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EVALUATION OF FETAL KIDNEY MEASUREMENT AS ADJUNCT TO GESTATIONAL AGE ESTIMATION IN SECOND AND THIRD TRIMESTER

A Dissertation submitted by

DR. RENUKANANDAN PATIL

POSTGRADUATE IN OBSTETRICS AND GYNAECOLOGY

DEPT OF OBSTETRICS AND GYNAECOLOGY

In partial fulfilment of the requirements for the award of a degree of

MASTER OF SURGERY

In OBSTETRICS AND GYNECOLOGY

UNDER THE GUIDANCE OF

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I hereby declare that this dissertation/thesis entitled "**EVALUATION OF FETAL KIDNEY LENGTH MEASUREMENT AS ADJUNCT TO GESTATIONAL AGE ESTIMATION IN SECOND AND THIRD TRIMESTER**" is a bonafide and genuine research work carried out by me under the guidance of **Dr. S R Bidri** Associate Professor, Department of Obstetrics and Gynaecology, Shri. B. M. Patil Medical College and Research Centre, Vijayapura

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Abbreviation

AC	Abdominal Circumference
BPD	Biparietal Diameter
CRL	Crown Lump Length
FL	Femur Length
FKL	fetal kidney length
GA	gestational age
HC	Head Circumference
LMP	last menstrual period

Table of content

Abstract

Introduction:

Gestational assessment in antenatal women is an important in deciding timing of delivery and good fetal outcome. Inaccurate GA estimation can lead to iatrogenic preterm or postmaturity, dysfunctional labor, surgical delivery, needless induction, incorrect test interpretation, and delayed or unsuccessful fetal care, all of which increase perinatal morbidity and mortality. One such unconventional metric for evaluating the GA under investigation is FKL. It is simple to measure and recognize. It has been shown to develop linearly during pregnancy on MRI, and it has a good correlation with GA . The present study was undertaken to validate the fetal kidney length measurement as an additional morphological measurement of fetal growth along with other parameters like BP, HC,FL, AC .The fetal kidney length can hence be used as a valuable and easy diagnostic tool

Objectives

To assess the efficacy of ultrasonographic measurement of fetal kidney length in calculating the gestational age in second and third trimester of pregnancy.

Methodology

It's a Prospective observational study conducted at Dept. Of Obg Blde(Du) Shri Bm Patil Medical College And Rc Vijayapura on Pregnant women visiting outpatient for routine antenatal care with the gestational age of 20 to 40 weeks with sample size of 300 1st APRIL 2023 1st APRIL 2025(2 years) Data will be recorded in Microsoft Excel and analyzed using SPSS (Version 20).Results will be presented as Mean, SD, counts, percentages, and visual diagrams. For Categorical Variables: Chi-square test or Fisher's exact test.

Results

Out of 300 population 51.7%, n = 155 belonged to the 21–25 years age group with mean age 24.69 years 58.3% (n = 175) were multigravida, 52.3% (n = 157), had a fundal height corresponding to term size, indicating they were in the final stage of pregnancy. The mean and standard deviation of right left and mean of both the kidney length and found that mean and SD is 36.27(2.203), 35.26(2.36) and 35.755(2.24) for right kidney length, left kidney length, and mean length respectively. The p-values for comparisons across gestational ages were highly significant ($p < 0.0001$)

Conclusion:

fetal kidney length is a handy extra measure for figuring out gestational age during the second and third trimesters. FKL's significance is clear, especially when traditional fetal biometric measures might not hold up

EVALUATION OF FETAL KIDNEY MEASUREMENT AS ADJUNCT TO GESTATIONAL AGE ESTIMATION IN SECOND AND THIRD TRIMESTER

Introduction

Gestational assessment in antenatal women is an important in deciding timing of delivery and good fetal outcome. In prenatal medicine, accurate gestational age (GA) measurement is crucial for predicting fetal health and labor dates.[1] For the purpose of diagnosing development abnormalities and determining the best time to deliver a baby, accurate gestational age assessment is essential. Iatrogenic preterm or post maturity, which are linked to higher prenatal morbidity and mortality, can be the outcome of failure. In the past, the starting day of the last menstrual period (LMP) in a typical 28-day menstrual cycle was used to date pregnancies. radiographic evaluation of ossification centers and dental development, as well as uterine size assessment (e.g., McDonald's rule). However, these procedures are beset with considerable variability. [2]The precise assessment of intrauterine gestational age is largely dependent on obstetric sonography.

Comprehending gestational age is important for a number of reasons : It facilitates scheduling invasive procedures like amniocentesis and chorionic villus sampling, schedules spontaneous or elective deliveries within the full-term pregnancy timeframe (38 to 42 weeks), evaluates fetal growth, and influences management choices when fetal abnormalities are present. Therefore, gestational age influences important clinical judgments.[2] For the identification of growth problems, the evaluation of incorrect or forgotten dates, and the scheduling of birth by caesarean section or induction, an obstetrician relies heavily on accurate GA estimation. It is especially crucial in high-risk pregnancies (severe preeclampsia, persistent hypertension, severe IUGR, central placenta previa, sensitized Rh-negative mother, etc.), because as soon as the fetus reaches adulthood, early termination may be required.

Inaccurate GA estimation can lead to iatrogenic preterm or postmaturity, dysfunctional labor, surgical delivery, needless induction, incorrect test interpretation, and delayed or unsuccessful fetal care, all of which increase perinatal morbidity and mortality. Traditionally, the starting day of the last menstrual period (LMP) has been used to estimate GA. This method's flaw is that ovulation timing fluctuates widely from cycle to cycle and from person to person in regard to the menstrual cycle. 18% of women with specific menstrual dates show notable variations between menstrual and ultrasonographic dating, and around 10–45% of pregnant women are unable to offer helpful information regarding their LMP.[3,4]. Further, factors such as menstrual abnormalities, lactational amenorrhea, oral contraceptive failure, bleeding in early pregnancy and chronic anovulation may interfere with accurate calculation of GA from the date of LMP.[3,4]

The diagnosis of many medical disorders depends heavily on ultrasound. Since the beginning of time, when people began making hesitant attempts to rid themselves of illness, diagnosis has been a difficult task. Therefore, the world of medicine has been invaded by a variety of diagnostic procedures recently. One of the most important of these is the discovery of ultrasonography. Ultrasound has significantly influenced management decision-making in the field of obstetrics, where it has specifically transformed diagnosis and treatment. Ultrasound has been a combined boon in poor nations like India where maternal and fetal fatalities are common.

It has undoubtedly contributed significantly to a decrease in maternal and fetal morbidity and mortality. Because ultrasound is non-invasive, non-ionizing, cost-effective, and has a great safety record, its use as a diagnostic tool has advanced significantly over the past 20 years, changing management and care [5].

For establishing GA, ultrasound fetal biometry is the most commonly utilized technique. Crown Lump Length (CRL), Biparietal Diameter (BPD), Head Circumference (HC), Abdominal Circumference (AC), and Femur Length (FL) are typical sonographic biometric measurements.[3] CRL measures can only be used for instances that present in the first trimester, although they accurately anticipate GA to occur within ± 5-7 days. BPD, FL, HC, and AC can all predict GA with a fair degree of accuracy in the first two trimesters (±10-11 days, ±10-20 days, ±10-14 days, and ±10-14 days, respectively).However, these markers lose their predictive power for GA as the pregnancy progresses [6]. As a result, it is still difficult to accurately estimate GA in the late second and third trimesters. Transverse cerebellar diameter, fetal foot length, epiphyseal ossification centres, amniotic fluid volume, and placental grading are among the non-traditional sonographic characteristics being investigated for GA estimation [7].

One such unconventional metric for evaluating the GA under investigation is FKL. It is simple to measure and recognize. It has been shown to develop linearly during pregnancy on MRI, and it has a good correlation with GA [8].

After the 24th week of pregnancy, it is a more accurate way of estimating GA than BPD, FL, HC, and AC . We Sono graphically measured FKL in this longitudinal investigation, assessed its function in GA estimation, and contrasted its precision with other recognized biometric markers. [9]

Over the last 20 years, a lot of research has been done on the sonographic measurement of fetal kidney length (FKL). Numerous investigations were conducted in the early stages of the study to diagnose fetal renal malformation and subsequently to evaluate the relationship between FKL and gestational age [10]

The present study was undertaken to validate the fetal kidney length measurement as an additional morphological measurement of fetal growth along with other parameters like BP, HC,FL, AC . The fetal kidney length can hence be used as a valuable and easy diagnostic tool that will accurately predict the estimated date of delivery without being affected by the discrepancy of late trimester.

Objectives of the study

1.To assess the efficacy of ultrasonographic measurement of fetal kidney length in calculating the gestational age in second and third trimester of pregnancy.

Review of literature

Accurate gestational age assessment is essential for providing quality prenatal care. Femur length (FL), head circumference (HC), abdominal circumference (AC), and biparietal diameter (BPD) are examples of measures that have historically been used. In the later phases of pregnancy, these measurements may become less accurate. Fetal kidney measures were the subject of research in the early 1990s[11]. In a study by **Chatterjee S** in 1991 study that included 397 obstetric patients generated normative data for fetal kidney lengths, demonstrating a robust relationship between kidney length and gestational age. [12]A study conducted in 1996 by **M peter et al** focused on the association between kidney size and gestational age by examining fetal kidney morphometry during gestation. The accuracy of FKL's gestational age prediction was shown to be ±9.048 days in 2002, indicating that its combination with other biometric indices could increase precision. [13]

Kidney length was found to have a strong correlation with assigned gestational age in a 2017 study that included 100 pregnant women, indicating its validity as a stand-alone measure, particularly in later trimesters.

FKL measures were found to be able to predict gestational age with an accuracy of ±9.048 days in another 2017 study including 60 pregnant women. The predictability increased to ±8.299 days when paired with other biometric indices.[13]

Gestational age (GA) is estimated to determine whether or not a newborn will be born prematurely.[14]Throughout pregnancy, healthcare professionals consider gestational age as a crucial piece of information to decide when to do certain screening tests and evaluations of the mother and fetus. Numerous methods exist for determining gestational age. Prior to sonography, medical professionals had to rely on thorough histories and physical examination results. Finding the date of the last known menstrual cycle was very important. Numerous formulas can provide an estimated gestational age and an expected delivery date when the date of the last menstrual period is entered. [15,16,17]

Both the mother and the unborn child are at a higher risk of morbidity and death throughout pregnancy and labor. Improving the result of childbearing and delivery requires knowledge of the advantages and disadvantages of various obstetrical exams and procedures. Assessing fetal growth in relation to gestational duration during pregnancy requires a proper timing of pregnancy. The development of the fetus is vital to the management and observation of pregnancy and labor. [18,19]

One way to estimate gestational age is to use physical exam results, such as uterine fundal height. The more accurate way to determine fetal gestational age, particularly during the first trimester, is ultrasound. For a more precise estimation of gestational age, both transvaginal and transabdominal probe examinations are utilized. Information about gestational age may be obtained using postnatal scoring systems that incorporate targeted physical and neurological examinations.

Technique or Treatment

Prenatal Techniques

Non-Sonographic Methods for Determining Gestational Age Naegele's Rule:[20]

Establish the patient for their medical history to determine the date of their most recent menstrual cycle. Subtract three months and add one year and seven days from this date. This will give you an idea of when the delivery is expected. The approximate start date for the fetus's age can be found from the date of the last known menstrual period.[21]The uterus has been characterized as a soft, spherical pelvic organ. To make room for the growing fetus, the uterus enlarges throughout pregnancy. The first trimester, namely weeks 8–12, is the most accurate time to calculate gestational age.The fastest and most stable growth rates take place during this period, and gestational age can be precisely determined to within five days.The uterus enlarges to the point that it may be felt just above the pubic symphysis at around 12 weeks of pregnancy. The uterine fundus, located halfway between the pubic symphysis and the umbilicus, can be felt during 16 weeks of pregnancy. The fundus is palpable at the level of the umbilicus at 20 weeks of pregnancy. The pubic symphysis to fundal height in millimeters should match the week of gestation after 20 weeks.

Gestational sac: A transvaginal examination at around 5 weeks and a transabdominal examination at approximately 6 weeks allow for the first observation of the gestational sac. It grows about 1 mm every day, and until it gets to be 14 mm in size, measurements become less precise. The mean diameter of the sac, measured from inside wall to inside wall, is used to calculate the embryo's gestational age. Sagittal and transverse images can be used to measure three orthogonal distances from the inside of the gestational sac if it is not entirely spherical. After that, the mean sac diameter is either entered into a regression model, compared to a table of values, or sent into the ultrasound device to ascertain the age through pre-set calculators on an "Obstetric" setting.

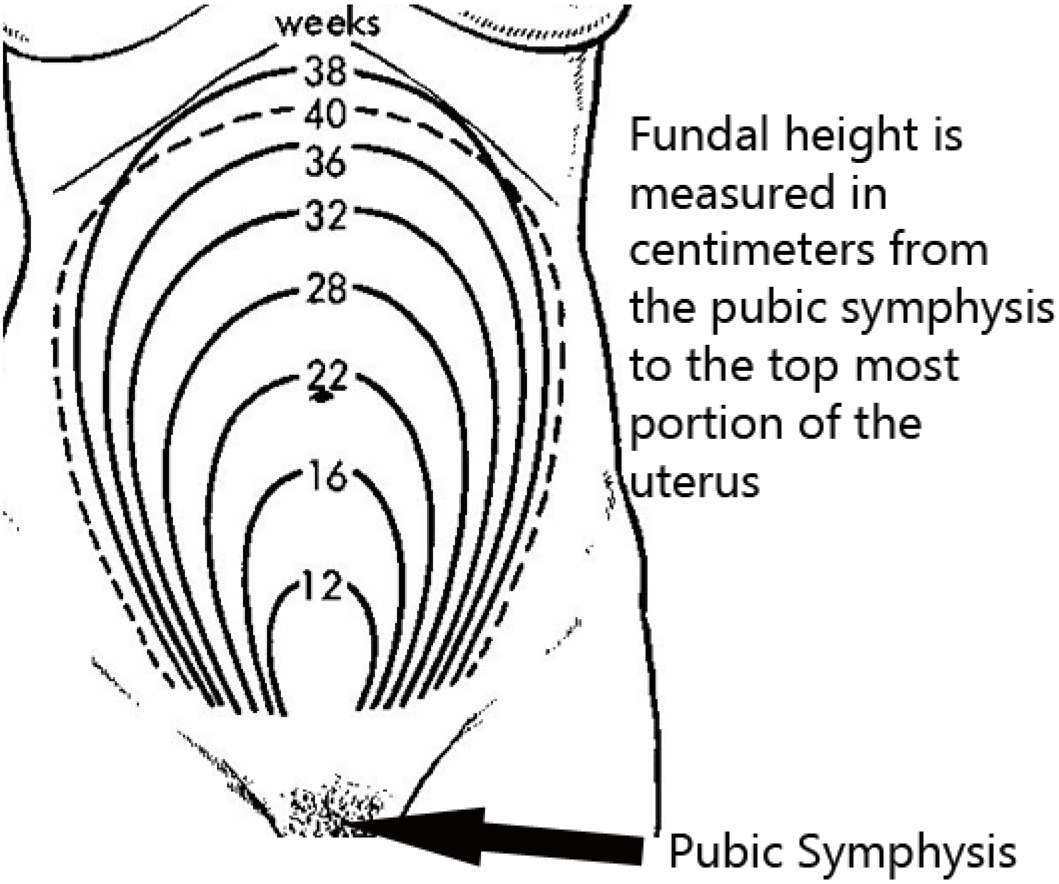

Figure 1: Fundal height

Sonographic Techniques for First Trimester Dating and Gestational Age Determination: The most precise estimate of gestational age will be obtained by sonographic evaluation during the first 13 weeks and 6 days. It is possible to employ both transvaginal and transabdominal methods. The transvaginal method, however, might offer a clearer and more precise image of the early embryonic features. Despite being the first quantifiable indicators seen on ultrasonography, the gestational sac and yolk sac have a poor correlation with gestational age. The measurement that most accurately correlates gestational age is the crown-rump length (CRL).

Crown-rump length (CRL).[21]

A author by **Carl Skinner** suggest that the CRL measure is the most reliable way to determine gestational age among the first trimester techniques. By measuring a straight line from the outer edge of the cephalic pole to the embryo's rump using the calipers on the ultrasonography equipment, CRL can be calculated by averaging three measurements. Numerous validated tables and algorithms that have a strong correlation with gestational age can be used using this parameter. In the event that gestational age cannot be ascertained during the first trimester, alternative sonographic methods may be employed to estimate gestational age. Although they are more useful in figuring out whether the fetal size is within the usual range, these methods are typically not advised as first-line dating approaches. The gestational age and delivery date should remain unchanged if a prior CRL was determined during the first trimester.

