Sudan University of Science and Technology

College of Graduate Studies

Evaluation of Normal Amniotic Fluid Volume in Second and Third Trimester Using Ultrasonography

تقييم السائل الأمنيوني الطبيعي في الفترة الثانية والثالثة من الحمل بإستخدام التصوير بالموجات الصوتية

A thesis Submitted for Requirement of Partial Fulfillment of M.Sc. Degree in Medical Diagnostic Ultrasound

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بسم الله الرحمن الرحيم

قال تعالى:

(اقرأ باسم ربك الذي خلق (1) خلق
الانسان من علق (2) اقرأ و ربك
الاكرم (3) الذي علم بالقلم (4) علم
الإنسان ما لم يعلم (5)

صدق الله العظيم

سورة العلق

Dedication

I dedicate this work to my parents, my brothers and sisters, my children, my husband and my teacher, my friends and colleagues.

Acknowledgement

First and foremost, praises and thanks to the God, the Almighty, for his shows of blessing though out my research work to complete the research successfully. And I am grateful for all who help me though this research, beginning from my supervisor Dr. Babiker who supervise this research and guide me , with big thanks to Sudan university of science and technology college of graduate studies in making this program of Master in diagnosis with ultrasound wave successful . I am extending my heartfelt thank to the family of Ban jaded Hospital for their moral support.

Abstract

This descriptive study was conducted in order to assess the amniotic fluids volume in pregnant women in second and third trimester. The study was used the universal protocol in the work of ultrasound for pregnant women through data collection sheet that were collected in the period from December 2018 to December 2019 , it was collect from Al Ban Jaded hospital in Khartoum State . The study aimed to identify normal value of amniotic fluid volume in pregnant women in second and third trimester to correlate gestation age and maternal age and weight with amniotic fluid volume. The result outcome from this study is that the assessment of the amniotic fluid volume is 100%.

Study conclusion, this study shows that most Sudanese pregnant ladies have normal amniotic fluid volume on the other hand abnormal amniotic fluid volume is rare ultrasonography finding.

Recommendations assessment of amniotic fluid volume is an essential part for antenatal care and follow up by u\s should be done in all pregnant ladies to predict prenatal complication.

Early diagnosis and better management of fetal abnormalities incidence of polyhydramnios.

ملخص الدراسة

هذه الدراسة الوصفية أجريت بغرض تقييم حجم السائل الامنيوني في النساء الحوامل في الثلث الثاني و الثالث من الحمل باستخدام البروتوكول العالمي في عمل الموجات الصوتية باستخدام استمارة جمع البيانات في الفترة من ديسمبر 2018 م الى ديسمبر 2019 م و جمعت البيانات من مستشفى البانجديد بولاية الخرطوم.

الهدف من الدراسة تحديد الحجم الطبيعي للسائل الاموني في النساء الحوامل في الثلث الثاني و الثالث من الحمل و ربط حجم السائل الامنيوني بعمر الجنين و وزن و عمر الام.

من النتائج المستنتجة من الدراسة ان قياس السائل الامنيوني بحجمه الطبيعي بنسبة100%.

في الختام هذه الدراسة تبين ان اغلبية النساء الحوامل لديهن كمية طبيعية من السائل الامنيوني و بالنسبة للنساء الحوامل ذوات الكمية غير الطبيعية من السائل الامنيوني فهن أقلية و ذلك حسب نتائج صور الموجات الصوتية.

اما في التوصيات فإن تقدير كمية السائل الامنيوني عامل أساسي في عملية الرعاية الصحية للحوامل اثناء فترات الحمل و المتابعة بالموجات الصوتية لكل الحوامل عن طريق الموجات الصوتية لتنبأ بأي مضاعفات اثناء فترة ما قبل الولادة.

بالإضافة الى التشخيص المبكر و العلاج الافضل لمشاكل الاجنة خاصة في حالات زيادة او نقصان كمية السائل الامنيوني عن المدى الطبيعي.

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Abbreviations

AC	Abdominal circumference
AF	Amniotic fluid
AFI	Amniotic fluid index
AFV	Amniotic fluid volume
GA	Gestational age
MHz	Megahertz
SDP	Single deepest pool
SPSS	Statistically package for social science
T/A	Transabdominal scan
U/S	Ultrasound

Chapter One

Introduction

1.1 Introduction

The amniotic fluid is the protective liquid contained by the amniotic sac of a gravid amniote . This fluid serves as a cushion for the growing fetus, but also serves to facilitate the exchange of nutrients, water, and biochemical products between mother and fetus.

Amniotic fluid is present from formation of the gestational sac .Amniotic fluid is in the amniotic sac .it is generated from maternal plasma ,and passes through the fetal membranes by osmotic and hydrostatic forces .when fetal kidneys begin to function in about week 16 , fetal urine also contributes to the fluid (Larsen ,willing .(2001).In earlier times , it was believed that the amniotic fluid was composed entirely of fetal urine .

The fluid is absorbed through the fetal tissue and skin after the 15th -25th week of pregnancy when keratinization of an embryo's skin occurs, the fluid is primarily absorbed by the fetal gut (Larsen, William, 2001).

At first, amniotic fluid is mainly water with electrolytes, but by about the 12-14th week the liquid also contains proteins,carbohydrate , lipids ,phospholipids, urea ,all of which aid in the growth of the fetus . Swallowed amniotic fluid creates urine and contributes to the formation of meconium. Amniotic fluid protects the developing baby by cushioning against blows to the mother abdomen, allowing for easier fetal movement and promoting muscular, skeletal development. Amniotic fluid swallowed by the fetus helps in the formation of gastrointinal tract. Contrary to popular belief, amniotic fluid has not been conclusively shown to be inhaled and exhaled by the fetus .in fact; studies from the 1970 show that in a heath fetus ,they is no inward flow of amniotic fluid into the airway (Lily A.W1972).instead, lung development occur as a result of production of fetal lung fluid which expands the lungs .It also prevents the fetus from mechanical jerks and shocks 2.

Amniotic fluid may be normal or polyhydominos or oligohydramnios due to deferent's reason.

Polyhydramnios is define as amniotic fluid volume greater than normal for gestational age while oligohydramnios is amniotic fluid volume that is abnormally low for gestational age. Polyhydramnios associated with

fetal neural tube defect central nervous system, abnormalities affecting fetal swallowing, gastrointestinal obstruction, infection, isoimmunisation, gestational dibetes mellitus, non immune fetal hydrops, chorioangioma of the placenta and pulmonary hyperplasia while oligohydramnios is associated with small for gestational age fetus renal anomalies and urinary tract dysplasia.[Umar2004]

Sonography is the method of choice for diagnosis and assessment of amniotic fluid volume and it is assesses reasons of abnormal amniotic fluid volume.

