بسم الله الرحمن الرحيم

Sudan University of science and Technology

Collage of graduate studies

Estimation of Gestation Age by Fetus kidney length Using Ultrasonography

قياس عمر الكيس الجنيني بقياس طول كلية الجنين باستخدام الموجات فوق الصوتيه التشخيصيه

A thesis submitted for requirement of partial fulfillment of M.Sc.

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الآية

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

وَلَقَدْ خَلَقْنَا الْإِنْسَانَ مِنْ سُلَالَةٍ مِنْ طِينٍ (12) ثُمَّ جَعَلْنَاهُ نُطْفَةً فِي قَرَارٍ مَكِينٍ (13) ثُمَّ خَلَقْنَا النُّطْفَةَ عَلَقَةً فَخَلَقْنَا الْعَلَقَةَ مُضْغَةً فَخَلَقْنَا الْمُضْغَةَ عِظَامًا فَكَسَوْنَا الْعِظَامَ لَحْمًا ثُمَّ أَنْشَأْنَاهُ خَلْقًا آخَرَ فَتَبَارَكَ اللَّهُ أَحْسَنُ الْخَالِقِينَ (14) ثُمَّ إِنَّكُمْ بَعْدَ ذَلِكَ لَمَيِّتُونَ (15) ثُمَّ إِنَّكُمْ يَوْمَ الْقِيَامَةِ تُبْعَثُونَ (16)

صدق الله العظيم.

Dedication

First and foremost , all praise be to Allah the almighty for the completion of this research , I here would like to greatly thanks my Mother for their countless giving , may Allah bestow his blessing and acceptances for all their good deeds . I also, thanks my sisters, brother and my husband for her precious time and effort she granted me with, as more than what I hoped for. Not for get my teachers, colleagues, physicians, who without their accomplishment. I ask Allah, for this work to benefit our people and to gain the acceptance and rewards from Allah the almighty.

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- **Reem Abd Elkreem**

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Abstract

Objective of this study to estimate the fetal gestational age by using renal length in age between 20-40 weeks, compare the measured fetus renal length value to the BPD, FL and HC and determine if renal length can be used correctly to estimated GA .

The study is analytical prospective study, conducted in Yastabshroon private hospital to 60 pregnant women gestation age between 20-40 week, From July to September 2016. By using ultrasound machine (SAMSUNG MEDSION) curved linear transducer 3.5MHZ. any pregnant women comes for follow up antenatal ultrasound scan was asked about her LMP AND also be taken from follow up card for more conformation. If her LMP was known then the patient will be included in the study after verbal consent taken, her age, weight and length will also be taken., The exam was done by measuring BPD, HC, FL, and AC will be measure the GA, last measurement taken is right and left renal length   in millimeters. The renal length is measure from longitudinal, sagittal section of the fetus the adrenal gland lying superior to the anterior pole of kidney was not included in the kidney length.

The study showed there was significant correlation between RT and LT kidney length with gestation age ($R2=0.823$ $R2=0.773$) and ($R=0.91$, $R=0.88$)respectively.

The result indicates that the kidney length in the present study correlated well with the assigned gestational age and found almost same as all the ultrasound biometric parameters put together.

ملخص البحث

تهدف هدة الدراسة الي تقييم عمر الجنين باستخدام طول كلية الجنين فى العمر الجنيني مابين 20-40 اسبوع ومقارنتة بالقياسات العمرية الاخري للجنينن .

اجريت هدة الدراسة التحليلية بمستشفى يستبشرون الخاص لعدد 60 امراة حامل بعد حضورها الي عيادة المتابعة الدورية بعد التاكد من تاريخ اخر دورة شهريه والتاكد من التاريخ من كرت المتابعة وتم اخد الموافقة من الحامل بعد دلك تم اخد عمر الحامل ووزنها وطولها وكان العمر الجنيني مابين 20-40 اسبوع فى الفترة من شهر يوليو الي شهر سبتمبر واستخدم فيها جهاز موجات (Samsung mendelson) وتم اخد قياسات قطر الراس وطول عظم الفخد ومحيط البطن والراس وطول الكلية اليمني واليسرى بالمليميترات .ووزن الطفل ومقارنها بعمر الجنين.

توصلت هذه الدراسة الي وجود علاقة قوية بين عمر الطفل وطول الكلية اليمين واليسار (R2=0.773 R2=0.823) (R=0.91 R=0.85) علي التوالي. وعلى ان طول الكلية يزداد بزيادة عمر الجنين بمعدل 1.20ملم للكلية اليمني و1.21 للكلية اليسرى اسبوعيا.ولدلك نوصى باستخدام قياس طول الكلية لتقدير عمر الجنين.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

List of Abbreviations:

BPD	Biparital diameter
GA	Gestation age
FL	Femur length
AC	Abdominal circumference
HC	Head circumference
FKL	fetus renal length
FW	Fetus weight
AF	Amniotic fluid
BMI	Body mass index

Chapter one

1.1 introduction

The introduction of obstetric ultrasonography in the early 1970s led to a marked improvement in the evaluation of fetal and placental anatomy, as well as fetal growth. Now, it is by far the most accurate technique for estimating gestational age (GA).

Most pregnant women have a first trimester scan, followed by a detailed scan for anomalies in second trimester. Other documented benefits of obstetric ultrasonography include the detection of multiple pregnancies and fetal abnormalities, and the identification of placenta Previa. Gestational age, synonymous with menstrual age, is defined in weeks beginning from the first day of the last menstrual period (LMP) prior to conception. Accurate determination of gestational age is fundamental to obstetric care and is important in a variety of situations in prematurity and post maturity problem arise when mothers are not aware of LMP and appropriate care is not provide to reduce complication such as asphyxia or hypoglycemia.(Mongelli et al 2016).

Estimation of the gestational age by sonographic measurements of foetal parameters is usually done by measuring mean sac diameter (MSD), Crown-rump length (CRL), biparietal diameter (BPD), head circumference (HC), femoral length (FL) and abdominal circumference (AC) depending on the trimester of pregnancy

In routine ultrasonography, the ultrasonologist measures the biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL) in estimating the GA and estimated date of delivery. the use of all four biometric indices are recommended for all pregnancies beyond 20 weeks for reduction of variability.

In second trimester BPD, HC, AC and FL can predict GA with fair accuracy (±10-14 days). As pregnancy advances these parameters become increasingly unreliable in estimation of GA. we need another parameter and compare it with another parameter as kidney length (FKL.) (Benson CB et al 1997).

Both the kidneys can be easily visualized on ultrasonography in third trimester and can be easily and accurately measured. This parameter alone can estimate the GA. The FKL in mm collaborates nicely with GA in weeks. When the traditionally used four parameters (BPD, HC, AC, FL) alone give unreliable results in third trimester, FKL can be combined to give more accurate estimation of (Shivalingaiah- 2014) In this study an attempt to evaluate the possibility of using fetus kidney length in estimation of gestation age after20 week gestation compare to BPD and FL.

1.2 **Problem of the study**

In some clinical conditions the routinely used parameters in estimating GA e.g. BPD ,FL , HC and AC can give inaccurate result ,thus the use of fetus renal length can be of great value in cases where these is a discrepancy in gestation age equivalent between BPD and FL.In fetuses with problem in head the use of BPD for estimating fetal age will be useless ,also fetuses with abnormal femur cannot be used to estimate the GA, thus fetus renal length will be suitable in these cases.

1.3 Objectives

1.3.1General objectives

To estimate the fetal gestational age by using renal length in age between 20-40 weeks.

1.3.2 Specific objectives

 *To compare the measured fetus renal length value to the BPD, FL and HC.

  *To determine if renal length can be used correctly to estimated GA.

