



**Sudan University of Science and Technology**

**College of Graduate Studies**



**Evaluation of Normal Amniotic Fluid Volume in third Trimester  
Using Ultrasonography**

تقويم الحجم الطبيعي للسائل الامنيوني في الثلث الاخير للحمل باستخدام الموجات فوق الصوتية

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

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(آية: 114)

## **Dedication**

All praise to Allah, today we fold the days tiredness and the errand summing up between the cover of this humble work.

To utmost knowledge lighthouse, to our greatest and most honored prophet Mohamed –May peace and grace from Allah be upon him.

To the spring that never stops giving, to my mother who weaves my happiness with strings from her merciful heart to my mother.

To the big heart my dear father

To those who have demonstrated to me what is the most beautiful of life my children

To whom he strives to bless comfort and welfare and never stints what he owns to push me in the success way to my husband.

To those who taught us letters of gold and wards of jewel of the utmost and sweetest sentences in the whole knowledge to our honored teachers.

## **Acknowledgement**

I would like to express my appreciation to my supervisor who has cheerfully answered my queries, provided me with material, assisted me in a myriad ways with the writing and helpfully commented on earlier drafts of this study. Also, I am also very grateful to my friends, family for their good humor and support throughout the production of this study.

## **Abstract**

The study was carried out to assess the amniotic fluid volume in third trimester by ultrasound in Sudanese patients at Khartoum state-Sudan in Elrakha hospital, Elsoudy hospital and Ahfad family health center in period from March to October 2016. The study aimed to identify normal value of amniotic fluid in Sudanese pregnant ladies in third trimester and to correlate gestational age with amniotic fluid volume in Sudanese pregnant ladies. The study concluded several results including, found most of Sudanese pregnant ladies have normal amniotic fluid 96% and few pregnant ladies have abnormal amniotic fluid 4%. The study reviewed the international studies of normal amniotic fluid volume in different countries and found that the amniotic fluid volume is different from population to population due to environment, maternal size and intrauterine volume and not have constant value. The study recommended that assessment of amniotic fluid volume by ultrasound is an essential parameter of antenatal care.

### ملخص البحث

هذه الدراسة أجريت لتقييم حجم السائل الامنيوني للسيدات السودانيات الحوامل في الثلث الاخير من الحمل باستخدام فحص الموجات فوق الصوتية بولاية الخرطوم في كل من مستشفى الرخا والمستشفى السعودي و مركز الاحفاد لتنظيم الاسرة وذلك في الفترة من شهر مايو لشهر اغسطس لسنة 2016م.

الهدف من هذه الدراسة هو تحديد الحجم الطبيعي للسائل الامنيوني للسيدات السودانيات الحوامل في الثلث الاخير من الحمل وربط حجم السائل الامنيوني بعمر الجنين. من النتائج المستنتجة من هذه الدراسة:

ان أغلب قياس السائل الامنيوني لدي النساء السودانيات الحوامل بحجمة الطبيي وذلك بنسبة 96% منهن و4% منهن غير طبيعى وكذلك اوجدت هذه الدراسة بعد مراجعة الدراسات السابقة ان الحجم الطبيعى للسائل الامنيوني للحوامل يختلف من منطقة لاخرى بحسب عوامل متغيرة منها بيئة المنطقة وحجم المرأة الحامل وحجم رحمها.

### Abbreviate table

AF	Amniotic fluid
AFI	Amniotic fluid index
GA	Gestational age
IUGR	Intrauterine growth restriction
M/AFI	Mean of Amniotic fluid index
M/SDP	Mean of Single deepest pocket
N/pt	Number of patient
NO	Number
PROM	Premature rupture of membranes
SDP	Single deepest pocket
US	Ultrasound

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## Chapter one

### 1-1 Introduction:

The amniotic fluid is clear watery fluid that is surrounded by sac called the amnion. And it is produced by its cellular wall. The possible sources of amniotic fluid in the first trimester include transudate of maternal plasma through the chorioamnion or from fetal plasma through the permeable fetal skin prior to keratinization. In the second and third trimester of pregnancy amniotic fluid volume is maintained by a balance of fetal fluid production in lung fluid and urine as well as fluid resorption in fetal swallowing and flow across the fetal membranes to the uterus. [William 2001]

The amniotic fluid cushions the embryo, providing it with nutrition, maintains a constant temperature, prevents the amnion from adhering to the developing embryo and permits symmetrical growth, helps in the development of the fetal lung and free movement of the fetus. The amniotic fluid volume is an important marker of intrauterine fetal wellbeing; the excessive or reduced production of amniotic fluid during pregnancy is a strong predictor of possible associated congenital fetal anomalies. [Umar 2004]

Polyhydramnios is defined as amniotic fluid volume greater than normal for gestational age while oligohydramnios is amniotic fluid volume that is abnormally low for gestational age. Polyhydramnios is associated with fetal neural tube defects, central nervous system abnormalities, affecting fetal swallowing, gastrointestinal obstruction, infection, isoimmunisation, gestational diabetes 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. [Umar 2004]

Sonography is the method of choice for diagnosis and assessment of amniotic fluid volume and it 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 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. [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]

**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- Problem of study:**

Assessment of 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 prenatal complications.

### **1- 3- Objectives:**

#### **1-3-1- General objective:**

To determine amniotic fluid volume among Sudanese pregnant women.

#### **1-3-2- Specific objective:**

To determine normal values of amniotic fluid volume for Sudanese population.

To determine incidence of polyhydramnios and oligohydramnios in Sudan and determine of them.

#### **1-4Over view of study:**

Chapter [1]: Will be include Introduction.

Chapter [2]: Will be include literature review [include anatomy and physiology and pathology and pervious study.

Chapter [3]: This will be including methodology

Chapter [4]:This will be include result and analysis

Chapter [5]: This will be including discussion, conclusion, recommendations, appendices and references.

## Chapter Two

### Literature review

#### 2-1 Anatomy

##### 2-1-1 Amnion and amniotic cavity:

The amnion is a membrane that closely the embryo. It fills with the amniotic fluid which causes the amnion to expand and become the amniotic sac, this fluid increases in quantity and causes the amnion to expand and ultimately to adhere to inner surface of the chorionic.

The amnion and amniotic cavity emerge at about (day 22-23) last period or (8 day following conception). The amniotic cavity initially, is small and line one side of the embryo while the other side is lined the yolk sac, then the amniotic cavity completely envelope the embryo (Dean 1992).



Figure (1-1) 10-week-old human fetus surrounded by amniotic fluid within the amniotic sac

##### 2-1-2 Amniotic fluid:

###### 2-1-2-1 Definition:

Amniotic fluid is a clear, slightly yellowish liquid that surrounds the embryo during pregnancy. It is contained in the amniotic sac. [Abramovich 1979]

###### 2-1-2-2 Characteristics of amniotic fluid:

It is water content and osmolality. At first time amniotic fluid has an electrolyte composition and osmolality similar to that of fetal and maternal

blood. As fetal urine begins to enter the amniotic cavity, amniotic fluid osmolality decreases compared with fetal blood. At term it contains 99% water. The osmolality, sodium, urea and creatinine is not significantly different from the maternal serum. The osmolality is lowest at term (250-260mOsm/kg) compared with fetal blood osmolality of 280mOsm/kg water. This is a result of extremely hypotonic fetal urine(60-140mOsm/kg water) in combination of lesser volume of lung fluid. [ Abramovich 1979]

### **2-1-2-3 Color:**

It's slightly turbid, but may be greenish-brownish if contaminated with any meconium, or blood stained if any blood passed. [ Abramovich 1979]

### **2-1-2-4 Amniotic Fluid Production**

In the first half of pregnancy, amniotic fluid is derived from fetal and possibly maternal compartments. Water and solutes freely traverse fetal skin and may diffuse through the amnion and chorion as well.<sup>1</sup> Thus amniotic fluid in early gestation is a dialysis that is identical to the fetal and maternal plasma, but with a lower protein concentration. Active secretion of fluid from the amniotic epithelium had been previously suggested to play a role in early amniotic fluid formation, but this has not been demonstrated.[ Abramovich 1979]