There are three methods for assessing amniotic fluid volume by using ultrasound which are:

Subjective assessment: With experience, it is possible to classify amniotic fluid volume in to the broad categories absent, low, normal, increased and excessive. Although reliable in the hands of an experienced operator, this method has proved impossible to standardize in clinical and research terms. [Chudieigh 2004]

Single deepest pool: The size of the deepest cord, free pool of amniotic fluid is assessed with the ultrasound probe perpendicular to the maternal abdomen.
The vertical depth of the largest pool is measured. When this method was first introduced, a 1-cm pool was considered acceptable in normal pregnancy, but subsequent studies have suggested that a minimum depth of 2–3 cm is a more appropriate threshold.[Chudieigh 2004] 3. Amniotic fluid index: This is a semi quantitative volume. Using the maternal umbilicus as a reference point, the abdomen is divided into four quarters.
With the ultrasound probe held in the longitudinal axis of the mother and perpendicular to the floor, the largest vertical pool depth in each quadrant is recorded. The sum of these measurements represents the amniotic fluid index (AFI). Value between 8.1-18cm consider normal. Even though this method is accepted as superior to the single deepest pool technique, considerable intra and inter observer variation exists .Although the importance of quantifying the amniotic fluid volume is unquestionable, a practical and reproducible technique for the accurate assessment of amniotic fluid volume has yet to be introduced into clinical practice. [Chudieigh 2004].

1. 2 Problems of Study

The oligohydramnios can be difficult to confirm due to the questionable accuracy of AF measurement by ultrasound, when pocket of AF containing umbilical cord.

AFI measurements may vary with the amount of pressure applied to the abdomen and with fetal position or movement .Serial measurements taken by ultrasound operator have been shown to differ from the true volume by I cm.

1.3 Objectives:

1.3.1 General Objectives

To asses AF by ultrasound in pregnant women in second and third trimester.

1.3.2 Specific Objectives:

- To identify normal values of fluid index in pregnant women.

- To detect common cause of polyhydramnios and olighydramnios in pregnant women.

1. 4 Significant of the Study:

This study will provide information about assessment of amniotic fluid volume in normal pregnant female in the second and third trimester.

1. 5 Overview of the Study:

This study consists of five chapters: Chapter one deal with introduction ,problem of study and objectives Chapter two include Literature review, Anatomy- Physiology ,Pathology and previous studies, Chapter three deal with Material and methods, Chapter four include Data collection - analysis and results and Chapter five deal with Discussion–conclusion and recommendation.

Chapter Two

Theoretical Background and Literature Review

2.1 Anatomy

2.1.1Amnion and Amniotic Cavity

The amnion is a membranous sac which surrounds and protects the embryo. It is the first of the three cavities (amnion, chorion and yolk sac) in the embryo and is formed on about day 22-23 LMP (8 days following conception). (El-Rakhawy .2008) At the eighth day of development, the blastocyst is partially embedded in the endometrial stroma. In the area over the embryoblast, the trophoblast has differentiated into two layers: inner layer of mononucleated cells, the cytotrophoblast and the outer multinucleated zone without distinct cell boundaries, the syncytiotrophoblast. Thus, cells in the cytotrophoblast divide and migrate into the syncytiotrophoblast, where they fuse and lose their individual cell membranes. Cells of the inner cell mass or embryoblast also differentiate into two layers: a layer of small cuboidal cells adjacent to the blastocyst cavity, known as the hypoblast layerand layer of high columnar cells adjacent to the amniotic cavity, the epiblast layer. Together, the layers form a flat disc. At the same time, a small cavity appears within the epiblast. This cavity enlarges to become the amniotic cavity (Sadler .2012). Initially, the amniotic cavity is small and lines one side of the embryo while the other side is lined with the yolk sac. With growth and folding of the embryo, the amniotic cavity completely envelops the embryo. The amniotic cavity expands at a faster rate than the chorionic cavity resulting in the amnion coming into contact with the chorion by about 9 weeks LMP and obliterating the chorionic cavity. The amnion and chorion fuse together to form the amniochorionic membrane. This process is variable in duration but fusion is usually complete by 20 weeks LMP or midterm (Dean-2005). The amniotic cavity starts as a small space which soon expands to fill the whole uterine cavity. This occurs in the following way. The amniotic cavity appears – during implantation of the blastocyst -as small clefts between the ectoderm (of the inner cell mass) and trophoblast ; very early in pregnancy the ectodermal cells are attached to the trophoblast. As the development proceeds (at about day (8)) small intracellular clefts appear between the ectoderm and trophoblast. When these clefts join together they form a small space called the amniotic cavity. As the amniotic cavity enlarges, layer of large

flattened cells called amnioblasts develops from the inner surface of the trophoblast and form the roof of the amniotic cavity (El-Rakhawy-2008).

2.1.2 Amniotic Fluid:

2.1.2.1 Development of amniotic fluid:

The fluid in the amniotic cavity bathing the fetus is known as amniotic fluid or liquor amnii. A normal amount of AF is important for normal fetal development and growth. Too little or too much AF is associated with different conditions and places the fetus at risk for perinatal complications (Dean-2005). Amniotic fluid originates from the maternal plasma, and passes through the fetal membranes by osmotic and hydrostatic forces. As the Placental and fetal vessels develop, the fluid passes through the fetal tissue, as the exsudatum of the skin (Carter.2012). Amniotic fluid volume normally increaseswith linear regression to the growth of fetus. AFV normally peaksat about 36 weeks and then decreases at term. Studies have determined the AFV to be approximately 25 ml at 10weeks, 400 ml at 20 weeks, 1000 ml at 35 weeks, and 250 ml at 43 weeks gestation (Dean -2005). From the 8th week, when the fetal kidneys begin to function, fetal urine is also present in the AF. Approximately in the 10th week the breathing and swallowing of the fetus slightly decrease the amount of AF, but neither urination nor swallowing contributes significantly to AF quantity changes, up until the 25 week, when keratinisation of skin is complete. The waters are released when the amnion rupture. This is commonly known as the time when a woman's "water breaks". When this occurs during labour at term, it is known as (SROM). If the rupture precedes labour at term, however, it is referred to as (PROM).The majority of the hind waters remain inside the womb until the baby is born. A manual rupture of the amniotic sac can also be performed to release the fluid if the amnion has not spontaneously ruptured (ARM). (https://en.wikipedia.org -2009)

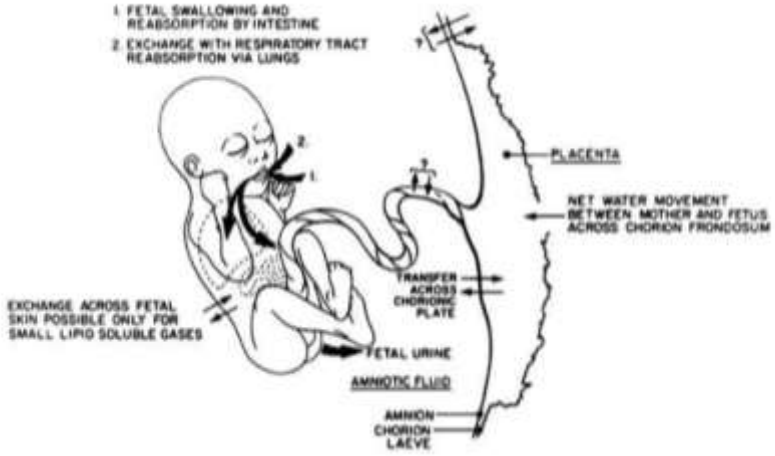


Figure 2-1 : Embryo within the uterine cavity (Dean 2005)

2.1.2.2 Components of amniotic fluid:

Amniotic fluid is a solution in which undissolved material is suspended. It consists of desquamated fetal epithelial cells and approximately equal portions of organic and inorganic salts, in 98 - 99% water. Half of the organic constituents are protein; and the other half consists of carbohydrates, fats, enzymes, hormones, and pigments. As pregnancy advances, the composition of the amniotic fluid changes as fetal excreta(fetal urine, meconium) are added. Because fetal urine is added to amniotic fluid, studies of fetal enzyme systems, amino acids, hormones, and other substances can beconducted on fluid obtained by amniocentesis (Dean -2005).