1.4 Overview of the study

The study write in five chapters, chapter one includes a brief introduction and objectives of study ,chapter two deals with anatomy, physiology, and pathological conditions that effect of renal morphology and which can be detected by ultrasounds as it will deal with literature review which will include the son graphic technique through which we can obtain renal length as this chapter will also include previous studies done by another authors in estimating the GA by renal length ,chapter three will deal with methods and materials ,chapter four will include the results, and chapter five will deal with the discussion and conclusion.

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Chapter Two

Anatomy, physiology, and pathology

</div>

Literature Review

2.1Anatomy development of kidney

The development of the kidney proceeds through a series of successive phases, each marked by the development of a more advanced kidney: the pronephros, mesonephros, and metanephros.(Bruce M.carlson,2004) the pronephros is the most immature form of kidney, while the metanephros is most developed. The metanephros persists as the definitive adult kidney.

Three slightly overlapping kidney systems are formed in a cranial-to-caudal sequence during intrauterine life in humans: the pronephros, mesonephros, and metanephros. The first of these systems is rudimentary and non-functional; the second may function for a short time during the early foetal period; the third forms the permanent kidney.(Sadler , 2011)

2.1.1Pronephros

At the beginning of the fourth week, the pro-nephrons is represented by 7 to 10 solid cell groups in the cervical region. These groups form vestigial excretory units, nephrostomies that regress before more caudal ones are formed. By the end of the fourth week, all indications of the pronephric system have disappeared (Sadler, 2011)

 2.1.2Mesonephros

The mesonephros and mesonephric ducts are derived from intermediate mesoderm from upper thoracic to upper lumbar (L3) segments. Early in the fourth week of development, during regression of the pronephric system, the first excretory tubules of the mesonephros appear. They lengthen rapidly, form an S-shaped loop, and acquire a tuft of capillaries that will form a glomerulus at their medial extremity. Around the glomerulus, the tubules

form Bowman's capsule, and together these structures constitute a renal corpuscle. Laterally, the tubule enters the longitudinal collecting duct known as the mesonephric or wolffi and duct .In the middle of the second month, the meso-nephros forms a large ovoid organ on each side of the midline .Since the developing gonad is on its medial side, the ridge formed by both organs is known as the urogenital ridge .While caudal tubules are still differ-entailing, cranial tubules and glomeruli show degenerative changes, and by the end of the second month, the majority have disappeared. In the male, a few of the caudal tubules and the meso-nephric duct persist and participate in formation of the genital system, but they disappearinthefemale(sadler,2011)

2.1.3Metanephros:

  The Definitive Kidney, third urinary organ, the metanephros or permanent kidney, appears in the fifth week. Its excretory units develop from met nephric mesoderm .in the same manner as in the mesonephric system. The development of the duct system differs from that of the other kidney systems Collecting System.

Collecting ducts of the permanent kidney develop from the ureteric bud, an outgrowth of the mesonephric duct close to its entrance to the cloaca .The bud penetrates the meta-nephric tissue, which is molded over its distal end as a cap Subsequently, the bud dilates, forming the primitive renal pelvis, and splits into cranial and caudal portions, the future major calyces. Each calyx forms two new buds while penetrating the met nephric tissue. These buds continue to subdivide until 12 or more generations of tubules have formed .Meanwhile, at the periphery, more tubules form until the end of the fifth month. The tubules of the second order enlarge and absorb those of the third and fourth generations, forming the minor calyces of the renal pelvis. During further development, collecting tubules of the fifth and successive

generations elongate considerably and converge on the minor calyx, forming the renal pyramid .The ureteric bud gives rise to the ureter, the renal pelvis, the major and minor calyces, and approximately 1 to 3 million collecting tubule.(Sadler . 2011)
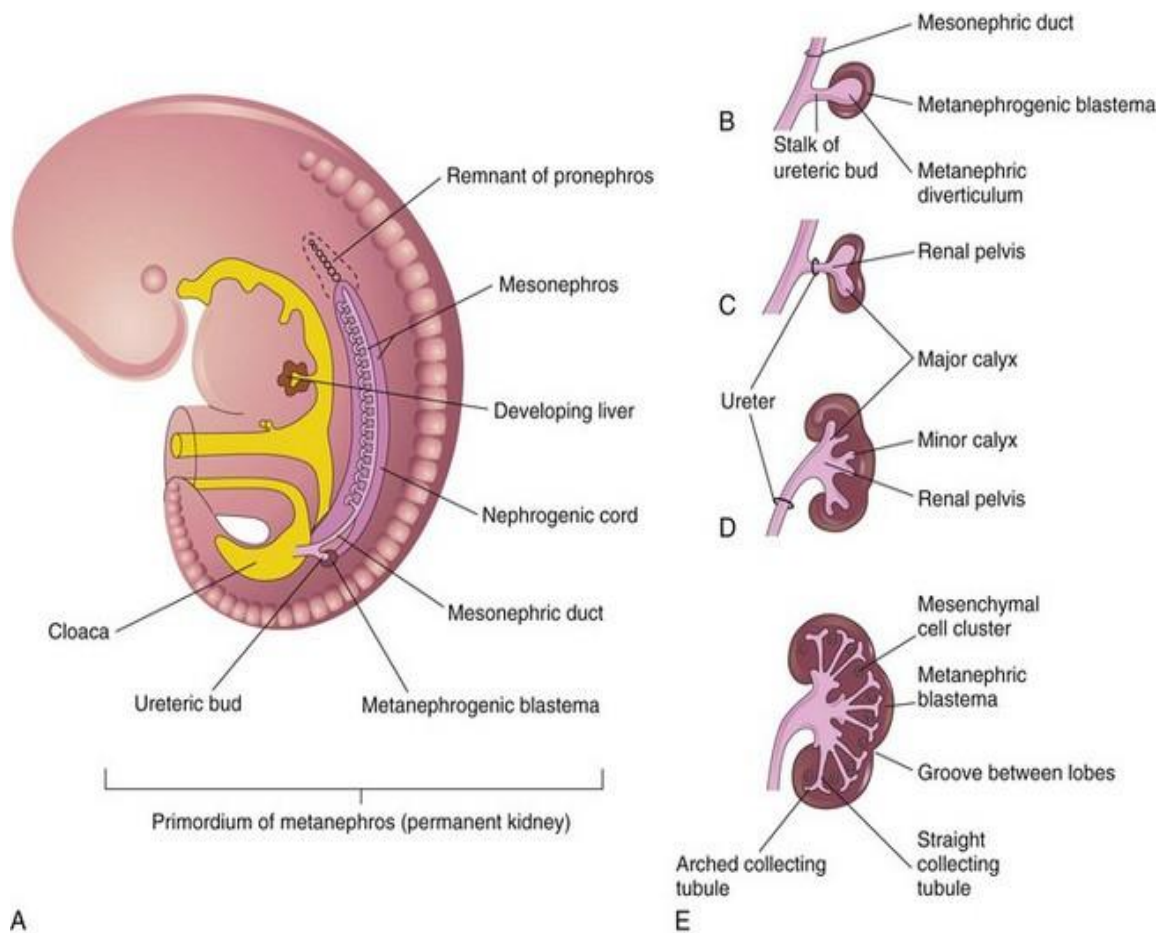
Figure 2.1 show development kidney (https://en.wikipedia.org */wiki/ Kidney_development).*

2.2 Physiology of Kidney

2.2.1 Excretory System

Each newly formed collecting tubule is covered at its distal end by a met nephric tissue cap .Under the inductive influence of the tubule, cells of the tissue cap form small vesicles, the renal vesicles, which in turn give rise to small S-shaped tubules Capillaries grow into the pocket at one end of the S and differentiate into glomeruli. These tubules, together with their glomeruli,

form nephrons, or excretory units. The proximal end of each nephron forms Bowman's capsule, which is deeply indented by a glomerulus). The distal end forms an open connection with one of the collecting tubules, establishing a passageway from Bowman's capsule to the collecting unit. Continuous lengthening of the excretory tubule results in formation of the proximal convoluted tubule, loop of Henle, and distal convoluted tubule .Hence, the kidney develops from two sources:

*met nephric mesoderm, which provides excretory units

*the ureteric bud, which gives rise to the collecting system.

