



Sudan University of Science and Technology
College of Graduate Studies



**Estimation of Gestational Age in Third Trimester by Fetal
Kidney Length Using Ultrasonography.**

تقدير عمر الجنين عن طريق طول الكلية في الثلث الثالث من الحمل
بإستخدام الموجات فوق الصوتية.

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

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الآية

بسم الله الرحمن الرحيم

(هُوَ الَّذِي خَلَقَكُمْ مِنْ تُرَابٍ ثُمَّ مِنْ نُطْفَةٍ ثُمَّ مِنْ عَلَقَةٍ ثُمَّ يُخْرِجُكُمْ طِفْلًا ثُمَّ لِتَبْلُغُوا أَشُدَّكُمْ ثُمَّ لِتَكُونُوا شُيُوخًا وَمِنْكُمْ مَنْ يُتَوَفَّى مِنْ قَبْلٍ وَلِتَبْلُغُوا أَجَلًا مُسَمًّى وَلَعَلَّكُمْ تَعْقِلُونَ)

[غافر: ٦٧]

Dedication

To my father who showed me in his life the meaning of life.

To my mother who showed me how to choose my way

To my husband for his patience and hard work in guidance, encouragement and continuous support.

To my sisters and brothers

To my friends who support me all the time.

Acknowledgement

At the beginning I thank **Allah** who guide me in this work. I'm extremely grateful to many people who have supported me during completion of this research. Firstly, I would like to thank my supervisor prof **Caroline Edward** for her advises and help. I would like to thank the sonographers **Mammon Elbasheir, Alfatih Awad Alkareem** who help me in the data collection and measurement. Finally, without forgetting to thank everyone who help me for research up to the desired image.

Abstract

Estimation of gestational age plays an important role in maternity care. Ultrasound provides an accurate method of determining fetal age in utero. There was some limitation in routine ultrasound parameter that use in estimation of gestational age such as biparital diameter and femur length that lead to under or over estimation of gestational.

The aim of this study were to measure the fetal right renal length and to determine if renal length can be used correctly to estimated gestational age and to compare it with other ultrasound parameters that was used routinely in estimation of gestational age, including biparital diameter and femur length.

Across sectional study was done at ELmek Nimir university hospital from August to December 2018, by using ultrasound machine (Fukuda Denshi) curved linear transducer 3.5MHZ, for 50 healthy pregnant women, all were sure of their last menstrual period and with single live fetus and no maternal or fetal complications. Their ages were between (15-40) years. The study was done during the 27-40 week of gestation by measuring biparital diameter and femur length, the gestational age was measured and right renal length in millimeters. The results were analyzed and showed there was strong positive correlation between RT kidney length in mm with gestation age in weeks ($R^2= 0.95$), which is significant at p-value 0.01.and the length of RT kidney increase by 0.96 each week from 25 weeks of gestation.

The study obtained that kidney length was accurate parameter for estimating gestational age than other biometric indices in third trimester and could be easily incorporated into the models for estimating gestational age.

مستخلص البحث

للموجات فوق الصوتية دوراً مهماً في تحديد عمر الجنين ورعاية الأم الحامل . في بعض الحالات القياسات الروتينية التي تستخدم في الموجات فوق الصوتية لتقدير عمر الجنين تكون محدودة مما ينتج عنها قياسات اكبر او اقل من العمر المتوقع للجنين .

تهدف هذه الدراسة الي تقدير عمر الجنين عن طريق قياس طول كلية الجنين اليمنى في الثلث الثالث من الحمل، ومقارنتة بالقياسات العمرية الاخرى للجنين.

أجريت هذه الدراسة التحليلية بمستشفى المك نمر الجامعي، لعدد ٥٠ امرأة حامل أعمارهن ما بين ١٥-٤٠ سنة، بعد حضورهن الي عيادة المتابعة الدورية و التأكد من تاريخ آخر دورة شهرية , وتم أخذ الموافقة من الحامل بعد ذلك، وكان العمر الجنيني ما بين ٢٧-٤٠ إسبوع، في الفترة من شهر أغسطس الي ديسمبر ٢٠١٨م. وأستخدم فيها جهاز موجات فوكدا دينيشي وتم أخذ قياسات قطر الرأس , طول عظم الفخذ وطول الكلية اليمنى بالمليمترات ومقارنتها بعمر الجنين. توصلت هذه الدراسة الي وجود علاقة قوية بين عمر الطفل وطول الكلية اليمنى بمستوي ثقة ٠,٠١ ومعامل إرتباط خطي ٠,٩٥ و أن طول الكلية اليمنى يزداد بزيادة عمر الجنين بمعدل ٠,٩٦ ملم كل إسبوع بعد الإسبوع الخامس والعشرون من عمر الجنين. ولذلك نوصى بإستخدام قياس طول الكلية لتقدير عمر الجنين.

Contents

الآية	I
Dedication	II
Acknowledgement	III
Abstract	IV
مستخلص البحث	V
Contents.....	VI
Chapter One	1
Introduction.....	1
1.1. Introduction	1
1.2. Problem of the study:	2
1.3. Objectives of the study:.....	2
1.3.1. General objectives.....	2
1.3.2. Specific objectives	2
1.4. Scope of the study:	3
Chapter Two.....	4
Anatomy, Physiology and Literature Review.....	4
2.1. Development of kidney:	4
2.1.1. Pronephros:	4
2.1.2. Mesonephros:	4
2.1.3. Metanephros: The Definitive Kidney.....	5
2.2. Collecting System:	6
2.3. Function of The Fetal Kidney:	8
2.4. Importance of estimation of gestational age:	8
2.5. Methods of gestational age estimation:.....	8
2.5.1. Last Menstrual Period(LMP):.....	8

2.5.2. Ultrasonic estimation of gestational age:	9
2.5.2.1 Bi parietal Diameter (BPD):	10
2.5.2.2 Femur Length:.....	11
2.5.2.3 Fetal kidney:	12
2.6. Previous Studies:	13
Chapter Three.....	16
Materials and Methods.....	16
3.1. Study design:	16
3.2. Inclusion criteria:.....	16
3.3. Exclusion criteria:.....	16
3.4. Study area:.....	16
3.5. Study duration:	16
3.6. The equipment:.....	17
3.7. Data collection:.....	17
3.8. Technique:	17
3.9. Ethical clearance:	17
3.10. Data analysis:	18
3.11. Limitation:	18
Chapter Four	19
Result & Data analysis.....	19
Chapter Five.....	24
Discussion, Conclusion and Recommendations	24
5.1. Discussion:	24
5.2. Conclusion:.....	25
5.3. Recommendations:	26
References:.....	27