2.2 Physiology

The normal amniotic fluid volume is essential for normal fetal development. An excess or deficiency of amniotic fluid is associated with an increased incidence of fetal and neonatal morbidity and mortality.

2.2.1 Functions of amniotic fluid:

Amniotic fluid provides a medium in which the fetus can move, grow, and develop symmetrically without pressure on its delicate tissues. Blood flow is also unrestricted as it is transported through the umbilical cord. The fluid also helps to maintain an even environment temperature for the fetus. An adequate amount of amniotic fluid helps to promote normal

development and maturation of the fetal lung. Amniotic fluid also allows the fetus to exercise its limbs freely (Dean-2005).

Analysis of amniotic fluid, drawn out of the mother's abdomen in an amniocentesis procedure, can reveal many aspects of the baby's genetic health. This is because the fluid also contains fetal cells, which can be examined for genetic defects (Dinaael,Mowa Fe-2004).

2.2.2 Production and absorption:

The umbilical cord and membranes, lungs, skin, and kidneys all contribute to the production of amniotic fluid. Fetal urination into the amniotic sac accounts for most of the total volume of amniotic fluid by the second half of pregnancy, and the quantity of fluid is directly related to kidney function. A fetus lacking kidneys or with malformed kidneys produces little or no amniotic fluid. The amount of amniotic fluid is regulated not only by the production of amniotic fluid but also by removal of fluid by swallowing, by fluid exchange within the lungs, and by the membranes and cord. Normal lung development is critically dependent on the exchange of amniotic fluid within the lungs. Inadequate lung development may occur when severe oligohydramnios is present, placing the fetus at high risk for developing small or hypoplastic lungs (Sandra.2012). Amniotic fluid production is attributed initially to the amniotic fluid epithelium and later to fetal kidneys. The fetal membrane and umbilical cord are the most important structures for continues exchange of water and electrolytes, while the swallowing of amniotic fluid by the fetus and fetal urine output into the amniotic fluid are intermittent process (Phelan etal-2004).

2.2.3 Source and regulation of amniotic fluid volume:

Amniotic fluid is derived from several sources and the contribution of these sources varies during the pregnancy. In early pregnancy, the primary source of the fluid appears to be the amniotic membrane and transudate from the maternal blood by transport across the amniotic membrane. The fetal kidneys begin to function in the second trimester and contribute fluid volume to the amniotic fluid. Fetal urinary output as asource of amniotic fluid becomes increasingly important as pregnancy advances. It is estimated that about 500 ml of fetal urine is added daily to

the amniotic fluid. The fluids constantly being formed and resorbed with replacement about every 3 hours. Large volumes of fluid move in both directions between the fetal and maternal circulations. Fetal swallowing of amniotic fluid begins at about 11-13 weeks of gestation. Most of the fluid passes into the fetal gastrointestinal tract, but some of it also passes into the fetal lungs. In either case, the fluid is absorbed into the fetal circulation and then passes into the maternal circulation via the placental membrane. In the final stages of pregnancy, the fetus swallows up to 400 ml of amniotic fluid per day. Some fluid also passes from the amniotic cavity into the maternal blood across the chorioamniotic membrane. If the fetus is unable to swallow adequate amounts of amniotic fluid or if the fetus swallows the fluid but it is not absorbed properly because of an obstruction in the upper fetal (GIT), polyhydramnios will occur (Dean-2005).

2.3 Assessment of amniotic fluid volume:

The amniotic fluid volume reflects the status of both the mother and the fetus and is altered in many physiological and pathological conditions. Ultrasound has a potential role in the management of such conditions, by the assessment of amniotic fluid volume (Trish,Basky -2004).

There are three methods for assessing amniotic fluid volume:

2.3.1 Subjective assessment:

With experience, it is possible to classify amniotic fluid volume into the broad categories absent, low, normal, Increased and excessive. Although reliable in the hands of an experienced operator, this method has proved impossible to standardize in clinical and research terms (Trish,Basky 2004).

2.3.2 Single deepest pool or Single vertical pocket:

The size of the deepest, cord-free pool of amniotic fluid is assessed with the ultrasound probe perpendicular to the maternal abdomen. The vertical depth of the largest pool is measured. When this method was first introduced, a 1-cm pool was considered acceptable in normal pregnancy, but subsequent studies have suggested that minimum depth of 2–3 cm is a more appropriate threshold. Deepest vertical pocket is the most commonly used method for biophysical profiles and multiple pregnancy examinations (Trish,Basky -2004).

Table (2.1): Quantitative determination of amniotic fluid volume by single vertical pocket (Dean-2005)

Chamberlain Method Single Vertical Pocket Measurement	
< 1 cm	severe oligohydramnios
1-2 cm	significant oligohydramnios
2-8 cm	Normal
8-12 cm	mild polyhydramnios
12-16 cm	moderate polyhydramnios
> 16 cm	severe polyhydramnioss

2.3.3 Amniotic fluid index:

This is a semi quantitative technique for assessing amniotic fluid volume. Using the maternal umbilicus as a reference point, divides the uterine cavity into four equal quadrants by two imaginary lines running perpendicular to each other. The largest vertical pocket of amniotic fluid, excluding fetal limbs or umbilical cord loops, is measured. The sum of the four quadrants is called the amniotic fluid index (Sandra .2012). Although the AFI is known to vary with gestational age, an AFI < 5 cm is classified as oligohydramnios and an AFI > 20 cm is classified as polyhydramnios .Even though this method is accepted as superior to the single deepest pool technique, AFI is one of the essential component of fetal BPP (Trish,Basky .2004).

Table (2.2): Quantitative determination of amniotic fluid volume by amniotic fluid index. (Dean.2005)

Phelan Method Four Quadrant Amniotic Fluid Index	
<5 cm	severe oligohydramnios
5.1 - 8 cm	significant oligohydramnios
8.1 - 18.0 cm	Normal
> 18 cm	Polyhydramnios

2.4 Consistency of Amniotic Fluid:

In general, amniotic fluid appears anechoic throughout pregnancy in the majority of patients at normal gain settings and transducer frequencies. Echogenic amniotic fluid at different stages of gestation can occur and is associated with different etiologies, some physiological and others pathological. In the first trimester of pregnancy, normal amniotic fluid should appear echo free. In contrast, chorionic fluid frequently appears to have dispersed low amplitude echoes which are especially evident at higher transducer frequencies and gain settings. In the second and third trimesters of pregnancy, amniotic fluid echoes may be seen in normal pregnancies or may be associated with underlying pathological causes including anencephaly and intra-amniotic bleeding. The source of amniotic fluid debris echoes in normal pregnancies is mainly related to desquamated or exfoliated fetal skin cells and vernixcaseosa. Vernixcaseosa is the normal oily substance produced by fetal skin and covering the fetal skin to protect it in its aqueous environment.Near term, meconium released into the amniotic fluid by the fetus may be another source of amniotic fluid debris echoes. Under ordinary circumstances, meconium is usually not released in utero although it may be a normal event that occurs with progressive fetal maturation, without evidence of fetal distress or poor outcome. Other causes associated with meconium passage in utero include hypoxia-induced peristalsis and sphincter relaxation, and umbilical cord compression induced vagal stimulation in mature fetuses. There appears to be a link between gestational age and meconium passage after the 38th week.The cause of the meconium passage may vary from patient to patient, and in some patients may result from a combination of causes which may explain why there has not been a clear relationship demonstrated between its passage in utero and fetal outcome. Other potential causes of

amniotic fluid debris echoes include fetal bleeding associated with percutaneous umbilical cord sampling, rupture of an umbilical vessel associated with velamentous insertion of the umbilical cord, chorioamnionitis, and idiopathic causes (Dean -2005).

