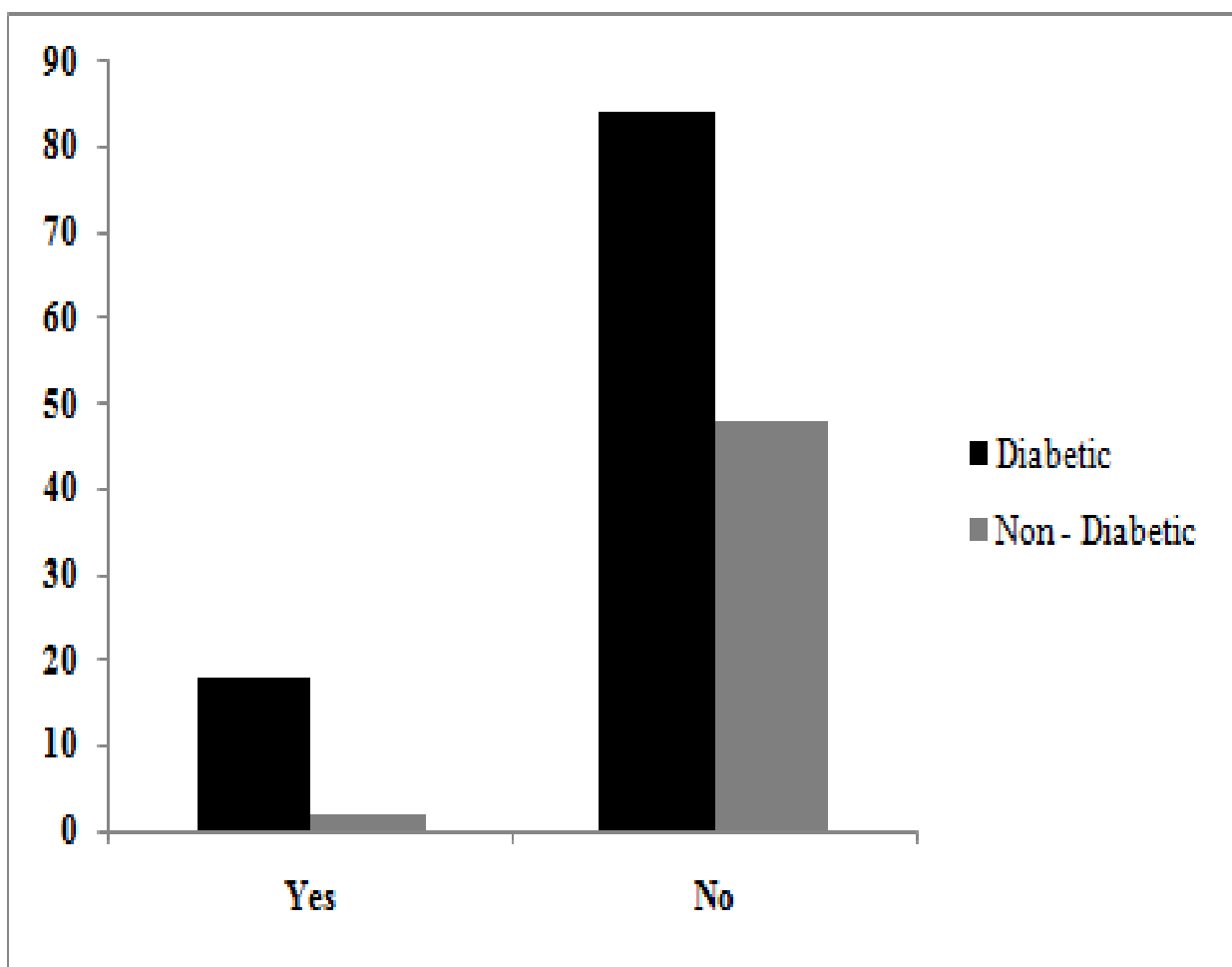


Figure 4-2 show Prevalence of gall stone in diabetic and none –Diabetic patients

Table (4-3)