List of Tables

Table (4.1): show mother demographic data expressed as mean and standard deviation.....	19
Table (4.2.): show Fetal parameters express as mean and standard deviation.....	19
Table (4.3.): show Correlation between gestational age and age by last menstrual period.....	19
Table (4.4): show Correlation between fetal age and age by biparital diameter....	20
Table (4.5): show Correlations between fetal age and age by femur length.....	21
Table (4.6): show Correlation between fetal age and age by RT kidney length....	22

List of Figures

Figure (2.1): Show Relationship of the intermediate mesoderm of the pronephric, mesonephric, and metanephric systems.....	5
Figure (2.2): Show Ventral view of an embryo at week 5 illustrates the sets of excretory systems.....	7
Figure (2.3): Show Transverse section of the fetal head demonstrating the landmarks required to measure the BPD using the thalami view.....	11
Figure (2.4): Trance abdominal ultrasound show Measurement of the fetal femur..	12
Figure (2.5): Normal ultrasound image of the fetal kidneys.....	13
Figure (4.1): A Scatter plot diagram shows the relation between fetal age and age by LMP.....	20
Figure (4.2): A Scatter plot diagram shows the relation between fetal age and age by biparital diameter.....	21
Figure (4.3): A Scatter plot diagram shows the relation between fetal age and age by Femur length.....	22
Figure (4.4): A Scatter plot diagram shows the relation between fetal age and age by RT fetal kidney length.....	23

Abbreviations

BPD	Bi Parietal Diameter
GA	Gestational Age
FL	Femur Length
LMP	Last Menstrual Period
SD	Standard Deviation
FKL	Fetal Kidney Length
CRL	Crown Rump Length
AC	Abdomen Circumference
HC	Head Circumference
R ²	Correlation Coefficient
IUGR	Intra Uterine Growth Restriction
T12	Twelve Thoracic Vertebra
L3	3 rd Lumber Vertebra
S1	First Sacral Vertebra
S2	Second Sacral Vertebra

Chapter one

Chapter One

Introduction

1.1. Introduction

Gestation age estimation is an important aspect of routine obstetric scanning, knowing gestation age accuracy is essential for optimal prenatal delivery and post-natal care (Imtiaz et al., 2010). Gestation age initial estimation using the women`s last menstrual period (LMP) and clinical methods such as uterine size assessment and fundal height movement. Theses method have many limitation, dating the last menstrual period may have difficult because of poor recollection, irregular menstrual cycle of varying duration, locational amenorrhea, bleeding in early pregnancy and hormonal contraceptive use prior to conception. Fundal height may be diminished by multiple pregnancy, intra uterine growth restriction and other fetal characteristics. (Imtiaz et al., 2010).

Ultrasound is an effective way of dating pregnancy, the use of fetal biometric parameter such as femur length (FL), Bi parietal diameter (BPD), head

Circumference and abdominal circumference are routinely use in estimation of age in the second and third trimester.

The accuracy of theses parameter decreases as pregnancy advance in age (Karki 2006). so we need other parameter in predicting the age especially as pregnancy advise to the third trimester.

The kidneys develop from the ureteric bud and metanephric mesoderm .it initiate to form at seven weeks of gestation and get to appropriate function at week eleven of pregnancy (Ahmadi et al., 2015).

Appearance of kidney in the first trimester was never positively identified, between 15 and 26 weeks it was seen but was difficult to distinguish from surrounding tissue. In early third trimester either an echogenic border or increased echogenicity of renal

sinus was observed, in late third trimester the echogenicity was increase in both it is thought that the echogenicity is result of fat deposition in Para renal space and renal sinus. (Bowie 1983).

1.2. Problem of the study:

There are some limitations in routine ultrasound parameters that use in estimation of gestational age as BPD which can be difficult under certain conditions such as deeply engaged fetal head, fetal in transverse and breach presentation, also become unreliable in conditions altering the shape of the skull (dolichocephalic) which produce measurement that could be small for gestational age. Femur length is shortened in cases of achondroplasia making it unreliable parameter in estimation of gestational age. also ethnicity, growth parameter of intrauterine environment, physical and mental wellbeing of mother, maternal nutrition and genetic factor lead to over or under estimation of gestational age.

1.3. Objectives of the study:

1.3.1. General objectives

To estimate the gestational age in the third trimester by length of right kidney using ultra sound.

1.3.2. Specific objectives

- To measure the length of kidney and correlate it with gestational age of Fetus.
- To compare the fetal length with other commonly used sonographic parameter likes femoral length(FL), Bi parietal diameter(BPD).
- To estimate the possibility of kidney length to determine the fetal age in 3rd trimester.
- To determine if the length of kidney can be used correctly to estimate the gestational age?

- To find out the most reliable parameter in estimation of gestational age

1.4. Scope of the study:

This study will include five chapters.

- **Chapter One:** deal with introduction, problems of study, objectives and research question.
- **Chapter Two:** Anatomy, physiology and Literature review.
- **Chapter Three:** Material and methods.
- **Chapter Four:** Results and data analysis
- **Chapter Five:** Discussion, conclusion and recommendations.
- **References.**

Chapter Two

Chapter Two

Anatomy, Physiology and Literature Review

2.1. Development of 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 nonfunctional; the second may function for a short time during the early fetal period; the third forms the permanent kidney. (Sadler 2004).

2.1.1. Pronephros:

At the beginning of the fourth week, the pronephros is represented by 7 to 10 solid cell groups in the cervical region. These groups form vestigial excretory units, nephrotomes, that regress before more caudal ones are formed. By the end of the fourth week, all indications of the pronephric system have disappeared. (Sadler 2004)

2.1.2. Mesonephros:

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 wolffian duct.

In the middle of the second month the mesonephros 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 differentiating, 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 mesonephric duct persist and participate in formation of the genital system, but they disappear in the female. (Sadler 2004).