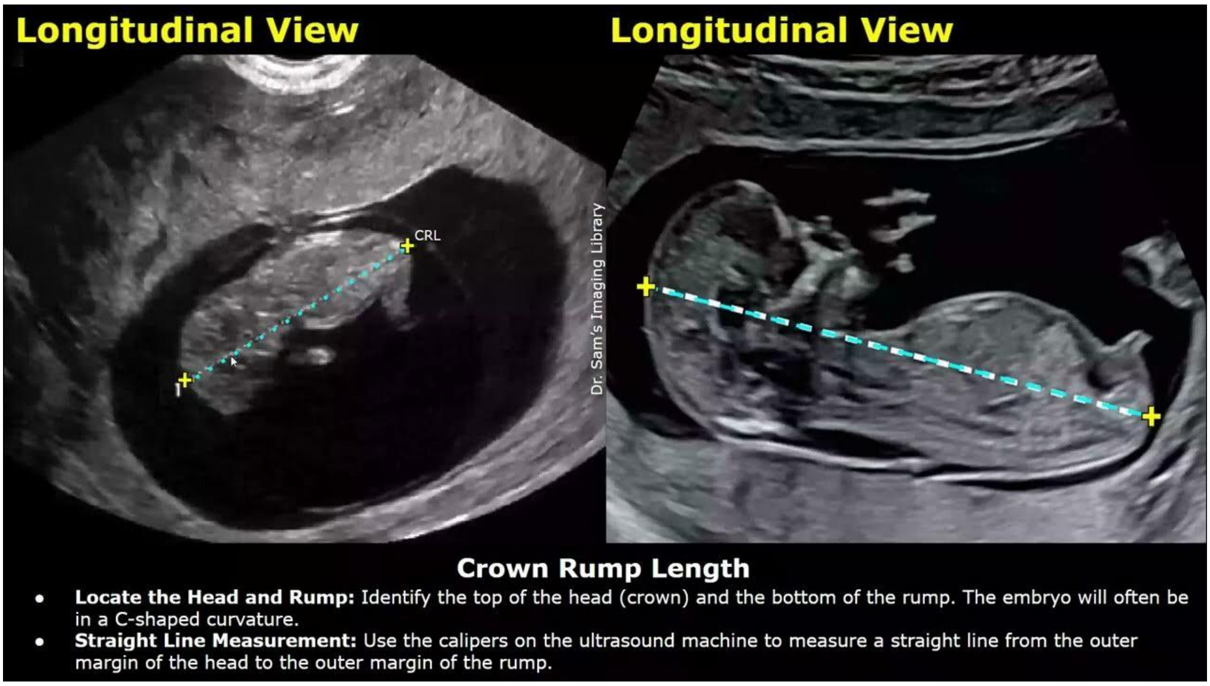

Figure 2: Crown rump length.

Biparietal Diameter (BPD): Due to its extensive research and high reproducibility, this biometric measure is advised as a powerful dating modality. The phased array or curvilinear transducer is positioned perpendicular to the fetal parietal bones in a transabdominal manner. The calvarium should show up as a smooth, symmetrical, hyperechoic (bright white) structure. A plane that crosses the thalami and the third ventricle is used to quantify the BPD. Cursors are positioned on the inner and outer edges of the proximal and distal skulls, respectively, using the caliper function. The biparietal diameter will be determined by this value.[21]

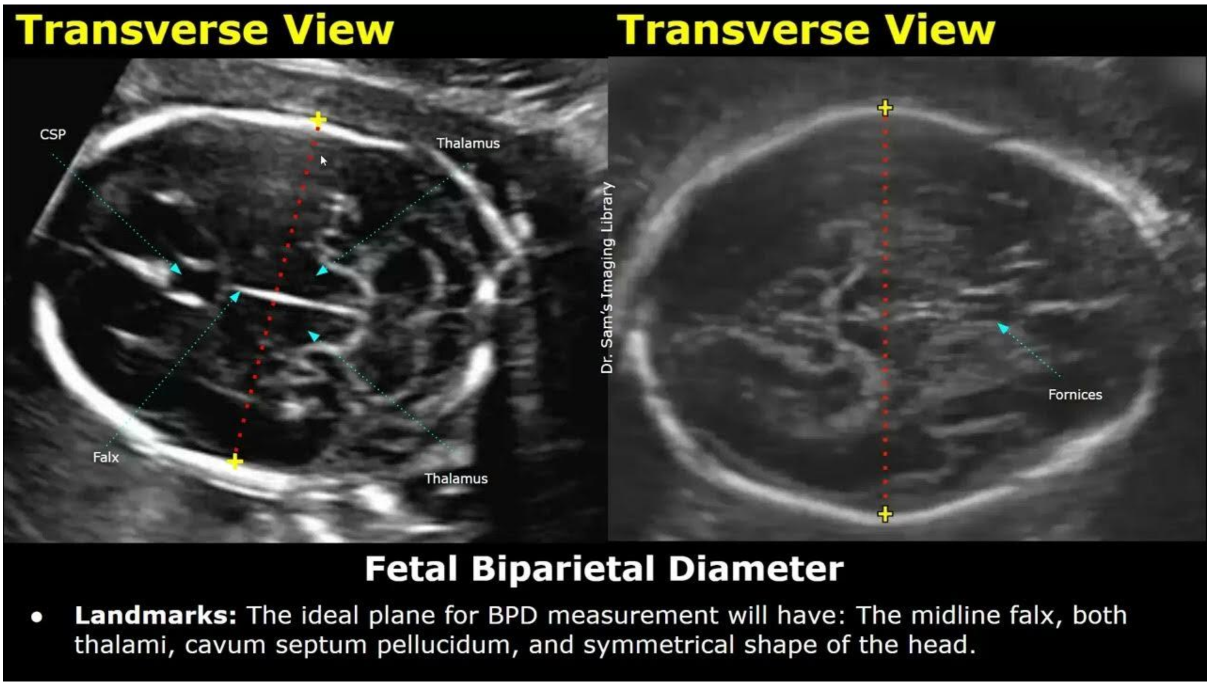

Figure 3: Fetal biparietal diameter

Head circumference (HC): According to certain research, this biometric measure is a better indicator of gestational age than the biparietal diameter. Clinically, this metric might also be helpful in evaluating for growth problems. Here, a sonographic method akin to the BPD is employed. A plane that crosses the thalami and third ventricle is visualized using a phased array or curvilinear transducer. The cavum septum pellucidum must be seen anteriorly, and the tentorial hiatus must be seen posteriorly, in order to obtain the largest anterior-posterior diameter. A conventional HC view should not be used to visualize the lateral ventricles or the cerebellum. Mark the cursors on both sides of the calvarium's outside edges with the calipers. There should be an elliptical measuring device on the ultrasound tool that will generate a measurement of the perimeter of the calvarium.[21]

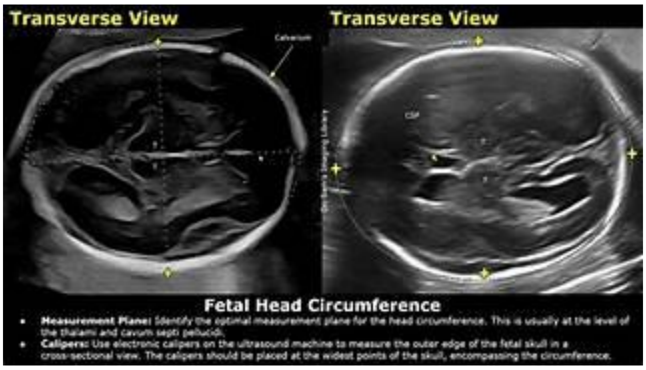

Figure 4: Fetal head circumference

Femur Length (FL): Because of its size and density on ultrasound, the femur can be seen as early as 10 weeks of pregnancy. Align along the closest femur's long axis using a curvilinear transducer or phased array. Visualize the greater trochanter or femoral head proximally, and the femoral condyle distally. Measure the diaphysis' length using the calipers, being careful not to include the femoral head, greater trochanter, or femoral condyle, at the point where bone and cartilage meet.[21]

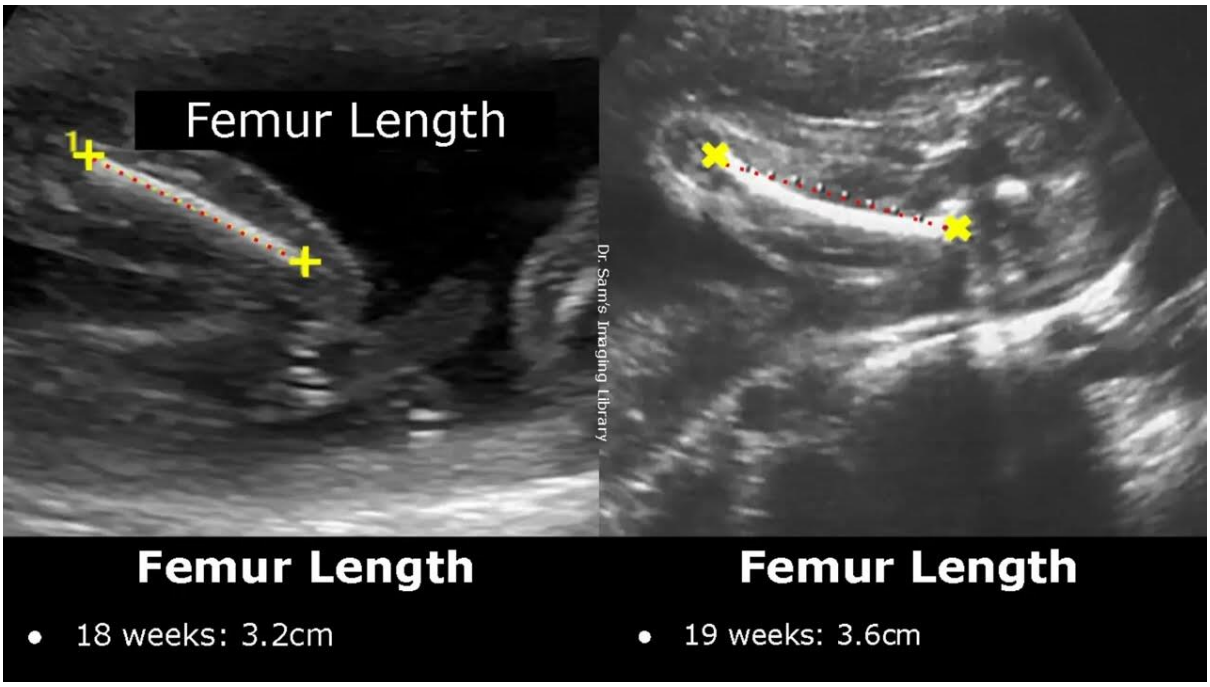

Figure 5: Femur length

The biometric measure of abdominal circumference (AC) is more challenging to assess and has a lower accuracy rate in predicting gestational age than the other methods discussed. Nonetheless, it might be helpful for estimating fetal weight, noting interval growth, and fetuses with limb or cranial anomalies. See how the lower ribs appear symmetrical by positioning the phased array or curvilinear transducer perpendicular to the fetal abdomen wall. This view ought to be at the fetal liver's biggest diameter. Note that this level is frequently used to visualize the unborn stomach.[2]

Figure 6: **Biometric measure of abdominal circumference (AC)**

Another indicator of proper placement is the left portal vein's umbilical segment at its shortest view. Using the calipers, mark four calibration points on the skin's edge across the abdomen, avoiding the rib cage. Circumference can also be computed with the ellipse tool.Dating in the Third Trimester: Several indicators are associated with estimated age and fetal maturity if gestational age has not been established by the third trimester. For instance, at 32 weeks, femoral epiphyseal ossification centers are frequently observed. At 35 weeks, the proximal tibial ossification centers are visible. There is a correlation between the proximal humeral ossification centers and fetal lung maturity, and they emerge in the latter part of pregnancy

The **Dubowitz Method,** which was based on 34 physical and neurological tests, was the conventional approach for calculating postnatal gestational age. Tone, tone patterns, reflexes, movements, aberrant symptoms, and behaviors are the six categories into which these evaluations are separated. A thorough illustration sheet serves as the basis for assigning scores. Greater maturity is correlated with higher scores. On a graph that also connects with gestational age, the overall score might be shown.[20] New Ballard Score: Infants as premature as 20 weeks can have their postnatal gestational age determined using this enhanced scoring method. The system is separated into six neuromuscular and six physical maturity components. Skin, lanugo, plantar creases, breast, ear/eye, and genitalia are the physical maturity components. Posture, square window/wrist, arm recoil, popliteal angle, scarf sign, and heel to ear are among the neuromuscular elements. For ill babies, this test may be more bearable and is faster to complete.

First trimester[22]

In the first trimester, gestational age is calculated using the mean diameter of the gestational sac and the length of the crown-rump

The **gestational sac** is the first sign of early pregnancy on ultrasound and can be seen with endovaginal ultrasound at approximately 3-5 weeks gestation when the mean sac diameter (MSD) would approximately measure 2-3 mm in diameter. A true gestational sac can be distinguished from a pseudogestational sac by noting: Its normal eccentric location: it is embedded in the endometrium, rather than centrally within the uterine cavity. presence of the double decidual sign (most helpful at 4.0-6.5 weeks)presence of a yolk sac: seen at approximately 5.5 weeks (unequivocal evidence of a gestational sac)

Crown-rump length:. This measure is the most reliable way to determine gestational age among the first trimester techniques. When the embryo first shows as a linear hyperechoic structure on the yolk sac's edge, at around six weeks, this is measured. When it is growing at its fastest and most steady rate, which is between 6 and 10 weeks, it is most accurate. It is accurate within 3 to 8 days and can be measured up to approximately 14 weeks.[29,30] The limbs and yolk sac are not included in the measurement, which is made as the embryo develops from the outermost cephalad part to the rump.Based on these readings, the majority of ultrasound machines will calculate the sonographer's age. If that isn't possible, using published tables or regression models will provide this estimate.

The second trimester [23,24]

The estimation of gestational age during the second and third trimesters is less precise due to changes in the growing fetus's characteristics, growth, and genetic variances. A single measurement doesn't seem to be as accurate as a combination of approaches. During these phases of growth, five approaches are frequently employed.

Crown-rump length: Up until roughly 14 weeks of pregnancy, crown-rump length can be measured. This measurement is comparable to biparietal measures from weeks 12 through 14.The biparietal approach ought to be applied whenever the crown-rump length measures 84 mm.The crown-rump length is measured in the second trimester using the same procedure as in the first. During this phase, the accuracy is lower and the gestational age can be properly estimated to within 8 days.[25]

Biparietal Diameter: This measurement, which is impacted by various skull shapes, is accurate to within 3 to 8 days in the first trimester and 7 to 12 days in the second.16 The probe is positioned to provide symmetric views of both hemispheres in order to measure the biparietal diameter in an axial plane. The thalamus and cavum septi pellucidi must be visible in the picture. The outside borders of the skull wall that are closest to one another and the interior edges that are furthest apart should be where the ultrasonic calipers are positioned.[30]

Head Circumference: This measurement is precise within 7 to 12 days and may be most accurate during the second trimester. The circumference, which measures the circumference of the skull, is measured in the same plane as the biparietal diameter.[25]

Abdominal circumference: This measurement is accurate to within 7 to 15 days during the second trimester. It should include the stomach and is taken in an axial, transverse plane at the point where the portal vein splits. Its accuracy varies greatly due to fetal flexion, growth fluctuations, and other positions.

Femur length: This measurement is accurate to within 7 to 17 days of the second trimester. The length of bone, excluding cartilage, is measured using a probe positioned perpendicular to the femur's length. Its length varies according to ethnicity and can be impacted by various medical conditions.

Third trimester.

In the third trimester, gestational age is determined by measuring the circumference of the abdomen and the length of the femur. As explained in the second trimester, these measures are taken. Repeat testing and follow-up are necessary because dating is less accurate during the third trimester.

Abdominal Circumference: Using the same technique as in the second trimester, the abdominal circumference is measured during the third trimester with an accuracy of 18 to 35 days.

Femur length: Measured using the same technique as in the second trimester, the femur length is accurate to within 21 days during this trimester.

Clinical Importance

When determining gestational age, early sonography has proven to be a helpful supplement to the results of the history and physical examination. Sonography can show the pregnancy at different stages, but it must be used properly and its limits must be taken into account. The greatest medical treatment for the mother and fetus over the rest of the pregnancy is typically made feasible by determining the most correct gestational age as soon as possible.

Signals Every pregnant patient should have their gestational age determined so that the mother and fetus can be safely evaluated during the rest of the pregnancy. Contraindications Determining the gestational age of a pregnant patient has no particular contraindications. However, certain patients may not benefit from the gestational age assessment technique. Pregnant patients with vaginal hemorrhage and known placenta previa, those with preterm rupture of the membranes, and those who refuse the examination after being informed should not have a transvaginal ultrasound examination. Transabdominal ultrasonography has no particular contraindications, but it would not be the best option for patient care or picture capture to scan over an open wound.