Distribution according to the age :

Age	diabetic	%	Non – diabetic	%
less than 30	6	5.9%	15	30%
30 – 50 years	31	30.4%	19	38%
51- 70 years	46	45.1 %	9	18%
71 – 90 years	18	17.6%	7	14%
more than 90 years	1	1%	0	0%
Total	102	100%	50	100%

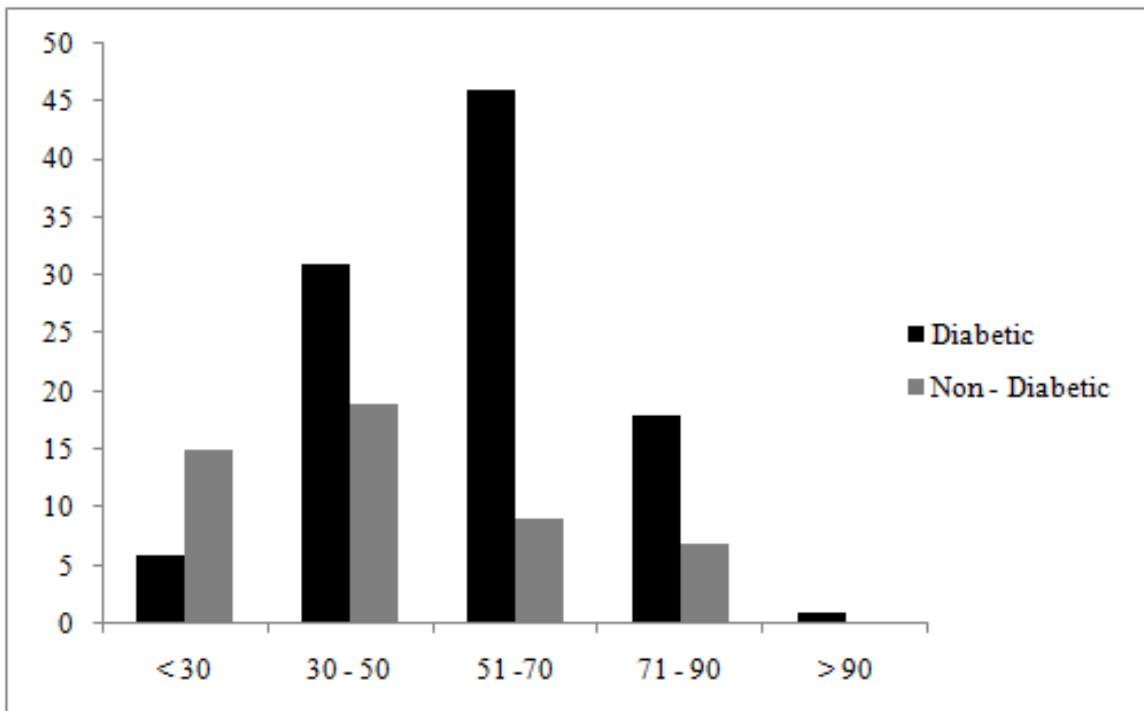


Figure (4-3) Distribution according to the age

Table (4-4)

Distribution according to Prescnece of GS related to gender:

Total	%	No	%	Yes	Prescnece of GS
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					Gender
69	47.73%	63	30%	6	Male
83	52.27%	69	70%	14	Female
152	100%	132	100%	20	Total