Nephrons are formed until birth, at which time there are approximately 1 million in each kidney. Urine production begins early in gestation, soon after differentiation of the glomerular capillaries, which start to form by the 10th week. At birth, the kidneys have a lobulated appearance, but the lobulation disappears during infancy as a result of further growth of the nephrons, although there is no increase in their number .

Function unit of the kidney, the uriniferous tubules, is composed of the nephron and collecting tubules. The nephrons produce urine, and the collecting tubules concentrate and transport it. The proximal portion of each nephron is called the renal corpuscle. It consists of a cup-like structure called Bowman's capsule and a glomerulus.

The renal corpuscle has a vascular pole and a urinary pole (Johnson KE, 1988)

Blood vessels enter exit the glomerulus at the vascular pole. The parietal epithelium of Bowman's capsule continues with the proximal tubule at the urinary pole. The proximal and distal portions of the tubules are convoluted. Between these convoluted sections lies the loop of Henle. The collecting tubules are ducts that collect urine from the distal tubules and transport it to

the papillary ducts (McCance, 1990) Urine production in the fetus is related to regulation of the amniotic fluid volume. Amniotic fluid provides some protection from pathogenic bacteria during fetal   life (Baker, Gomez, 1990). The amniotic fluid compartment provides the few space to grow, move about and develop. Without this space, the uterus would close down on the fetus and restrict development (Birnholz, Madana, 1995).

  In cases of first trimester amniotic fluid leakage, a fern may develop structural abnormalities secondary to uterine compression. By mid pregnancy, the amniotic fluid plays a critical role in pulmonary development. Successful pulmonary development requires that the respiratory tract be filled with fluid and that the fetus be able to move the fluid in and out of the lungs. Low levels amniotic fluid during this period of fetal development are associated with pulmonary hypoplasia. Recent intrauterine them peutic techniques may reduce fetal morbidity and mortality secondary to obstructive uropathy (Dura etal, 1984).

 During labor and delivery, the amniotic fluid the fetus participates in the regulation of the amniotic fluid volume by producing hypotonic urine to increase volume and swallowing it to reduce volume. (Gulbis, Gewy, Jauniaux, 1998).

 the fetal kidneys produce 600-700 ml of hypotonic urine per day. The lungs produce approximately 250 ml of fluid per day. The fetus swallows approximately 590 ml of fluid per day and another 350-450 ml are reabsorbed across the chorioamnion as a result of the osmotic gradient between the amniotic fluid and maternal plasma. (Gulbis etal, 1996) .
These fluid dynamics assist the obstetrician with evaluating fetaldevelopment.

Oligohydramnios, a small volume of amniotic fluid, suggests renal agenesis or renal obstruction.(Heikinheimo,1980).

Polyhydramnios, a large volume of amniotic fluid, suggests anencephaly Because of the inability to swallow or esophageal atresia fetal nitrogenous waste is eliminated by maternal urination since. the nitrogenous wastes diffuse across the placenta membrane into the maternal blood Supply. (Szaflik etal ,1998) .

2.3Pathology of fetus kidney

2.3.1Renal abnormalities

3.1.1Abnormalities in number and location

Unilateral renal agenesis occurs in approximately 1/1,300 pregnancies (Cascio S,Paran S Puri P, 1999), the majority of which are probably cases of renal aplasia (Hiraoka M, Hori C, Tsukahara H 1999). The difference between both cannot bemade by ultrasound. Although unilateral renal agenesis is mostly isolated andsporadic, it might be part of a genetic syndrome, or occur in association withchromosomal or developmental defects (VACTERL association) and genital abnormalities. If associated anomalies are present, amniocentesis should be offered.

On ultrasound examination the lumbar fossa is empty and the adrenal gland appears elongated ("lying down adrenal sign"). The amount of amniotic fluid will be normal.

Recent follow up studies attribute an increased risk for chronic kidney disease in adulthood in patients with a solitary functioning kidney, especially in the presence of ipsilateral abnormalities of the kidney or urinary tract .Clinical follow up is thus recommended.

Bilateral renal agenesis is a lethal condition with an incidence of 1/4,000 pregnancies .Ultrasound features are early anhydramnios from 16 weeks of

gestation onwards, absence of bladder filling and empty lumbar fossae. Renal artery color Doppler and Magnetic Resonance Imaging (MRI) may be helpful in confirming the diagnosis.

Ectopic kidneys occur in about 1/1,000 pregnancies (Yuksel, Batukan, et al ,2004). They are usually smaller and may be malrotated. The pelvic location is the most common, but horseshoe kidneys, crossed (fused) ectopic and even intrathoracic kidneys have been described Uncomplicated renal duplication should be considered as a normal variant. However, renal duplication is often associated with ureteral abnormalities and hydronephrosis.

2.3.1.2 Abnormalities in renal size, structure and echogenicity

Kidneys appear hyper echoic if they look brighter than the liver and spleen beyond 17 weeks of pregnancy.

Hyper echoic kidneys are normal in premature babies and infants up to 6 months. However, they are an indicator of significant renal pathology in the pediatric population. Fetal hyper echoic kidneys present an etiological diversity with an outcome that is specific for each of the conditions.

Non-hereditary, fetal hyper echoic kidneys can result from various causes such as an obstructive dysplasia, bilateral multicystic kidney disease, nephroblastomatosis, renal vein thrombosis, ischemia, infectious and metabolic diseases, nephrotic syndrome and aneuploidy. In case of an underlying genetic syndrome and in polycystic kidney disease, the recurrence rate is high. The presence of hyper echoic enlarged kidneys without associated malformations is most frequently associated with polycystic kidney disease (both autosomal recessive and dominant) (Chaumoitre, Brun, , et al 2006).

In case of bilateral, isolated hyper echogenic kidneys without family history or cysts, the diagnosis of the underlying etiology and the counseling of the

parents on the long term prognosis may be challenging. Fetuses with very large kidneys and/or severe oligohydramnios are likely to have a poor outcome. With normal amniotic fluid volumes and moderately enlarged kidneys (< 4SD), the probability of survival without significant morbidity in infancy is high (14/17 survivors of whom 9 symptom-free) (Wilson 2004).

The presence of associated malformations should raise the suspicion of an underlying genetic syndrome, frequently showing an autosomal recessive inheritance pattern (e.g. Bardet-Biedl, Meckel-Gruber, Beemer syndromes). Detailed fetal ultrasound examination, fetal karyotyping, family history and ultrasound examination of the urinary system in parents are all important in the work up of hyper echoic enlarged kidneys.

Autosomal recessive polycystic kidney disease (ARPKD) occurs with an incidence of 1 in 20,000 live births (Wilson 2004). It is most frequently caused by a mutation in the PKHD-1 gene, but probably additional genes play a role. Disease expression may vary widely within affected families. The disease is characterized by cystic dilatation of the tubules, predominantly in the medulla. The outer cortex is spared. Additionally, patients have biliary dysgenesis and hepatic fibrosis. Ultrasound scans can be normal up to 20 weeks of pregnancy. Kidneys will be markedly enlarged (+4-15 SD) and hyper echoic without (or with reversed) corticomedullary differentiation and with a hypo echoic outer cortical rim (Brun, Maugey-Laulom, Eurin, et al 2004). In the perinatal form, oligohydramnios as a consequence of renal failure results in lethal pulmonary hypoplasia. Children with the infantile and juvenile types develop chronic renal failure (with need for transplantation in their teens), hepatic fibrosis and portal hypertension. The recurrence rate is 25% and if the mutation is known, prenatal diagnosis can be offered.