By the second trimester, the fetal skin becomes keratinized, making it impermeable to further diffusion. At this time, a fetus contributes to amniotic fluid volume and composition almost exclusively through urination. Urine has been observed in the fetal bladder as early as 11 weeks transabdominally and 9 weeks transvaginally. Because fetal urine is hypotonic (80–140 mOsm/liter), it results in progressively hypotonic fluid (250–260 mOsm/liter near term) that contains increasing concentrations of urea, uric acid, and creatinine as the fetal kidneys mature. By term, a fetus produces on average from 500 to 700 ml/day with a slight decline in hourly fetal urine production after 40 weeks' gestation.[Abramovich 1979],



### **1-2-3Amniotic sac:**

The amniotic sac, commonly called the bag of waters, sometimes the membranes, is the sac in which the fetus develops in amniotic. It is a thin but tough transparent pair of membranes that hold a developing embryo and later fetus until shortly before birth. The inner of these fetal membranes, the amnion, encloses the amniotic cavity, containing the amniotic fluid and the fetus. The outer membrane, the chorion contains the amnion and is part of the placenta. On the outer side,, the amniotic sac is connected to the yolk sac, to the allantois and, through the umbilical cord, to the placenta. The chorion is a bilayered membrane formed by 7.5 dpc, consisting of an outer layer of extra embryonic ectoderm (trophectoderm) and an inner epiblast-derived extra embryonic mesoderm. The chorion bilayer fuses at 8.5 dpc with the allantois and together they form the chorioallantoic placenta [Larsen etl 2001]

### **2-1-4Chorion and chorionic cavity:**

The chorionic bilayer lines the chorionic cavity which is one of three cavities in the embryo: chorion, amnion and yolk sac. The chorionic cavity is formed as the extraembryonic mesoderm splits into two layers, and the embryo (with the dorsal amnion and ventral yolk sac) is separated from the chorion, the outermost layer. The embryo remains enclosed in the chorionic cavity with the connecting stalk serving as the sole anchor to the outer chorion (placenta) by 13 day before certonization. [Larsen et al 2001]

### **2-2 physiology:**

#### **2-2-1Amniotic fluid circulation:**

The amniotic fluid volume (AFV) is regulated by several systems, including the intramembranous pathway, fetal production (fetal urine and lung fluid) and uptake (fetalswallowing), and the balance of fluid movement via osmotic gradients nous pathway (movement of water and solutes across the surface area of the amnion and chorion), secretions by the fetal oral-nasal cavities, and

movement of water across the highly permeable fetal skin during early gestation.

In early gestation, substantial amounts of amniotic fluid are present before the establishment of fetal urine production. Little is known about the dynamics of amniotic fluid early in gestation, but a likely scenario is the active transport of solutes across the amnion into the amniotic space with water moving passively down the chemical gradient. The fluid may also arise as a transudate of plasma across fetal non-keratinized skin or from the mother across the uterine decidua and/or the placental surface. [Chudleigh 2004]

Much more is known about the dynamics of the AFV in the second half of pregnancy after fetal skin keratinizes at 22 to 25 weeks' gestation, resulting in the prevention of further water movement across skin. As the gestational age increases, amniotic fluid osmolality and sodium concentrations decrease, which is thought to be due to the increasing production of diluted fetal urine. Amniotic fluid osmolality ultimately reaches 250 to 260 mosm/mL at term. [Chudleigh 2004]

Fetal urine production is the predominant source of amniotic fluid in the second half of pregnancy, as evidenced by the almost complete absence of amniotic fluid with renal agenesis or fetal urinary tract obstruction. Fetal urine first enters the amniotic space at 8 to 11 weeks' gestation and constantly increases throughout gestation. Estimates of fetal urine output have been made from sonographic studies of the fetal bladder measured at regular intervals. The best estimate of the human fetal urine output at term is 700 to 900 ml per day.

The fetus is able to respond to changes in fluid status by adjusting urine flow and thereby contributes to the regulation of the AFV. [Chudleigh 2004]

Fetal swallowing plays a vital role in the maintenance of the AFV, as evidenced by the association of hydramnios with disturbances in fetal swallowing. The human fetus begins to swallow at the same time that fetal

urine begins to enter the amniotic cavity, around 8 to 11 weeks' gestation. Near term, the human fetus swallows an estimated average of 210 to 760 mL per day. [Chudleigh 2004]

The fetal lung secretes considerable fluid that is largely isotonic with fetal plasma, approximating 350 mL per day at term. At least half of the secreted lung fluid is immediately swallowed, however, so that the net of lung fluid secretion (150–170 mL/day) and its effect on AFV is small relative to the fetal urinary contribution. [Chudleigh 2004]

Intramembranous and Tranmembranous Pathways is the sum of the fetal urine production plus the secreted fetal lung fluid minus the amount removed via fetal swallowing leaves approximately 400 mL in excess within the amniotic cavity. Intramembranous movement of water and solutes into the fetal circulation across the fetal vessels on the surface of the placenta is driven by the osmotic difference between the fetal circulation and the amniotic fluid.[Chudleigh 2004]

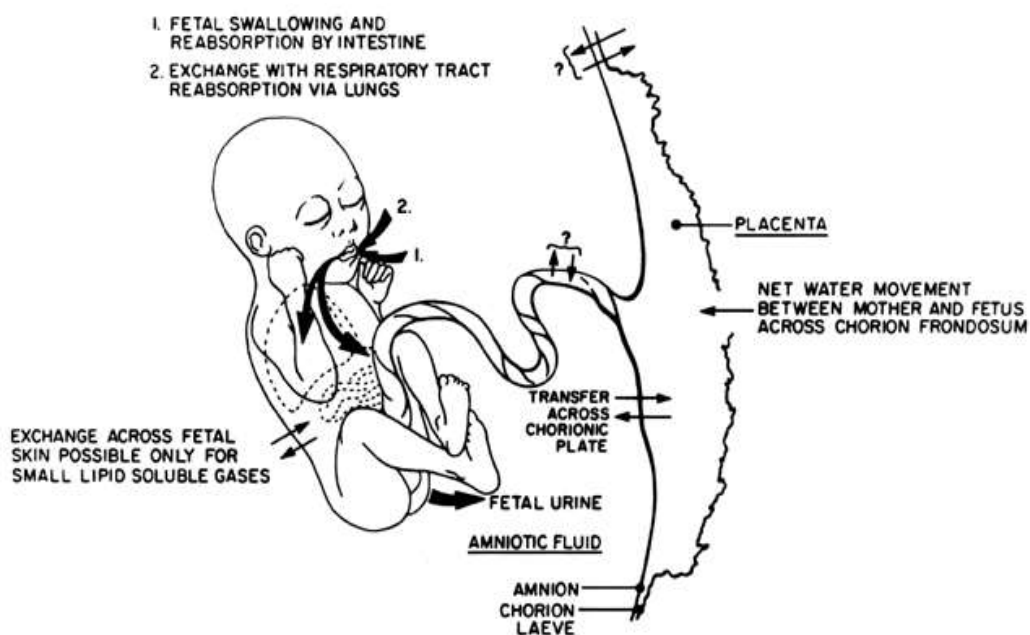


Figure 2-1 Amniotic fluid circulation. (Seeds AE: Amniotic fluid physiology. In Sciarra JJ (ed): Gynecology and Obstetrics, Vol 3. New York, Harper & Row, 1989)

### **2-2-2Function of amniotic fluid:**

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's abdomen, allowing for easier fetal movement and promoting muscular/skeletal development. Amniotic fluid swallowed by the fetus helps in the formation of the gastrointestinal 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 1970s show that in a healthy fetus, there is no inward flow of amniotic fluid into the airway. Instead, lung development occurs as a result of the production of fetal lung fluid which expands the lungs. ( Lily 1972 )

### **2-2-3 Normal amniotic fluid volume:**

Amniotic fluid volume is most predictable in the first half of pregnancy, when it correlates with fetal weight. This may relate to the predominant contribution of fetal skin dialysis to amniotic fluid volume between 8 and 20 weeks. At 12 weeks' gestation, the average volume is 60 ml. By 16 weeks, when genetic amniocentesis is often performed, the mean volume is 175 ml. From 20 weeks on, there is greater variance of amniotic fluid volume. It has been determined that amniotic fluid volume increases steadily throughout pregnancy to a maximum of 400–1200 ml at 34–38 weeks. However, wide variation does exist; increase of amniotic fluid is only 5–10 ml/day in the third trimester. After 38 weeks, fluid volume declines by approximately 125 ml/week, to an average volume of 800 ml at 40 weeks. After 43 weeks, this volume is reduced to 250 ml. (Brance 1989)

### **2-3Pathology:**

#### **2-3-1 Oligohydromnios/Anhydromnios:**

Oligohydramnios/anhydramnios is defined as reduced/absent amniotic fluid volume for a given gestational age. The finding of anhydramnios in the first and second trimesters is usually associated with a poor prognosis because of

the subsequent development of lethal fetal pulmonary hypoplasia. Prolonged oligohydramnios/anhydramnios is also associated with limb contractures, such as talipes.