2.5 Ultrasound physics:-

Ultrasound waves are defined as sound waves of high frequency that is inaudible to the ear. These are longitudinal waves that propel in a direction parallel to that of wave propagation in a medium.

High-frequency sound waves are inaudible to humans in the range of 2-20million cycles per second (2-20MHz) – this is the range of diagnostic ultrasound.

Sound audible to humans is<20KHz.

Ultrasounds is >20KHz.

Speed of sound in air is 330meters per seconds.

Speed of sound in fat is 1.450 meters per second

Speed of sound in soft tissue is 1.540-1.580 meters per second

Speed of sound in bone is 4.080meters per seconds

2.5.1 Principles of sonography:-

Based on PULSE-ECHO principle:

Pluses of high-frequency sound waves are transmitted to the patient echoes returning from various tissues boundaries are detected. The received echo products and ultrasound image.

Electricity converted into sound-pulse

Sound converted into electricity-echo

If more sound is received back suggestive of stronger reflector – whiter image

If less sound is received back – suggestive of weaker reflector – blacker image

2.5.2 Instruments:-

1- Transmitter: sends voltage to energize the transducer.

2- Transducer.
3- Receiver: to detect and amplify weak signals and sends them to display it controls the dynamic range and time-gain compensation (TGC).
4- Display: to present the USG image/data in a form suitable for analysis and interpretation.

The transducer's input is communicated to scanner through the cable and the data can be visualized on the monitor.

Following are the ways through which spatial information can be displayed:

A. Mode: amplitude mode; it is used for ophthalmic purposes.
B. Mode: brightness mode (grey scale, real time); it is used routine sonography

M. Mode: motion mode; it is used to measure the heart rate.

2.5.3 Ultrasonography transducer:-

Ultrasongraphy (USG) transducer is a device that converts electrical energy to mechanical energy and vice versa.

1- Transmitter electrical energy is converted to acoustic pulse, which is transmitted to the patient.
2- Receiver: receiver reflected echoes. Weak pressure changes are converted to electrical signals for processing.

It is based on the principle of piezoelectricity.

Ultrasound pulses generated by transducer are propagated, reflect, and absorbed in tissue to provide useful clinical information.

Transducers (scanning probes) are the costliest part of any ultrasound unit.

2.5.3.1 Types of transducer:-

The shape of the scans from different transducers is different.

1- Curved array convex transducer: wider fan shape image

Useful for all body parts except echocardiography

Large versions for general abdomino-pelvic and obstetrics scan

Small high-frequency curved array scanners for transvaginal, transrectal scans

2- Linear array: rectangular shape

Most useful for small and superficial parts such as thyroid, testicle, and breast

Vascular, musculoskeletal, and obstetric applications

3- Phased array sector scanner: triangular fan shaped

Used in cardiac examination through intercostals scanning

2.5.3.2 Selection of transducer:-

The thickness of the transducer (usually 0.1-1 mm) determines its frequency (inversely proportional).

Each transducer is focused at a particular depth.

Penetration of the ultrasound diminishes with an increase in frequency.

Higher the frequency, shorter the wave length , and better the resolution.

Frequencies from 7.5 to 15 MHz are used for superficial vessels and organs such as thyroid and breast lying within -1-3 centimeters of the surface.

Frequencies of 2-5MHz are required for deeper structures in abdomen and pelvis, that is,>12-15cm from the surface.

High frequencies –better spatial resolution, greater attenuation, and poor penetration

High frequencies->

- Broadens the bandwidth.
- Reduces the quality factor(Q)

- Shortens the spatial pulse length(SPL)

2.5.3.3 Specialized transducer:-

1- Endovaginal probes for early obstetric and gynecologic problems.
2- Endorectal probes for prostate imaging .
3- Intraoperative/laparoscopic port in the abdominal wall enter into the abdominal cavity and retroperitoneum.

2.5.3.4 Real-time Ultrasound:-

Real-time imaging systems are those that has frame rates fast enough to allow movement to be followed (>16 frame rates / seconds) for the fast – moving structure such as heart, high frame rate are beneficial.

Types:-

1-mechanical scanners: single- element transducer is mechanically moved to from images in real time it is obsolete nowadays.

- Oscillating transducer
- Rotating wheel transducer

2-electronic array: transducers do not move but are activated electronically to cause ultrasound beam to sweep across the patient it is most frequently used now.

2.5.4 Construction of transducer:-

Piezoelectric crystal element: located near the face of a transducer.

Outside electrode: grounded to protect the patient from shock. Its outer surface is coated with a water- tight electrical insulator.

Inside electrode: abuts against a thick backing block; absorb the sound waves transmitted back into the transducer.

Backing block (damping) : made of tungsten and rubber powder in epoxy resin.

- Absorb the sound waves transmitted back into the transducer
- Shortens the pulse duration and pulse length (SPL)

- Increase axial resolution
- Widens the bandwidth and reduce the quality factor (o)

Housing-strong plastic: acoustic insulator of rubber/ cork that prevents sound from passing into the housing

Diagnostic transducer: have damping material wide bandwidth, low Q

Therapeutic transducers: without backing material narrow bandwidth

2.5.5 Piezoelectric crystal:-

Piezoelectric effect (PE) crystal is the main component of a transducer (located near the transducer's face).

Has the unique ability to respond to the action of an electric fire by changing the shape (strain). Strain is the deformity of crystal (into different shapes) when compressed.

Naturally occurring PE materials-ferroelectrics-lead (Plumbium) zirconate titanate (PZT) , barium lead titanate, lead metianobate , and polyvinylidene fluoride(PVDF)

Synthetic materials are good both at transmitted and receiving sound waves, whereas naturally occurring crystals are better at doing one or the other.

Frequency: the number of cycles per second; measured in Hertz.

Wavelength: the distance between two consecutive waves. It depends on the frequency of waves and speed of propagation in the medium through which it is passing. It is inversely proportional to frequency to frequency.

Bandwidth: range of frequencies produced by the transducer.

Pulse length: small number of cycles in a pulse.

2.6 lab investigation:-

We use amniotic fluid analysis also known as amniocentesis under ultrasound gaudiness, to suck by the syringe 10 to 20 ml of the fluid for the lab investigation also known as culture amniotic fluid and amniotic cells and the fetal lung maturity tests.