2.3.2 Autosomal dominant polycystic kidney disease (ADPKD)

has an incidence of 1 in 800 live births (Wilson, 2004). Inheritance is autosomal dominant with a 100% penetrance. Expression is variable and new mutations are frequent: the family history is positive in only half of cases (Brun, Maugey-Laulom, Eurin, et al 2004). ADPKD is usually asymptomatic until the age of 30-40 years. It is rarely seen in fetal life. The disease is characterized by cysts in both renal cortex and medulla, in the liver, pancreas and spleen. On prenatal ultrasound, kidneys are usually moderately enlarged (+1-2 SD) with hyper echoic cortex and hypo echoic medulla (persisting corticomedullary differentiation) but other patterns are described, including absent or decreased corticomedullary differentiation or totally normal appearance .Cysts may be visible in the third trimester. The amniotic fluid volume is normal.

2.3.3 Multicystic kidney disease (MCKD)

is a developmental disorder of the kidney, in which the normal renal parenchyma is replaced by multiple, non-communicating cysts of varying size. The renal outline is difficult to delineate and can be irregular The incidence is about 1/4,300 pregnancies (Schreuder, Westland,etal 2009). In 25-40% the contralateral kidney will also be abnormal, reflux being the most frequently associated anomaly .The natural course in utero is variable and the final result is a non-functional kidney. Bilateral multicystic kidney disease occurs in about 10-20% of cases and is a lethal condition

2.3.3 Obstructive cystic dysplasia

is the most common cause of non-hereditary fetal renal cystic disease and hyper echoic kidneys. Ultrasound features are those of a lower or upper urinary tract obstruction in association with a hyper echoic appearance of the

renal cortex and eventually the presence of cysts variable in size renal size can also vary.

Obstructive cystic dysplasia can be unilateral, bilateral or segmental but it is usually a progressive lesion. The amount of amniotic fluid is variable and renal function is usually impaired

2.3.4Simple renal cysts are rather uncommon in the fetus. They are usually solitary and localized in the upper pole of a normal kidney. There is no association with other malformations and the prognosis is good. A follow up ultrasound is usually recommended to exclude a more diffuse distribution or other cystic renal diseases.

2.3.5Renal tumors are uncommon in fetal life. Mesoblastic nephroma, the most frequent tumor, is a benign, mostly large mesenchymal tumor, which appears as a solid or partially cystic mass, commonly associated with polyhydramnios. It has to be differentiated from Wilm's tumors which have a good prognosis. Nephroblastomatosis is characterized by multiple benign nodular lesions and bilateral involvement.

2.4Technique of kidney ultrasound

 The fetal kidneys can be seen Trans abdominally from 14 weeks' gestation and are easily visible at 20–22 weeks. They are best located from a transverse section of the abdomen. By sliding caudally from the section required for measurement

 Of the AC, look closely in the para spinal gutters (Trish Chudleigh, Basky etal 2004).

The first clue that you have found the kidney is the hypo echoic area – delineated by a hyper echoic bright border – that represents the renal pelvis.

If the fetal spine is directly anterior then both kidneys can be seen on the same section; if the spine is lateral then the lower kidney is usually hidden in the acoustic shadow from the spine.

To see the lower kidney, the probe should be rotated around the maternal abdomen in an attempt to bring the spine to the top of the screen.

Having located the kidneys in the transverse plane, bring one kidney into the center of the screen by sliding the probe across the maternal abdomen.

Rotate the probe through 90° keeping that kidney in view until a longitudinal, sagittal section of the kidney is obtained .If the upper and lower limits of the kidney are difficult to see, make tiny lateral sliding movements of the probe.

Fetal breathing movements aid in the identification of the renal end-points. the appearance of the renal pelvis in this view. The echogenicity of the renal cortex is very similar to that of the fetal lungs, i.e. low level, homogeneous echoes.

Renal size is assessed from longitudinal, antero posterior and transverse diameter measurements.

The maximum longitudinal renal diameter should be measured from a longitudinal, sagittal section of the fetus, rather than a longitudinal, coronal; necessary to obtain the maximum longitudinal axis of the kidney (Trish Chudleigh, BaskyThilaganathan2004)

2.5 Normal sonographic appearance of fetus kidney

The ultrasound examination of the normal urinary tract consists of the assessment of the presence, location and size of both kidneys and the evaluation of their structure and echogenicity

From about 9 to 12 weeks of pregnancy, the fetal kidneys and adrenal glands can be visualized at both sites of the lumbar spine. They are usually easy to identify because of their relatively hyperechogenic aspect in the first

trimester (Fig. 1A). The visualization of the renal arteries by colour Doppler can facilitate their identification. The sonographic cortico-medullary differentiation starts at 15 weeks and will become more clear with advancing gestational age. The outer, more hyperechogenic renal cortex can be clearly distinguished from the inner, more hypoechogenic medulla at the 20th week of gestation. Renal echogenicity will also decrease, lower than that of the liver and spleen from 17 weeks on (Fig. 1B). The antero-posterior diameter of the renal pelvis (APPD) should be less than 4 mm in the second trimester and less than 7mm in the third trimester, although cut-off values vary in literature and consensus is lacking (Nguyen et al., 2010)
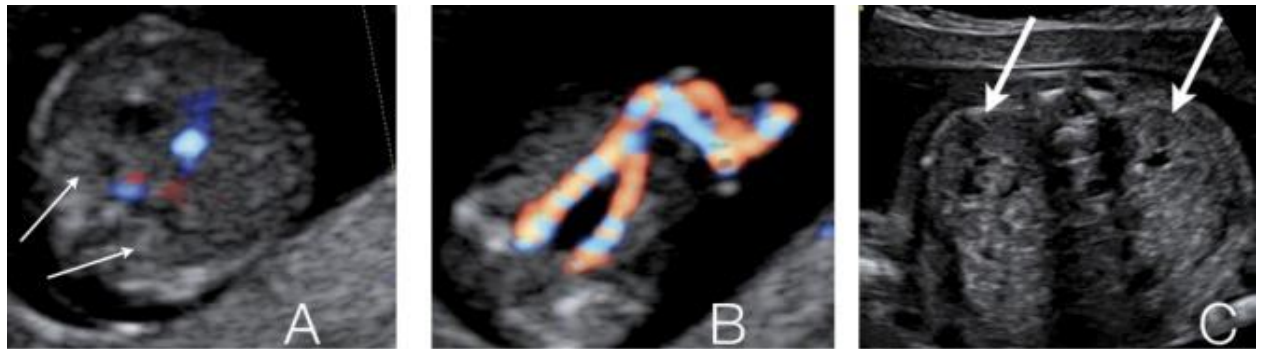

Figure1 Normal ultrasound image of the fetal kidneys and bladder. A. First trimester fetal kidneys at both sides of the lumbar spine. B. The fetal bladder between the umbilical arteries as seen in the first trimester of pregnancy. C. Decreased echogenicity and beginning of cortico-medullary differentiation in second trimester fetal kidneys

Table 2.1show the normal growth of longtitual diameter of the kidney with gestational age. (ADAPTEDFROM CHITTY & ALTMAN 1993)

Longitudinal diameter (mm)

Weeks of gestation	5th centile	50th centile	95th centile
14	8.0	9.8	11.8
15	9.3	11.4	13.7
16	10.6	13.1	15.8
17	12.0	14.8	17.9
18	13.4	16.5	20.0
19	14.8	18.3	22.2
20	16.2	20.1	24.4
21	17.6	21.8	26.5
22	19.0	23.6	28.7
23	20.4	25.3	30.8
24	21.8	27.0	32.8
25	23.2	28.7	34.8
26	24.5	30.3	36.8
27	25.8	31.9	38.6
28	27.0	33.4	40.4
29	28.2	34.8	42.1
30	29.4	36.2	43.6
31	30.5	37.4	45.1
32	31.5	38.6	46.4
33	32.4	39.7	47.6
34	33.3	40.6	48.7
35	34.1	41.5	49.7
36	34.9	42.3	50.5
37	35.5	43.0	51.1
38	36.1	43.5	51.6
39	36.6	43.9	52.0
40	36.9	44.2	52.2
41	37.3	44.4	52.3
42	37.5	44.5	52.2

2.6 Previous Study

-In 2016 Mete Gugur et al, doing study to determine the validity of fetal kidney length and amniotic fluid index (AFI) in labor dating.