### **2-3-1-1 Causes of oligohydramnios/anhydramnios:**

There are three main pathological reasons for the finding of reduced or absent amniotic fluid:

#### **2-3-1-1-1 Uteroplacental insufficiency :**

oligohydramnios is an early feature of uteroplacental insufficiency and is associated with decreased fetal biometry particularly the abdominal circumference. Other ultrasound features, such as echogenic bowel, mild cardiomegaly and abnormal uteroplacental/fetal Dopplers, aid in the confirmation of uteroplacental insufficiency as the cause for the reduced amniotic fluid volume.[varma et al 2004]

#### **2-3-1-1-2 Amniotic membrane rupture –**

The maternal history of persistent vaginal loss and dampness would suggest a diagnosis of prelabor membrane rupture. The latter is often associated with anhydramnios rather than oligohydramnios. The finding of normal amniotic fluid volume or oligohydramnios, however, does not exclude this diagnosis. Hence, ultrasound is of limited diagnostic value when this diagnosis is suspected .[varma etl 2004]

#### **2-3-1-1-3 Abnormal fetal renal function**

Unilateral renal problems in the fetus are usually associated with normal amniotic fluid volume. Conversely, bilateral renal agenesis, polycystic kidney disease, multicystic dysplasia and bladder outflow obstruction characteristically present with anhydramnios on ultrasound.[varma et al 2004]

### **2-3-1-2 Management:**

Anhydramnios as a consequence of renal pathology or early/midtrimester membrane rupture is frequently associated with a poor prognosis. If oligohydramnios is due to uteroplacental insufficiency, the management will

depend on the severity of growth restriction and the gestation of the pregnancy.

Oligohydramnios of unknown etiology is of dubious clinical significance. Given the poor reproducibility of subjective and objective amniotic fluid estimations, one could question the value of reporting this when present as an isolated finding. The exception to this recommendation would appear to be prolonged or post-term pregnancy, where reduced amniotic fluid volume can be associated with poorer fetal and neonatal outcomes.[moise et al 1988]

### **2-3-2 Polyhydramnios:**

#### **2-3-2-1 Incidence and Origin:**

Polyhydramnios, or hydramnios, is defined as an excessive volume of amniotic fluid relative to the gestational age. Polyhydramnios may be acute or chronic. Acute polyhydramnios is usually a fulminate second-trimester process, with fluid accumulating rapidly over a period of a few days. Chronic polyhydramnios has a more gradual onset and course, often presenting in the third trimester. The incidence varies, depending on whether the diagnosis is clinical or sonographic. Overall, polyhydramnios complicates approximately 0.3–1.6% of all pregnancies. Chronic polyhydramnios is more frequent, exceeding the incidence of acute polyhydramnios by a 50: 1 ratio.(Queenan et al 1970)

#### **2-3-2-2 Risk factors:**

Risk factors for polyhydramnios may be broadly divided into maternal, fetal, placental and idiopathic origins (Table 1).

##### **2-3-2-2-1 Maternal conditions:**

###### **2-3-2-2-1-1 Diabetes mellitus:**

Diabetes mellitus is the most common maternal factor, occurring in approximately 25% of cases. The exact mechanism for polyhydramnios with diabetes is unclear. It may represent fetal polyuria secondary to fetal hyperglycemia. However, van Otterlo and colleagues, measuring fetal urinary

output by ultrasonography, found no increase in urine output in 12 of 13 diabetic pregnancies complicated by polyhydramnios. Alternatively, fetal glycosuria may lead to an increase in amniotic fluid osmolality, resulting in water transfer from the fetal compartment to maintain osmolar equilibrium. Pedersen, however, found no association between amniotic fluid glucose concentration and volume. (vanOtterlo et al 1977)

#### **2-3-2-2-1-2 Isoimmunization:**

Isoimmunization is another, albeit decreasing, cause of polyhydramnios. The proposed inciting mechanism is extramedullary hematopoiesis in response to fetal anemia, which results in portal hypertension and hypoalbuminemia. The decrease in colloid oncotic pressure, as well as hydrostatic venous engorgement, leads to extravasation of fluid into the interstitium of the placenta. How this extravascular fluid results in hydramnios is unclear. The extracellular fluid could possibly be transferred across the placenta and membranes into the amniotic cavity. Alternatively, the interstitial fluid in the placenta could perhaps interfere with water transfer between the fetal and maternal compartments, resulting in fetal volume overload, polyuria, and ultimately polyhydramnios. (Wallenburg et al 1977)

#### **2-3-2-2-2 Fetal conditions:**

Fetal conditions have been observed in approximately 20% of polyhydramnios cases. Fetal malformations of the central nervous system (CNS) comprise almost 50% of fetal anomalies, with anencephaly being the most common. The postulated mechanisms for polyhydramnios due to CNS malformations include centrally-mediated reduction in fetal swallowing, fetal polyuria resulting from insufficient production of vasopressin from the fetal pituitary, and transudation of fluid across the uncovered meninges. Gastrointestinal anomalies constitute the second leading structural fetal cause. Any gastrointestinal obstruction proximal to the ligament of Treitz, such as

duodenal or esophageal Arteria, may interfere with the effective removal of amniotic fluid by the alimentary tract. . (Jacoby1966)

Fetal circulatory disturbances account for approximately 7% of fetal anomalies responsible for hydramnios. Structural cardiac malformations and persistent fetal arrhythmias may result in right and left heart failure. Presumably, the resulting increase in venous pressure causes an elevation in hydrostatic pressure in the fetal capillaries, with transudation of fluid into the interstitial space. This mechanism would occur systemically in the fetus, leading to the characteristic appearance of nonimmune hydrops (subcutaneous edema, ascites, pleural and pericardial effusions), as well as in the placenta, resulting in polyhydramnios. . (Jacoby1966)

Other circulatory disturbances can also result in polyhydramnios. In twin-to-twin transfusion syndrome, the recipient twin becomes plethoric and may develop hydramnios, either through volume overload, increased renal blood flow, and polyuria, or through a hydropic placenta. The donor twin becomes anemic, often leading to oligohydramnios and the “stuck twin” syndrome. Placental chorioangiomas and sacrococcygealteratomas are other abnormalities in which large arteriovenous shunts may lead to high-output cardiac failure and ultimately polyhydramnios.

Inadequate fetal respiratory activity secondary to anomalies may prevent fluid absorption at the alveolar/capillary interface, leading to polyhydramnios. Examples include compressing tumors, such as cystic adenomatoid malformations, displaced abdominal contents, such as congenital diaphragmatic hernia, and thoracic wall abnormalities, such as thanatophoric dysplasia. . (Jacoby1966)

Polyhydramnios not associated with an identifiable cause is labeled “idiopathic” and accounts for 30–60% of cases. Further research is necessary to identify other as yet undetermined causes. One such possibility is a disorder of intra-amniotic prolactin regulation by the chorion and decidua.