Both the curvilinear and endocavitary probes provide transverse and sagittal images of the developing fetus inside the uterus. Following the identification of gestation and the acquisition of pictures, gestational age can be calculated in a number of ways, using the estimated age derived from physical examination or the dates of the previous menstrual cycle.

Fetal Kidney

Anatomy of the kidney [26,27]

Human kidney development begins in the first trimester .There are 3 stages of mammalian kidney development: the pronephros, mesonephros, and metanephros. The pronephros and mesonephros form and then essentially involute first .

Kidney development happens in three stages, starting from the urogenital ridge (intermediate mesoderm) and moving chronologically from cranial to caudal direction.
Pronephros, mesonephros, and metanephric mesoderm/blastema arise from intermediate mesoderm → urogenital ridge (longitudinal elevation along dorsal body wall) → nephrogenic cord."

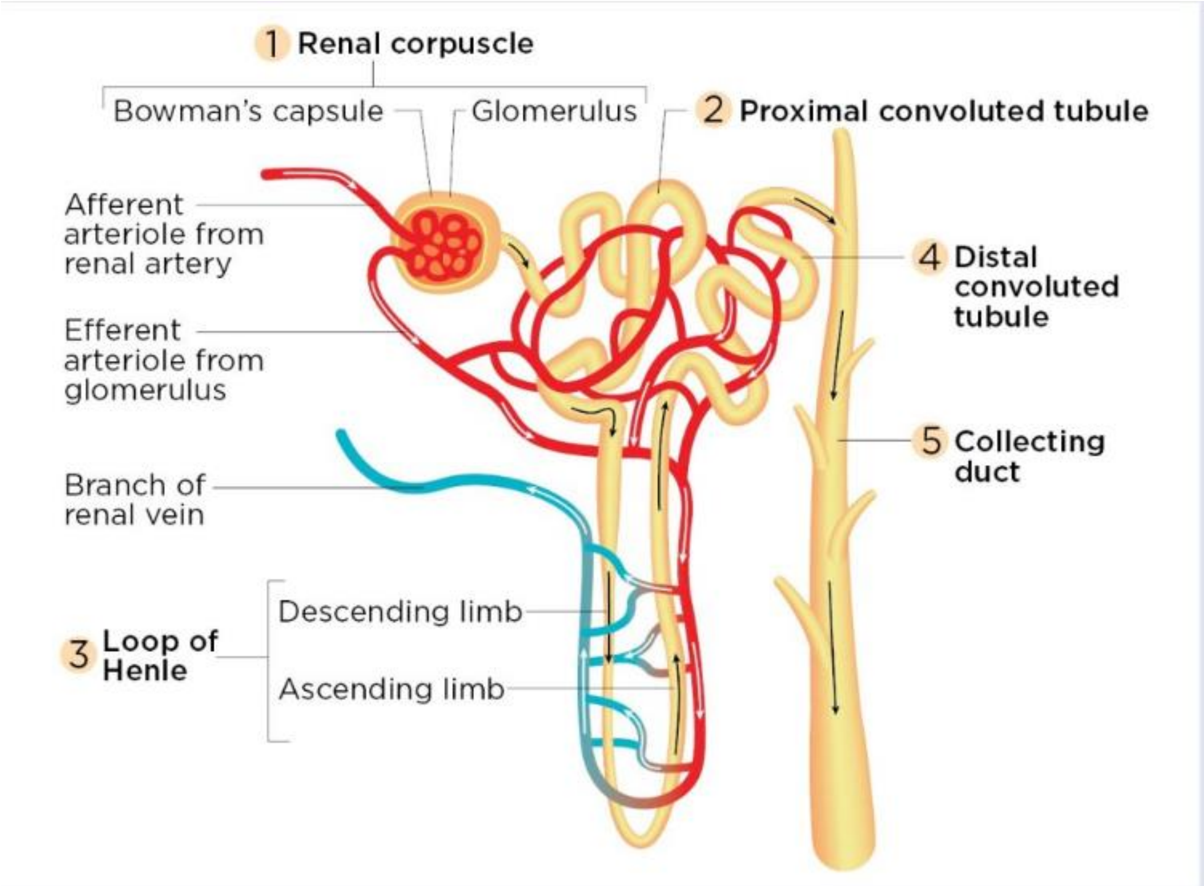

Figure 7: Anatomy of kidney

First trimester[27]

1.Pronephros

Pronephric ducts and tubules

Cervical-most nephric structure originating from cervical intermediate mesoderm

It just provides a blueprint for the kidneys' continued growth; it is non-functional and appears and regresses during the fourth week.

2. **Mesonephros**

The middle nephric structure, which develops from the thoracic and lumbar intermediate mesoderm, the mesonephric duct, and the tubules

Shows up during the fifth week;

Features:

- Provides ureteric bud, a component of the metanephros, and aids in the differentiation of metanephric blastema, mass, and mesoderm
- Regresses fully by 12 weeks (1st trimester)
- Temporary kidney, mostly from 5 to 9 weeks

  Male-forms Wolffian duct (forerunner of the ejaculatory duct, vas deferens, and epididymis); appendix epididymis; paradidymis; appendix vesiculosa; and gartner's duct are examples of mesonephric duct remnants in females.
- The mesonephric tubules' vesicular remains, epoophoron and paroophoron

3.Metanephros;

lumbar and sacral intermediate mesoderm give rise to the caudalmost nephric structure; ureteric bud penetrating metanephric blastema/mass/mesoderm and causing its differentiation

Nephrogenesis continues through 32–36 weeks of gestation; functional maturation of nephrons continues throughout infancy; distal tubules (metanephros) have connected with collecting ducts (ureteric bud); appears in the fifth week and coexists with mesonephros until it degenerates; and functions from the tenth to the twelfth week. .[27]

The mesenchyme's expression of WT1 enables metanephric blastema to react to ureteric bud induction. WNT4 causes the condensed mesenchyme to epithelialize and form tubules, whereas PAX2 encourages the mesenchyme to condense before tubule formation. The volume of amniotic fluid is increased by the fetal urine's excretion into the amniotic sac, where it is ingested and recycled.

The placenta, not the fetal kidney, is in charge of eliminating waste.

The most frequent location of obstruction in congenital hydronephrosis and the slowest to canalize is the uretero-pelvic junction.

Metanephros development

Ureteric bud: Collecting system

1. Ureters
2. Renal pelvis
3. Major calyces
4. Minor calyces
5. Collecting ducts

Metanephric cap/blastema/mass/mesoderm: Nephron

Metanephric mesoderm → Metanephric vesicles → Primitive S-shaped renal tubules → Nephrons

1. Collecting tubules
2. Distal convuleted tubule (DCT)
3. Loop of Henle
4. Bowman’s capsule

Ascent and Rotation of Kidneys

- Fetal metanephros is located at S1-S2
- Definitive adult kidney is located at T12-L3

- The ascent of kidneys is due to disproportionate fetal growth caudal to metanephros.
- During the ascent – kidneys rotate 90°, causing the hilum, which initially faces ventrally, to finally face medially.
- Rather than "drag" their blood supply with them as they ascend, the kidneys send out new and slightly more cranial branches and then induce the regression of the more caudal branches until definitive renal arteries develop at L2.

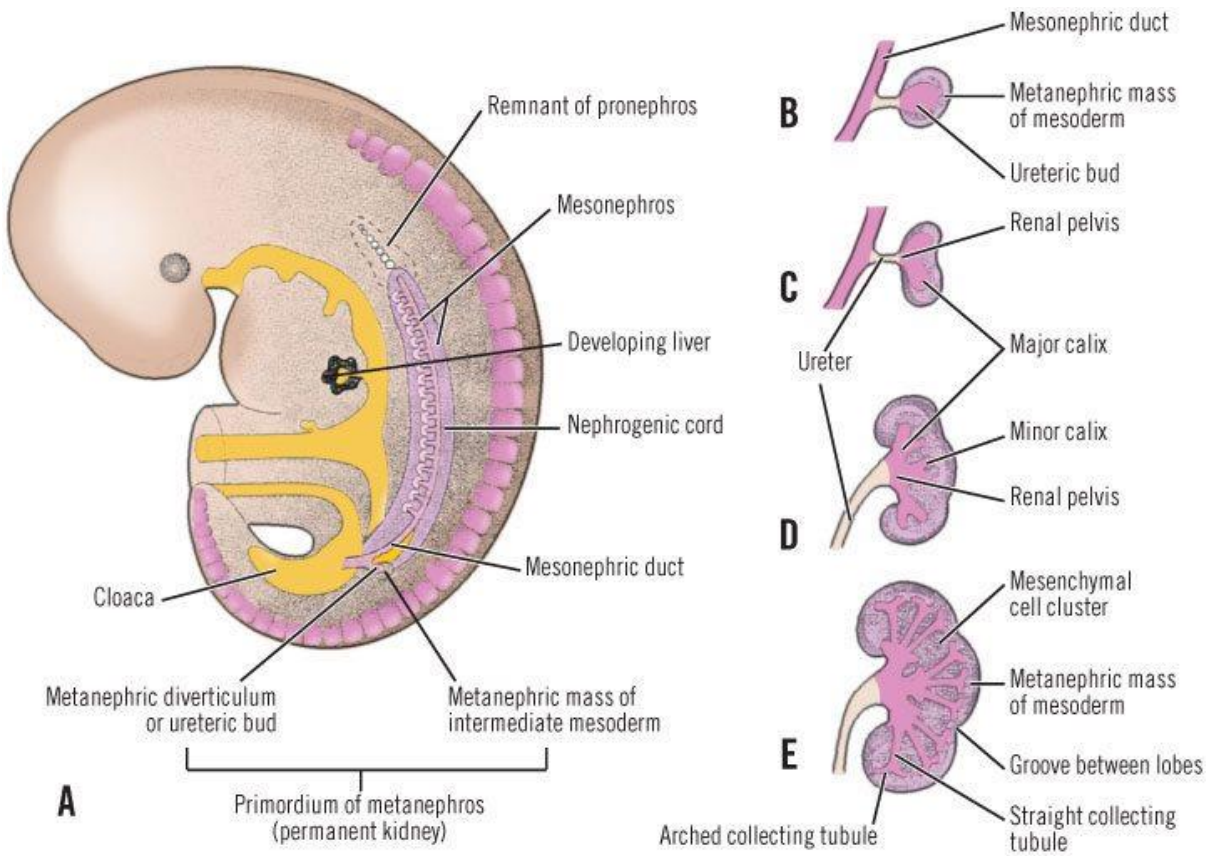

Figure 8: Development of kidney

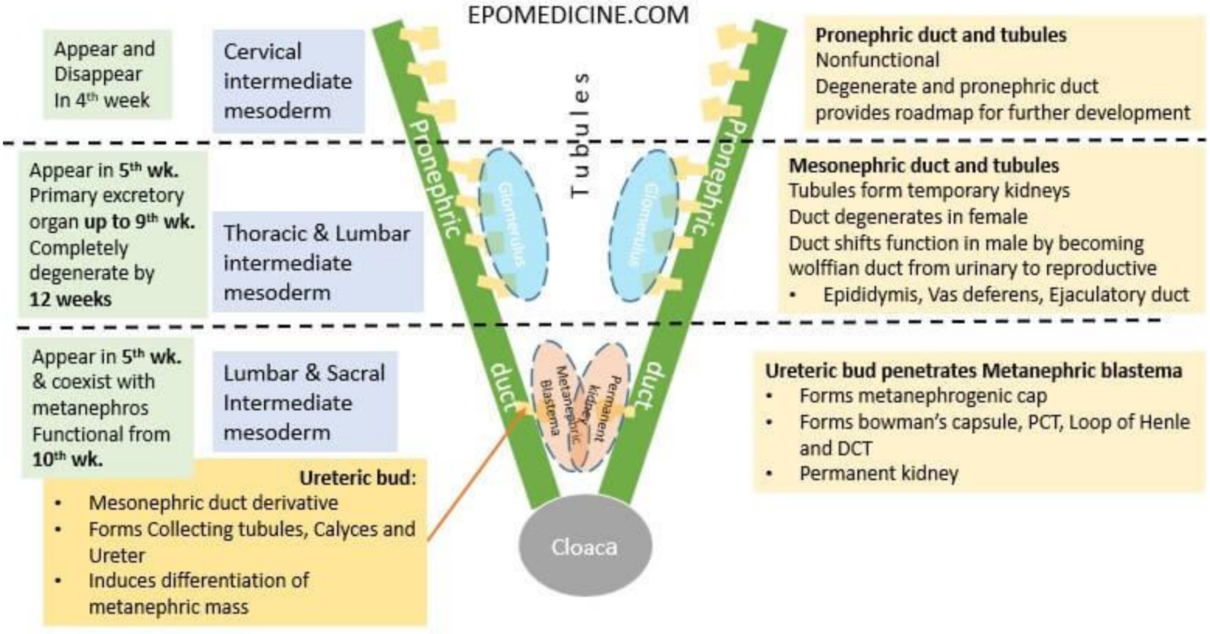

Figure 9:Embryology of kidney

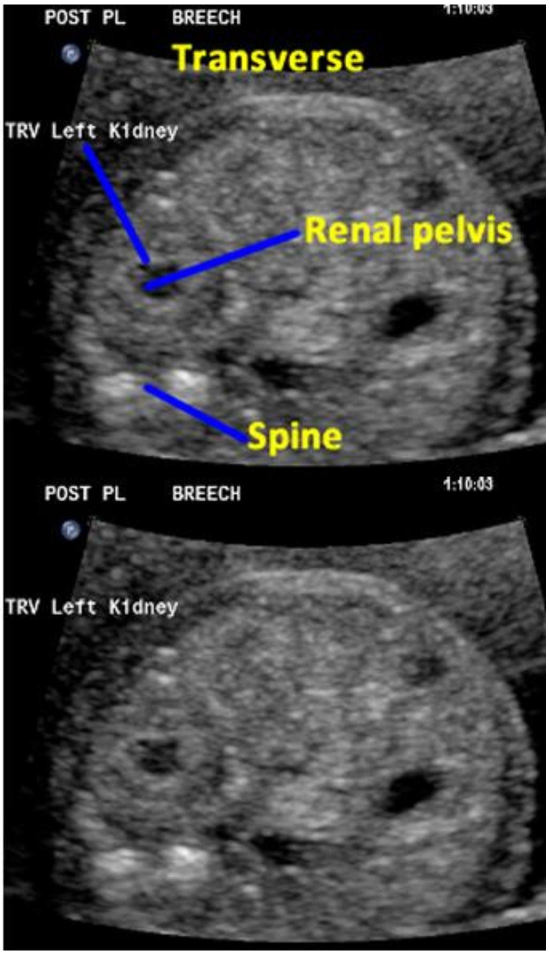

Figure 10: .2 weeks gestation. Transverse view. Spine is now lateral and inferior to the classic dorsal position, but the right kidney is well imaged in this position

Second trimester[27]

Nephrons are initial established once a ureteric bud reacts with the metanephric blastema. At the end of this trimester, about 60% of nephrons are completed. The formation of urine begins at about the twelfth week of pregnancy. Fetal urine is also known to have a huge input to the amount of amniotic fluid. There is gradual encroachment of blood vessels into the initial formation of the glomeruli for the filtration purpose. The cortex and medulla of the kidneys can be differentiated. Branching morphogenesis persists and hence the arborization of the collecting duct system is observed. the interaction between the ureteric bud and metanephric blastema.