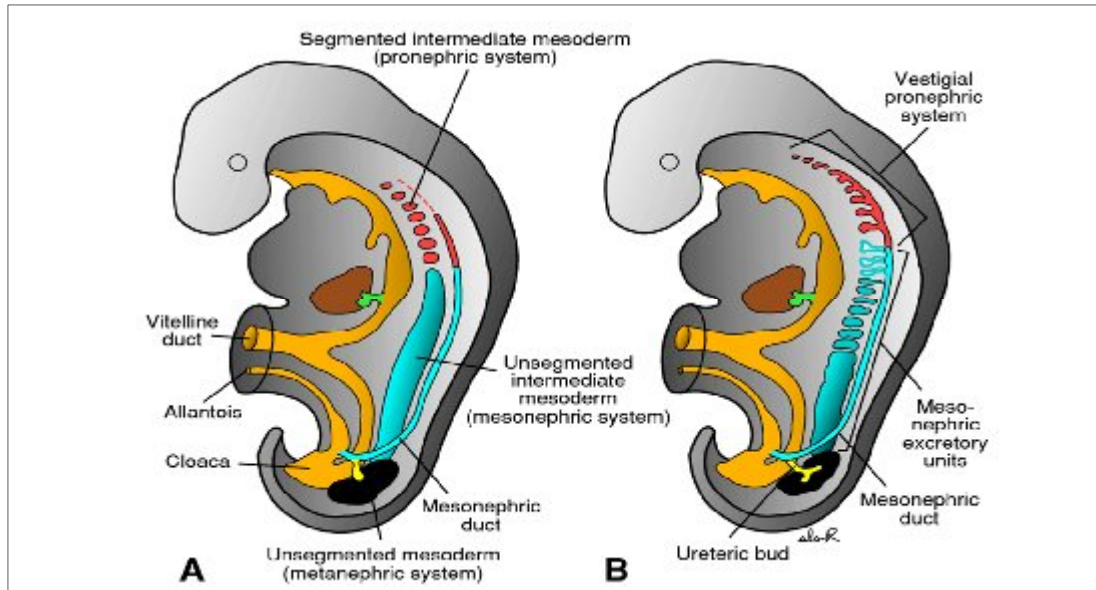


Figure 2.1 Show: A. Relationship of the intermediate mesoderm of the pronephric, mesonephric and metanephric system. In the cervical and upper thoracic regions intermediate mesoderm is segmented, in the lower thoracic, lumbar and sacral regions it forms a solid unsegmented mass of tissue, the nephrogenic cord. Note the longitudinal collecting duct form initially by pronephric but later by the mesonephros. B. Excretory tubules of the pronephric and mesonephric system in a 5-week- old embryo. (Sadler 2004).

2.1.3. Metanephros: The Definitive Kidney

The third urinary organ, the metanephros, or permanent kidney. Its excretory units develop from metanephric mesoderm. (Sadler 2004).

begins to develop by week 5 in the sacral region, but it is functional nearly a week 10, it develops from;

1. The ureteric bud (an outgrowth from the mesonephric duct) → collecting system (upper most parts of ureters and renal pelvis).

Initially, the ureteric bud penetrates the metanephrogenic cap and undergoes repetitive branching and further development giving rise to major calyces, minor calyces and collecting ducts. (Ezzatly 2017)

2. The metanephrogenic cap (mass of metanephric mesoderm) form excretory system. M. cap differentiates into small metanephric vesicles which later elongate to form S - shaped metanephrogenic tubules. These tubules develop into connecting tubule, distal convoluted tubule, loops of Henle, proximal convoluted tubule and Bowman's capsule. The latter will invaginate by a tuft of capillaries forming the glomerulus. (Ezzatly 2017)

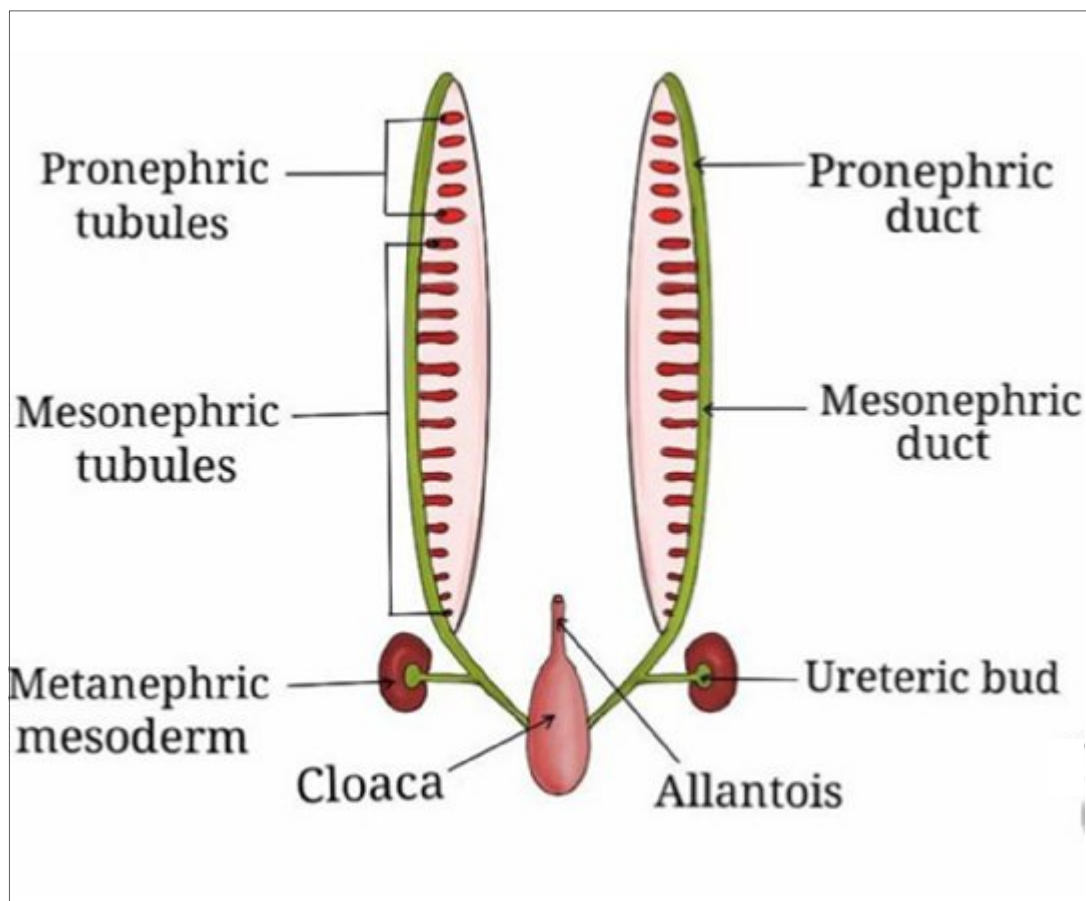
The nephron is formed until birth when there is about 1 million per kidney. Urine production starts at approximately 10 weeks of gestation. At birth, the kidney surface is lobulated, but this lobulation disappears during infancy and becomes smooth.

Kidneys are a pelvic organ at first (S1-S2), then, and due to the rapid growth of the embryo in this region, it ascends on the posterior abdominal wall to reach the adult position (T12-L3). The kidneys rotate medially 90 degrees, thus, the hilum of the adult kidney faces medially (instead of ventrally). (Ezzatly 2017)

2.2. 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 metanephric 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 metanephric 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 million to 3 million collecting tubules. (Sadler 2004).