2.7 Obstetric Ultrasound:

Obstetrics ultrasound is safe investigation for fetus to evaluating fetal health, determining gestational age and assessing the intrauterine environment. Very high frequency sound waves of between 3.5 to 7.0 MHz are generally used for this purpose. It is plays an important role in the care of every pregnant woman by using (T/A) scans or (T/V) scans . Other specialized examinations might include fetal Doppler, biophysical profile, fetal echocardiogram, or additional biometric measurements, 3D and 4-D Ultrasound (ACR web-2007) .

2.7.1 Fetal Safety:

Diagnostic ultrasound studies of the fetus are generally considered to be safe during pregnancy. This diagnostic procedure should be performed only when there is a valid medical indication, and the lowest possible ultrasonic exposure setting should be used to gain the necessary diagnostic information under the (ALARA) principle (ACR web-2007).

2.8 Previous Study:

M.S Ayat ALnour Ahmed Mohammed in 2017 university of sudan science and Technology.

The Evaluation of normal Amniotic Fluid volume in third Trimester using ultrasonogrophy.

This study was carried on 75 Sudanese married patient were investigate in different hospital and clinics diagnostic centers in Khartoum state (ELrakhahospital and Elsoudy hospital and Ahfad Family health center) and enrolled of in this study in order to determine normal volume of amniotic fluid.

Assessment of Amniotic Fluid Volume in Second and Third Trimester by Ultrasound in Pregnant Women

Ms. Hala ElAwni Mahdi ElAwnitm 2015 Sudan University of Science and

Technology was study the normal volume of amniotic fluid among Sudanese population in 2nd and 3rd trimester by using ultrasound The

study was conducted on 90 pregnant women their second and third trimester over a period from August 2015 to December 2015, in Kosti Teaching Hospital, depended on the international study protocol in obstetrical scanning. All pregnant women were subjected to be examined by U/S scanning using Toshiba and General Electric scanner with 3.5MHz convex probe. Trans abdominal scanning were performed for all pregnant women and measure the amniotic fluid volume by using, the four –quadrants amniotic fluid index

(AFI) and the deepest pocket (large pocket) methods The problem of study is that the difficult measurement of oligohydramnios by ultrasound. The study found that most of the pregnant women have normal amniotic fluid (88.9%) and few others pregnant women have an abnormal amniotic fluid (11.1%).

The study showed the normal range of amniotic fluid index in pregnant women from 24-40 weeks, it showed that the mean of normal amniotic fluid index reaches its peak at 26-week gestation and gradually declined at 40-week gestation. The study recommended that assessment of amniotic fluid volume by ultrasound is an essential parameter of the antenatal care. For better interpretation of amniotic fluid index normal reference values in varies weeks of pregnancy in pregnant women in Sudan is recommended. The study also recommended facilitating ultrasound machine in every hospital and medical health centers The study was carried out to assess the amniotic fluid volume in pregnant women in second and third trimester.

Assessment of Amniotic Fluid Volume in Sudanese Pregnant Women in Second and Third Trimester by Ultrasound Imaging

Mr. Mohammed Alhaj Ali Abdalgader Ali 2016.Sudan University of Science and Technology. His study was carried out to assess the amniotic

fluid volume in pregnant women in second and third trimester The study was conducted on 50 pregnant women their second and third trimester over a period from September 2016 to November 2016 in universal Ribat Hospital, depended on the international study protocol in obstetrical scanning. All pregnant women were subjected to be examined by Ultrasound scanning using simense scanner with 3.5MHz convex probe Trans abdominal scanning were performed for all pregnant women and measure the amniotic fluid volume by using, the deepest pocket (large pocket) methods. The problem of study is that the difficult measurement of oligohydramnios by ultrasound.

The study found that most of the pregnant women have normal amniotic fluid (56%) and few others pregnant women have an abnormal amniotic fluid (44%). Amniotic fluid must be assess by ultrasound method and not depend only on The observation of the sonographer to prevent missing amniotic fluid volume abnormality

Chapter Three

Materials and Methods

3.1 Materials

This study was done in Alban Jadeed Hospital during the period from December 2018 December 2019.

3.1.1 Ultrasound Machine:

In this study, transabdominal scanning was done by using (Mindray model DP-20& SN=QM26000264) device, with (3.5MH),convex probe,and measured amniotic fluid volume by single deepest pocket and amniotic fluid index in the third trimester.

3.1.2 Ultrasound procedure:

All transabdominal study was generally performed with the patient in supine position. 3.5 MHz transabdominal transducers and 5 MHz for thin women were used.

An ultrasound procedure used to assess the amount of amniotic fluid. The single largest pocket measured, then the amniotic fluid index is measured by dividing the uterus into four imaginary quadrants. The lineanigra is used to divide the uterus into right and left halves. The umbilicus serves as the dividing point for the upper and lower halves. The transducer is kept parallel to the patient longitudinal axis and perpendicular to the floor. The deepest vertical pocket of fluid was measured in each quadrant in centimeters. The four pocket measurements are then added to calculate the AFI.

Each patient was scanned twice, in an international scan guidelines and protocols. Firstly by the researcher then by a qualified sinologist to confirm the findings and diagnosis

3.2 Methods

3.2.1 Study Sample:

100 normal Sudanese pregnant women in second and third trimesters, Sudanese pregnant women in first trimesters were excluded from the study.

3.2.2 Data analysis:

The data was collected in data collecting sheet, And was analyzed using SPSS for windows version 20. Descriptive statistics as well as frequency table and correlation were obtained.

3.2.3 Ethical consideration:

Data was collected from different patient with maintain privacy and confidentiality. No patient information was published throughout this study.

3.2.4Study design:

This study was descriptive study deal with the role of ultrasound in evaluation of amniotic fluid volume in diabetic pregnant women among Sudanese population .

3.2.5 Study variables:

-Maternal age.

-Gestational age.

-Single vertical pocket volume.

- 4 pocket volume.

-Consistency of amniotic fluid.

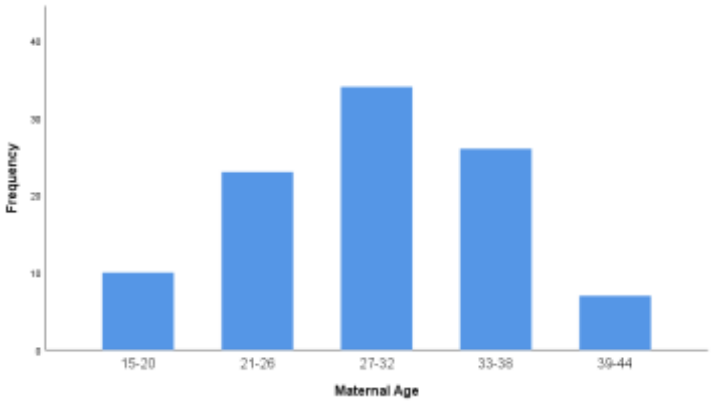
Chapter Four

Results

Statistical Methods: the comparative analytical method was used, using the SPSS statistical program based descriptive statistics and comparative and relationship hypothesis tests (0.05 sig. level), to demonstrate the relationships between (**SDP and AFI**) with respect to (maternal and gestational age, maternal weight and No. of parities). The test was used for (t-tests and correlations) to study the hypothesis.