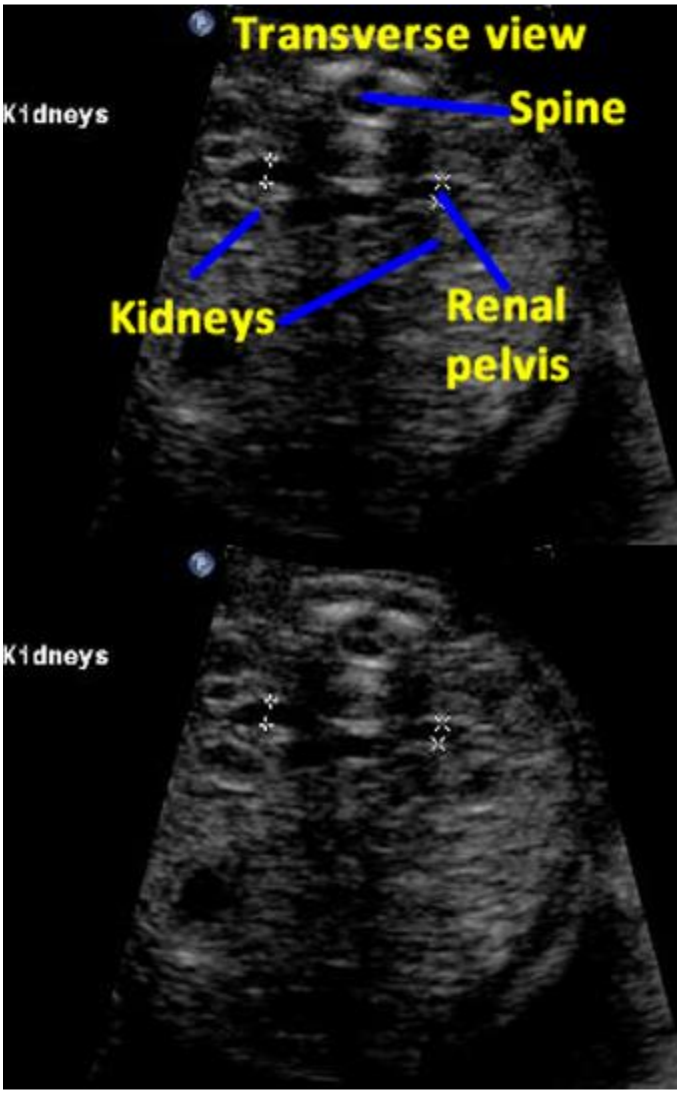

Figure 11 : Transverse View of the Kidneys

Third trimester

Nephron formation is progressively occurring and is most abundant during week 34-36. At birth, the kidney has about 1-2 million nephrons which is the overall lifetime nephron complement. Filtration capacity increases but still less than that observed in postnatal life. Tubular reabsorption and concentrating ability are in Apache Indians immature. The size of the cortex and medulla increases and they become distinguishable. The kidney starts developing features of the adult kidney. In the late stage of pregnancy, fetal kidney contributes to almost all the amniotic fluid responsible for lung growth as well as protection of the fetus. the kidney contains approximately 1-2 million nephrons, the maximum number for life.

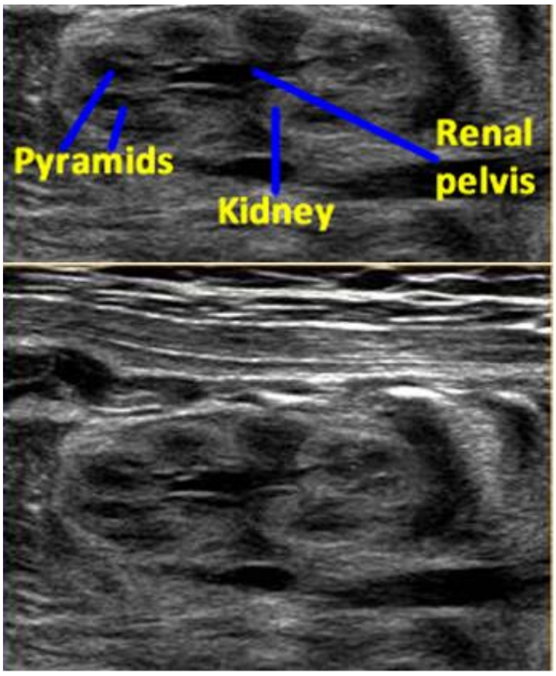

Figure12: 33 weeks gestation. Renal pyramids are echopenic. Peri renal fat outlines the kidney and the renal pelvis is normal

Physiology of fetal kidney[28,29]

The **physiology of the fetal kidney** evolves significantly during pregnancy as it transitions from a rudimentary structure to an organ capable of limited function in utero. Its primary roles during fetal development include urine production, regulation of amniotic fluid volume, and preparation for postnatal life

Pregnancy has an impact on practically every facet of renal physiology. The coordination of these changes is a physiological achievement. Significant volume expansion and vasodilation are characteristics of kidney and systemic hemodynamics. Renal plasma flow (RPF) rises up to 80% and glomerular filtration rate (GFR) rises 50% when compared to nonpregnant levels.[45,46] Proteinuria and glucosuria mildly increase, serum osmolality decreases, and serum sodium levels decrease as a result of impaired tubular activity and water and electrolyte handling. Pregnancy causes fluid retention, which makes the kidneys bigger and increases the risk of physiologic hydronephrosis.[28]

The function of the fetal kidneys does not begin until the second trimester and during the first trimester they are merely formative structures. The mesonephros is involved in small amount of filtrating a fluid for a short time and plays a minor role in forming waste by products. The only fluid generated by the mesonephros enters the cavum venosum through the blockage of the Wolffian duct. The metanephros (definitive kidney) begins to develop.; However, aside from the limited functional development, the ground for future required physiological jobs is developing structurally and are not yet functionally active in regulating fluid or producing urine.

Second trimester: The metanephric kidneys starts forming small volumes of dilute urine by filtering plasma like fluid from fetal blood. This urine helps in the build of amniotic fluid that is used in the development of lungs and fetal shock absorber. The total solids and potassium levels are higher than postnatal values due to the functional immaturity of the kidneys and the renal vasculature. Filtration is mainly between small solutes; large solutes cannot be filtered efficiently by the kidneys or controlled substances such as urea. Fetal kidneys regulate electrolyte balance through sodium, potassium, and chloride in the urine levels although these abilities are poorly developed. Although actually it is worth mentioning that about 90% of the regulation of the amounts of fluids and electrolyte is done by the placenta and not the kidneys. Fetal urine adds to the volume of the amniotic fluid by the third trimester of pregnancy.

Third trimester

The kidneys distal to the PA generate relatively greater amounts of dilute urine, which accounts for up to 90% of AF by term pregnancy. It has also increased with improvements in vascularization, as well as nephron maturation. High renal vascular resistance can be found in some of the following procedures:Low systemic blood pressure,Immature glomerular development:

The renal tubules are less selective in their ability to actively transport back into the circulation, filtered solutes such as sodium and glucose. Its concentration is generally low because there is poor development of counter current techniques in the nephron. The fetal kidneys contribute little to maintenance of acid-base balance; most of it is maintained by the placenta. The kidneys establish organizational form and machinery necessary for independent regulation of fluid, electrolyte and waste balance after birth. Elevated RAAS activity occurs in preparation for postnatal systemic blood pressure regulation.

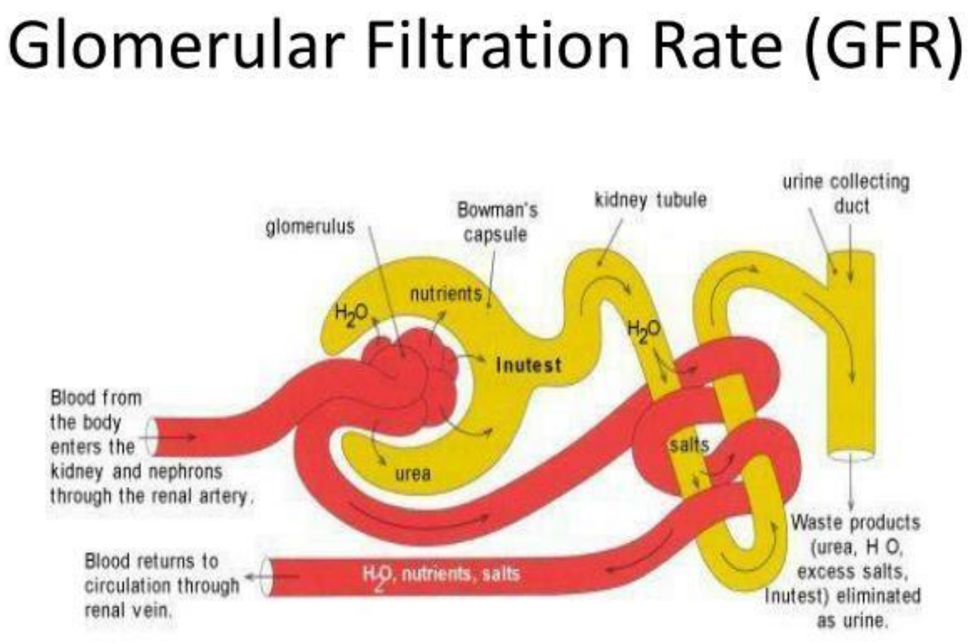

Figure 13: Glomerular filtration rate

The extent of the rise observed during pregnancy cannot be explained by progesterone, although it can cause an increase in RPF and GFR. The corpus luteum, decidua, and placenta all release the vasodilating hormone relaxin. Through the endothelium endothelin B receptor-nitric oxide route, it functions by upregulating vascular gelatinase activity, which is linked to the renal physiology of pregnancy in rodents. Relaxin levels steadily increased during pregnancy and then decreased after delivery, according to Ogueh and colleagues. It has not been shown that relaxin levels and hemodynamic parameters, at least in late pregnancy and the postpartum period, are clinically correlated.[29]

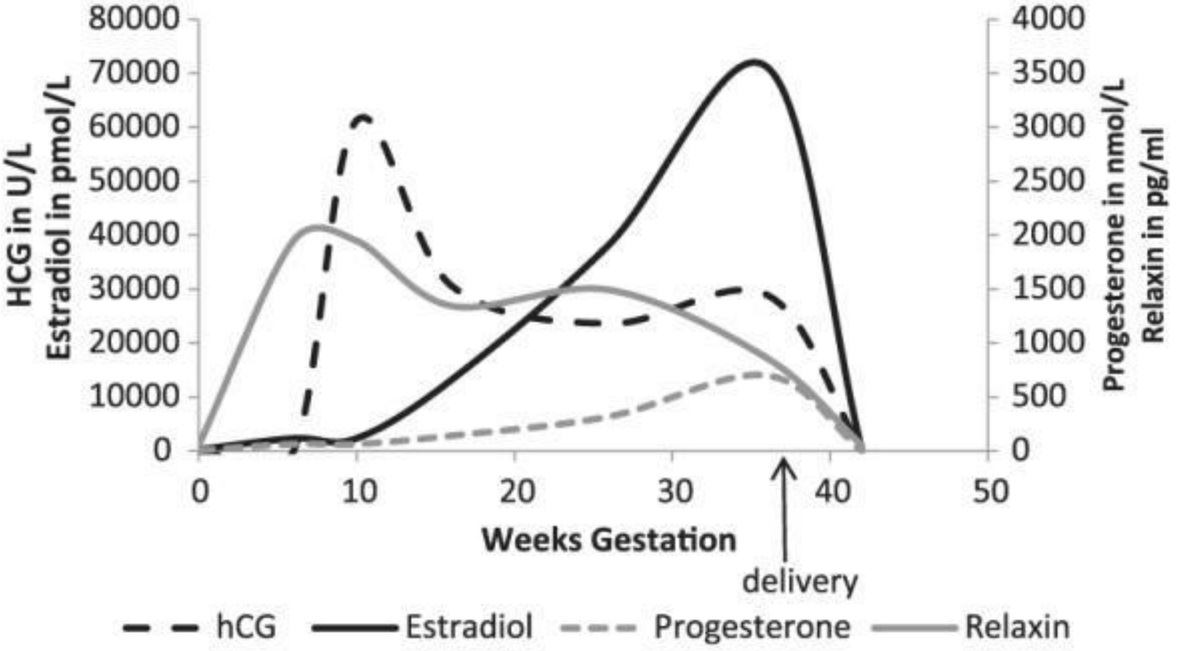

Figure 14: Hormonal variation throughout pregnancy and early postpartum. Mean data are of plasma human chorionic gonadotropin, estradiol, progesterone, and relaxin levels, before, during, and 6 weeks after pregnancy

Lower levels of blood creatinine, urea, and uric acid are the result of an early rise in GFR that peaks at 40% to 50% of prepregnancy values. Water retention is higher, with gains of up to 1.6 L, but there is a net gain of potassium and sodium. Progesterone's actions and changes in RAAS cause the systemic vascular resistance to decrease, which lowers blood pressure and raises RPF. The formation and maintenance of a good pregnancy for both mother and child depend on the careful coordination of hemodynamic changes and fluid and electrolyte balance.

A study by **Indhu kaul et al** In the late second and third trimesters, fetal kidney length (FKL) is the most accurate single parameter for estimating GA compared to other biometric indices, and it is simple to add into GA estimation models. FKL had the lowest standard error in GA prediction (±8.56 days), followed by femur length (±8.9 days) and belly circumference (±11.72 days). All five variables (femur length, FKL, biparietal diameter, head, and belly circumference) were included in the best model for calculating GA, which had a standard error of ±7.41 days. Compared to other parameters, FKL is the most accurate one for estimating GA. [3]

HISTORICAL ASPECTS OF THE ULTRASONOGRAPHY[30]

The history of ultrasound in general is strongly tied to the history of the European Federation of Societies in Ultrasound in Medicine and Biology (EFSUMB) . There have been significant advancements in both technological and clinical aspects of clinical ultrasound (US) in obstetrics and gynecology over the past 65 years. This breakthrough is the result of the efforts of numerous pioneers, engineers, and clinicians from various nations.

Ultrasound in gynecology

Alfred Kratochwil of the Second University Frauenklinik in Vienna, Austria, was one of the most significant pioneers in the field of gynecological US. He began using a proprietary vaginal scanner from Kretztechnik, Austria, to examine the female pelvis in the late 1960s after being inspired by Ian Donald's work. Early on, he observed that inserting US transducers into natural bodily orifices would greatly enhance the investigation of intrapelvic organs by allowing for a closer scan of the region of interest . Kretztechnik (1968) produced the first transvaginal scanner, an A-mode transducer connected to a mechanical system that enabled the transducer to rotate 360 degrees and move longitudinally.

But it wasn't until 1985 when Kretztechnik, Austria, constructed the first real-time mechanical vaginal sector transducer with a scan angle of 240°, proving the true worth of transvaginal sonography (TVS). Abdominal probes were used for gynecological US tests in the meantime. There were two drawbacks to this strategy. First, patients must have a full bladder, which can be uncomfortable, and second, obese patients have significantly worse image quality. Numerous teams began developing biometric measurements of the embryo and fetus in the 1970s and 1980s. Robinson introduced the crown-rump measure in the first trimester in 1973 .

The female reproductive anatomy can be viewed with ultrasound either transvaginally or transabdominally; the former method provides a clearer image of the tissues. The uterus is situated in front of the colon and behind the bladder. With transvaginal ultrasonography, the cervix, body, and fundus can all be seen, starting with the most caudal portion of the uterus. During pregnancy, the gestational sac is located in the uterus and is usually visible in the middle of the uterus between weeks 4.5 and 5. Additionally, it is the first structure that is seen throughout pregnancy.The female reproductive organs located lateral to the uterus are the ovaries and Fallopian tubes.

The fetal heartbeat is initially described as a "flickering" structure and becomes detectable at 6 weeks of gestation. By 10 weeks of pregnancy, a transabdominal ultrasound can show the placenta. Usually found along the anterior or posterior uterine wall, it appears as a consistently echogenic structure with rounded borders that surrounds the gestational sac with a thicker echogenic rim of tissue.

Figure 15: First commercial 3D ultrasound unit (Combison 330) introduced by Kretztechnik, Zipf, Austria, in 1989 with automatic abdominal 3D probe with a relatively large size.

3D/4D ultrasound in obstetrics and gynaecology[29]

2D US can be used for a wide range of diagnosis. However, only individual image planes can be used to visualize areas of interest . Unlike 2D US, 3D US offers a number of imaging modes, including multiplanar, tomographic, surface, transparent, HDlive, and others, that are employed in gynecology and prenatal diagnostics, depending on the specific problem. The ability to preserve three-dimensional structures digitally without sacrificing quality in the form of 3D photos, volumes, or sequences is another important benefit of 3D US for the examiner . Virtual US inspections and the spatial representation of structures that may be evaluated more clearly in rotation mode and with moveable light sources are also made possible by 3D/4D US.

In order to conduct accurate investigations on fetal movements, 4D US gives the examiner real-time surface or transparent images . Finally, compared to individual sectional planes, 3D representations are also simpler for patients to comprehend. Numerous studies have been published demonstrating the advantages of routine 3D and 4D US in prenatal examinations , gynecologic diagnosis and networking of US volumes thirty-three years after 3D US was first introduced in obstetrics and gynecology.