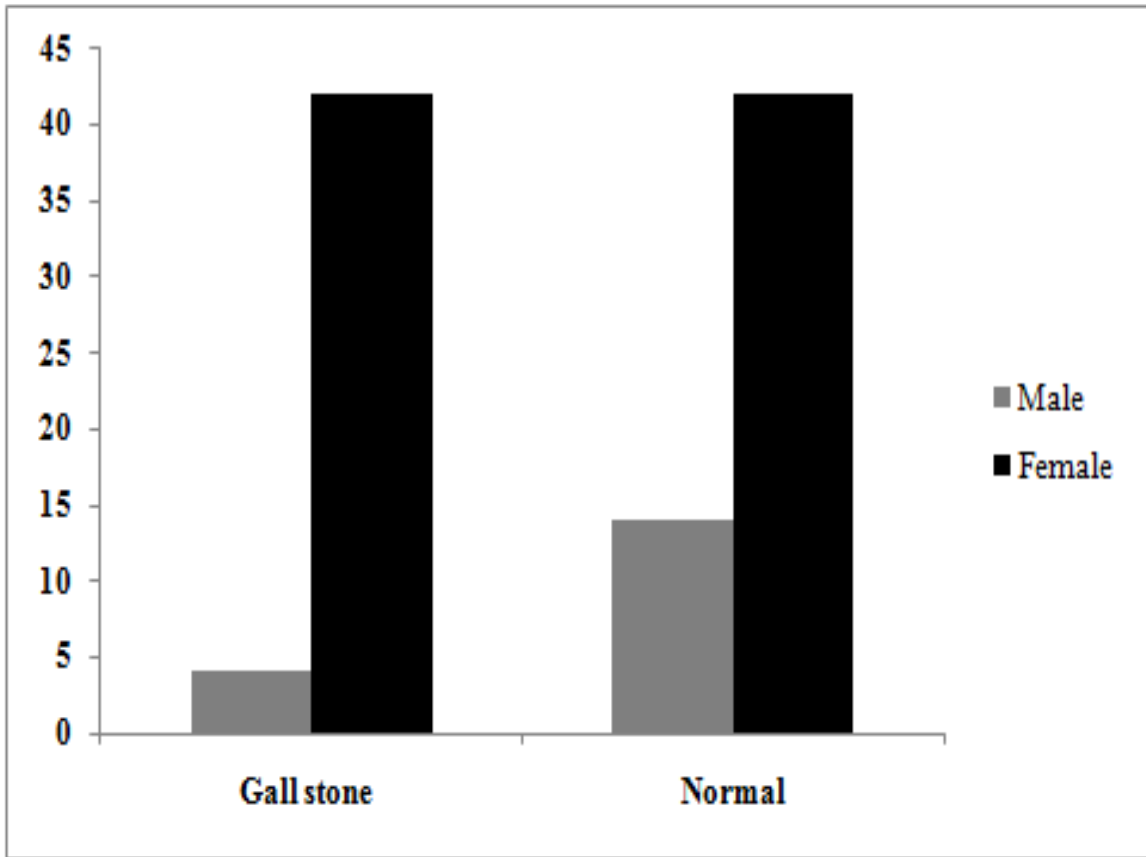


Table (4-5)

Distribution according to gender:

%	Male	%	Female		
5.80%	4	16.87%	14	Gallstone	Diabetics

60.87%	42	50.60%	42	No- gallstone	Non-diabetic
2.90%	2	0%	0	Gallstone	
30.43%	21	32.53%	27	No- gallstone	
100%	69	100%	83		Total