Under normal circumstances, prolactin may be partially responsible for control of water homeostasis in the intra-amniotic environment. *In vitro* studies on human amnion have shown reduced diffusion of water in response to ovine prolactin administered on the fetal side of the membrane. Hence, an overproduction of decidual prolactin may impair diffusional flow of water away from the amniotic compartment, leading to polyhydramnios . (Jacoby1966)

### **2-3-2-3 Clinical Presentation:**

The maternal signs and symptoms of polyhydramnios are usually caused by the overdistended uterus and its compressing effect on intrathoracic and intra-abdominal organs. Elevation of the diaphragm can result in dyspnea and occasionally respiratory distress. Back and abdominal discomfort are also frequent complaints, as are nausea and vomiting. Edema of the lower extremities may result from compression of the inferior vena cava (Queenan et al 1970)

### **2-3-2-4 Diagnosis of Polyhydramnios :**

The diagnosis of polyhydramnios had formerly been a clinical one, retrospectively based on the presence of more than 2000 ml of amniotic fluid at the time of delivery or membrane rupture. Antenatal suspicion was raised by difficulty in palpating fetal parts, distant fetal heart sounds by unamplified auscultation, a tense uterine wall, and disproportionate growth of the fundal height. Historically, amniography was used to qualitatively assess amniotic fluid volume. This method was subsequently supplanted by static ultrasonographic imaging, which was used to calculate total intrauterine volume (TIUV). However, inaccuracies in measurement as well as the advent of real-time ultrasonography led to the abandonment of TIUV. Real-time ultrasonography is now the primary means of amniotic fluid volume assessment; however, strict ultrasonographic criteria have never been uniformly adopted. Chamberlain and colleagues arbitrarily defined

polyhydramnios as a fluid pocket of at least 8 cm in vertical and transverse diameters. Using this criterion, the incidence of polyhydramnios in a select high-risk referral population was 3.2%. Those patients with polyhydramnios had a higher incidence of major congenital anomalies (4%), macrosomia (33%), and perinatal mortality (3.3%) compared to a control group with normal amniotic fluid volume. An AFI of greater than 20 cm was arbitrarily defined as excessive amniotic fluid volume. An alternative to the semi-quantitative techniques mentioned above is simply the subjective impression of increased amniotic fluid volume.<sup>1</sup> Subjective criteria have included the displacement of the fetus from the anterior uterine wall by amniotic fluid, as well as the presence of “floating extremities. Simply put, if there appears to be excessively abundant fluid, it probably is. Bottoms and colleagues, using subjective criteria, found that the sensitivity and positive predictive value in detecting infants large for gestational age were similar to the 8-cm largest vertical pocket rule.<sup>(Chamberlain 1984)</sup>

### **2-3-2-5 Perinatal Complications:**

The increased prenatal morbidity and mortality associated with polyhydramnios are due to both an increase in congenital/genetic anomalies and preterm births. Prenatal mortality used to approach 100% with acute polyhydramnios however, with aggressive repetitive amniocentesis, survivors have been reported. Chronic polyhydramnios tends to have a better prognosis, especially if idiopathic in origin. Prenatal mortality has ranged from 34% to 69% in older studies. However, Chamberlain and colleagues quoted a 3.3% mortality when the diagnosis was made sonographically. Some of the variation in survival may be a function of diagnostic criteria differences and prenatal therapy, as well as improved survival of both preterm and anomalous infants.<sup>(Zama et al 1982)</sup>

Polyhydramnios may be complicated by preterm labor in up to 26% and premature rupture of membranes in up to 19% of cases. Both may occur as a

result of overdistention of the uterus. Malpresentations are also encountered more frequently, as a result of both the abundance of amniotic fluid in which the fetus may maneuver and the earlier gestational age at the time of delivery. Other intrapartum complications may include placental abruption due to rapid decompression of the uterus at the time of rupture of membranes, dysfunctional labor patterns, and postpartum hemorrhage as a result of uterine tony. (Zama et al 1982)

### **2-3-2-6 Clinical Management:**

Treatment of polyhydramnios may be medical or surgical or both. The method chosen will depend on the etiology, severity, clinical symptoms, and gestational age at diagnosis, as well as the presence and type of associated anomalies.

If the diagnosis is made on the basis of ultrasonographic findings, an attempt should be made to establish the cause. In cases that are not acute or severe and are not associated with a fetal malformation, patients should be rescanned periodically to assess the progression or improvement of the fluid volume. Some reports have documented gradual resolution of polyhydramnios, either spontaneously or as a result of treating the underlying cause (*e.g.*, control of hyperglycemia, intrauterine transfusion of the anemic fetus). These pregnancies progressed uneventfully after resolution of the polyhydramnios, with no adverse sequel observed. ( Hill 1988)

In the absence of rapidly progressive polyhydramnios or maternal symptoms, management is expectant. If a patient experiences increasing dyspnea, back pain, or preterm labor, hospitalization for possible tocolysis and amniocentesis should be considered. ( Moise1988)

Medical management, including salt restriction, diuretics, and intra-amniotic vasopressin has not proved beneficial. Indomethacin has been suggested as a therapeutic modality to reduce the amniotic fluid volume, because it has been observed to decrease urinary output in neonates being treated for patent

ductus arteriosus. A reduction in amniotic fluid has been observed in one series of eight patients with hydramnios treated with indomethacin, as documented by decreasing fundal height measurements and largest vertical fluid pocket by ultrasonography. This observation further confirms the important contribution of fetal urination in overall amniotic fluid dynamics. Although case reports and early studies suggested the therapeutic benefit of indomethacin in the treatment of polyhydramnios, it is not typically used in the third trimester, due to its recognized effects of in-uteri narrowing of the fetal ductus arterioses, which can result in pulmonary hypertension postnatal. (Moise1988)

Therapeutic amniocentesis, or amnioreduction, is an effective modality for acute decompression of the tense and distended uterine cavity. It is typically performed for relief of maternal symptoms or preterm labor. It should be performed under ultrasonic guidance to avoid fetal contact, using a long 20 gauge amniocentesis needle which is often connected via plastic tubing to a suction bottle. Amnioreduction is usually accomplished over 30–45 minutes, although no ideal time period for drainage has been established. During this time, uterine contractions may occur, which can be uncomfortable for the patient. Typically, these contractions will abate spontaneously within 24 hours after the procedure has been completed. The quantity of amniotic fluid that should be removed has also not been established and may be dependent on gestational age, severity, and rapidity of re-accumulation. Volumes aspirated in various reports have ranged from 200 to 4000 ml. There has been concern that too rapid or too extensive a decompression could result in placental separation. Amniocentesis may need to be repeated initially 2–3 times in the first week, followed by weekly amnioreduction or as clinically indicated. Periodic evaluation of maternal electrolytes and serum protein may need to be assessed if frequent amniocenteses are required although no studies have demonstrated the efficacy of such surveillance (Pitkin1976)

## **2-4 Ultrasound assessment of amniotic fluid volume:**

### **2-4-1 Subjective assessment:**

The fetus occupies less than half of the intrauterine volume until approximately (22 weeks) in the normal pregnancy .Thereafter the fetus progressively occupies a larger proportion of the intrauterine volume. This is a qualitative assessment of amniotic and is therefore not standardize. (Chauhan2004)

### **2-4-2 Single deepest pocket measurement:**

Chamberlain, associates and others demonstrated that when the largest vertical pocket (LVP) was less than (1cm) ,prenatal morbidity was increase , and when it was less than (9.5cm) the prenatal mortality rate increased. (Chauhan2004)

Regarding the generally accepted technique for measuring the deepest amniotic fluid pockets, the following guidelines are typically observed:

- Orient the ultrasound transducer beam perpendicular to the patient's coronal plane and maintain aligned in the patient's sagittal plane.
- Search for the deepest unobstructed amniotic fluid pocket in the planes above, measuring the depth of the deepest pocket.
- Avoid measurements in gray areas on the screen; amniotic fluid is ordinarily near the black end of the gray scale.
- Avoid measuring into very narrow spaces between fetal structures and the uterus; the pocket should be at least several millimeters wide at all points.
- Do not measure through fetal anatomic structures (eg, arm or leg) or through a loop of umbilical cord.