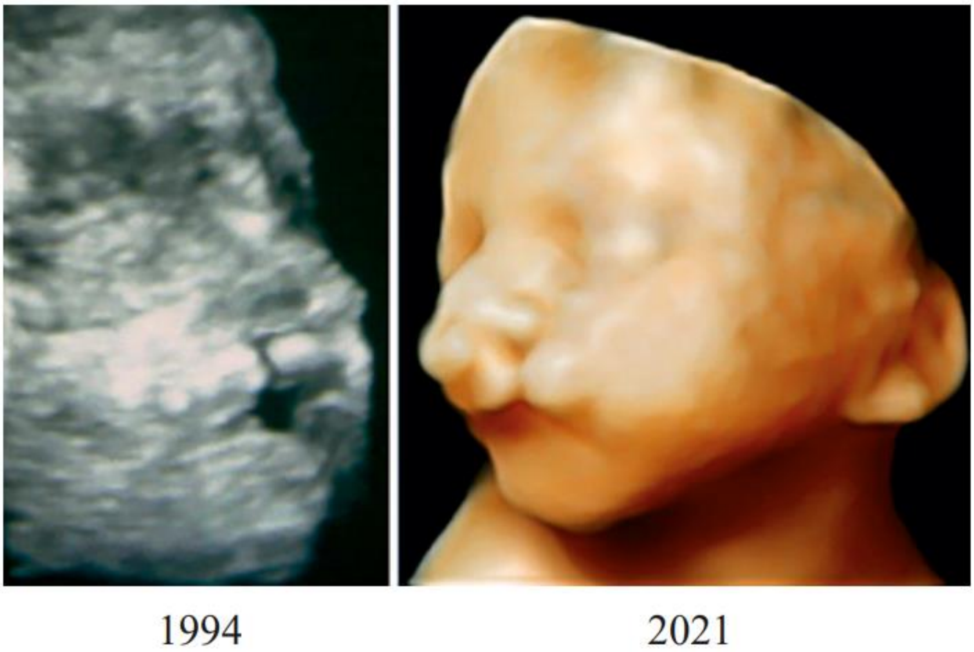

Figure 16: Demonstration of the improvement in surface image quality between 1994 and 2021: lateral cleft lip (surface view)

Clinical Significance[31,32]

In obstetrics, ultrasound is the most often utilized diagnostic technique. Convenient, painless, and usually regarded as safe, ultrasound produces results instantly. Both acute or emergency situations and routine care can benefit from ultrasound. Ultrasound is used in regular prenatal care to check the number of babies, establish viability, and determine gestational age. When an embryo exhibits heart activity, fetal viability is verified. In the sixth week of pregnancy, when the embryo is 2 mm or larger, cardiac activity is frequently evident.. Viability can be predicted by other early pregnancy sonographic markers if heart activity is not visible.

Adavantages of fetal kidney estimation for Gestational age [33,34]

There are several advantages associated with estimating the size or developmental stage of fetal kidneys in order to determine GA. Few studies by **Choudary et al and Kalliyil F J** suggested that evaluation of fetal kidneys by imaging including, ultrasound provides valuable data on fetal development. Gestational Age Estimation GA and Kidney development: There's an established pattern of fetal kidney development during pregnancy. Second and third trimester: precise measurements of the renal length, width or volume show a strong relationship with the gestational age of the fetus.

1.It is mainly Helpful in cases where other parameters are not trustworthy: Kidney measures are another method of the GA estimation for cases when biometrical parameters, such as BPD and FL, are not very suitable for exact assessment of the GA, e.g. in growth restricted or macrosomic fetus.

2. Evaluation in Late Pregnancy :

Steady Growth in Late Pregnancy: The kidneys also keep growing fairly steadily in the course of the third trimester, which is decidedly different from other aspects of fetal development that may stabilize. For this reason, kidney measures are most beneficial when considering GA later in the second and especially the third trimester.

3. Another way of approaching the problem of when to use the early ultrasound or the last menstrual period (LMP)

a. Assistance when LMP is unknown: A renal mean diameter measurement is a useful predictor of gestation age when a prior menstrual history is not known, or first-trimester images cannot be obtained.

b.Reduces Discrepancies: Use of measurement in the shape and size of the kidneys helps to reduce dating that is done to pregnancies where the dates are unclear or where there date is possibly wrong.

4. Practical and Non-Invasive

a. Simple to Measure with Ultrasound:

In certain cases, especially in the second and third trimesters, the fetal kidneys are easily visualized by ultrasound with no discomfort to the mother.

b. No Need for Specialized Equipment: If complex imaging technologies are not available, then conventional types of ultrasound devices may provide accurate measures.

5. Knowledge of Fetal Health

a.Amniotic Fluid Correlation: Thus, measuring the size and development of fetal kidneys, imputes information about amniotic fluid volume, a third index for gestational age and fetal wellbeing.

b.Identification of Anomalies: To be precise, abnormal kidney size and shape can suggest renal agenesis, dysplasia or hydronephrosis and can interfere with the definition of GA and fetal growth.

6.More Figure Accuracy in Special cases

a.Macrosomia or Fetal development Restrictions (FGR): Thus, kidney size remains appropriate for gestational age when fetal growth indexes are different owing to macrosomia or intrauterine growth restriction.

In twin and multiple pregnancies, where failure could be expected to occur due to difference in biometric measurement between the fetuses, size measurement of kidneys is quite useful.

A study by **Agnieszka Zalinska** showed that Kidney dimensions strongly correlated with gestational age. Fetal kidney growth in normal pregnancy is linear process. Fetal kidney measurements can provide additional biometric parameters for accurate gestational age assessment.[35]

A study by **Indu Kaul et al FKL** is easy to identify and measure. It is the 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 GA. It could prove to be a valuable tool in cases where other established biometric indices are difficult to obtain show gross discrepancies with each other or with GA.[3]

A study by **Rebala Harshini et al** [2] When all the parameters were compared to clinical gestational age, least standard deviation for FKL was 0.43 at 26 and 29 weeks, for BPD was 0.73 at 26 weeks, for HC was 0.25 at 26 weeks, for AC was 0.7 at 26 and 29 weeks and for FL was 0.1 at 26 weeks. All the parameters were significant in estimating GA in both second and third trimesters but more accurate in second trimester. The FKL showed linear correlation with increasing gestational age, thus showing correlation of clinical GA best with FKL (r=0.953)

Conclusion

Fetal kidney development is a good and accurate way to estimate gestational age, particularly when other indicators are unclear or inconsistent. It is a useful tool in routine obstetric treatment because it also offers further information on the health of the fetus.

Materials and methods

STUDY PLACE: Study will be conducted at Dept. Of Obg Blde(Du) Shri Bm Patil Medical College And Rc Vijayapura.

STUDY DESIGN- Prospective observational study

STUDY POPULATION- Pregnant women visiting outpatient for routine antenatal care with the gestational age of 20 to 40 weeks

SAMPLE SIZE- 275

STUDY PERIOD– 1st APRIL 2023 1st APRIL 2025(2 years)

INCLUSION CRITERIA: Singleton pregnancies between gestational age of 20 to 40 weeks who have an appropriately done dating scan and with known LMP.

EXCLUSION CRITERIA

1. Pregnancies with obstetric and medical complications such as Hypertensive disorders of pregnancy, Gestational diabetes, Intrauterine growth restriction, Cardiac disease, epilepsy etc
2. Pregnancies with inherited renal an anomalies such as Polycystic kidney disease, Multi cystic dysplastic kidney
3. Pregnancies where fetus has known congenital renal anomalies including ectopic kidneys
4. Pregnancies with either unknown LMP or with no dating scan or both**.**
5. Pyelectasis with cut off value of 10 millimetres

SAMPLE SIZE ESTIMATION

As per the study done by JC KONJE et al[59]., Considering the confidence interval to be 95% with 5% level of significance and margin of error 0.5 .The sample size computed using the following formula

Sample size (n) = (Z * σ /d) 2

Where, z is the z score= 1.96

d is the margin of error= 0.5

n is the population size

σ is the Standard Deviation =4.2

The estimated sample size of this study is **300**

METHODOLOGY

- The pregnant women with gestational age between 20-40 weeks will be enrolled after considering the inclusion and exclusion criteria.
- The gestational age at the time of enrollment will be estimated by using ACOG application which requires an accurate LMP and appropriately taken dating scan and is considered gestational age by standard method.
- The participants will be subjected for routine growth scan and fetal gestational age will be estimated using Hadlock formula.
- The length of both the kidneys of the fetus will be measured individually in millimeters supero inferiorly in sagittal or coronal plane and noted. The mean length of the kidneys will be calculated and noted.
- The hypothesis is renal length in millimeters is equal to gestational age in weeks. The gestational age estimated by renal length will be noted.

- The data obtained will be tabulated and analyzed with appropriate statistical methods.
- The gestational age obtained by Hadlock's formula and the gestational age obtained by renal measurement will be compared gestational age by standard methods.

Statistical analysis

Data will be recorded in Microsoft Excel and analyzed using SPSS (Version 20).Results will be presented as Mean, SD, counts, percentages, and visual diagrams. **Continuous Variables:** Independent sample t-test for normally distributed data Mann-Whitney U test for non-normally distributed data. For **Categorical Variables:** Chi-square test or Fisher's exact test. **Significance Threshold:** $p < 0.05$ (two-tailed).

Results

Table 1: Age wise distribution of study participants

Sl no	Age	Frequency (n)	Percentages %
1	<20 years	42	14.0
2	21-25 years	155	51.7
3	26-30 years	76	25.3
4	>30 years	27	9.0
5	Total	300	100.0

Variables	Mean	Standard deviation
Age in years	24.69	4.09

The table presents the age-wise distribution of study participants, revealing that the majority (51.7%, n = 155) belonged to the 21–25 years age group. This was followed by 25.3% (n = 76) in the 26–30 years age group, while the smallest proportion of participants were aged above 30 years.

The mean age of mothers was 24.69 years, with a standard deviation of 4.09. This distribution is visually represented in the accompanying bar diagram.

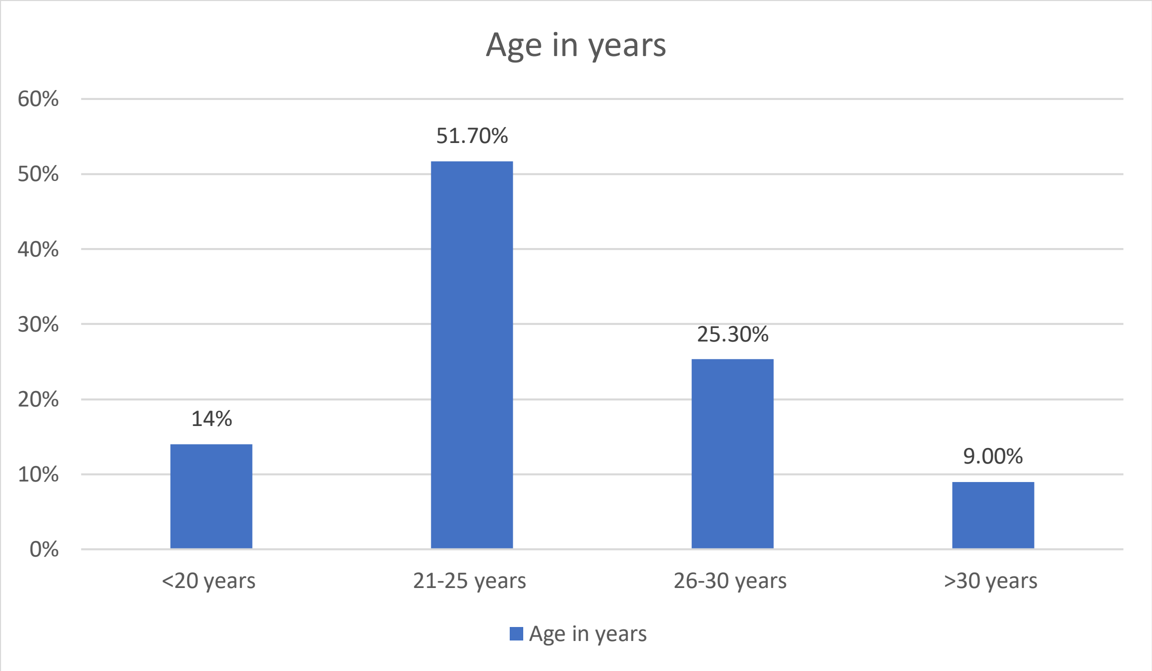

Figure 17: Age wise distribution of study participants

Table 2: Obstetric score wise distribution of study participants

Sl no	Obstetric score	Frequency	Percentages
1	PRIMI	125	41.7
2	Multi para	175	58.3
3	Total	300	100.0

The table illustrates the distribution of study participants based on their obstetric score. It was observed that **58.3% (n = 175) were multigravida**, while **41.7% (n = 125) were primigravida**. This distribution is visually represented in the accompanying pie diagram.

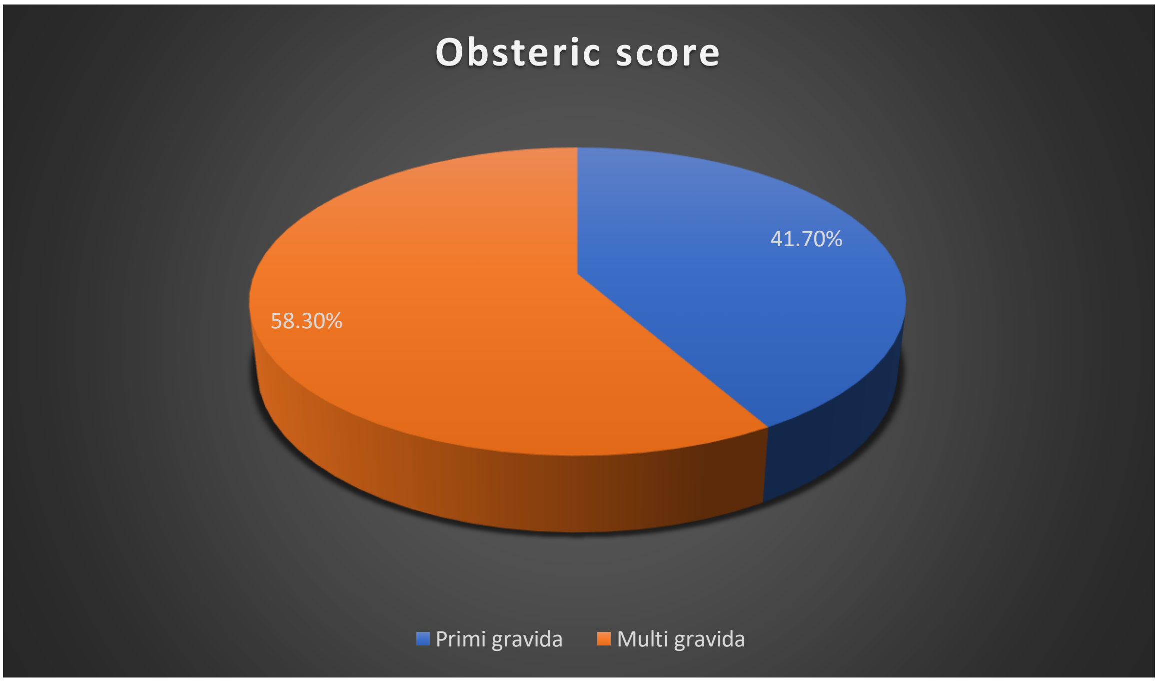

Figure 18: Obstetric score wise distribution of study participants

Table 3: Distribution of study participants according to Fundal height

Sl no	Fundal height	Frequency	Percentages
1	28-30weeks	7	3.0
2	32-34 weeks	26	8.7
3	34-36 weeks	110	36.7
4	Term size	157	52.3
5	Total	300	100.0

The distribution of study participants based on fundal height shows that the majority, **52.3% (n = 157), had a fundal height corresponding to term size**, indicating they were in the final stage of pregnancy. This was followed by **36.7% (n = 110) in the 34–36 weeks category**, suggesting they were approaching full term. A smaller proportion, **8.7% (n = 26), had a fundal height of 32–34 weeks**, while only **3.0% (n = 7) were in the 28–30 weeks range**, representing the early third trimester. The total sample size was **300 participants (100%)**, with most women being in the later stages of pregnancy.

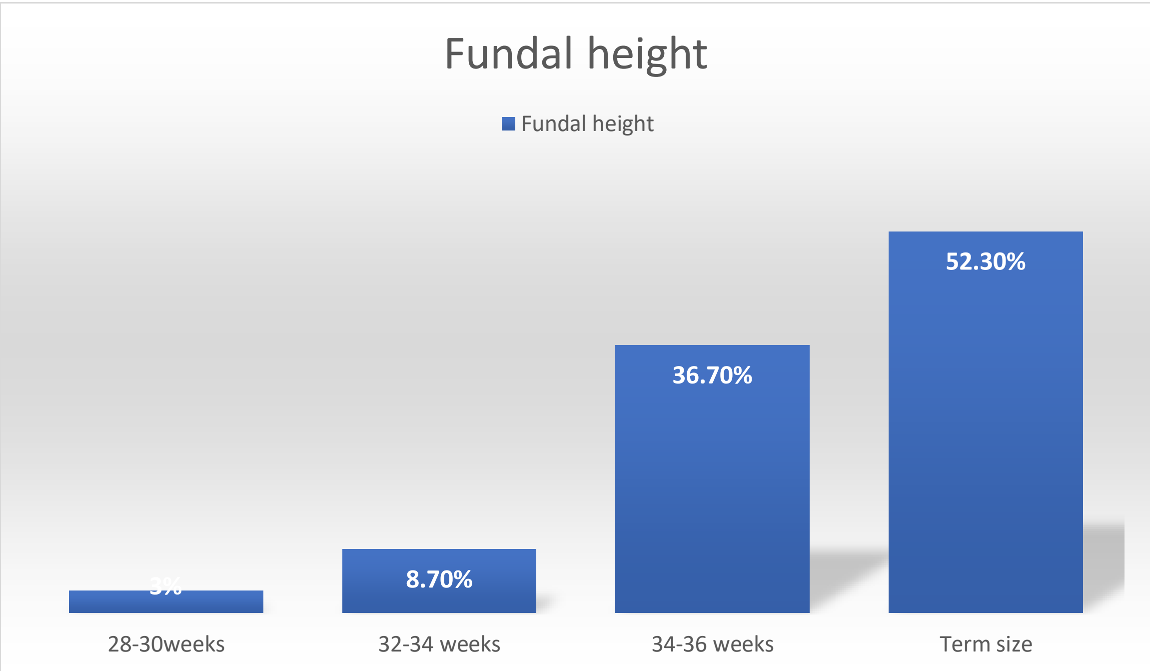

Figure19: Distribution of study participants according to Fundal height.