Prospective study included 180 pregnant women followed up in the outpatient clinic at the Department of Obstetrics and Gynecology, Gaziantep University, Turkey, between January 2014 and January 2015. The gestational age (GA) was estimated by early fetal ultrasound measures and last menstrual period. Routine fetal biometric parameters, fetal kidney length, and amniotic fluid index were measured. We studied the correlation between fetal kidney length, amniotic fluid index, and gestational age.

The result show mean gestational age depending on last menstrual period and early ultrasound was 31.98 ± 4.29 (24-39 weeks). The mean kidney length was 35.66 ± 6.61 (19-49 mm). There was a significant correlation between gestational age and fetal kidney length ($r=0.947$, $p=0.001$). However, there was a moderate negative correlation between GA and AFI. Adding fetal kidney length to the routine biometrics improved the effectiveness of the model used to estimate GA ($R^2=0.965$ to $R^2=0.987$).

 Gestational age can be better predicted by adding fetal kidney length to other routine parameters (Mete G. Ugur,et al 2016)

-In2002 Kanje JC et al, study carried to evaluate the application of kidney length measurement to the determination of gestational age between the 24th and 38th weeks and to compare its accuracy with that of other fetal biometric indices.

Seventy-three women with singleton uncomplicated pregnancies underwent standard ultrasound fetal biometry and kidney length measurement every 2 weeks between 24 and 38 weeks' gestation. These measurements were used to date the pregnancies relative to crown-rump length dating between 8 and 10

weeks' gestation. Linear regression models for estimation of gestational age were derived from the biometric indices and kidney length. In addition, stepwise regression models were constructed to determine the best model for determining gestational age between 24 and 38 weeks. Comparisons were then made between the accuracy of these models in the determination of gestational age.

The result best model for estimating gestational age in late pregnancy included the variables kidney length, bi parietal diameter, head circumference, femur length and abdominal circumference. This model accurately predicted gestational age with a standard error of +/- 8.48 days. A model including kidney length, bi parietal diameter, head circumference and femur length accurately predicted gestational age with a standard error of +/- 8.57 days. These models were slightly more accurate than models derived from the biometric indices of bi parietal diameter, head circumference and femur length (+/- 9.87 days), bi parietal diameter, head circumference, femur length and abdominal circumference (+/- 9.45 days) and bi parietal diameter and femur length (+/- 9.9 days). Kidney length and femur length were the most accurate single parameters for predicting gestational age using simple linear regression models (+/- 10.29 and 10.96 days, respectively); the abdominal circumference was the least accurate (+/- 14.54 days).

Kidney length is a more accurate method of determining gestational age than the fetal biometric indices of bi parietal diameter, head circumference, femur length and abdominal circumference between 24 and 38 weeks' gestation. When combined with bi parietal diameter, head circumference and femur length, the precision of dating is improved by 2 days. This measurement is easy to make and could therefore be easily incorporated into the model for dating pregnancies after 24 weeks of gestation, in particular when

measurements of the bi parietal diameter and head circumference are difficult (Konje JC et al 2002).

-Kuldeep Kumar et al in2013   study was carried out on 199 women with singleton uncomplicated pregnancies attending the outdoor patient department (OPD) for routine ultrasound fetal biometry. Fetal kidney length was measured biweekly, between 18 weeks and 38 weeks of gestation. Linear regression models for estimation of gestational age were derived from biometric indices (BPD and FL) and kidney length.

The *result*: the earliest age at which fetal kidney could be seen son graphically was the 18th week of gestation with the mean kidney length of 12 ± 1.31 mm.   The mean sonographic kidney length at the 38th week of gestation was 40.4 ± 1.71 mm, indicating that the mean fetal kidney length increases as pregnancy progresses from 18 weeks to 38 weeks of gestation.

  The best linear regression model for estimating fetal gestational age is femur length, kidney length, and bi parietal diameter in that order, with standard error of ±3.85 days, ±8.04 days, and ±8.75 days, respectively(Kuldeep Kumur et al 2013)

---JJ Kansaria*, SV Parulekar in2009 evaluate the application and accuracy of foetal kidney length measurement in determining the gestational age of the fetus. Prospective study carried: Out of 70 women, 50 women who were certain of their last menstrual periods (LMP) and who had regular menstrual cycle completed the study. Serial study of foetal biometry at 2 weekly intervals between 22 weeks and 38 weeks of gestation was performed to measure foetal kidney parameters and BPD, FL, AC, head circumference (HC).result: Foetal kidney length grows at the rate of 1.7 mm fortnightly. Kidney length predicted gestational age with better precision than the model

with biometric indices of Bi parietal Diameter (BPD), Abdominal Circumference (AC) and Femur Length (FL).:

The study demonstrated that by measuring kidney length, pregnancies could be dated within 9.17 days in those booking late or in those who had forgotten their last menstrual periods and presented late for booking(JJ Kansaria, SV Parulekar2009).

-Farrokh Seilanian Toosi and Hossein Rezaie-Delui in2012 carried out study aimed to evaluate the normal fetal kidney length (KL) and its correlation with GA. A cross-sectional study on 92 pregnant women between 8thand 10thweek of gestation with normal singleton pregnancy underwent standard ultrasound fetal biometry and kidney length measurement. Uni variant and multivariate linear regression analysis was used to create a predictive equation to estimate GA on the KL and feto biometry parameters. A significant correlation was found between GA and KL (r=0.83, P<0.002).

The best GA predictor was obtained by combining head circumference, fetal bi parietal diameter, femur length and KL with a standard error (SE) about 14.2 days. Our findings showed that KL measurements combination with other fetal biometric parameters could predict age of pregnancy with a better precision (Farrokh Seilanian Toosi and Hossein Rezaie-Delui 2013)

-*Nirmala Shivalingaiah* et al in 2014 carried study establishing the gestational age of the fetus, especially in late trimester is a challenge to aptly treat the pregnant woman. Ultrasound parameters like BPD, HC, AC & FL in second and third trimesters are not very reliable for dating the pregnancy. Fetal kidney length has been studied and shown to strongly correlate with the gestational age in late trimesters even in IUGR foetuses. The present study evaluated the role of kidney length in determining the gestation age with the study population of 60 pregnant women between 24 -

36 weeks of gestation whose pregnancies were dated accurately by early dating scan. Length of the nearer kidney was measured in centimetres, 4 weekly in the longitudinal axis along with other biometric indices. Results: According to the observations, the mean deviation from the gestational age at all the weeks is least for KL. The result indicates that the kidney length in the present study correlated well with the assigned gestational age and found almost same as all the ultrasound biometric parameters put together.

Kidney length can be used as an individual parameter in estimating gestational age, especially in later trimesters, where biometric indices may not be much reliable(*Nirmala Shivalingaiah* et al 2014).

Chapter Three

Methodology

3.1 STUDY Area and population

*The study was conducted in YASTABSHROON PRIVATE HOSPITAL.

*The population are Sudanese pregnant women

3.2 The Study Design

*The study is analytical prospective study

3.3 Study Duration

*From July to September 2016.

3.4 Sampling

*60 pregnant women.

3.5 Inclusion and Exclusion criteria

3.5.1 Inclusion criteria

*60 pregnant women between 20-40 weeks gestation age of singleton foetus.

*known LMP

*Head, abdomen and femur should be normal.

3.5.2 Exclusion criteria

*pregnant women with uncertain LMP.