Ultrasonographic estimation of amniotic fluid volume by measuring the largest vertical pocket:

(<1cm)~oligohydramnios

(1-2cm)~decreased fluid

(2-8)~normal

(>8cm)~polyhydramnios

Ultrasonographic estimation of amniotic fluid volume by measuring the largest vertical pocket (Manning 1981).

### **2-4-3 Amniotic fluid index:**

This is a semi quantitative technique for assessing amniotic fluid 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). Although the AFI is known to vary with gestational age, an AFI < 5 cm is classified as oligohydramnios and an AFI > 25 cm is classified as polyhydramnios. Even this method is accepted as superior to the single deepest pool technique,

There were some advantages of amniotic fluid index

- Easy to perform.
- More subjective approach than amniotic fluid assessment
- Requires little training to perform and is ideally suited to real time ultrasound.
- Provides a frame of reference for the inexperienced sonographer.
- Gives a better assessment of amniotic fluid volume than does the single deepest pocket measurement, as the sum of all four quadrants correlate more closely with volume than by using single measurement.(Dean 1992)

## **2-5 Previous studies:**

### **2-5-1 Ultrasound of amniotic fluid volume for Sudanese population in the 3<sup>rd</sup> trimester**

Dr . Nadia Hussein in 2006 university of AL-Zaeim AL-Azhari study the normal volume of amniotic fluid among Sudanese population in 3<sup>rd</sup> trimester by using ultrasound.

This study was carried out on hundred pregnant ladies in 3<sup>rd</sup> trimester scanned in Khartoum hospitals include Khartoum Bahri hospital ,Central police hospital and Saad Abo El-ella hospital .the data collected from September 2005 to may 2006. The study result found that most Sudanese population have normal amniotic fluid volume . Amniotic fluid index between 8-19.2cm in Sudanese population are consider normal while single deepest pocket between 2.2-8cm are consider normal.

### **2-5-2 Ultrasound of amniotic fluid and normal values for Sudanese population**

Ms.leilaElbdriokash in 2001 study the normal amniotic fluid volume in second and third trimester by ultrasound in Sudanese patient at Khartoum state-Sudan in Omdurman maternity hospital. the study results found most of Sudanese pregnant ladies have normal amniotic fluid 91.4% and few pregnant ladies have abnormal amniotic fluid 8.6%

### **2-5-3 Sonographic evaluation of the Amniotic Fluid Index in normal singleton pregnancies in a Nigerian population.**

Igbinidu E et al (Radiology Department, College of Medicine, University of BeninTeaching Hospital, Benin City, Nigeria).

This study was to assess the AFI in Nigerian women and correlate same with their gestational age. It is a prospective cross sectional study of 300 scanned singleton pregnancies between 15-42 gestational ages. Their amniotic fluid indices were determined and correlated with their gestational age. The study population mean AFI was  $12.91 \pm 4.82$ cm, ranging from 4.17 – 22.05cm and a

median of 12.56; . The mean AFI for preterm and term gestations were  $12.70 \pm 5.02$  cm and  $14.07 \pm 3.34$  cm respectively. There was no statistically significant difference between the mean AFI of the total study population and that of preterm and term gestations. The peak mean AFI value occurred at 28 weeks gestational age, with no bias in the distribution of amniotic fluid in the four quadrants of the uterus. Apart from establishing the normal AFI values in this environment, this study also showed that there was a weak positive correlation between gestational age and AFI.

#### **2-5-4 Ultrasonographic Assessment of Normal Amniotic fluid Index in A Group of Iranian Women**

Dr. Birang in 26 August 2007 ShahidBeheshti university of medical sciences, Tehran, Iran.

This study was carried out on 489 normal pregnant women with 20-42 week of gestational age scanned in Loghmanhospital .the mean (+-SD) gestation age of pregnant woman studies was  $31.46 \pm 6.1$  (range:20-41) week .The mean (+-SD) AFI was  $13.26 \pm 4.59$  (range:5.1-26.1) cm. The mean (+-SD) AFI was  $12.1 \pm 1.6$  cm (confidence interval 95 %:8.9-15.3) at the 20<sup>th</sup> week, increased to  $14.6 \pm 1.2$  cm (CI95%:12.2-17) at the 27<sup>th</sup> week, which then declined to  $10.9 \pm 1.2$  (CI 95%:8.5-13.3) at the 41 week.



## **Chapter three**

### **Materials and methods**

#### **3-1-Materials:**

##### **3-1-1 Study population:**

Seventy five normal pregnant women referred to ultrasound department for routine check up

**Inclusive criteria:** Any normal pregnant women in third trimester

**Exclusive criteria:** Women who had any fetomaternal pathology or complication

##### **3-1-2 Equipment:**

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.

#### **3-2 Method:**

Each patient scanned twice, firstly by researcher and secondly by a qualified sonologist to confirm the final diagnosis.

##### **3-2-1 Technique:**

An ultrasound procedure used to assess the amount of amniotic fluid. Patient positioning supine , applied coupling gel to lower abdomen, the deepest vertical pocket measured by using (3.5MH) frequencies.

The amniotic fluid index measured by dividing the uterus in to four imaginary quadrants. The lineanigra used to divide the uterus in to right and left halve.

The umbilicus served as the dividing point for the upper and lower halve.

The traducer kept parallel to the patient's longitudinal axis and perpendicular to the floor. The deepest, unobstructed, vertical pocket of fluid measure in each quadrant in centimeter. The four pocket measurement done then added to calculate the amniotic fluid index. Normal amniotic fluid index value range from (5-25cm).

### **3-2-2 Data analysis method:**

It carried out by computer programming (SPSS), data collecting sheet (questionnaire) and correlation.

### **3-2-3 Study variable:**

Maternal age, maternal weight, gravidity and gestational age

## Chapter four

### Result

The data were presented fallow by table and figure

Table (4-1)

Distribution of 75 pregnant women scanned during the study period according to age group

Age group	No of patients11	Percentage
15-20	5	6.67 %
20-25	11	14.67%
25-30	20	26.66%
30-35	17	22.66%
35-40	17	22.66%
40-45	5	6.67%

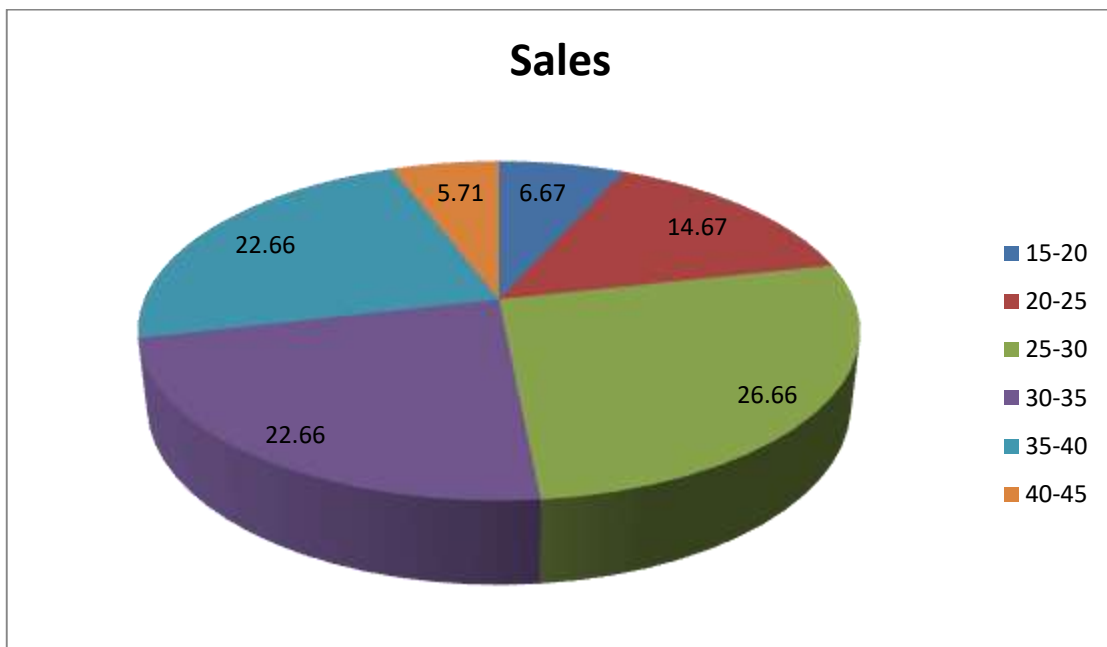


Figure (4-1) Distribution of 75 pregnant women scanned during the study period according to age group