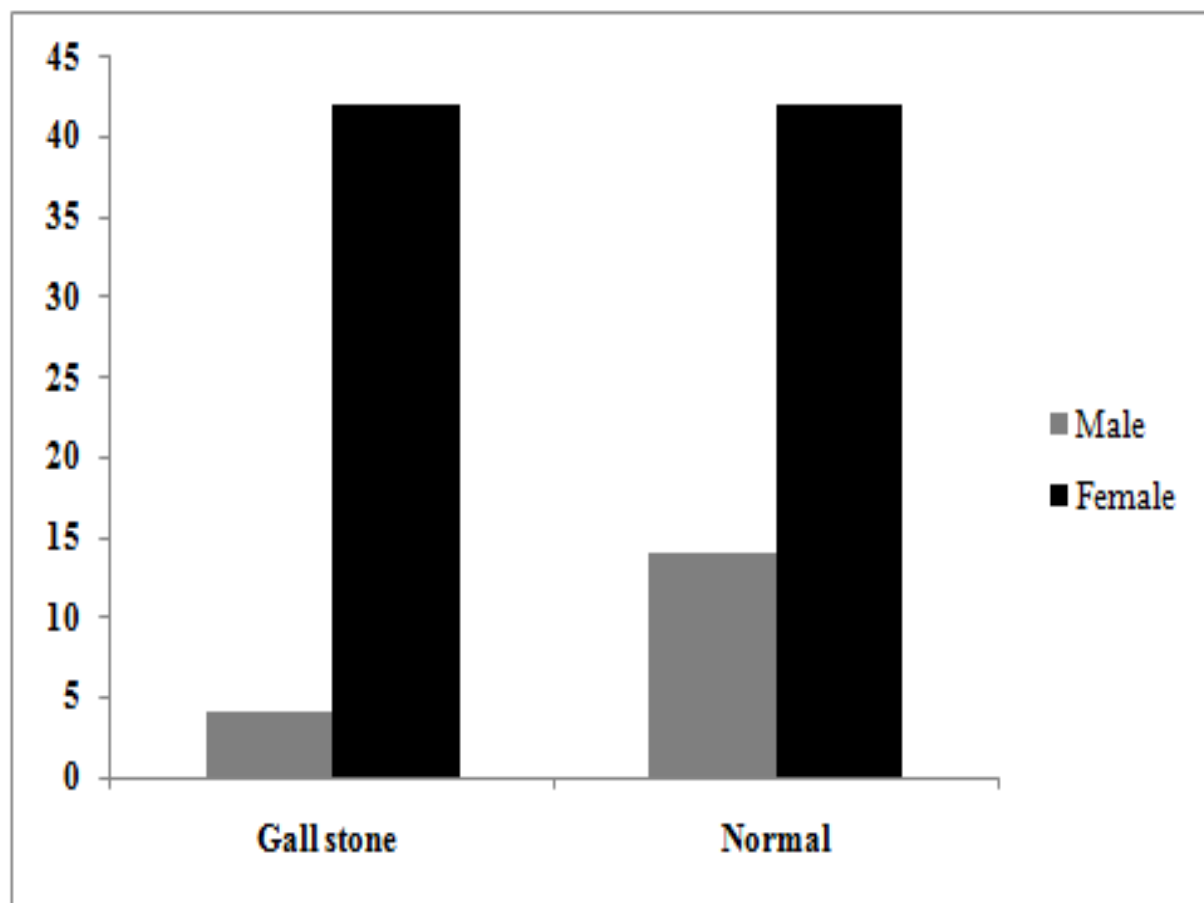


Figure (4-5) result of Distribution according to gender

Table (4-6)

Distribution of size gallstone in diabetic and non-diabetic patients according to gender:

F	M	Size of gallstone
5	4	1-5mm

9	2	6-10mm
14	6	Total

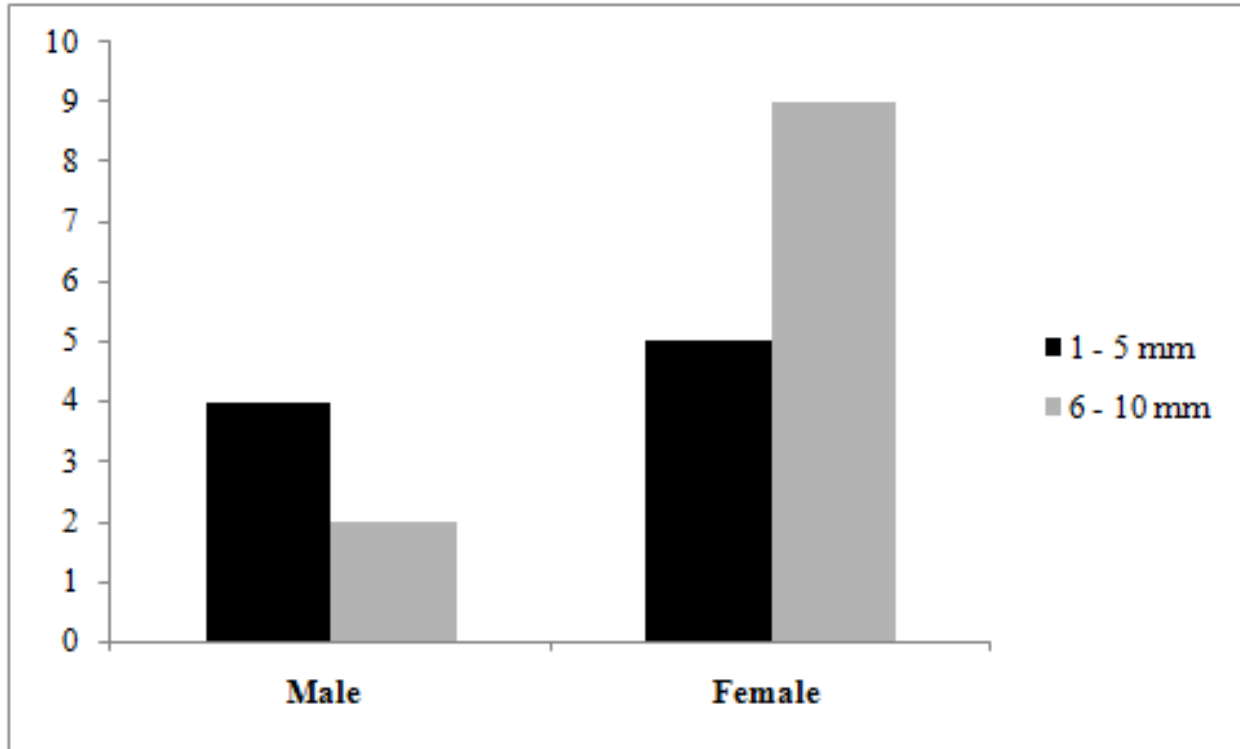


Figure (4-6) Distribution of size gallstone in diabetic and non-diabetic patients according to gender

Table (4-7)

Distribution of diameter of CBD in diabetic and non-diabetic patients with gallstone according to gender :