*Pregnant women with history of diseases like hypertension and gestation diabetic.

*foetuses with renal morphological pathology were exclude.

*foetus with skeletal abnormality which affect the femur, abdomen abnormality and cranial anomaly were exclude.

3.6 Data collection and tool

Data collected by using ultrasound machine (SAMSUNG MEDSION) curved linear transducer 3.5MHZ.

Any pregnant women comes for follow up antenatal ultrasound scan was asked about her LMP AND also be taken from follow up card for more conformation. If her LMP was known then the patient will be included in the study after verbal consent taken, her age, weight and length will also be taken.

The exam was done by measuring BPD, HC, FL, and AC will be measure the GA, last measurement taken is right and left renal length in millimetres. The renal length is measure from longitudinal, sagittal section of the foetus rather than longitual, coronal section, slight rotation of probe from long axis 0f the foetus nessaseray to obtain the maximum length of kidney, the adrenal gland lying superior to the anterior pole of kidney was not included in the kidney length.

3.7 Data analysis

Data analysis by using excel programme.

3.8 Limitation

Non proper foetal position may make visualization of kidney son graphic anatomy difficult thus this case exclude from study.

CHAPTER FOUR

Results

Table (4.1) mother data express as mean and SD

Data	means±SD
Mother Age/ years	29,75±4.88
Mother weight/Kg	71.48±13.69
Parity	2,06±1.41

Table (4.2) fetus parameters

Parameters	Means ±SD
Gestation age/week	31.77 ±5.57
Fetus weight/g	2571.81 ±4260.51
Right Kidney length/mm	28.48 ±7.41
Left Kidney length/mm	29.61 ±7.72
Biparitel diameter/mm	78.28 ±14.78
Femur length/mm	61.08 ±13.53
Head circumference	281.83 ±52.99
Abdominal circumference	262.24 ±63.81
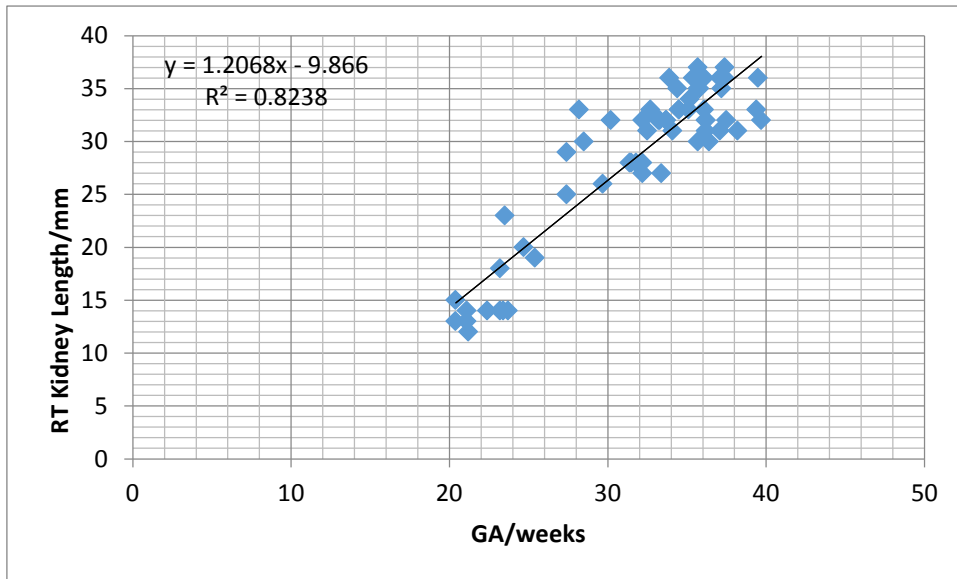
Figure4.1 Ascatter plot diagram shows the correlation between gestation age and right kidney length, the right kidney length increased by1.20 mm each week.
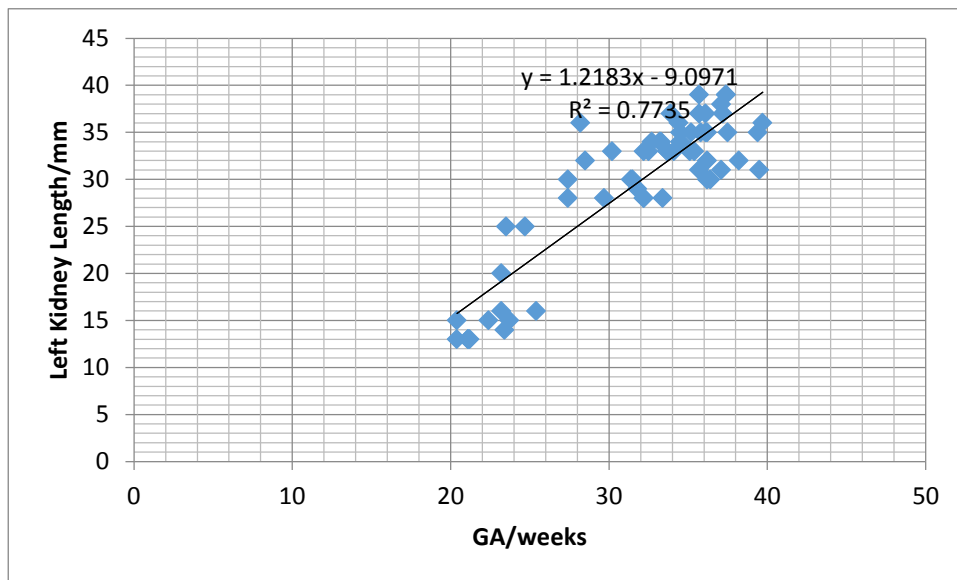

Figure4.2 Ascatter plot diagram shows the correlation between gestation age and left kidney length, the left kidney length increased by1.21mm each week.
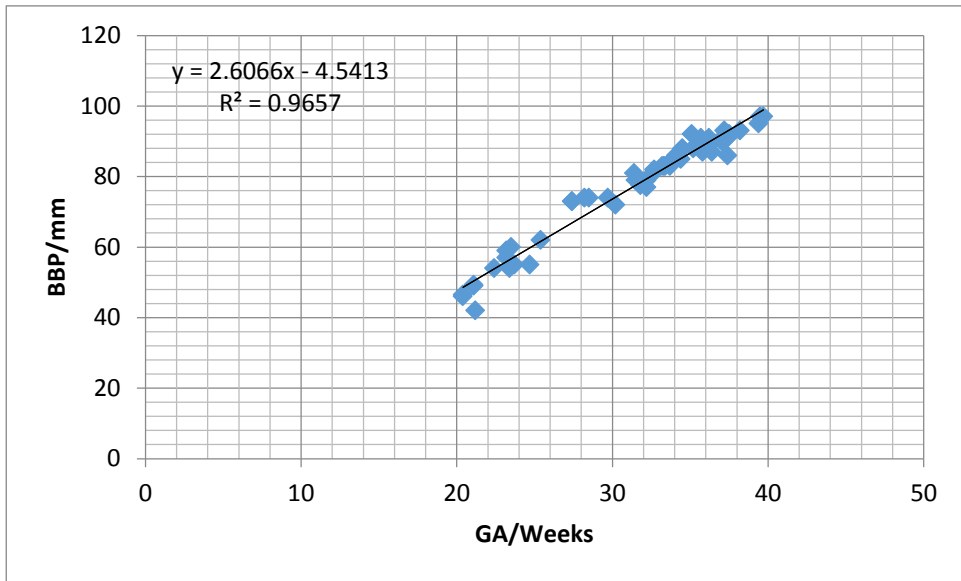
Figure4.3 Ascatter plot diagram shows the correlation between gestation age and biparital diameter, the biparital diameter increased by2.60mm each week
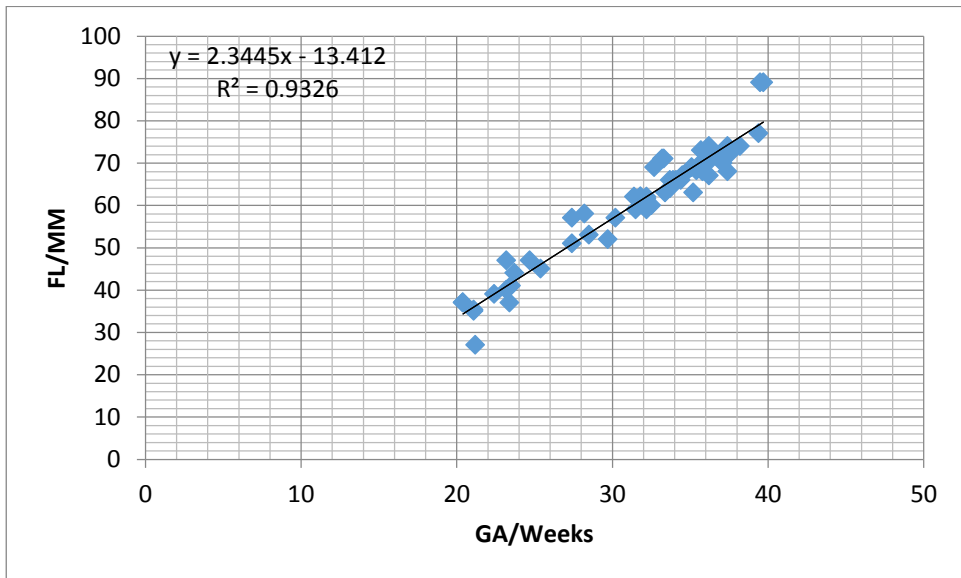