Table (4-1): Distribution of 100 pregnant women scanned during the study period according to Maternal age group

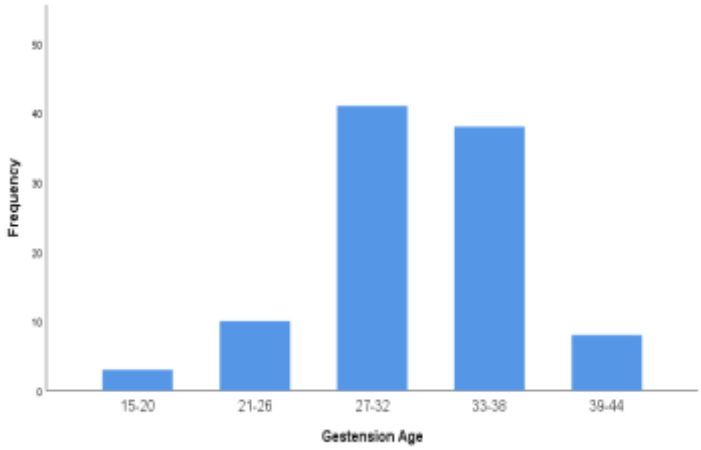
Maternal age	Frequency	Percent
years 20-15	10	10.0
years 26-21	23	23.0
years 32-27	34	34.0
years 38-33	26	26.0
years 44-39	7	7.0
Total	**100**	**100.0**



Figure(4-1): Distribution of 100 pregnant women scanned during the study period according to Maternal age group

Table (4-2): Distribution of 100 pregnant women scanned during the study period according to gestation's age:

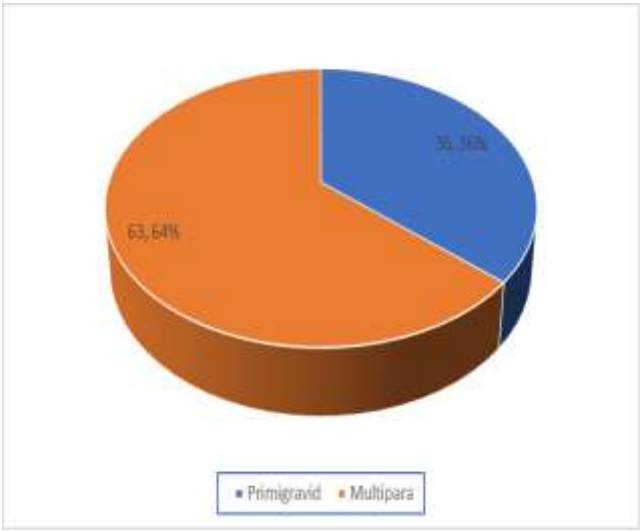
Gestational age	Frequency	Percent
weeks 20-15	3	3.0
weeks 26-21	10	10.0
weeks 32-27	41	41.0
weeks 38-33	38	38.0
weeks 44-39	8	8.0
Total	**100**	**100.0**



Figure(4-2):Distribution of 100 pregnant women scanned during the study period according to gestation's age:

Table (4-3):Distribution of 100 pregnant women scanned during the study period according to parity :

	Frequency	**Percentage**
Primary gravid	36	%36.4
Multipara	63	%63.6
Total	**100**	**%100**



Figure(4-3) : Distribution of 100 pregnant women scanned during the study period according to parity .

Table (4-4): Correlation between SDP and AFI

		AFV_AFI
AFV_SDP	Pearson Correlation	0.248
	(tailed-2) .Sig	0.013
	N	100

Table (4-5): Correlation between SDP and AFI with respect to gestational **.**age

Control Variables			AFV_AFI
Gestational age	AFV_SDP	Correlation	0.237
		-Significance (2 (tailed	0.018
		df	97

Table (4-6): and AFI with respect to maternal Correlation between SDP age.

Control Variables			AFV_AFI
Maternal age	AFV_SDP	Correlation	0.249
		-Significance (2 (tailed	0.013
		df	97

Table (4-7):correlation between SDPand AFI with respect to maternal .weight

Control Variables			AFV_AFI
Maternal weight	AFV_SDP	Correlation	0.248
		-Significance (2 (tailed	0.013
		df	97

Table (4-8): Mean SDP and AFI with respect to parity

	Para	N	Mean	Std. Deviation
AFV_SDP	Primary gravidity	36	5.74	1.293
	Multipara	64	6.73	8.372
AFV_AFI	Primary gravidity	36	16.82	2.251
	Multipara	64	16.97	2.342

Table (4-9): test for equality of mean SDP and AFI with respect to -t parity

	test for Equality of Means-t				
		-Sig. (2 (tailed	Mean Difference	Std. Error Difference	
AFV_SDP	0.707-	98	0.481	-0.995	1.408
AFV_AFI	0.326-	98	0.745	-0.157	0.481

Chapter Five

Discussion, Conclusion &Recommendations

5.1 Discussion:

This study was analytical and descriptive study deal with the role of ultrasound to evaluation of amniotic fluid volume in pregnant women among Sudanese population,the data in this study was collected from 100 pregnant women pregnant in second and third trimester.

Table (4.1) and figure (4.1) show that the majority (83%) of participant old, while only (10%) of them were less than 21 years, years 38-were 21 ..and only (7%) of them were more than 38 years old

-Table (4.2) and figure (4.2) show that most (79%) of participant were 27 weeks 26-weeks for their gestation, since (10%) of them were in 21 38 of them were in more than 38 weeks of their gestation, while (%8) and .weeks 20-only (3%) of them were 15.

Table (4.3) and figure (4.3) show that most (63.6%) of participant were multipara, while (36.4%) of them have primary gravidity.Table (4.4) at the Pearsonabove shows th's linear correlation coefficients between SDP and AFI) is (0.248), with corresponding significance values of) demonstrating statistically significant weak positive relationships (0.013) s AFI increasebetween (SDP) and (AFI) indicating that SDP increases a

Table (4.5) above shows that the Pearson's linear correlation coefficients between (SDP and AFI) when gestational age considered is (0.237), with corresponding significance values of (0.018) demonstrating statistically ive relationships between (SDP) and (AFI) in significant weak posit presence of gestational age, indicating that SDP increases as AFI increase ..irrespective of gestational age

Table (4.6) above shows that the Pearson's linear correlation coefficients maternal age considered is (0.249), with between (SDP and AFI) when corresponding significance values of (0.013) demonstrating statistically significant weak positive relationships between (SDP) and (AFI) in presence of maternal age, indicating that SDP increases as AFI increase espective of maternal ageirr.

Table (4.7) above shows that the Pearson's linear correlation coefficients between (SDP and AFI) when maternal weight considered is (0.249), with corresponding significance values of (0.013) demonstrating

significant weak positive relationships between (SDP) and statistically AFI) in presence of maternal weight, indicating that SDP increases as) ..AFI increase irrespective of maternal weight

Table (4.8) provides useful descriptive statistics for the two groups that .mpared, including the mean and standard deviationwe co

test results will tell us if the mean (SDP and AFI) for the two groups -T were statistically different (significantly different) or they were relatively .the same

ultipara means for (SDP and We can see that the primary gravidity and m significantly different because the all values of -AFI), are statistically, non tailed) are more than 0.05. Looking at the -values in "Sig. (2-P Distributions of two groups table (4.8) above, we can conclude that there stically significant difference between (SDP and AFI) mean is no stati .measures for primary gravidity and multipara

The study showed that the amniotic fluid volume is varying according to

gestational age and it decreased from 27th week in the third trimester.