Table 4: Distribution of study participants according to Mean Height .

Sl no	Height	
1	Mean	154.83
2	Median	155.00
3	Std. Deviation	4.017
4	Range	23
5	Minimum	145
6	Maximum	168

This table presents the mean and standard deviation of height among study participants and found that mean height is 154.83 cm with standard deviation 4.017

Table 5: Distribution of study participants according to Mean weight .

Sl no	Weight	
1	Mean	57.38
2	Median	58.00
3	Std. Deviation	4.171
4	Range	30
5	Minimum	38
6	Maximum	68

This table presents the mean and standard deviation of weight among study participants and found that mean weight is 57.38kg with standard deviation 4.17

Table 6: Distribution of study participants according to Mean Abdominal circumferences

Sl no	Abdominal circumferences	
1	Mean	87.904533
2	Median	88.900000
3	Std. Deviation	3.5215588
4	Range	20.3200
5	Minimum	71.1200
6	Maximum	91.4400

This table presents the mean and standard deviation of Abdominal circumferences among study participants and found that mean Abdominal circumferences is 87.90cm with standard deviation 3.52

Table 7: Distribution of study participants according to Gestational age

Sl no	Gestational week	Frequency	Percentages
1	28	4	1.3
2	32	17	5.7
3	34	82	27.3
4	36	72	24.0
5	38	125	41.7
6	Total	300	100.0

The distribution of study participants based on gestational age shows that the majority, 41.7% (n = 125), were at 38 weeks of gestation, indicating that a significant portion of the participants were near full term. This was followed by 27.3% (n = 82) at 34 weeks and 24.0% (n = 72) at 36 weeks, representing those in the later stages of pregnancy. A smaller proportion, 5.7% (n = 17), were at 32 weeks, while only 1.3% (n = 4) were at 28 weeks, indicating that very few participants were in the earlier part of the third trimester. The total sample size consisted of 300 participants (100%), with the majority being in the later stages of gestation.

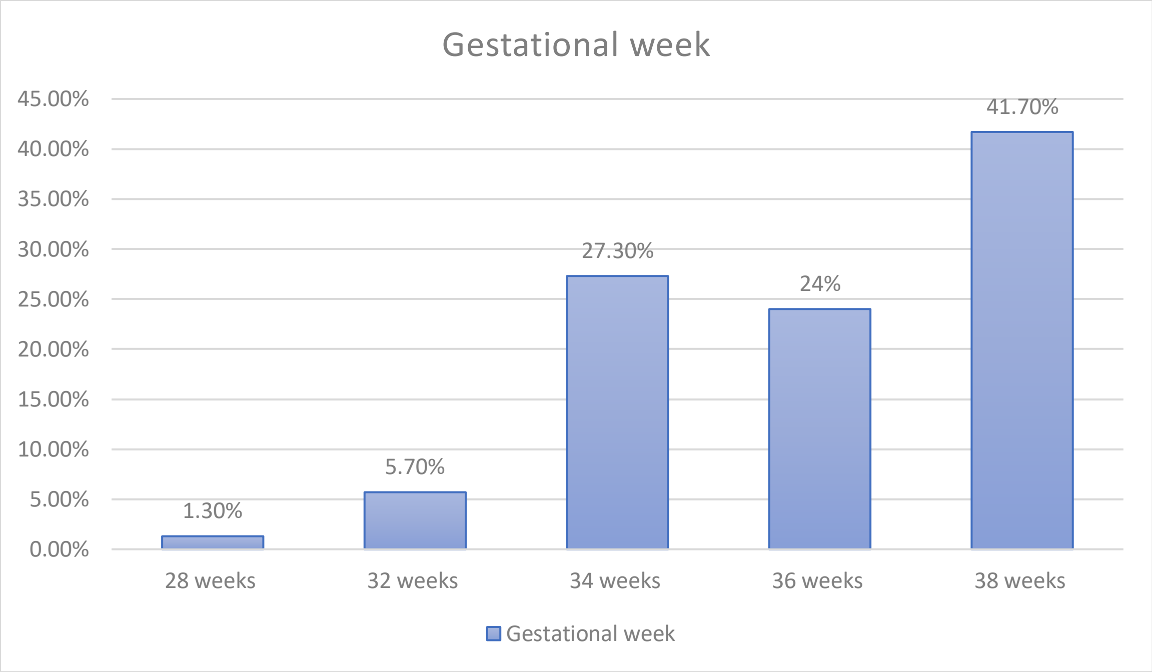

Figure 20: Distribution of study participants according to Gestational age

Table 8: Distribution of study participants according to Kidney length

Sl No	Variables	Mean	Standard Deviation
1	Right kidney length	36.27	2.203
2	Left Kidney length	35.26	2.365
3	Mean length	35.755	2.24

This table presents the mean and standard deviation of right left and mean of both the kidney length and found that mean and SD is 36.27(2.203), 35.26(2.36) and 35.755(2.24) for right kidney length, left kidney length, and mean length respectively and it is shown in bar diagram

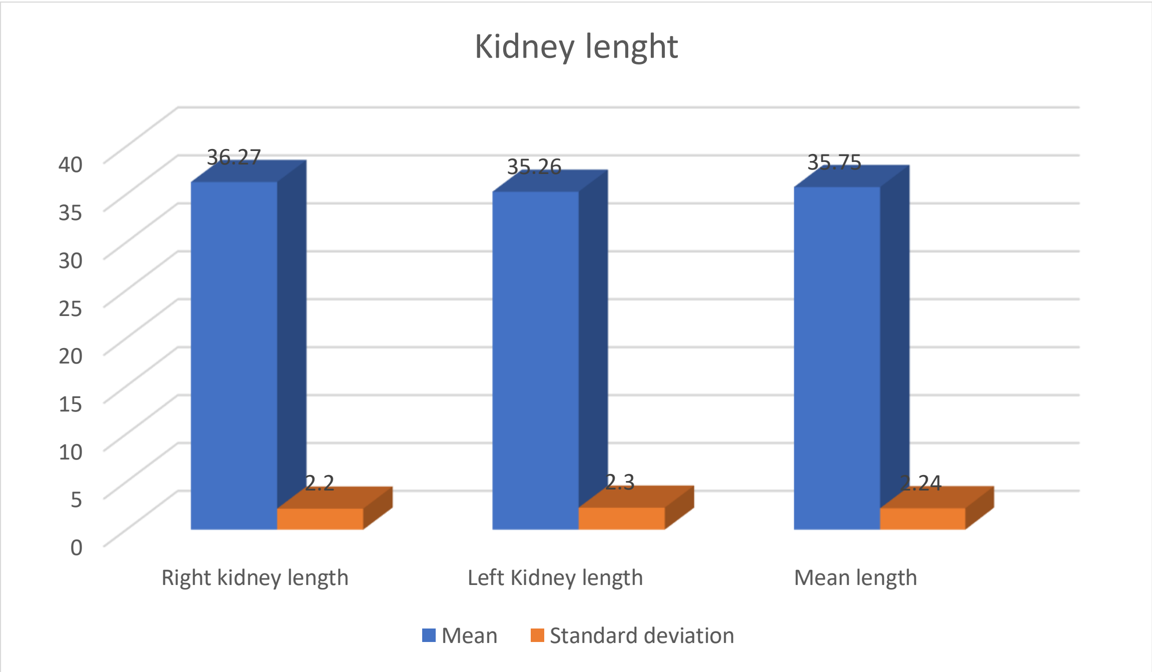

Figure 21: Distribution of study participants according to Kidney length

Table 9: Association between Gestational week and mean Right and left kidney length

Sl no	Gestational week	Right Kidney length Mean (SD)	Left Kidney length Mean (SD)	P value
1	28 weeks	29 (1.15)	28.50(2.38)	**<0.0001**
2	32 weeks	32.06 (1.14)	30.88 (1.4)	**<0.0001**
3	34 weeks	34.88 (1.05)	33.7 (1.4)	**<0.0001**
4	36 weeks	36.24 (0.94)	35.4 (1.1)	**<0.0001**
5	38 weeks	38.02 (1.3)	37.0 (1.4)	0.2006

The analysis of kidney length across different gestational weeks shows a progressive increase in both right and left kidney lengths as gestation advances. At 28 weeks, the mean right kidney length was 29 mm (SD ±1.15), while the left kidney measured 28.50 mm (SD ±2.38). By 32 weeks, the right and left kidneys had increased to 32.06 mm (SD ±1.14) and 30.88 mm (SD ±1.4), respectively. This growth trend continued at 34 weeks, with the right kidney averaging 34.88 mm (SD ±1.05) and the left kidney 33.7 mm (SD ±1.4). At 36 weeks, the right kidney reached 36.24 mm (SD ±0.94), while the left kidney measured 35.4 mm (SD ±1.1). By 38 weeks, the right kidney length further increased to 38.02 mm (SD ±1.3), and the left kidney to 37.0 mm (SD ±1.4).

The p-values for comparisons across gestational ages were highly significant ($p < 0.0001$), except at 38 weeks ($p = 0.2006$), where the difference was not statistically significant. This suggests that kidney growth was significant throughout gestation, with the most notable changes occurring before 38 weeks. The findings indicate that fetal kidney size increases consistently with gestational age, which could serve as a potential parameter for assessing normal renal development during pregnancy

Table 10: Correlation between Gestational week and Right kidney length

Sl no	**Pearson correlation coefficient (r)**		P value
1	Right Kidney length	1	**<0.01**
2	Gestational week	0.844	

The Pearson correlation coefficient (r) = 0.844 indicates a strong positive correlation between Right Kidney Length (RKL) and Gestational Week. This means that as the gestational age increases, the right kidney length also increases. The p-value < 0.01 suggests that the correlation is highly significant

Table 11: Correlation between Gestational week and left kidney length

Sl no	**Pearson correlation coefficient (r)**		P value
1	Left Kidney length	1	<**0.001**
2	Gestational week	0.805	

The Pearson correlation coefficient (r) = 0.805 indicates a strong positive correlation between Left Kidney Length (LKL) and Gestational Week. This suggests that as Gestational Week increases, Left kidney also tends to increase.The p-value (Sig. 2-tailed) = 0.000, which is highly significant at the 0.01 level.

Table 12: Correlation between Gestational week and Mean kidney length

Sl no	**Pearson correlation coefficient (r)**		P value
1	Mean Kidney length	1	**<0.01**
2	Gestational week	0.840	

The Pearson correlation coefficient (r) = 0.840 indicates a strong positive correlation between Mean Kidney Length (MKL) and Gestational Week. This means that as the gestational age increases, the Mean kidney length also increases. The p-value < 0.01 suggests that the correlation is highly significant

Discussion

A study with titled "Evaluation Of Fetal Kidney Length Measurement As Adjunct To Gestational Age Estimation In Second And Third Trimester" with the objectives to assess the efficacy of ultrasonographic measurement of fetal kidney length in calculating the gestational age in second and third trimester

A study conducted at Dept. of OBG BLDE(DU) SHRI BM PATIL MEDICAL COLLEGE AND RC VIJAYAPURA. Its a Prospective observational study Done on Pregnant women visiting outpatient for routine antenatal care with the gestational age of 20 to 40 weeks on 300 pregnant women .

We found that in the second and third trimesters, our study evaluated the accuracy of fetal kidney length (FKL) measured by ultrasound in estimating gestational age (GA). 51.7% of the individuals in your study were between the ages of 21 and 25, and 58.3% of them were multigravida

There was this study by **Gautam et al.** with 250 pregnant women at Nobel Medical College in Nepal. They found a really strong positive correlation between GA and FKL (r = 0.921, p = 0.001). When they looked at FKL alongside other common fetal metrics, the accuracy for predicting GA really improved. The findings suggest that FKL can be a reliable extra measure for figuring out GA. [36]

Another interesting study by **Walad et al.** involved 200 participants at ESIC Medical College in Kalaburgi, India. They found an even stronger association (r = 0.997) with an average FKL of 40.09 mm at 40 weeks, suggesting FKL is a solid way to assess GA, especially in the third trimester. [37]

All these studies really back up the idea that there's a strong link between FKL and GA, which also aligns with what we found. Plus, our participant demographics mirror earlier studies, with more multigravida and younger individuals. These comparisons really make a case for including FKL in regular obstetric ultrasounds.

In our data, 52.3% of participants (n = 157) were at term size, 36.7% (n = 110) were in the 34–36 week range, 8.7% (n = 26) had fundal heights of 32–34 weeks, and 3.0% (n = 7) were in the 28–30 week group. There is difference to our study

In **Jirawan Deeluea's study**, the average fundal height went up by 0.8 cm every week, starting from 19.1 cm at 20 weeks and hitting 35.4 cm by 40 weeks. It's tricky to compare directly, though, because they didn't break down the participants by different fundal height groups. [38]

Similarly, **Jirawan Deeluea's study** looked at fundal height across different BMI groups, but didn't specify how they categorized participants by fundal height. [38]

We saw mean fetal kidney lengths of 36.27 mm (SD = 2.203) for the right kidney and 35.26 mm (SD = 2.36) for the left. When you average them together, that gives you a combined mean of 35.755 mm (SD = 2.24).

A study by **Gautam et al. in** 2022 at fetal kidney lengths among 250 pregnant women during their second and third trimesters and reported a mean length of 36.8 mm (SD = 4.02) at a mean gestational age of 35.5 weeks. This is comparable to our study .[36]

Another study from **Okoye et al**. in 2018 found that the mean fetal kidney length was 32.18 mm with SD = 5.96 in 400 pregnant women between 20 and 41 weeks of gestation. Even though this overall mean is a lower than what we observed, it account earlier weeks when kidney lengths are usually smaller.

The sample of 200 pregnant women studied by **Walad et al. (2023**) showed their fetal kidneys reached an average length of 40.09 mm at week 40.

This research showed right kidney lengths exceeded left ones at all gestational weeks and reported data for fetal kidney length measurements at each time point. A statistically significant difference appeared in both kidney measurements at 28, 32, 34, and 36 weeks ($p < 0.0001$) without reaching significance at week 38 ($p = .2006$).[40]

The results of this study share some comparisons but also show distinct points with respect to previous studies.

Edevbie and Akhigbe (2018) [39]conducted a study group consisting of 400 pregnant women between 20 and 41 weeks of gestation. They observed that the mean FKL gradually increased with gestational age—from 20.87 ± 0.75 mm at 20 weeks to 41.41 ± 0.07 mm at 41 weeks.

They also found a strong connection between FKL and gestational age (r = 0.997, p = 0.000), suggesting that FKL could be a good way to estimate gestational age.

On the other side, **Purohit et al. (2018)**[41] examined fetal kidney sizes in singleton pregnancies around 30 and 38 weeks and didn't find any major difference between the lengths of the right and left kidneys ($p > 0.05$). Their results indicated that both kidneys grow at similar rates and their lengths roughly align with gestational age. Similarly, **Cohen et al. (1991)** found a strong link between kidney length and gestational age after examining 498 fetal kidneys in 397 foetuses between 18 and 41 weeks. However, they also didn't see any notable difference in size between the right and left kidneys during their scans.

These comparisons reveal that while **Purohit et al. and Cohen et al**.[41] didn't find major size variations between the two kidneys, our study consistently observed a difference. This might be due to varying study designs, the characteristics of the population, measuring techniques, or sample sizes. To confirm whether the right kidney is indeed longer than the left across different groups, we definitely need more research with larger, standardized datasets.

Our findings illustrate a major positive relationship (r = 0.844) between kidney length and gestational week, and there's a perfect positive correlation (r = 1, $p < 0.01$) when it comes to right kidney length and gestational age. This aligns with other recent studies that also found a strong connection between gestational age and fetal kidney length. For example, Gautham et al. reported a mean FKL of 36.8 ± 4.02 mm, with a mean gestational age of 35.5 ± 3.4 weeks, showing a strong positive correlation (r = 0.921, p = 0.001). They noted that predicting gestational age was more accurate when FKL was factored in alongside regular fetal measures.