F	M	Diameter of CBD
10	3	<6mm
4	3	> 6mm

14	6	Total
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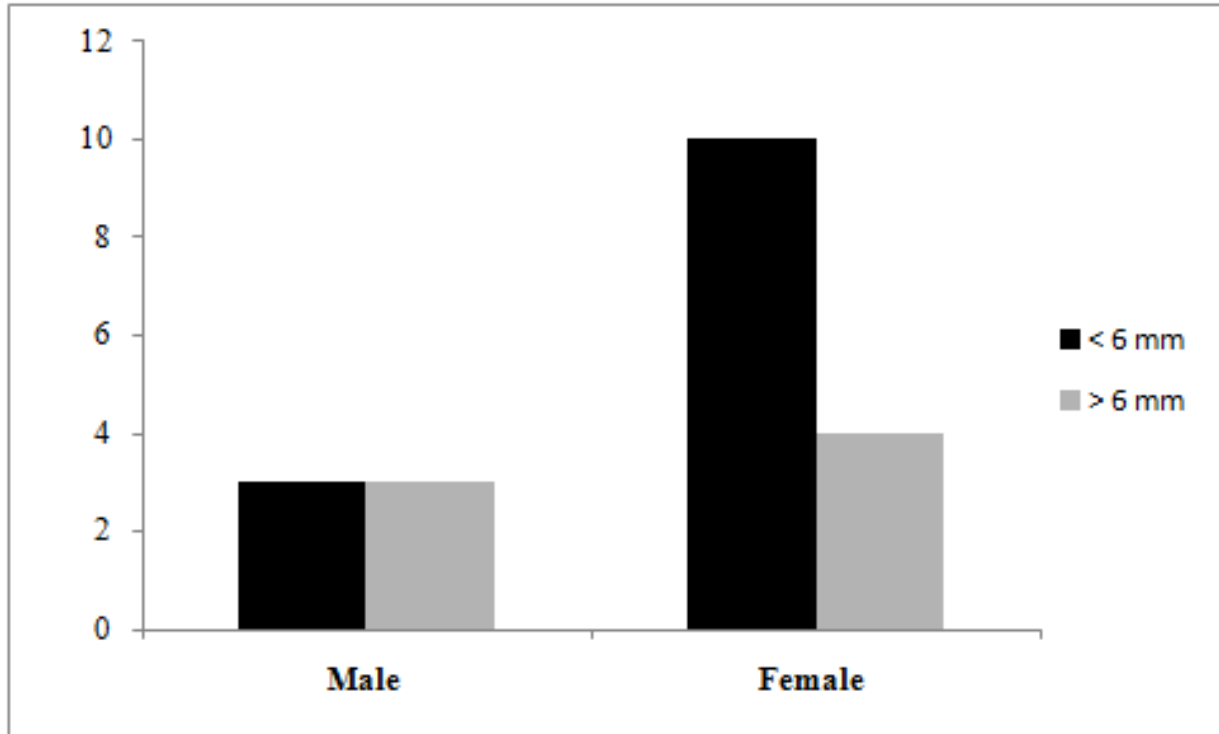


Figure (4-7) Distribution of diameter of CBD in diabetic and non-diabetic patients with gallstone according to gender

5.1 Discussion :

GB stones are responsible for a whole spectrum of disease entities ranging from simple biliary colic , acute emphysematous cholangitis (AEC) to fulminant cholangitis , necrotizing pancreatitis . and bowel perforation .

Mechanism involved in GS formation include : (i) super saturation of bile with cholesterol ,consequent sedimentation , crystalization.

A total of 152 patients were selected, in table (4-1) The frequency of diabetic patients 102 (67.1%) , the frequency of non –diabetic patients 50 (32.9%). Table (4-2) 18 patients from total 102 (67.1%) patients who had diabetes were found to be suffering from gall stone with percentage of 17.6% , while the other 84 (82.3%) had no gallstone , and 2 patients from total 50 (32.9%) non- diabetic patients with percentage 4% were suffering from gallstone, while the other 48 (96%) had no gallstone. Total of 20 (13.2%) patients had GS, while 132 (86.8%) had no GS . same result achieved by (Pagliarulo, 2004)

Table (4-3) 102 patients were diabetics and 50 patients were non-diabetics . in age group less than 30 years the frequency of diabetic patients was 6 (5.9%) while non- diabetic was 15 (30%), in age group 30 – 50 years the frequency of diabetic patients was 31 (30.4%) while non- diabetics were 19 (38%) , in age group 51- 70 years the frequency of diabetic patient was 46 (45.1 %) while non – diabetic patients were 9 (18%) , in age 71 – 90 years the frequency of diabetic patient was 18 (17.6%) while non –diabetic patients were 7 (14%) . in age group more than 90 years the frequency of diabetic patients was 1 (1%) and there was no non- diabetic patients . In this table show the age between 50- 71 were high prevalence of diabetic . Study found that Female with DM had more effectiveness in formation of stone as shown on table (4-3) similar result achieved by to a study was performed in Western Siberia they found that in the male population aged 35-54 years found no relationship between GSD and DM , while the female population aged 25- 64 years the prevalence of GSD was 10.5% and among women with DM the frequency of GSD showed 37.5% (Western Siberia) (Reshetnikov OV) also confirm with study was performed in Nigeria, (Agunloye AM) they found that prevalence of GS in diabetic patients was 17.5% and had a male to female ratio 3:4 .