This study result are near to result obtained by Dr .Nadia Hussein/ universityof AL-Zaeim AL-Azhari in 2006, And result obtained byIgbinidu E etal(Radiology Department, College of Medicine, University of BeninTeachingHospital, Benin City, Nigeria).And found that the amniotic fluidvolume in Sudanese population and in Nigeria are higher than, Iranianpopulation.

One limitation of our study was the low sample size we studied in each gestation week.

5.2 Conclusion

This study shows that most Sudanese pregnant ladies have normal amniotic fluid volume and abnormal amniotic fluid volume is rare ultrasonography finding.

The study shows that the mean of normal AFI from 27week to 40week GA in Sudanese pregnant ladies is at 27week GA and gradually declined to a mean of at 40 week GA Normal AFI occurs in 100%

5.3 Recommendations

-Assessment of amniotic fluid volume is an essential part for antenatal care and follow up by u/s should be done in all pregnant ladies to predict prenatal complication.

-For better interpretation of AFV normal reference value for this index in various weeks of pregnancy in Sudanese pregnant ladies are utterly needed.

-Multicenter studies are recommended for providing more accurate estimate of the normal range of AFV in Sudanese population.

-Early diagnosis and better management of fetal abnormalities incidence of polyhydramnios and oligohydramnios.

- Primary health care centers should be with ultrasound machine.

- All doctors and sonologists should be well training in fetal well-bearing and mother health , the assessment of fetal well-bearing to decrease the mortality and morbidity.

- The operators should update their knowledge about techniques use and any information regarding ultrasound.

- It is recommended that other factors which can effect on accuracy of amniotic fluid volume and contribute to differences should evaluate in further studies.

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APPENDICES

Appendix(1)

SUDAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

Collage of Graduate studies

Data Collection Sheet

Sonographic Evaluation of Amniotic Fluid Volume in Pregnant women During 2nd & 3rd Trimesters in Khartoum State

1- Patient Number:(……). Date:.....\.....\2019.

2-Patient age: (……) Years.

3- Gestational Age :(…….……) weeks. BPD (……...….), FL (……..……), AC (…….…..……).

4-Amniotic fluid volume: SDP (…..…).4pockets (…….).

Normal (…….…) Polyhydramnios (…….).oligohydramnios (…….).

5- Consistency of amniotic fluid:

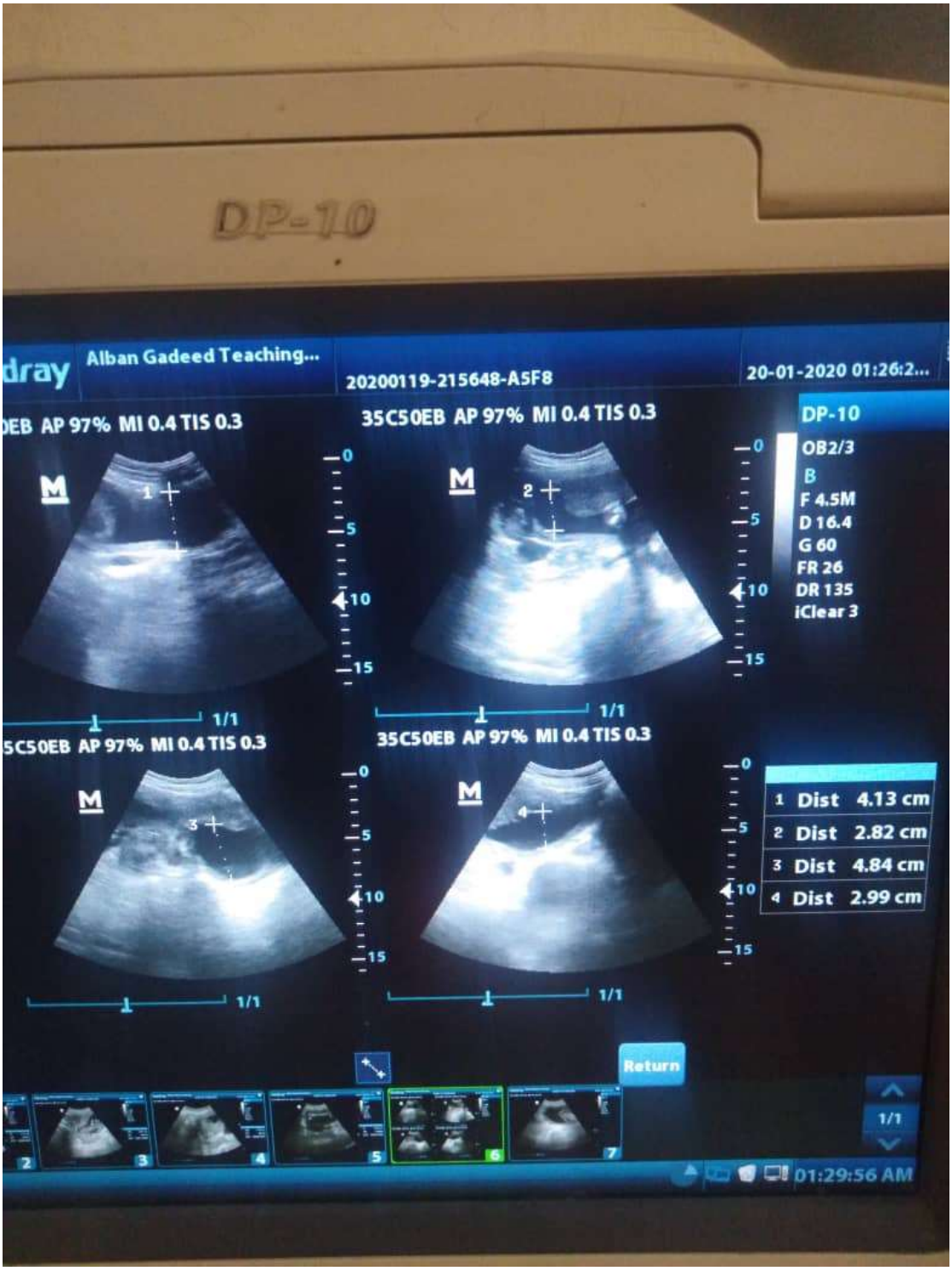
Echo free (……..). With debris (……).

6- EFW :(……..…) kg.

Normal (…….) Macrosomia (……).