Figure4.4 Ascatter plot diagram shows the correlation between gestation age and femur length ,increased by2.3mm each week.s
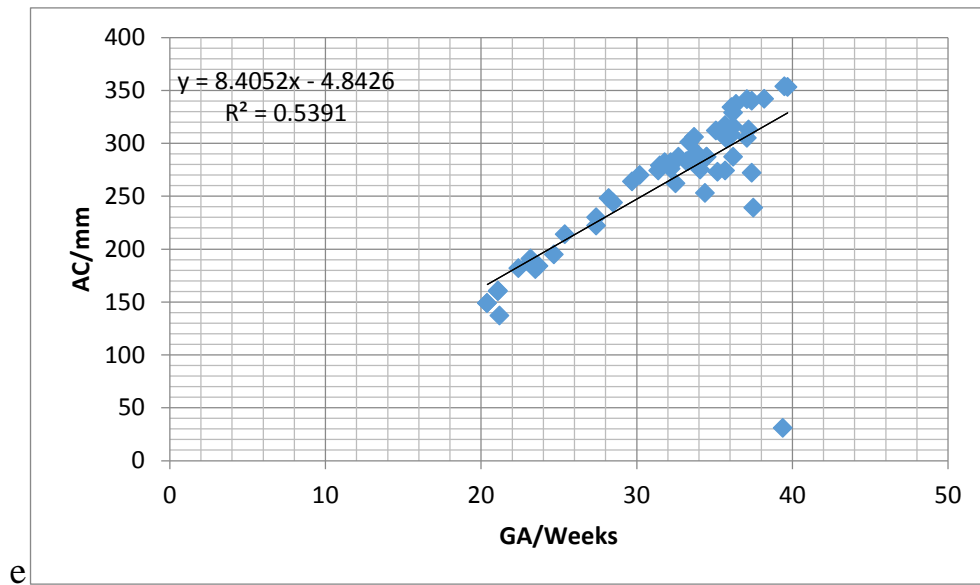
e

Figure4.5 Ascatter plot diagram shows the correlation between gestation age and abdominal circumference, the abdominal circumference increased by8.4mm each week.
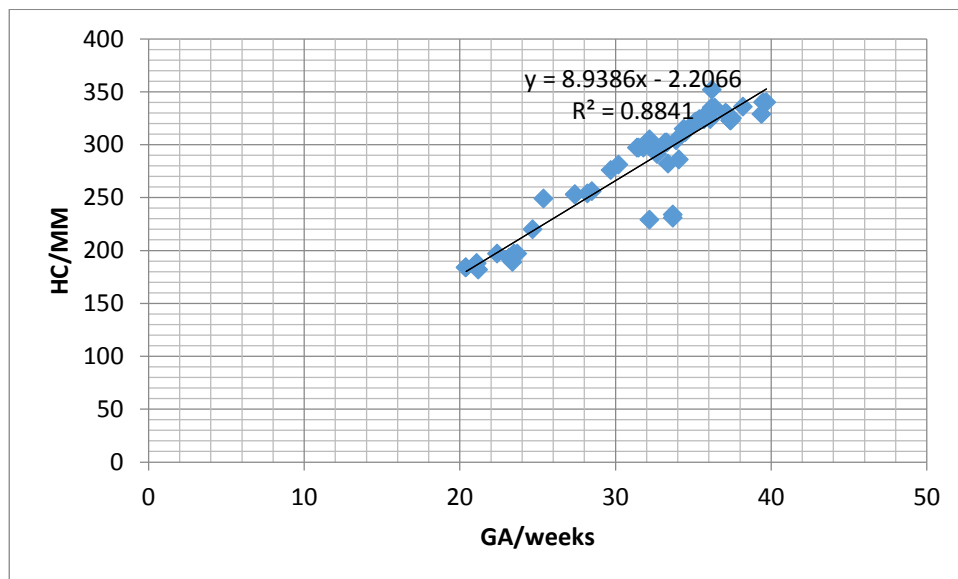

Figure4.6A Scatter plot diagram shows the correlation between gestation age and head circumference, the head circumference increased by8.9mm each week.
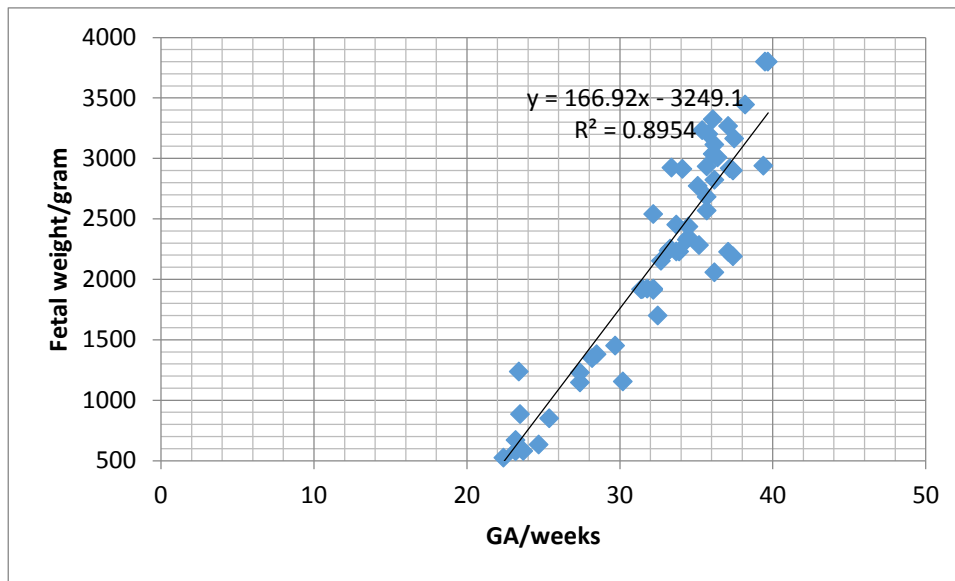
Figure4.7 Ascatter plot diagram shows the correlation between gestation age and Fetal weight, the fetal weight increased by166.9g each week.