Figure 2.2 show: Ventral view of an embryo at week 5 illustrates the sets of excretory systems. (Ezzatly 2017).

2.3. Function of The Fetal Kidney:

The definitive kidney formed from the metanephros becomes functional near the 12th week. (Sadler 2014). fetal urinary production starts at 9 weeks of pregnancy and increase significantly beyond 16 weeks. At 20 weeks about 90% of amniotic fluid consist of fetal urine. It estimated to be around 7.3ml/h at 24 weeks increasing to 71.4 ml/h or about 300 ml/kg/fetal weight/day near to term (Touboul et al., 2008). Urine is passed into the amniotic cavity and mixes with the amniotic fluid. The fluid is swallowed by the fetus and recycles through the kidneys. During fetal life, the kidneys are not responsible for excretion of waste products, since the placenta serves this function. (Sadler 2004).

2.4. Importance of estimation of gestational age:

Accurate gestational Age estimation is very important to an obstetrician for diagnosis of growth disorders, in assessment of wrong dates or forgotten dates and timing of delivery either by induction or caesarean section. It is particularly important in high risk pregnancies (severe preeclampsia, chronic hypertension, severe IUGR, central placenta Previa, sensitized Rh-negative mother etc.) where in some cases early termination may become necessary as soon as fetus becomes mature. GA estimation is also a prerequisite to interpret certain tests (amniotic fluid assay, serum assay, chorionic villus sampling) and to plan timing of various forms of fetal therapy. Failure in estimating GA accurately can result in unnecessary induction, dysfunctional labor, operative delivery, iatrogenic prematurity or post maturity, false interpretation of tests and delay or failure of fetal therapy, thereby increasing perinatal morbidity and mortality. (Indu et al., 2012).

2.5. Methods of gestational age estimation:

2.5.1. Last Menstrual Period(LMP):

Traditionally, the first day of the last menstrual period (LMP) has been used as a reference point, with a predicted delivery date 280 days later. The estimated date of

confinement (EDC) can also be calculated by Nagele's rule by subtracting three months and adding seven days to the first day of the last normal menstrual period. However, there are inherent problems in assessing gestational age using the menstrual cycle. (Walker et al., 1988).

The fallacy in this method is that the time of ovulation in relation to the menstrual cycle varies greatly both from cycle to cycle and individual to individual. About 10-45% of pregnant women cannot provide useful information about their LMP and 18% of women with certain menstrual dates have significant differences between menstrual and ultra-sonographic dating. Factors such as menstrual abnormalities, locational amenorrhea, oral contraceptive failure, bleeding in early pregnancy and chronic anovulation may interfere with accurate calculation of GA from the date of LMP. (Indu et al., 2012).

2.5.2. Ultrasonic estimation of gestational age:

Ultra sonographic fetal biometry is the most widespread method used to establish GA. Various sonographic biometric parameters commonly used are Crown Rump Length (CRL), Bi parietal diameter (BPD), Head circumference (HC), Abdominal circumference (AC) and Femur length (FL). CRL measurements accurately predict GA to within $\pm 5-7$ days but can be employed only in cases who present in 1st trimester. In early 2nd trimester BPD, FL, HC and AC can predict GA with fair accuracy ($\pm 10-11$ days, $\pm 10-20$ days, $\pm 10-14$ days and $\pm 10-14$ days) respectively. However, as the pregnancy advances these parameters become increasingly unreliable in prediction of GA. Therefore, accurate estimation of GA in late 2nd and 3rd trimester still remains a problem. Various non-traditional sonographic parameters for estimating GA are being studied like transverse cerebellar diameter, fetal foot length, epiphyseal ossification centers, amniotic fluid volume and placental grading. FKL is one such nontraditional parameter for estimating GA. It is easy to

identify and measure. It is more accurate method of GA estimation than BPD, FL, HC and AC after 24th week of gestation. (Indu et al., 2012).

2.5.2.1 Bi parietal Diameter (BPD):

Its accuracy is maximal between 12 to 20 weeks of gestation (Campbell et al., 1971). It has become an established method of assessing gestational age as it is easy to obtain. A single optimal measurement would predict gestational age within + 5 days. BPD is the maximal diameter of a transverse section of the fetal skull at the level of the parietal eminences. A correct section should include the following:

1. The Falx cerebri.
2. The cavum septum pellucidum
3. The thalami
4. The basal cisterns.

After assessing the ovoid shape of the fetal skull BPD is measured on a frozen image. Horizontal component of the first caliper is placed on the outer aspect of the proximal surface and the second caliper is placed on the inner aspect of the distal skull surface at right angles to the midline and at the widest diameter. The BPD is measured from outer to inner skull tables. (Hadlock et al., 1982).

In the second half of pregnancy, BPD obtained from the fetus presenting as breech or transverse may be unreliable. In these the fetal head may appear dolichocephalic (long and narrow). This produces a measurement that could be small for gestational age. (Shanmughavadivu 2014).