Table (4-2)

Distribution of 75 pregnant women scanned in Sudan during the study period according to weight group

Weight group	No of patient	Percentage
50-60	17	22.66%
60-70	26	34.67%
70-80	26	34.67%
80-90	6	8%

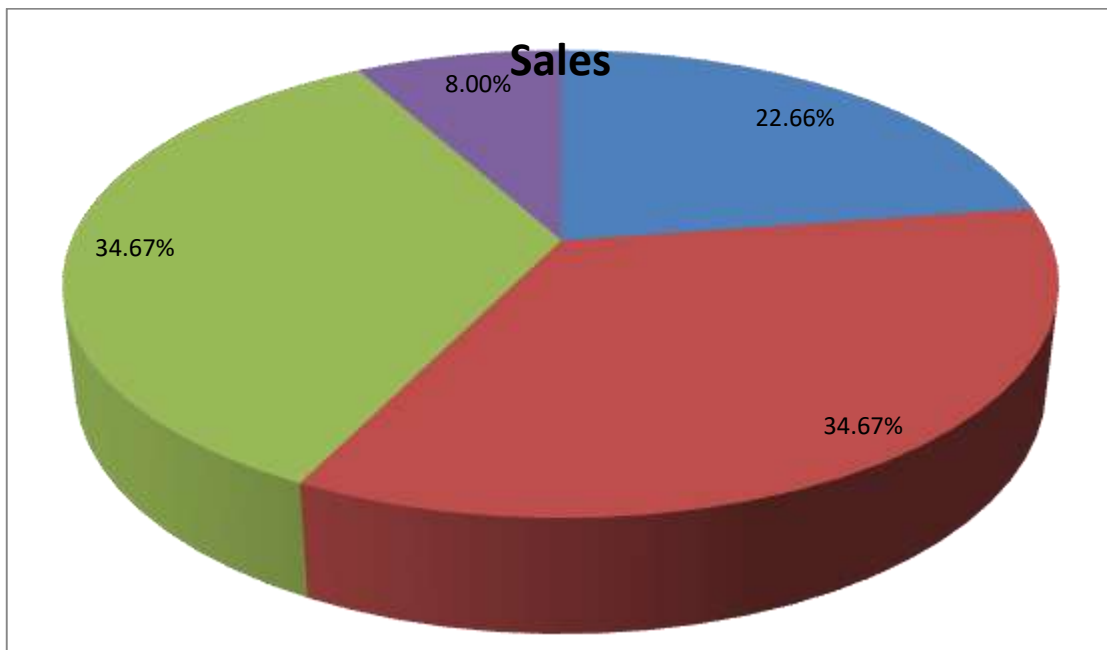


Figure (4-2) Distribution of 75 pregnant women scanned in Sudan during the study period according to weight group

Table (4-3)

Distribution of 75 pregnant women scanned in Sudan during the study period according to the gravidity

Gravidity	1	2	3	4	5	6	7	8
No of patient	10	17	13	13	6	5	7	4

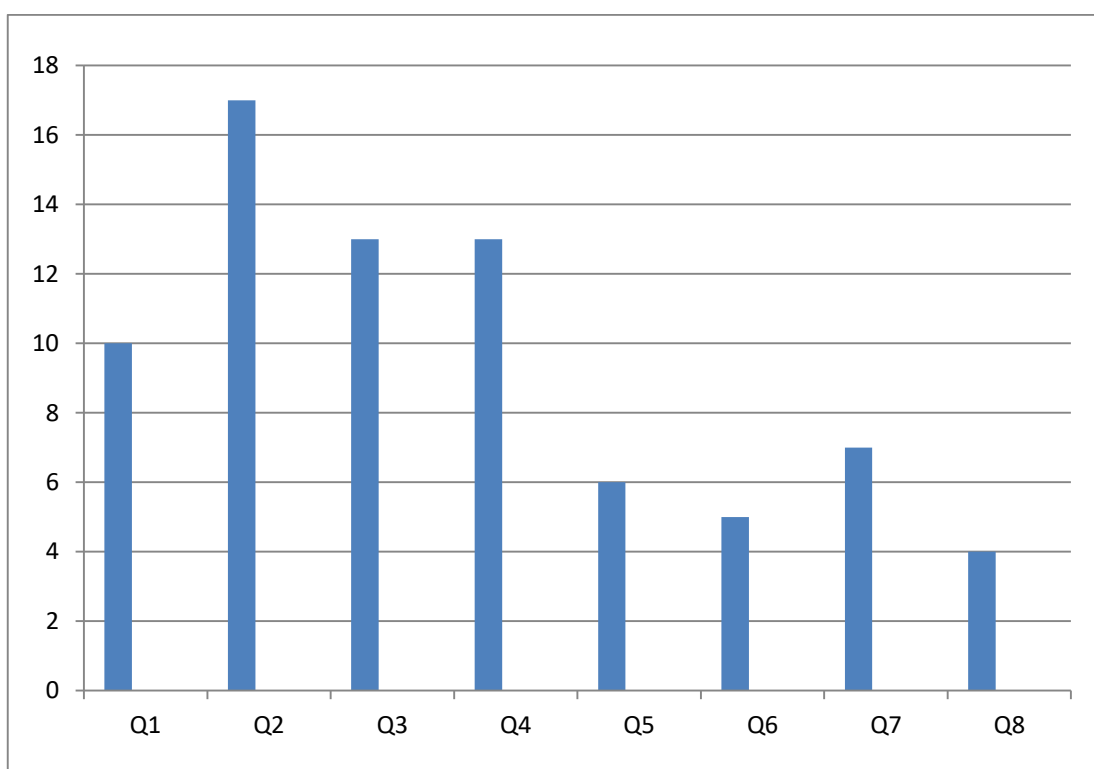


Figure (4-3) Distribution of 75 pregnant women scanned in Sudan during the study period according to the gravidity

Table (4-4)

Assessment of amniotic fluid volume measured by Phelan method (AFI)  
75 pregnant women included in the study

AFV	No of patients	Percentage %
Normal	72	96%
Polyhydramnios	1	1.33%
Oligohydromnios	2	2.66%