Table 4.3 shows R2 and R

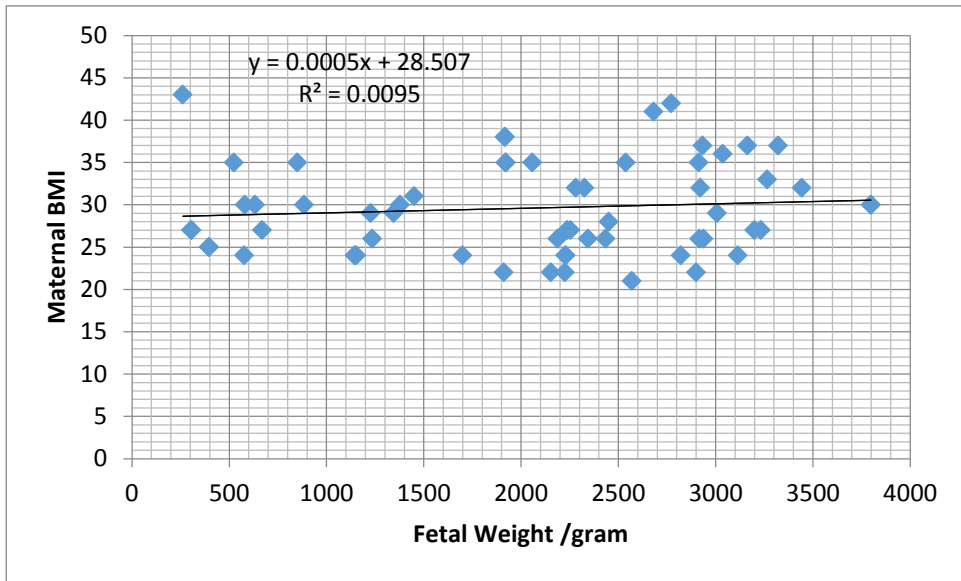| GA	HC	AC	FL	BPD	RT Kidney Length	LT Kidney Length	Fetal weight
R2	0.884	0.539	0.932	0.965	0.823	0.773	0.895
R	0.94	0.73	0.97	0.98	0.91	0.88	0.95

Figure4.8 Ascatter plot diagram shows the correlation between fetal weight and maternal BMI the ,there is week relation.
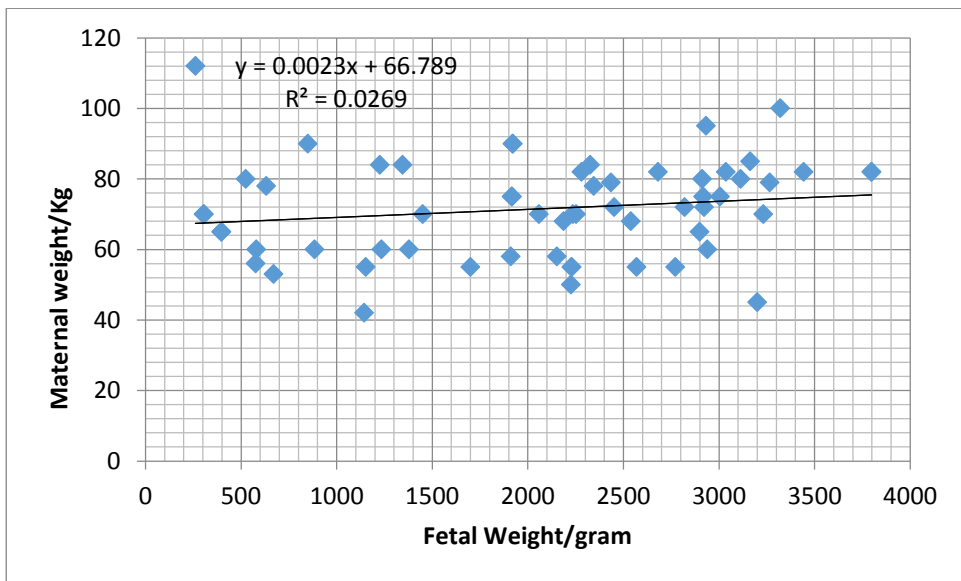

Figure4.9 Ascatter plot diagram shows the correlation between fetal weight and maternal weight ,there is week relation.

Chapter five

Discussion, Recommendation and conclusion

5.1Discussion

The study showed that the average gestation age 31.77 ±5.57 week ,average of foetus weight 2571.81 ±4260.51 g and average of right kidney and left kidney length 28.48 ±7.41 mm , 29.61 ±7.72mm respectively presented in table 4.2.

The study showed that the average of BPD, FL, HC, and AC 78.28±14.78 mm, 61.08 ±13.53mm , 281.83 ±52.99mm , 262.24 ±63.81 mm respectively ,presented in table 4.2.

These measure compared with study Mete Gugur et al mean gestational age depending on last menstrual period and early ultrasound was 31.98±4.29 (24-39 weeks). The mean kidney length was 35.66±6.61 (19-49 mm).

The study showed the correlation between gestation age and right kidney length, the right kidney length increased by1.20 mm each week, it was presented in scatter plot in figure4.1.

The study showed the correlation between gestation age and left kidney length, the left kidney length increased by1.21mm each week, it was presented in scatter plot in figure 4.2.

The study showed the correlation between gestation age and biparital diameter, the biparital diameter increased by2.60mm each week ,it was presented in scatter plot in figure4.3.

The study showed the correlation between gestation age and femur length, the femur length increased by2.34mm each week ,it was presented in scatter plot figure4.4.

The study showed the correlation between gestation age and abdominal circumference, the abdominal circumference increased by8.4mm each week ,it was presented in scatter plot figure 4.5.

 The study showed the correlation between gestation age and head circumference, the head circumference increased by8.9mm each week,it was presented as scatter plot figure 4.6.

The study showed the correlation between gestation age and Fetal weight, the fetal weight increased by166.9g each week, it was presented as scatter plot figure4.7.

The study showed R^2 of HC ,AC, FL ,BPD, RKL ,LKL,and ,FW were 0.884 ,0.539 ,0.932 ,0.965 ,0.823 ,0.773 ,0.895 and R of these parameter 0.94 ,0.73 , 0.97 ,0.98 ,0.91 ,0.88 ,0.95 respectively. The best parameter was BPD and least parameter was AC in estimation of gestation age.

   These study compared Farrokh Seilanian Toosi and Hossein Rezaie-Delui found that a significant correlation was found between GA and KL (R=0.83) and compared with Mete Gugur et al found that There was a significant correlation between gestational age and fetal kidney length (r=0.947) and Adding fetal kidney length to the routine biometrics improved the effectiveness of the model used to estimate GA (R^2=0.965 to R^2=0.987).

The study show correlation between fetal weight and maternal BMI , the relation weak R2=0.0095,it was presented as scatter plot figure 4.8.

The study show corrlelation between fetal weight and maternal weight ,the relation weakR2=0.0269,it was presented as scatter plot figure 4.9.

5.2 Conclusion

The study conclude the RT and LT kidney fetus average length 28.4 ±7.4 mm , 29.6 ±7.7mm respectively. And average of BPD, FL, HC, and AC 78.2 ±14.7 mm, 61.08 ±13.5mm , 281.8 ±52.9 mm , 262.2 ±63.8 mm respectively .

The relation between kidney length and gestation age RT and LT increase by 1.20 mm and 1.21 mm each week respectively.BPD increased by 2.60mm ,FL increase by 2.34mm ,AC increased by 8.4mm ,HC increased by 8.9mm .

The study showed there was significant correlation between RT and LT kidney length with gestation age (R2=0.823 R2=0.773) and (R=0.91, R =0.88) respectively.

5.3Recommendation

*Estimation **of** gestation age by kidney length include in routine fetus parameter.

*Any person re- search   in estimation of gestation age by kidney advised to take

transverse and anteriposterior diameter of kidney ,and increase the sample size.

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Appendix

SAMSUNG ULTRASOUND MACHINE (MENDLSON)