The connection between mean FKL and gestational age in our study was highly major ($r = 0.89$, $p = 0.001$). Their regression equation, $GA = 9.87 + 5.91 \times MKL$, emphasizes that FKL is a reliable method for estimating gestational age, as found by Enefia and colleagues (2023).

Strength

1.This study dives into fetal kidney length (FKL), which can help estimate how far along a pregnancy is during the second and third trimesters.

2.The larger sample size really boosts the reliability of the findings; it shows a solid link between FKL and gestational age, proving it can be a strong alternative metric.

3.High Statistical Significance: The study's results are backed up by a very major connection ($p < 0.01$) between gestational age and fetal kidney length (FKL).

4.Use of Pearson Correlation Coefficient: This method ensures that the relationship between gestational age and FKL is measured accurately.

5.Including Measurements for Both Kidneys: This study takes separate measurements for the right and left kidneys, allowing for a deeper analysis compared to earlier works that only looked at average kidney size.

Limitations

There are a few limitations to consider.

1.The study didn't account for factors like maternal health issues (like diabetes or high blood pressure) that could affect kidney development, and it was only done in one center, which might limit how applicable the findings are to other groups.

2.We also missed out on first-trimester data, which could have given us some early insights because the measurements were only taken in the second and third trimesters.

3.There might be minor measurement errors due to interobserver variability in ultrasound measurements; it's worth noting that the study relied solely on ultrasound data without histological checks.

Recommendations

1.For future research, it would be great to have a multicentric approach to make these findings more relevant across different populations.

2.Longitudinal studies that track the fetal kidney growth from the first trimester to term could give us a much better understanding of its development.

3.We could boost the accuracy of gestational age estimation by adding other indicators like fetal weight and amniotic fluid index.

4.Further research should explore how maternal conditions like gestational diabetes and hypertension affect fetal kidney development.

5.It would be helpful to come up with standardized procedures for measuring fetal kidneys to reduce interobserver variability.

Conclusion

Overall, this study shows that fetal kidney length is a handy extra measure for figuring out gestational age during the second and third trimesters. FKL's significance is clear, especially when traditional fetal biometric measures might not hold up. This research adds to the growing evidence that FKL is a useful tool for prenatal assessments, despite its limitations. Moving forward, it's recommended to test these findings in larger and more diverse populations to really nail down their broader clinical implications.

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Annexure I

INFORMED CONSENT FOR PARTICIPATION IN DISSERTATION/RESEARCH

I, the undersigned, _______________, D/O W/O ________________, aged __ years, ordinarily resident of ____________ do hereby state/declare that Dr RENUKANANDAN PATIL of Shri. B. M. Patil Medical College Hospital and Research Centre has examined me thoroughly on ______________ at ______________ (place) and it has been explained to me in my own language that I am being enrolled into the study. Further, DR RENUKANANDAN informed me that he/she is conducting dissertation / research titled "EVALUATION OF FETAL KIDNEY AS ADJUNCT TO GESTATIONAL AGE ASSESSMENT IN SECOND AND THIRD TRIMESTER" under the guidance of Dr S R BIDRI, requesting my participation in the study. Further Doctor has informed me that my participation in this study would help in the

evaluation of the results of the study, which is a useful reference to the estimation of period of gestataion of other similar cases in the near future.

The Doctor has also informed me that information given by me, observations made, photographs video graphs taken upon me by the investigator will be kept secret and not assessed by a person other than my legal hirer or me except for academic purposes. The Doctor did inform me that though my participation is purely voluntary, based on the information given by me. I can ask for any clarification during study related to diagnosis,

the procedure. At the same time, I have been that I can withdraw from my participation in this study at any time if I want, or the investigator can terminate me from the study at any time from the study.

After understanding the nature of dissertation or research, diagnosis made, the undersigned Smt _______________under my full conscious state of mind agree to participate in the said research/dissertation.

Signature of the patient: Signature Doctor:

ಭಾಗವಹಿಸುವಿಕೆಗೆ ಮಾಹಿತಿ ನೀಡಿದ ಒಪ್ಪಿಗೆ

ಪ್ರಬಂಧ/ಸಂಶೋಧನೆ

ನಾನು, ಕೆಳಗೆ ಸಹಿ ಮಾಡಿದ, ________________, D/O W/O __________________, __ ವರ್ಷ ವಯಸ್ಸಿನ, _____________ ನ ಸಾಮಾನ್ಯ ನಿವಾಸಿಯಾಗಿರುವ ಶ್ರೀ ಡಾ. B. M. ಪಾಟೀಲ್ ವೈದ್ಯಕೀಯ ಕಾಲೇಜು ಆಸ್ಪತ್ರೆ ಮತ್ತು ಸಂಶೋಧನಾ ಕೇಂದ್ರವು _______________ ನಲ್ಲಿ ________________ (ಸ್ಥಳ) ನಲ್ಲಿ ನನ್ನನ್ನು ಸಂಪೂರ್ಣವಾಗಿ ಪರೀಕ್ಷಿಸಿದೆ ಮತ್ತು ನಾನು ಅಧ್ಯಯನಕ್ಕೆ ದಾಖಲಾಗುತ್ತಿದ್ದೇನೆ ಎಂದು ನನ್ನ ಸ್ವಂತ ಭಾಷೆಯಲ್ಲಿ ನನಗೆ ವಿವರಿಸಲಾಗಿದೆ. ಇದಲ್ಲದೆ, ಡಾ. ರೇಣುಕಾನಂದನ್ ಅವರು ನನ್ನ ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸುವವರ ಮಾರ್ಗದರ್ಶನದಲ್ಲಿ ಎರಡನೇ ಮತ್ತು ಮೂರನೇ ತ್ರೈಮಾಸಿಕದಲ್ಲಿ ಗರ್ಭಾವಸ್ಥೆಯ ವಯೋಮಾನದ ಮೌಲ್ಯಮಾಪನಕ್ಕೆ "ಭ್ರೂಣದ ಮೂತ್ರಪಿಂಡದ ಮೌಲ್ಯಮಾಪನ" ಎಂಬ ಶೀರ್ಷಿಕೆಯ ಪ್ರಬಂಧ / ಸಂಶೋಧನೆಯನ್ನು ನಡೆಸುತ್ತಿದ್ದಾರೆ ಎಂದು ನನಗೆ ತಿಳಿಸಿದರು. ಈ ಅಧ್ಯಯನದಲ್ಲಿ ನನ್ನ ಭಾಗವಹಿಸುವಿಕೆಯು ಸಹಾಯ ಮಾಡುತ್ತದೆ ಎಂದು ನನಗೆ ತಿಳಿಸಿದ್ದಾರೆ

ಅಧ್ಯಯನದ ಫಲಿತಾಂಶಗಳ ಮೌಲ್ಯಮಾಪನ, ಇದು ಮುಂದಿನ ದಿನಗಳಲ್ಲಿ ಇತರ ರೀತಿಯ ಪ್ರಕರಣಗಳ ಗರ್ಭಾವಸ್ಥೆಯ ಅವಧಿಯ ಅಂದಾಜುಗೆ ಉಪಯುಕ್ತ ಉಲ್ಲೇಖವಾಗಿದೆ.

ನಾನು ನೀಡಿದ ಮಾಹಿತಿ, ಮಾಡಿದ ಅವಲೋಕನಗಳು, ತನಿಖಾಧಿಕಾರಿಗಳು ನನ್ನ ಮೇಲೆ ತೆಗೆದ ಛಾಯಾಚಿತ್ರಗಳ ವೀಡಿಯೊ ಗ್ರಾಫ್‌ಗಳನ್ನು ರಹಸ್ಯವಾಗಿಡಲಾಗುವುದು ಮತ್ತು ಶೈಕ್ಷಣಿಕ ಉದ್ದೇಶಗಳಿಗಾಗಿ ಹೊರತುಪಡಿಸಿ ನನ್ನ ಕಾನೂನು ಬಾಡಿಗೆದಾರ ಅಥವಾ ನನ್ನನ್ನು ಹೊರತುಪಡಿಸಿ ಬೇರೆ ವ್ಯಕ್ತಿಯಿಂದ ಮೌಲ್ಯಮಾಪನ ಮಾಡಲಾಗುವುದಿಲ್ಲ ಎಂದು ವೈದ್ಯರು ನನಗೆ

ತಿಳಿಸಿದ್ದಾರೆ. ನಾನು ನೀಡಿದ ಮಾಹಿತಿಯ ಆಧಾರದ ಮೇಲೆ ನನ್ನ ಭಾಗವಹಿಸುವಿಕೆಯು ಸಂಪೂರ್ಣವಾಗಿ ಸ್ವಯಂಪ್ರೇರಿತವಾಗಿದೆ ಎಂದು ವೈದ್ಯರು ನನಗೆ ತಿಳಿಸಿದರು. ರೋಗನಿರ್ಣಯಕ್ಕೆ ಸಂಬಂಧಿಸಿದ ಅಧ್ಯಯನದ ಸಮಯದಲ್ಲಿ ನಾನು ಯಾವುದೇ ಸ್ಪಷ್ಟೀಕರಣವನ್ನು ಕೇಳಬಹುದು,

ವಿಧಾನ. ಅದೇ ಸಮಯದಲ್ಲಿ, ನಾನು ಬಯಸಿದಲ್ಲಿ ಯಾವುದೇ ಸಮಯದಲ್ಲಿ ಈ ಅಧ್ಯಯನದಲ್ಲಿ ನನ್ನ ಭಾಗವಹಿಸುವಿಕೆಯಿಂದ ಹಿಂದೆ ಸರಿಯಬಹುದು ಅಥವಾ ತನಿಖಾಧಿಕಾರಿಯು ಅಧ್ಯಯನದಿಂದ ಯಾವುದೇ ಸಮಯದಲ್ಲಿ ನನ್ನನ್ನು ಅಧ್ಯಯನದಿಂದ ವಜಾಗೊಳಿಸಬಹುದು.

ಪ್ರಬಂಧ ಅಥವಾ ಸಂಶೋಧನೆಯ ಸ್ವರೂಪವನ್ನು ಅರ್ಥಮಾಡಿಕೊಂಡ ನಂತರ, ರೋಗನಿರ್ಣಯವನ್ನು ಮಾಡಲಾಗಿದೆ, ಕೆಳಗೆ ಸಹಿ ಮಾಡಲಾದ ಶ್ರೀಮತಿ _______________ ನನ್ನ ಸಂಪೂರ್ಣ ಪ್ರಜ್ಞಾಪೂರ್ವಕ ಮನಸ್ಸಿನ ಅಡಿಯಲ್ಲಿ ಹೇಳಿದ ಸಂಶೋಧನೆ/ಪ್ರಬಂಧದಲ್ಲಿ ಭಾಗವಹಿಸಲು ಒಪ್ಪುತ್ತಾರೆ.

ರೋಗಿಯ ಸಹಿ: ವೈದ್ಯರು ಸಹಿ

SHRI BM PATIL MEDICAL COLLEGE, HOSPITAL AND. RESEARCH CENTRE, VIJAYAPURA-586103

PROFORMA

Name: Age: Date of Enrolment:

OPD NO: Case No:

Address: Occupation:

Contact NO.

Married Life: Consanguineous / Non-Consanguineous

H/O_______ Months of Amenorrhoea

1. Obstetric history: G P L A

2.Menstrual history

- Past Menstrual Cycles-regular/ Irregular and length of the cycles
- Duration of flow-(<2 days, 2-4 days, >4 days)

3.Past History:

4. Family History:

5. Personal History:

Diet: Veg/ Mixed

Habits:

6. General Physical Examination:

Pulse Rate:

Blood pressure:

Height:

Weight:

7. Systemic Examination:

Cardiovascular system:

Respiratory system:

Per abdomen: Fundal height(weeks)-

Symphysio fundal height(cm)-

Abdominal circumference(cm)-

8.USG Finding: Growth scan findings.

GESTATIONAL AGE ASSESSMENT

1) GA assessment by LMP LMP-

EDD-

POG-

2) GA assessment by dating scan EDD-

POG-

GA on the date of scan-

3) GA assessment by growth scan EDD-

POG-

GA on the date of scan-

4)Standard gestational age according to ACOG APPLICATION

5)Fetal kidney length in millimeters

A) Right kidney length(mm)

B) Left kidney length(mm)

C)Mean length of both kidneys(mm)

MASTER CHART

ıge (	A	ob	OB	HEI	WEI	CVS	Fu	FU	S	AC(	GA b	GA			STA			L	LKL	MEA	ME
!6-30 y	28	PRIMI	PRIMI	156	62	NAD	Term	TERN	36	91	38+0	37+4	38	38+0	38+0	5	3:	5	35	5	36
!6-30 y	26	Multi	G2P1L	156	58	NAD	Term	TERN	36	88	38+0	37+2	38	38+0	38+0	5	3ł	5	36	5	37
:20 yea	20	PRIMI	PRIMI	158	56	NAD	Term	TERN	35	90	36+4	36+5	36	37+0	36+4	4	3(	4	37	4	36.5
!1-25 y	24	Multi	G3P2L	156	58	NAD	Term	TERN	36	91	39+0	38+4	38	39 T(	39+0	5	3!	5	37	5	38
:20 yea	20	PRIMI	PRIMI	152	52	NAD	34-3(	34-3(	35	88.9	36+0	36+3	34	35-3(	36+0	3	3!	3	33	3	34
-30 yea	35	Multi	G3P2L	156	58	NAD	28-3(	32-3	33	83.2	34+1	34+3	34	33-3	34+1	3	3	3	32	3	33
!6-30 y	28	Multi	G4P2L	158	56	NAD	34-3(	34-3(	34	86.3	34+4	34+6	34	34-3!	34+4	3	3!	3	34	3	34.5
:20 yea	19	PRIMI	PRIMI	149	50	NAD	32-3	33-3	32	81.2	34+0	34+4	34	33-3	34+0	3	3	3	32	3	33
!6-30 y	28	Multi	G2P1L	156	58	NAD	Term	TERN	36	91	39+0	38+3	38	38-3!	39+0	5	3!	5	37	5	38
!1-25 y	21	PRIMI	PRIMI	152	58	NAD	34-3(	34-3(	34	86.3	36+3	36+6	34	35-3(	36+3	3	3(	3	34	3	35
!1-25 y	22	PRIMI	PRIMI	156	58	NAD	32-3	32-3	33	83.82	34+4	34+2	34	33-3	34+4	3	3:	3	32	3	32.5
:20 yea	20	PRIMI	PRIMI	156	58	NAD	34-3(	34-3(	35	88.9	35+3	35+0	34	34-3!	35+3	3	3!	3	35	3	35
!1-25 y	23	Multi	G2P1L	156	58	NAD	34-3(	34-3(	35	88.9	37+0	37+5	36	36-3	37+0	4	3!	4	37	4	36
-30 yea	33	Multi	G3P2L	156	56	NAD	34-3(	34-3(	35	90	35+4	35+6	36	36-3	35+4	4	3!	4	36	4	35.5
!1-25 y	22	PRIMI	PRIMI	158	56	NAD	Term	TERN	36	91.4	37+6	37+4	38	39	37+6	5	3!	5	38	5	38.5
!1-25 y	22	PRIMI	PRIMI	158	56	NAD	Term	TERN	36	91	38+1	37+4	36	37+4	38+1	4	3:	4	36	4	36.5
!6-30 y	27	Multi	G3P2L	156	58	NAD	Term	TERN	35	88.9	36+3	36+6	36	37+3	36+3	4	3(	4	35	4	35.5
!1-25 y	25	PRIMI	PRIMI	158	58	NAD	34-3(	34-3(	34	86.3	34+6	35+2	34	35+3	34+6	3	3	3	33	3	33.5
!6-30 y	29	Multi	G4P2L	156	58	NAD	Term	TERN	35	88.9	39+0	38+3	36	37+5	39+0	4	3:	4	35	4	36
!6-30 y	29	Multi	G5P2L	156	56	NAD	34-3(	34-3(	35	88.9	38+3	37+0	36	36+6	38+3	4	3!	4	34	4	34.5
!1-25 y	22	PRIMI	PRIMI	158	64	NAD	Term	TERN	36	91.44	39+4	39+0	38	39+1	39+4	5	3ł	5	37	5	37.5
-30 yea	36	Multi	G2P1L	158	58	NAD	Term	TERN	36	91	37+4	37+6	38	37-3ł	37+4	5	3(	5	35	5	25
!1-25 y	25	Multi	G2P1L	152	56	NAD	Term	TERN	35	91	37+6	37+1	38	38+1	37+6	5	3ł	5	36	5	37
!1-25 y	22	PRIMI	PRIMI	155	60	NAD	34-3(	34-3(	33	83.82	34+6	35+3	34	35+4	34+6	3	3!	3	34	3	34.5
:20 yea	19	PRIMI	PRIMI	149	54	NAD	34-3(	34-3(	35	88.9	35+3	34+6	36	36+1	35+3	4	3!	4	34	4	34.5