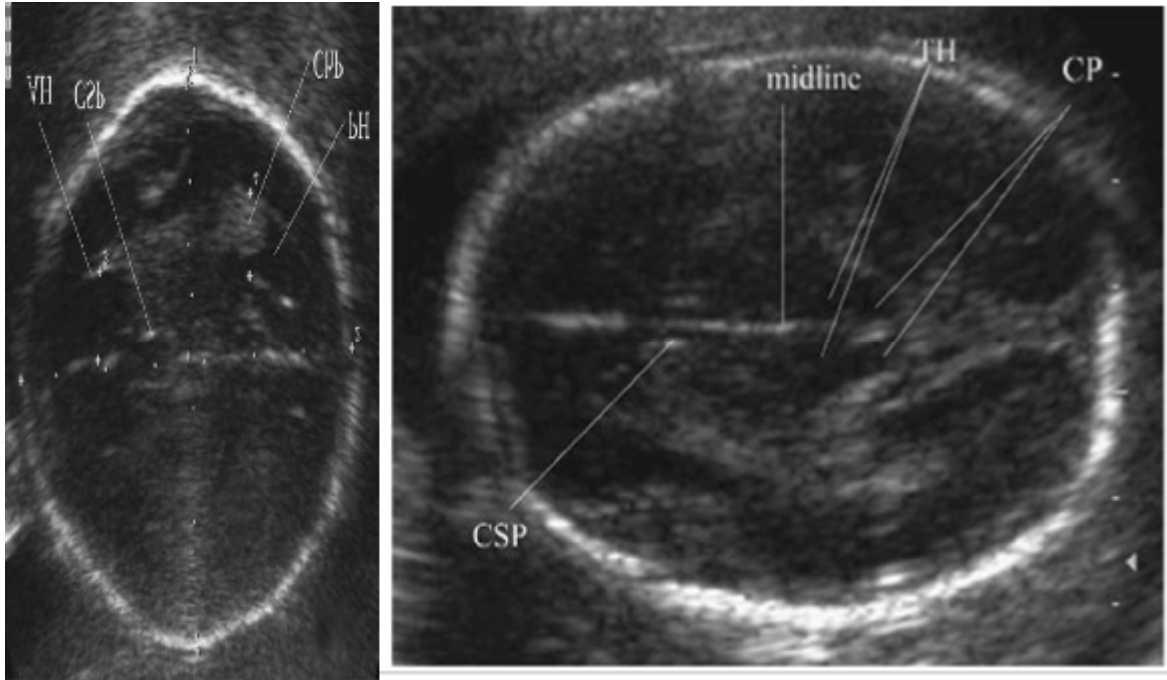


Figure 2.3 show: Transverse section of the fetal head demonstrating the landmarks required to measure the BPD using the thalami view. CP, cerebral peduncles; CSP, cavum septum pellucidum; TH, thalami. (Trish Chudleigh and Thilaganathan B., 2004).

2.5.2.2 Femur Length:

This measurement is as accurate as the BPD in the prediction of gestational age. It is useful in confirming the gestational age estimated from BPD or HC measurements and can often be obtained when fetal position prevents measurement of the BPD or HC. measurement of femur length should not replace that of the BPD or HC as the sole predictor of gestational age. The femur can be measured from 12 weeks to term. Measuring the femur is ideally undertaken after the AC has been measured. Slide the probe caudally from the AC section until the iliac bones are visualized. At this point, a cross-section of one or both femurs are usually seen. The upper femur should be selected for measurement. The lower femur is frequently difficult to image clearly because of acoustic shadowing from fetal structures anterior to it. Keeping the echo from the anterior femur in view, rotate the probe slowly until the full length of the femur is obtained.

Most problems arising with measuring the FL are due to a combination of fetal movements and slow use of the freeze button. (Trish Chudleigh and Thilaganathan B., 2004).



Figure 2.4 Transverse abdominal ultrasound show Measurement of the fetal femur. Note that soft tissue is visible beyond both ends of the bone. The femur length is the distance between the caliper markers. (Trish Chudleigh and Thilaganathan B., 2004).

2.5.2.3 Fetal kidney:

The fetal kidneys can be seen trans abdominally from 14 weeks' gestation and are easily visible at 20–22 weeks. The first clue that you have found the kidney is the hypoechoic area – delineated by a hyperechoic bright border that represents the renal pelvis. (Trish Chudleigh and Thilaganathan B., 2004)

The sonographic cortico-medullary differentiation starts at 15 weeks and will become more clear with advancing gestational age. The outer, more hyperechoic renal cortex can be clearly distinguished from the inner, more hypo

echogenic medulla at the 20th week of gestation. Renal echogenicity will also decrease, lower than that of the liver and spleen from 17 weeks. The antero-posterior diameter of the renal pelvis (APPD) should be less than 4mm in the second trimester and less than 7mm in the third trimester. (Nguyen et al., 2010)

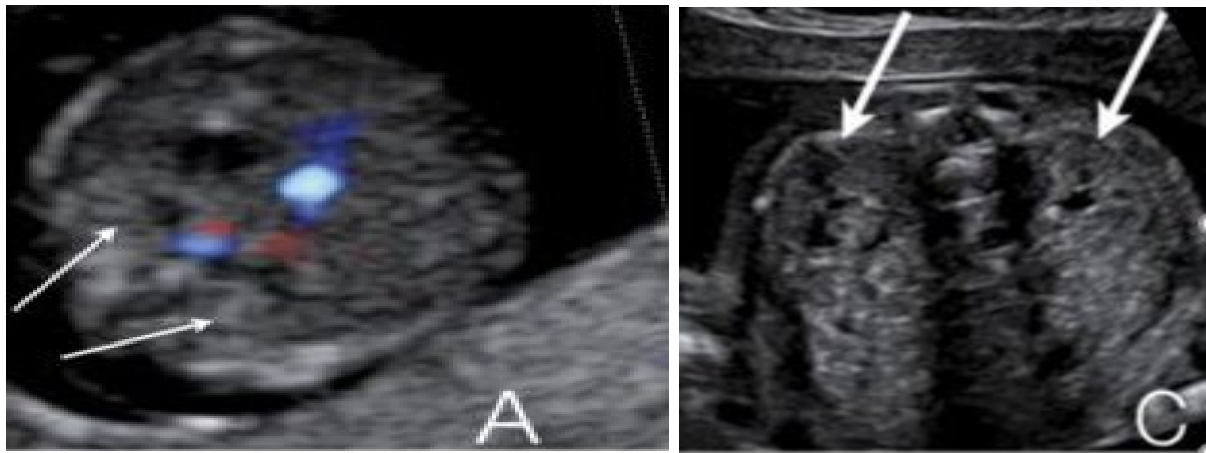


Figure 2 .5 Normal ultrasound image of the fetal kidneys. A. First trimester fetal kidneys at both sides of the lumbar spine. C. Decreased echogenicity and beginning of cortico-medullary differentiation in second trimester fetal kidneys. (Hindryckx A. and L. De Catte 2011).

2.6. Previous Studies:

Konje et al., in 2002, studied gestational age determination by measuring fetal kidney length after 24th week of gestation. 73 pregnant women with uncomplicated pregnancies were selected for the study. Serial measurement of fetal biometry and kidney length were done from 24 to 38 weeks of gestation. Linear regression analysis was done. The results showed that FL and fetal kidney length are the best parameters for determination of gestational age (± 10.29 and ± 10.96 days respectively). They concluded that fetal kidney length measurement was a more accurate method of estimating gestational age than other fetal biometric indices like BPD, HC, AC, FL. (Konje et al., 2002).

Yusuf. N et al., in 2007, studied the correlation of fetal kidney length with gestational age. The study included 102 pregnant women after 30 weeks of gestation. All the patients had dating scan done at early weeks of pregnancy. The fetal kidney length measurement showed a linear correlation with gestational age. The mean fetal kidney length in mm corresponds to gestational age in weeks. The result concluded that measurement of fetal kidney length can be used as an additional parameter for the estimation of gestational age. (Yusuf. N et al., 2007).

Indu Kaul et al., in 2012: A total of 98 pregnant women with singleton pregnancy underwent serial biometric & FKL measurements ultrasonographically at 24, 28, 32, 36 and 38 weeks of gestation. These measurements were used to date the pregnancies relative to dating by last menstrual period. Linear regression models for estimation of GA were derived from the biometric indices and FKL. Fetal Kidney Length (FKL) is most accurate single parameter for estimating GA than other biometric indices in late 2nd and 3rd trimester and could be easily incorporated into the models for estimating gestational ag. (Indu et al., 2012).