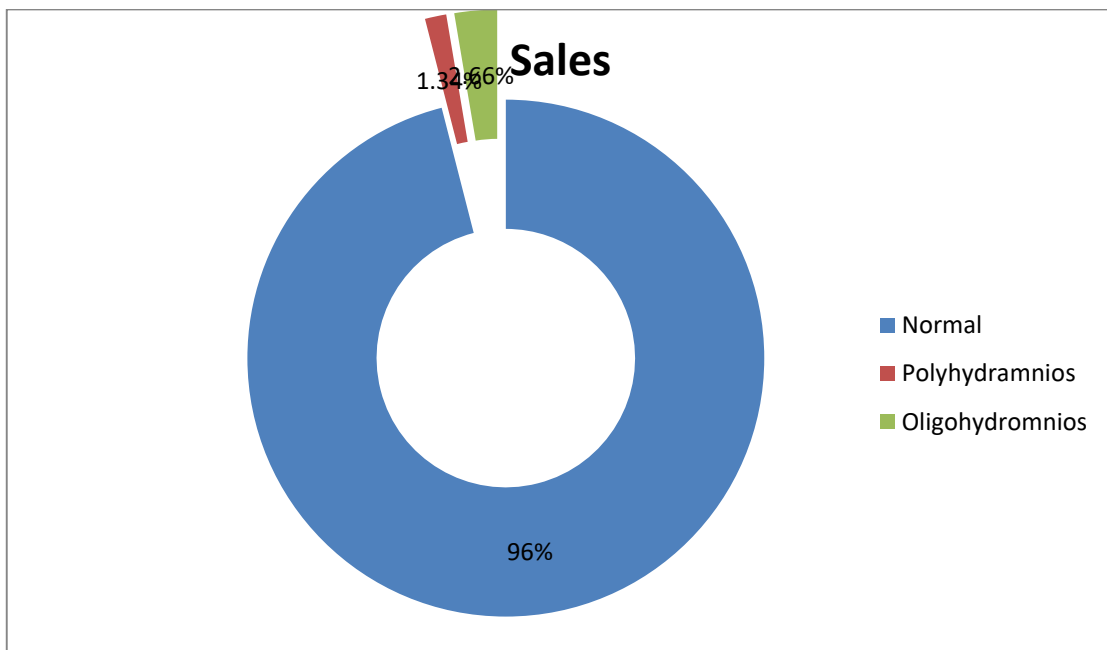


Figure (4-4) Assessment of amniotic fluid volume measured by  
method75 pregnant women included in the study AFI in

Table (4-5)

Assessment of amniotic fluid volume measured by Chamberlain method in 75 pregnant women included in the study

AFV	No of patients	Percentage %
Normal	71	94.66%
Polyhydromnios	1	1.33%
Oligohydromnios	3	4%

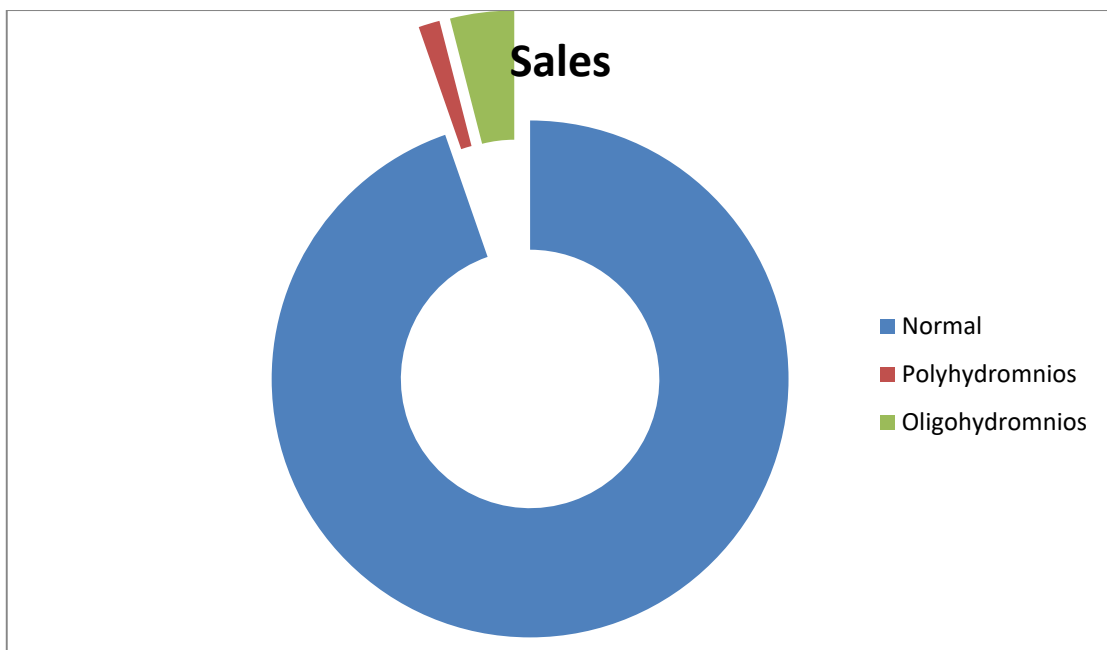


Figure (4-5) Assessment of amniotic fluid volume measured by Chamberlain method in 75 pregnant women included in the study.

Table (4-6)

Shows the largest and lowest SVP normal value among 75 cases scanned during the period of the study.

Measurement	SVP(cm)
Largest normal SVP	7.7
Lowest normal SVP	2.3

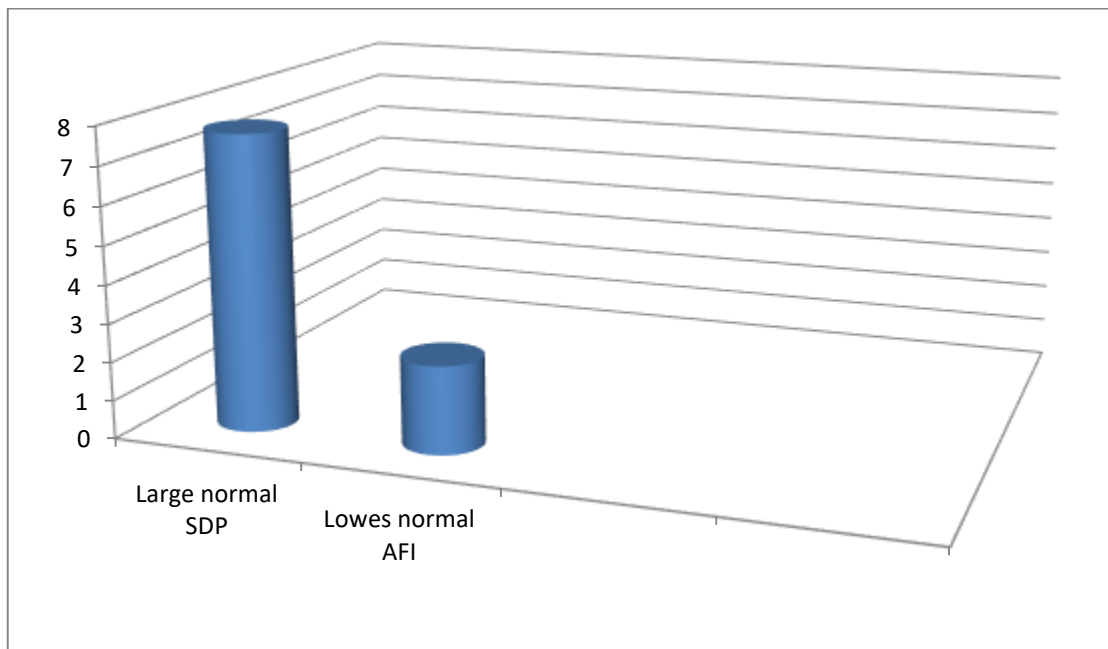


Figure (4-6) shows the largest and lowest SVP normal value among 75 cases scanned during the period of the study



Table (4-7)

Shows the largest and lowest AFI normal value among 75 cases scanned during the period of the study.