Table (4-4) Study found that female are more effected by stone with percentage of(70%) Which is similar to a study performed in North Italian Centers they was found that prevalence of gallstone disease was higher in females and increase with age same result achieved by (Pagliarulo , 2004).

In table (4-6) a study found the size gallstone in diabetic and non-diabetic patients patients , 4 from 6 male patients had size from 1 to 5mm, while two had size from 5 to 10mm and 14 female had size from 1-5mm and no other . this study not found in previous study .

In table (4-7) a study found the diameter of CBD in diabetic and non-diabetic patients with gallstone 3 male patients from 6 had diameter < 6mm while other 3 had diameter > 6 and 10 female patients from 14 had diameter < 6mm while other 4 had diameter > 6 this study not found in previous study .

5.2.Conclusion:

Gallstone have incidence of (17.6) in diabetic patients .

Incidence of gallstone was high in female diabetic patients compare to male

diabetic patients with male to female ratio 7:2.

In this study the most diabetic patients in age between 51 to 70 years, 45

diabetic patients from total 102 (45.1%)

Increasing age is not a factor in gallstone formation in diabetic patients .

5.3.Recommendation:

The incidence of GSD in DM in this study was about 17.6% ; it is therefore recommended that UUS of biliary system should be part of base line investigative modalities in diabetes .

Female diabetic patient had high incidence than female patients, so so it recommended to perform them routine USS of the biliary system.

The author recommends that the Government should introduce the ultrasound machines and increase the training institutes of ultrasound for increasing the sonologists skills and experiences

According to the high cost of scientific research which the researcher was faced, the government should appeal universities in Sudan and companies to support the researchers in order to improve plans of treating and management of such diseases

In this study, it is found that, there were a related between diabetic and formation of gall stone hasway recommend balanced diet of diabetes

Refrence

- Agunloye 2013, Nigeria journal of clinical practice , ,vol-16 , issue 1 , p71.
- Robbin and cotran ,2014 pathologic basis of disease 8th edition
- Valerie C .Scanlon , tina sanders . essential anatomy ,5th edition
- Carol M . Rumck,stephanie R .Willson J , Willan , Charboneau, Deborah Levine,2011 diagnostic ultra sound volume one edditon 4th .
- Mason R . 1992 The Billiary tract . in :sutton D. ediator, text book of radiology -5th –ed . London : churchillliving stone;p.928.

- Akute OO, Adeknule OO. 1984 Choleliathiasis In Ibadan, Nigeria , east Afr Med J ;61: 45-51 {pumbed}
- Tano N, Koizume M, Goto Y. The relationship between Choleliathiasis and diabetes mellitus .
- Martini, F. H., Timmons, M. J., & Tallitsch, R. B. (2009). *Human Anatomy*. (6th Edition). San Francisco: Pearson Benjamin Cumming
- <http://www.cancer.ca/en/cancer-information/cancer-type/gallbladder/anatomy-and-physiology/#ixzz48dqxMkt>
- <http://www.ncbi.nlm.nih.gov/pumbed/21916209>
- <http://www.ncbi.nlm.nih.gov/pumbed/15002821>
- <http://www.ncbi.nlm.nih.gov/pumbed/23377475>
- James A. 1996, Essential of Ultrasound Physics. USA. P1-17,21-40.
- Penelope A. Robert J. 2008 Farr's Physics for Medical Imaging.Second Edition. USA. P147-160.
- Auld, B.A., 1990,Acoustic Fields and Waves in Solids, Vol I & II, 2nd edition Krieger Publishing Company, February; ISBN: 089874783X
- James A. Zagzebski. 1998, Essential of ultrasound physics. Second edition. USA. P 20-21-22-23.