Shanmughavadivu in 2014, studied two hundred pregnant women with singleton uncomplicated pregnancies with the gestational age between 24 to 40 weeks of gestation were selected for the study. They underwent ultrasound fetal biometry and fetal kidney length measurement. These measurements were used to date the pregnancies and compared with clinical gestational age derived from last menstrual period and dating scan. Linear regression analysis was done to find out the best parameter for estimating gestational age. Pearson correlation was done to determine the accuracy of these parameters in the estimation of gestational age. The mean fetal kidney length showed a linear correlation with gestational age. Fetal kidney length determines gestational age with the accuracy of ± 9.8 days. BPD dates pregnancy with the accuracy of ± 11.5 days, Femur length by ± 11.3 days. From this study it was concluded that fetal kidney length measurement is the most accurate method of

determining gestational age than other fetal biometric indices like bi parietal diameter, head circumference, abdominal circumference, femur length between 24 to 40 weeks of gestation. (Shanmughavadivu 2014).

Divyasree et al., in 2017. studied the correlation between fetal kidney length and fetal biometry for 150 pregnant women after 28 weeks of gestation who were sure of their last menstrual period. The fetal kidney length measurements showed that there is a linear relationship between fetal kidney length and gestational age. the mean kidney length in mm approximates the gestational age in third trimester as predicted by BPD, HC, AC and FL. The fetal kidney length dates the pregnancy more accurately (correlation coefficient 0.98) when compare with BPD, HC AC and FL. The result obtained concluded that fetal kidney length can be use as reliable parameter for determination of gestational age. (Divyasree et al., 2017).

Chapter Three

Chapter Three

Materials and Methods

3.1. Study design:

It is the analytical descriptive study.

3.2. Inclusion criteria:

All 50 cases included in this study were normal pregnant women between age of 15 to 45 years old came to the ultrasound department for antenatal routine scanning.

The study population of women selected for this study met the following criteria:

1. women in third trimester who are sure of the last menstrual period.
2. Normal pregnancy.
3. Viable singleton

3.3. Exclusion criteria:

The study excluded those who met the following criteria:

1. pregnant women with uncertain last menstrual period.
2. Fetal congenital abnormalities.
3. Failure to clearly visualized / measures the fetal kidney.
4. Pregnancy associates hypertension.
5. maternal Diabetes mellitus.
6. multiple pregnancies.
7. oligo/poly hydrominous.
8. Intrauterine fetal death.

3.4. Study area:

Elmak Nimer university hospital (Shendi).

3.5. Study duration:

The study was conducted in August to December 2018.

3.6. The equipment:

FUKUDA DENSHI/ UF-870AG.with 3.5 MHz convex probe.

3.7. Data collection:

All data collection during study was collected in sheets of paper include (BPD, FL, Right kidney length, maternal age, parity and GA) which were designed especially for this study.

3.8. Technique:

Patients were examined in supine position and ultrasound coupling gel was applied. The fetuses were scanned for viability, and gestational age was measured using BPD and FL. The fetuses were scanned in the transverse plane until the RT kidneys were visualized then the probe was oriented 90 degrees to obtain the longitudinal length of RT kidney, using electronic calipers the lengths of the RT Kidneys were measured from the superior outer pole to inferior outer pole (which were seen as elliptical structures with central echogenic sinus and hypoechoic cortex.). RT FKL is easy to identify and measure, All the measurements were obtained using a 2D real-time mode. the adrenal gland lying superior to the anterior pole of kidney was not included in the kidney length measurement.

3.9. Ethical clearance:

The procedures of the scanning with ultrasound was explained to the patient and the purpose of study.

Permission from the hospital and the department the data of study were kept in confidentiality.

3.10. Data analysis:

statistical analyses were done using IMBSPSS statistics version 20, and Excel 2016. At each GA, RT FKL and other biometric indices were reported as Mean \pm standard deviation. Pearson correlation was used to determine the association between quantitative variables. The length of RT kidney was analyzed and correlated in relation to GA. as well as correlation between GA and other parameters (BPD, FL, LMP, maternal age and parity.) were presented in the form of scatter plots. Linear regression analysis was performed using GA as dependent variable and other fetal parameter as independent variable. Statistical significant was considered to be achieved at p-values ≤ 0.05 .

3.11. Limitation:

Non proper fetal position may make visualization of kidney difficult thus this case excludes from study.

Chapter Four

Chapter Four

Result & Data analysis

Table (4.1) mother demographic data expressed as mean and standard deviation.

Data	Means \pm SD
Mother Age/ year	27.12 \pm 7.07
LMP/week	32.56 \pm 4.57
Parity	2.54 \pm 2.06

Table (4.2) fetal parameters express as mean and standard deviation.

Parameters	Means \pm SD
Gestation age/week	31.70 \pm 6.06
Right Kidney / mm	32.34 \pm 4.45
BPD/mm	80.20 \pm .9.62
Femur length/mm	61.08 \pm 9.46

Table (4.3) Correlation between gestational age and age by last menstrual period.

		GA	LMP
GA	Pearson	1	0.412**
	Correlation		
	Sig. (2-tailed)		