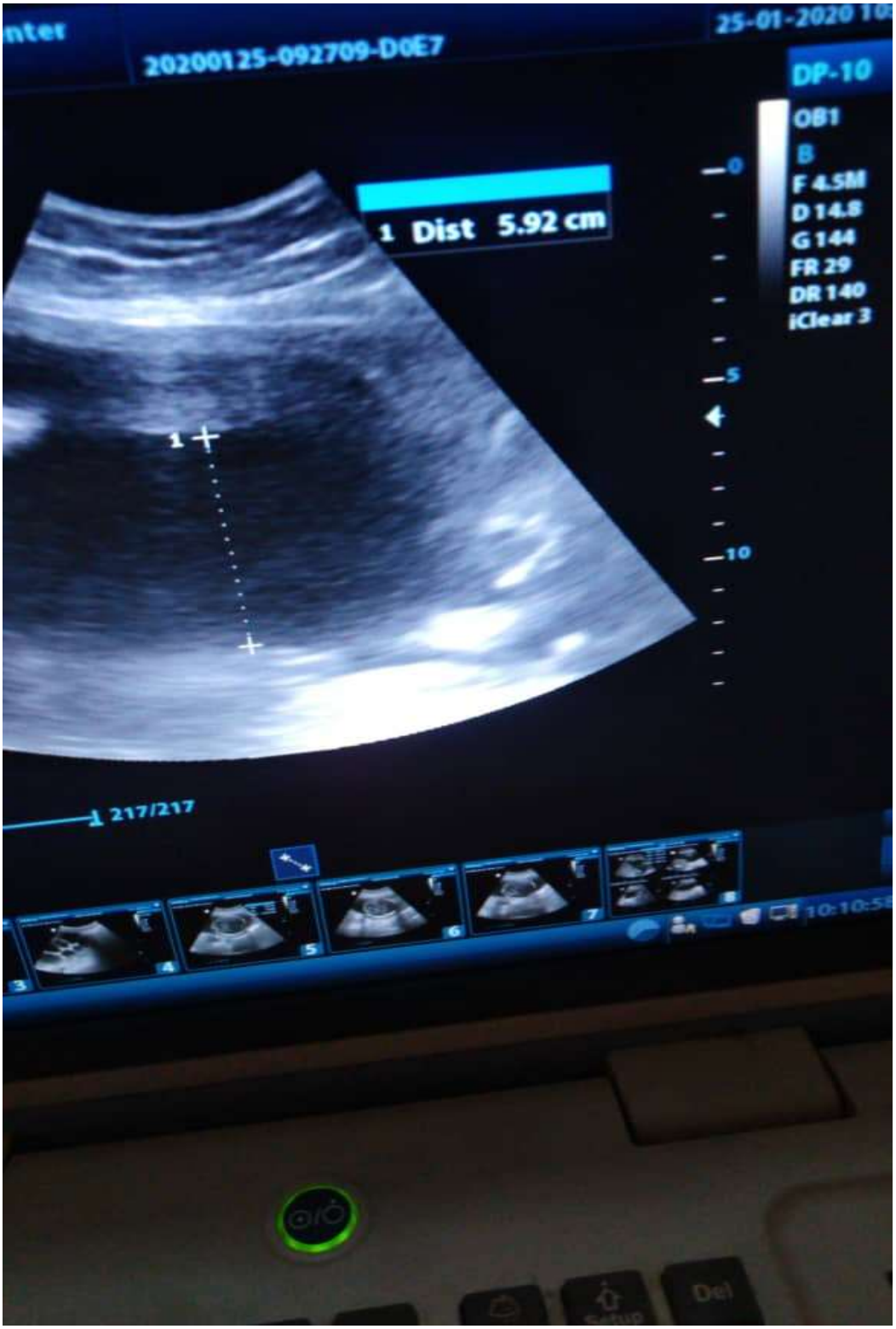
7- Congenital fetal anomalies:Yes (…….) No (…….).

Appendix(2)

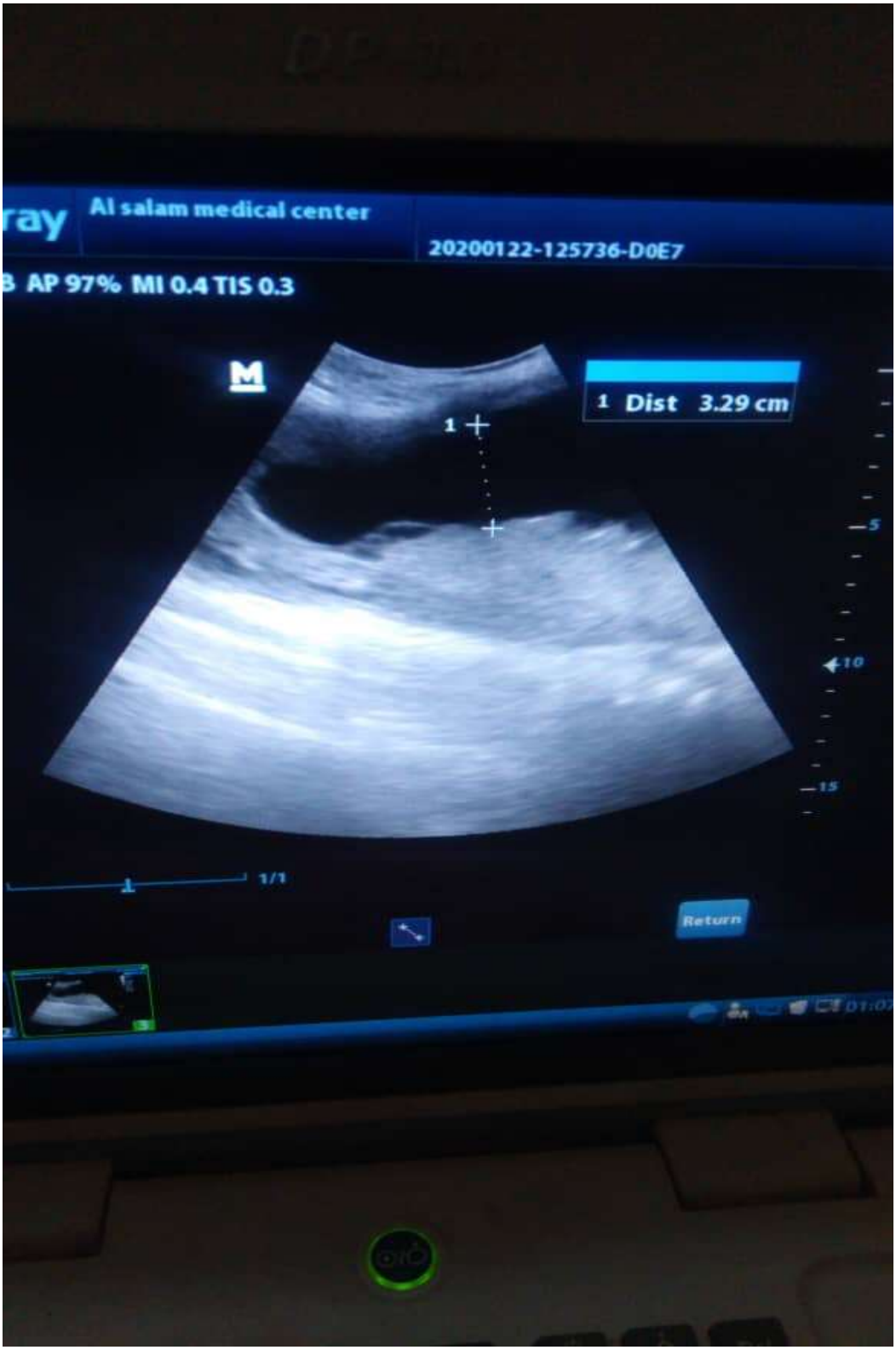


Pregnant women 28 years old and 33 week gestational age AFI 14.78 cm

Pregnant women 28 years old and 33 week gestational age SDP2.53cm



Pregnant woman 32 years old and 28 weeks gestational age and SPD 5.92 cm



Pregnant woman 25 years old and 30 weeks gestational age and SPD 3.29 cm