Measurement	SVP(cm)
Largest normal AFI	19
Lowest normal AFI	8.2

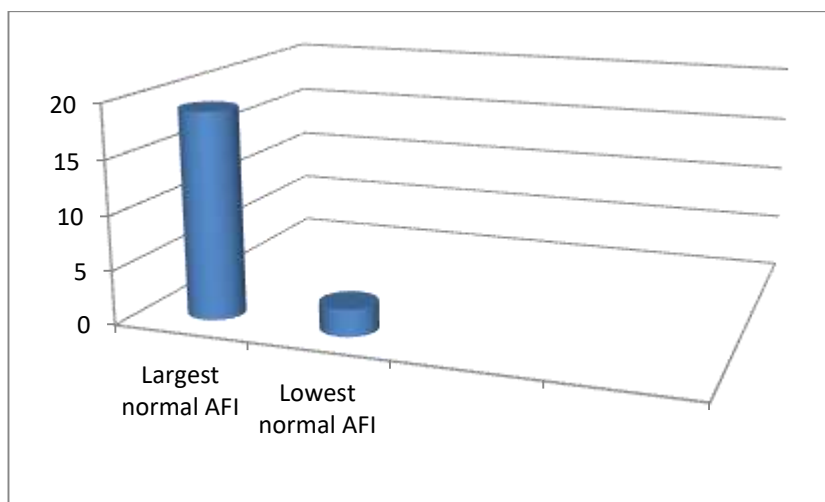


Figure (4-7) Shows the largest and lowest AFI normal value among 75 cases scanned during the period of the study

Table (4-8)

Show the correlation of the mean of SDP and mean of AFI with gestational age

GA(week)	N/Pt	M/SDP(cm)	M/AFI(cm)
27	9	6.7	16.73
28	8	6.1	16.68
29	4	5.95	16.3
30	5	5.26	15.78
31	4	4.85	14.03
32	3	4.73	13.73
33	2	4.55	13.5
34	7	4.31	13.08
35	7	4.2	11.25
36	7	3.95	11.20
37	4	3.72	11.1
38	5	3.4	10.21
39	4	3.06	8.93
40	3	2.76	8

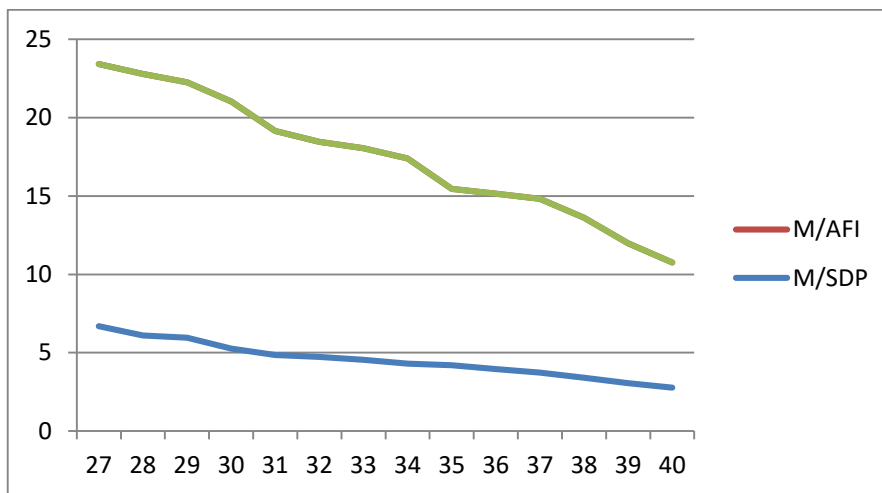


Figure (4-8) Show the correlation of the mean of SDP and mean of AFI with gestational age

## Chapter five

### Discussion, conclusion and recommendation

#### 5-1 Discussion:

75<sup>th</sup> Sudanese female married patients were investigated in different hospital & clinics diagnostic centers in Khartoum state. Sudan ( Elrakha hospital & Elsoudy hospital & Ahfad family health center) and enrolled of in this study in order to determine normal volume of amniotic fluid .

The amniotic fluid plays a vital role in fetal nutrition and protection during intra uterine life, therefore its volume is routinely estimated as part of the obstetric ultrasound scan. In the second and third trimesters, amniotic fluid is produced by fetal lung secretions and fetal urine while it is resorbed by fetal swallowing and flow across fetal membranes to the uterus. A defect in any of the above processes can therefore lead to abnormal amniotic fluid volumes. The estimation of the amniotic fluid volume can ultimately serve as an indicator of possible congenital anomaly with consequent poor pregnancy outcome. Its assessment is therefore an integral part of the obstetrician's decision taking on obstetric management and consequent pregnancy outcome, fetal and maternal mortality and morbidity and of course, safe motherhood.

The study shows 4% percent of pregnancies are associated with alternative in the quantity of the amniotic fluid volume occurring in third trimester by using Phelan (AFI) method, 1.33 % are polyhydromnios and 2.66% oligohydromnios , and 5.33% by using Chamberlain (SDP) method ,1.33% polyhydromnios and 4% oligohydromnios.

The study showed that the AFV in third trimester in Sudanese population are ranged from 8.2 cm to 19cm by using Phelan (AFI) and from 2.3cm to 7.7cm by using Chamberlain (SDP).

The study showed that the amniotic fluid volume is varying according to gestational age and it decreased from 27<sup>th</sup> week in the third trimester.

This study result are near to result obtained by Dr .Nadia Hussein/ university of AL-Zaeim AL-Azhari in 2006, And result obtained byIgbinidu E et al(Radiology Department, College of Medicine, University of Benin TeachingHospital, Benin City, Nigeria).And found that the amniotic fluid volume in Sudanese population and in Nigeria are higher than, Iranian population.

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 96% and abnormal occurs in 4% in abnormal amniotic fluid polyhydromnios in 1.33% and oligohydromnios occurs in 2.66%.

### **5-3 Recommendation:**

-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 polyhydromnios and oligohydramnios.

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# *Appendixes*



**Appendix [1]**  
**Sudan University of Science and Technology**  
**College of Graduate Studies**  
**M.sc, Program**  
**Data collection sheet**



**Evaluation of normal amniotic fluid volume in Sudanese population by using ultrasonography**

1-Serial number :

2-Date :  /  /2016

3-Age :  20-25y  25-30y  30-35 y  
 35-40 y  40- 45y

4-Medical history:

diabetes  hypertension

5-Weight  <50kg  50-70kg   
>70kg

6-LMP  /  /201

7-GA  w/  d

8-EED  /  /201

9-Qravidety

10-meassurment of amniotic fluid volume:

AFI:  / SVP

## Appendix[2]

Table 2-1. Risk factors for hydramnios

Maternal conditions	Isoimmunization
	Diabetes mellitus
Placental conditions	Chorioangioma
	Circumvallate placenta
Fetal conditions	
Multiple gestations	Twin-to-twin transfusion syndrome
Gastrointestinal	Esophageal atresia, duodenal or jejunal atresia, annular pancreas, midgut volvulus, diaphragmatic hernia, omphalocele, gastroschisis
CNS lesions	Anencephaly, hydrocephalus, encephalocele, spina bifida, microcephaly, hydranencephaly
Skeletal malformations	Arthrogryposis multiplex, osteogenesis imperfecta, thanatophoric dysplasia
Fetal tumors	Cystic adenomatoid malformation of the lung, sacrococcygeal teratoma, cervical teratoma
Cardiac disease	Severe congenital heart disease, fetal arrhythmias
Genetic disorders	Down syndrome, trisomy 13 and 18, Pena-Shokeir syndrome, multiple congenital anomalies, myotonic dystrophy
Fetal renal and endocrine disorders	Vasopressin insufficiency
Hematologic disorders	Homozygous $\alpha$ -thalassemia, fetomaternal hemorrhage
Intrauterine infections	Rubella, syphilis, toxoplasmosis, parvovirus
Miscellaneous	Nonimmune hydrops fetalis, fetal retroperitoneal fibrosis
Idiopathic	

(Modified from Cardwell MS: Polyhydramnios: A review. *ObstetGynecolSurv* 42:612, 1987. Copyright by Williams & Wilkins, 1987)

**Appendix[3]**



Figure (5-1) Pregnant ladies 33years old & 32week gestational age &SDP(3.8cm)



Figure (5-2) Pregnant ladies 25year & 28week gestational age&SDP(6.1cm)



Figure (5-3) Pregnant ladies 36year old & 37week gestational age& AFI (15.48cm)



Figure (5-4) Pregnant ladies 32year & 36week+3d gestational age&AFI(11.77cm)



Figure (5-5) Pregnant ladies 32year old & 37week+1d gestational age & SDP (2.4)



Figure (5-6) Pregnant ladies 25year old & 27week+3d gestational age &SDP(4.1)



Figure (5-7) Pregnant ladies 28year old &35week+3d gestational age & SDP  
(3.1)



Figure (5-8): Pregnant ladies 25year old &28week+3d gestational age &SDP  
(5.3)



Figure (5-9). Pregnant ladies 26year old &30week+3d gestational age &SDP  
(4.3)



Figure (5-10).Pregnant ladies 32year old &26week+3d gestational age &SDP (7.3)