** . Correlation is significant at the 0.01 level (2-tailed).

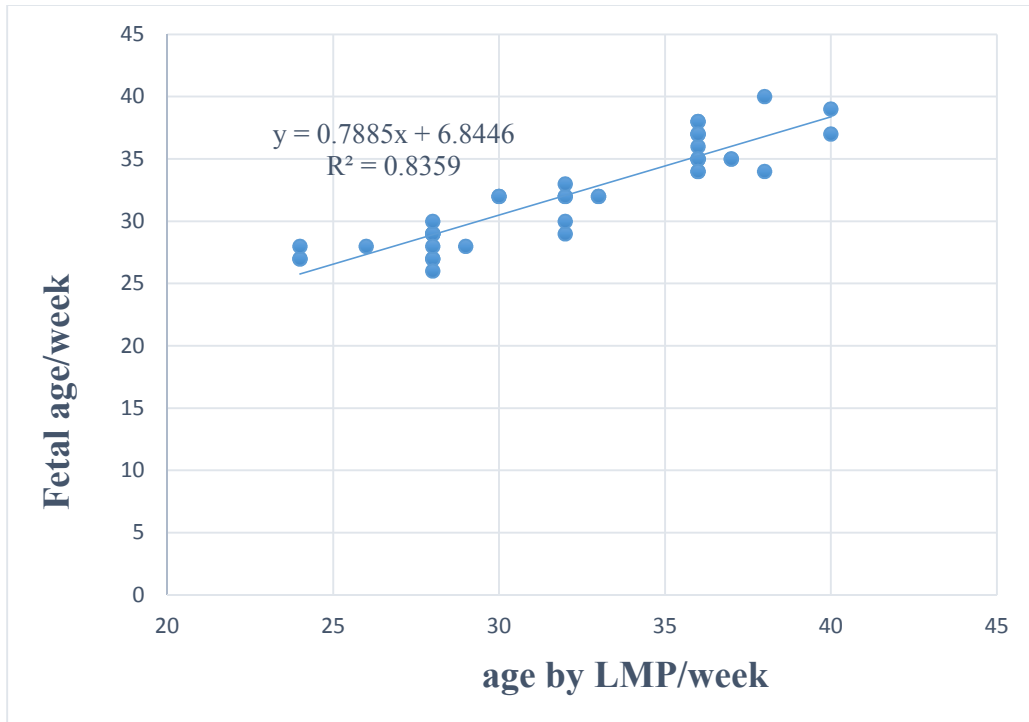


Figure 4.1 A Scatter plot diagram shows the relation between fetal age and age by LMP

Table (4.4): show Correlation between gestational age and age by Bi parietal diameter.

		GA	BPD
GA	Pearson Correlation	1	0.394**
	Sig. (2-tailed)		0.005

** . Correlation is significant at the 0.01 level (2-tailed).

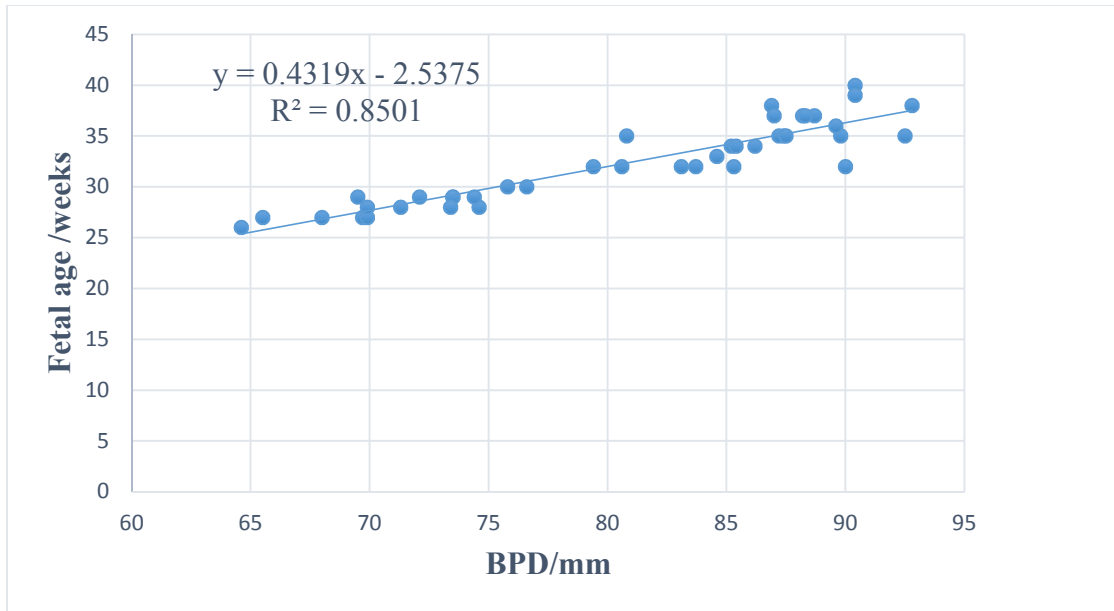


Figure 4.2 A Scatter plot diagram shows the relation between fetal age and age by Bi parietal diameter.

Table (4.5): Correlations between fetal age and age by femur length.

		GA	FL
GA	Pearson Correlation	1	0.356*
	Sig. (2-tailed)		0.011

*. Correlation is significant at the 0.05 level (2-tailed).

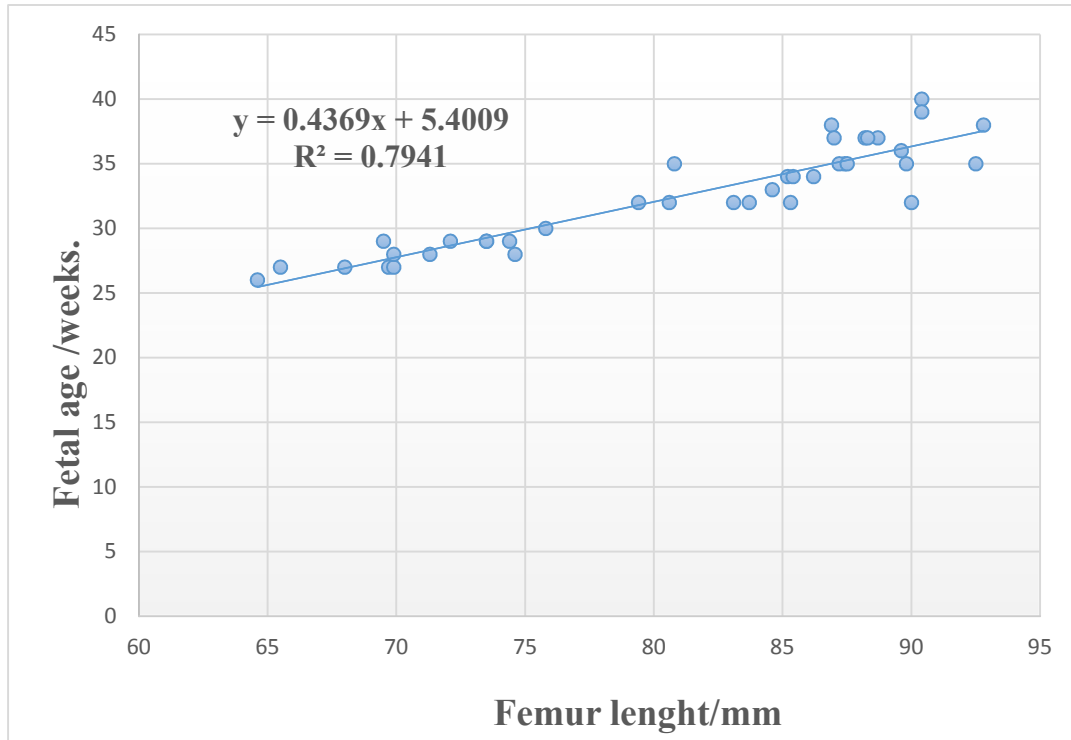


Figure 4.3 A Scatter plot diagram shows the relation between fetal age and age by Femur length.

Table (4.6) show Correlation between fetal age and age by RT kidney length

		GA	Rt. FKL
GA	Pearson Correlation	1	0.450**
	Sig. (2-tailed)		0.001

** . Correlation is significant at the 0.01 level (2-tailed).

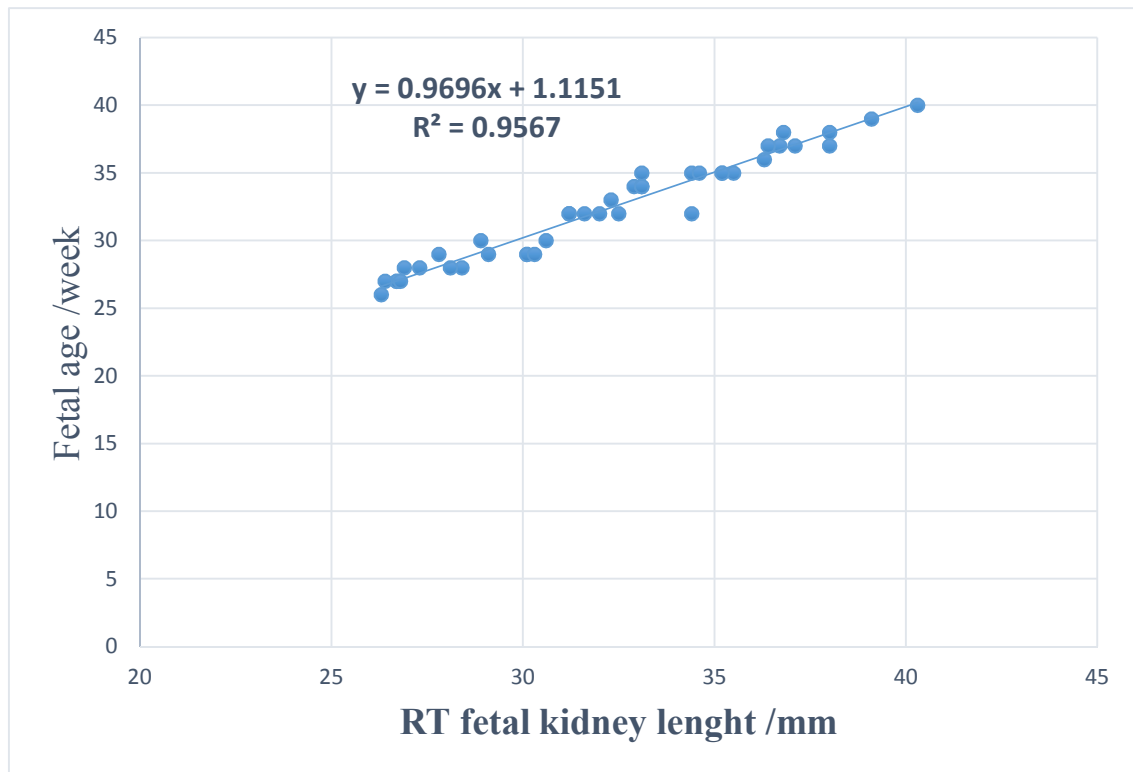


Figure 4.4 A Scatter plot diagram shows the relation between fetal age and age by RT fetal kidney length.

Gestational Age = 0.97*Fetal right kidney length +1.11

- Equation obtained from linear regression analysis was demonstrate prediction of gestational age by fetal right kidney length.

Chapter Five

Chapter Five

Discussion, Conclusion and Recommendations

5.1. Discussion:

This analytical prospective study of 50 health women with uncomplicated pregnancy showed that the average gestation age 31.70 ± 6.06 weeks also showed average right kidney length, BPD and FL 32.34 ± 4.45 , 80.20 ± 9.62 , 61.08 ± 9.46 respectively presented in table (4.2).

This study showed the strong positive correlation between gestation age and right kidney length which is significant at p-value 0.01 level with correlation coefficient ($R^2=0.957$), it was presented in Table (4.6).and there is linear relationship between right kidney length and gestational age at every week the RT kidney length increase by 0.96 mm after 25 weeks of gestational age, which repented in Figure 4.4. also showed positive correlation between fetal age and femur length which is significant at the p-value 0.05 in table (4.5) with correlation coefficient ($R^2=0.79$), and there is linear relationship between them in which the femur length increased by 0.43mm each 5 weeks, after 25 weeks of gestational age it was presented in figure (4.3) The study showed the correlation between fetal age and biparital diameter which is significant at p-value 0.01 with correlation coefficient ($R^2=0.85$). linear relationship shows the biparital diameter increased by 0.34mm each two weeks, after 25 weeks of gestational age, it was presented in scatter plot in figure (4.2).

The study showed the strong positive correlation between fetal age and age calculated by LMP which is significant at p-value 0.01 presented in **Table (4.3)** with correlation coefficient ($R^2 =0.83$) in figure (4.1). the study showed very strong correlation between FKL and GA as compared to previous studies done by **Konje et al., 2002** which concluded that fetal kidney length measurement was a more accurate method of estimating gestational age than other fetal biometric indices

($R^2=91$), also in study done by C.M. SHANMUGHAVADIVU et al., 2014 correlation coefficient ($R^2=0.94$).

And study done Nahid yusuf et al., in 2007, the correlation coefficient ($R^2=0.94$). result of this found to be similar with the study done by Indu Kaulet al., 2012, There was a statistically highly significant correlation between GA (weeks) and Fetal Kidney Length (FKL) which is most accurate single parameter for estimating GA than other biometric indices in late 2nd and 3rd trimester and could be easily incorporated into the models for estimating gestational ag. (KL; $R^2=0.95$).

This study compares to study done by Divyasree B Reddy et al., 2017 which show that there is a linear relationship between fetal kidney length and gestational age, the fetal kidney length dates the pregnancy more accurately with correlation coefficient ($R^2= 0.98$) when compare with BPD, HC AC and FL.

5.2. Conclusion:

This study showed the strong positive correlation between gestation age and right kidney length which is significant at p-value 0.01, with correlation coefficient ($R^2=0.957$) and there is linear relationship between right kidney length and gestational age at every week the RT kidney length increase by 0.96 mm after 25 weeks of gestational age. The result obtained concluded that RT fetal kidney length can be use as reliable parameter for determination of gestational age in 3rd trimester and could be easily incorporated into the models for estimating GA.

It could prove to be a valuable tool in cases where correct plain for measurement of other routine biometric indices are difficult to obtain, and for those are forgetting LMP.

5.3. Recommendations:

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

- Any person re- search in estimation of gestation age by fetal kidney length increase the sample size and use the fetal kidney in estimation of gestational age in abnormal pregnancy.

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