<20 yea	20	PRIMI	PRIMI	152	54	NAD	34-3(	34-3(	35	88.9	36+2	36+0	36	36-3	36-37	4	3	4	36	4	36.5
26-30 y	27	Multi	G3P2L	158	57	NAD	34-3(	34-3(	34	86.36	35+4	36+2	36	36+2	36+2	4	3!	4	34	4	34.5
<20 yea	20	PRIMI	PRIMI	155	49	NAD	32-3	32-3	33	83.82	33+6	34+1	34	34-3!	33+6	3	3:	3	34	3	33.5
>30 yea	34	Multi	G2P1L	158	62	NAD	34-3(	34-3(	35	88.9	36+1	35+4	34	35+5	36+1	3	3!	3	33	3	34
21-25 y	23	PRIMI	PRIMI	155	56	NAD	34-3(	34-3(	35	88.9	36+4	36+2	36	36+6	36+6	4	3(	4	34	4	35
21-25 y	22	PRIMI	PRIMI	157	58	NAD	32-3	32-3	33	83.8	33+2	33+4	32	33+6	33+2	2	3:	2	32	2	32.5
21-25 y	21	PRIMI	PRIMI	156	38	NAD	34-3(	34-3(	34	86.3	34+6	34+6	34	35+1	34+6	3	3!	3	33	3	34
21-25 y	21	PRIMI	PRIMI	152	56	NAD	Term	TERN	35	88.9	36+1	36+5	36	36+5	36+1	4	3!	4	34	4	34.5
<20 yea	19	PRIMI	PRIMI	155	58	NAD	Term	TERN	36	91.44	37+2	37+0	38	37-3!	37+2	5	3	5	35	5	36
26-30 y	29	Multi	G3P2L	158	56	NAD	28-3(	28-3(	29	73.6	30+0	30+0	32	30+2	30+0	2	3(	2	29	2	29.5
<20 yea	20	PRIMI	PRIMI	156	57	NAD	34-3(	34-3(	34	86.3	35+4	35+6	36	36+1	35+4	4	3!	4	34	4	33
21-25 y	23	PRIMI	PRIMI	155	59	NAD	Term	TERN	35	88.9	36+2	35+6	36	36+5	36+2	4	3!	4	36	4	35.5
26-30 y	30	Multi	G3P1L	158	56	NAD	34-3(	34-3(	34	86.3	36+4	36+2	36	36-3	36+4	4	3!	4	35	4	35
26-30 y	26	Multi	G3A2	147	50	NAD	32-3	30-3:	31	78.74	31+4	31+0	32	31-3:	31+4	2	3:	2	29	2	30
26-30 y	28	Multi	G2P1L	159	62	NAD	Term	TERN	36	91.44	36+6	37+3	38	37-3!	36+6	5	3	5	36	5	36.5
26-30 y	27	Multi	G2P2L	154	53	NAD	34-3(	~34	33	83.82	34+4	34+0	34	34-3!	34+0	3	3	3	32	3	33
21-25 y	24	Multi	G2P1L	158	58	NAD	Term	TERN	35	88.9	36+2	36+4	36	36+5	36+2	4	3(	4	33	4	34.5
21-25 y	21	PRIMI	PRIMI	155	56	NAD	Term	TERN	36	91.44	38+6	38+4	38	38-3!	38+4	5	3!	5	37	5	38
26-30 y	28	Multi	G4P2L	158	58	NAD	32-3	30-3:	32	80	32+3	31+6	32	31-3:	32+3	2	3:	2	30	2	31
21-25 y	23	Multi	G3A2	150	51	NAD	Term	TERN	35	88.9	37+4	37+0	38	37-3!	37+4	5	3	5	36	5	36.5
26-30 y	27	Multi	G2P1L	145	58	NAD	34-3(	34-3(	34	86.3	36+0	35+4	36	36-3	36+0	4	3	4	36	4	36.5
<20 yea	19	PRIMI	PRIMI	153	57	NAD	Term	TERN	36	91.44	36+6	37+2	36	36-3	36+6	4	3!	4	36	4	37
26-30 y	27	Multi	G3A2	156	59	NAD	34-3(	34-3(	35	88.9	34+6	35+2	34	35-3(	34+6	3	3!	3	34	3	34.5
21-25 y	22	PRIMI	PRIMI	152	56	NAD	34-3(	34-3(	34	86.86	35+4	36+2	36	36+3	35+2	4	3(	4	35	4	35.5
<20 yea	20	PRIMI	PRIMI	158	57	NAD	34-3(	~36	36	91.44	36+2	36+0	36	36-3	36+2	4	3!	4	36	4	35.5
<20 yea	20	Multi	G2A1	157	62	NAD	32-3	32-3	33	83.82	34+2	33+4	32	33+0	34+2	2	3:	2	32	2	32.5

21-25 y	21	PRIMI	PRIMI	152	59	NAD	Term	TERN	35	88.9	36+4	36+6	36	36+4	36-37	4	3!	4	36	4	35.5
21-25 y	22	PRIMI	PRIMI	158	52	NAD	34-3(	34-3(	34	86.86	35+6	36+0	36	36+2	35+6	4	3!	4	37	4	36
21-25 y	25	PRIMI	PRIMI	157	50	NAD	Term	TERN	36	91.44	38+4	39	38	38-3!	38+4	5	3	5	39	5	38
21-25 y	23	Multi	G2P1L	160	60	NAD	34-3(	34-3(	35	88.9	36+0	35+4	36	36-3	36+0	4	3!	4	36	4	35.5
21-25 y	25	PRIMI	PRIMI	149	63	NAD	34-3(	34-3(	34	86.86	35+2	35+6	34	35-3(	35+2	3	3!	3	34	3	34.5
21-25 y	24	Multi	G2P1L	155	58	NAD	34-3(	~36	35	88.9	35+6	36+0	36	36+2	36+0	4	3!	4	34	4	34.5
21-25 y	24	Multi	G2A1	153	58	NAD	Term	TERN	35	88.9	36+6	37+2	36	37+4	36+6	4	3	4	35	4	36
21-25 y	24	Multi	G2P1L	151	62	NAD	34-3(	~36	35	88.9	36+0	36+5	36	36+6	36+0	4	3!	4	33	4	34
26-30 y	30	Multi	G3P2L	149	56	NAD	Term	TERN	36	91.44	37+4	36+6	36	37+0	36+6	4	3(	4	34	4	35
21-25 y	23	Multi	G2P1L	155	58	NAD	32-3	30-3:	32	81.28	32+3	32+0	32	32+5	32+3	2	3:	2	31	2	31.5
21-25 y	21	PRIMI	PRIMI	150	56	NAD	32-3	30-3:	31	78.74	33+0	32+2	32	32	33+0	2	3:	2	29	2	30
21-25 y	21	Multi	G3A2	155	56	NAD	34-3(	34-3(	34	86.86	34+3	33+5	34	34+5	34+3	3	3!	3	33	3	34
21-25 y	24	Multi	G2P1L	158	58	NAD	34-3(	~35	34	86.86	35+0	35+3	34	35+5	35+0	3	3	3	32	3	33
26-30 y	30	Multi	G3P2L	152	54	NAD	Term	TERN	35	88.9	37+0	36+4	36	37+4	36+4	4	3(	4	35	4	35.5
21-25 y	23	PRIMI	PRIMI	150	55	NAD	Term	TERN	36	91.44	38+6	39+0	38	38-3!	38+6	5	3!	5	37	5	38
<20 yea	20	PRIMI	PRIMI	155	56	NAD	Term	TERN	35	88.9	37+4	37+0	38	37-3!	37+4	5	3	5	35	5	36
26-30 y	27	Multi	G2P1L	156	48	NAD	34-3(	34-3(	34	86.86	34+6	35+2	34	34-3!	34+6	3	3!	3	33	3	34
21-25 y	25	Multi	G2A1	150	52	NAD	Term	TERN	35	88.9	37+4	37+2	38	37-3!	37+4	5	3!	5	36	5	37
26-30 y	30	Multi	G3P2L	157	58	NAD	Term	TERN	36	91.44	37+6	37+2	38	37-3!	37+6	5	3(	5	37	5	36.5
>30 yea	31	Multi	G4P2L	150	56	NAD	34-3(	34-3(	34	86.86	34+4	34+0	34	34-3!	34+4	3	3	3	32	3	33
21-25 y	24	Multi	G2P1D	151	55	NAD	Term	TERN	35	88.9	37+2	37+6	38	37-3!	37+2	5	3(	5	36	5	36
26-30 y	27	Multi	G2P1L	156	58	NAD	34-3(	34-3(	34	86.86	35+4	36+2	34	35-3(	35+4	3	3!	3	33	3	34
21-25 y	24	PRIMI	PRIMI	158	57	NAD	Term	37+4	35	88.9	37+4	37+0	38	37-3!	37+0	5	3!	5	37	5	37.5
>30 yea	34	PRIMI	PRIMI	150	58	NAD	32-3	30-3:	32	81.28	31+6	31+4	32	31-3:	31+6	2	3(	2	29	2	29.5
21-25 y	24	Multi	G2P1L	156	59	NAD	34-3(	34-3(	34	86.86	36+6	36+4	36	36-3	36+6	4	3	4	35	4	36
21-25 y	22	PRIMI	PRIMI	156	52	NAD	Term	TERN	35	88.9	37+4	37+2	38	37-3!	37+4	5	3(	5	35	5	35.5

21-25 y	22	Multi	G2A1	158	62	NAD	34-3(	~34	34	86.86	33+2	33+2	34	34	33+2	3	3:	3	33	3	33
21-25 y	22	PRIMI	PRIMI	156	60	NAD	Term	TERN	35	88.9	36+2	36+4	36	36-3	36+2	4	3(	4	37	4	36.5
26-30 y	28	Multi	G2P1L	152	52	NAD	34-3(	34-3(	34	86.6	35+4	35+6	36	36+1	35+4	4	3'	4	35	4	36
<20 yea	20	PRIMI	PRIMI	155	56	NAD	Term	TERN	36	91.44	38+6	39+1	38	39+2	38+6	5	3!	5	37	5	38
<20 yea	20	Multi	G2A1	157	58	NAD	34-3(	34-3(	34	86.6	35+2	35+4	34	35+4	35+2	3	3!	3	34	3	34.5
26-30 y	26	Multi	G3P2L	155	56	NAD	Term	TERN	34	86.6	36+3	36+1	36	36-3	36+3	4	3(	4	37	4	36.5
21-25 y	22	PRIMI	PRIMI	145	51	NAD	Term	TERN	35	88.9	36+6	36+4	36	37+1	36+1	4	3'	4	36	4	36.5
26-30 y	28	Multi	G3P2L	152	57	NAD	Term	TERN	35	88.9	37+0	37+3	36	37+5	37+0	4	3'	4	36	4	36.5
21-25 y	23	PRIMI	PRIMI	156	58	NAD	34-3(	34-3(	34	86.6	35+3	35+0	34	35+5	35+0	3	3!	3	35	3	35
26-30 y	27	Multi	G3P1L	152	53	NAD	32-3‹	32-3‹	32	81.28	34+0	34+4	34	34+5	34+0	3	3‹	3	33	3	33.5
21-25 y	22	PRIMI	PRIMI	155	57	NAD	Term	TERN	35	88.9	37+0	37+6	36	37+3	37+0	4	3'	4	36	4	36.5
26-30 y	29	Multi	G2P1L	153	51	NAD	34-3(	34-3(	35	88.9	36+0	36+4	36	36+6	36+2	4	3(	4	35	4	35.5
21-25 y	23	PRIMI	PRIMI	148	57	NAD	34-3(	34-3(	34	86.6	34+6	35+2	34	35-3(	34+6	3	3!	3	34	3	34.5
26-30 y	26	Multi	G3A2	154	56	NAD	34-3(	~35	35	88.9	33+6	35+2	34	34-3!	33+6	3	3!	3	36	3	35.5
21-25 y	22	PRIMI	PRIMI	148	60	NAD	Term	TERN	36	91.44	37+2	37+6	38	37-3	37+6	5	3{	5	36	5	37
26-30 y	26	Multi	G3P2L	156	58	NAD	Term	TERN	35	88.9	38+6	39+2	38	39-4(	38+6	5	3!	5	38	5	38.5
26-30 y	26	Multi	G2P1L	158	57	NAD	28-3(	28-3(	29	73.66	29+6	30+1	32	30-3	29+6	2	3:	2	30	2	30.5
21-25 y	24	PRIMI	PRIMI	155	66	NAD	28-3(	28-3(	28	71.12	28+4	28+2	28	28+0	28+4	1	2!	1	27	1	27.5
21-25 y	21	PRIMI	PRIMI	146	50	NAD	34-3(	34-3(	34	86.6	34+6	35+3	34	35+4	34+6	3	3!	3	34	3	34.5
>30 yea	31	Multi	G4P2L	155	57	NAD	Term	TERN	35	88.9	37+0	37+4	36	37+4	37+0	4	3'	4	36	4	36.5
<20 yea	20	Multi	G2A1	160	58	NAD	34-3(	34-3(	34	86.6	35+4	35+2	34	35-3(	35+4	3	3!	3	34	3	34.5
21-25 y	22	Multi	G2P1L	148	56	NAD	34-3(	~34	33	83.8	33+6	33+4	34	34+2	33+6	3	3‹	3	33	3	33.5
26-30 y	26	Multi	G3P1L	156	57	NAD	34-3(	34-3(	35	88.9	35+6	36+3	36	36-3	35+6	4	3'	4	36	4	36.5
>30 yea	32	Multi	G4P3L	150	56	NAD	34-3(	34-3(	34	86.6	35+2	35+2	34	35+4	35+2	3	3!	3	34	3	34.5
26-30 y	27	Multi	G2P1L	156	61	NAD	Term	TERN	35	88.9	37+2	37+0	38	37-3	37+2	5	3{	5	37	5	37.5
21-25 y	23	PRIMI	PRIMI	153	58	NAD	34-3(	~35	34	86.6	36+4	37+2	36	36-3	37+2	4	3'	4	36	4	36.5

21-25 y	21	PRIMI	PRIMI	156	56	NAD	34-3(	34-3(	34	86.6	33+5	34+3	34	34+6	33+5	3	3‹	3	32	3	33
<20 yea	20	Multi	G2A1	151	55	NAD	34-3(	34-3(	33	83.8	34+6	34+4	34	34+4	34+6	3	3‹	3	35	3	34.5
26-30 y	27	Multi	G4P3L	156	57	NAD	34-3(	~36	35	88.9	35+6	35+4	36	36+2	35+6	4	3!	4	36	4	35.5
21-25 y	22	Multi	G3A2	152	54	NAD	28-3(	28-3(	29	73.66	28+2	27+4	28	28-2!	28+2	1	2!	1	27	1	27.5
26-30 y	26	Multi	G2P1L	156	56	NAD	Term	TERN	36	91.44	37+2	37+4	36	37+0	37+2	4	3(	4	37	4	36.5
21-25 y	21	PRIMI	PRIMI	155	58	NAD	34-3(	34-3(	34	86.6	35+3	35+1	34	35+0	35+1	3	3!	3	34	3	34.5
21-25 y	24	Multi	G2P1L	158	56	NAD	34-3(	34-3(	34	86.6	34+3	34+6	34	34-3!	34+3	3	3!	3	36	3	35.5
>30 yea	35	PRIMI	PRIMI	156	54	NAD	34-3(	34-3(	34	86.6	35+4	34+6	34	35+4	35+4	3	3!	3	36	3	35.5
<20 yea	20	Multi	G2P1L	154	56	NAD	32-3‹	32-3‹	33	83.8	33+2	33+4	32	33+6	33+2	2	3:	2	32	2	32.5
<20 yea	20	PRIMI	PRIMI	148	60	NAD	34-3(	34-3(	34	86.6	34+6	35+2	34	35-3(	34+6	3	3!	3	36	3	35.5
21-25 y	22	Multi	G2A1	154	56	NAD	Term	TERN	35	88.9	37+5	38+3	38	38+1	37+5	5	3{	5	37	5	37.5
26-30 y	27	PRIMI	PRIMI	157	58	NAD	34-3(	34-4(	34	86.6	35+1	35+6	34	35-3(	35+1	3	3(	3	34	3	35
21-25 y	24	Multi	G3P2L	155	60	NAD	34-3(	~35	35	88.9	36+0	35+4	34	35+6	36+0	3	3!	3	37	3	36
<20 yea	20	PRIMI	PRIMI	150	59	NAD	Term	TERN	35	88.9	38+4	38+0	38	38+1	38+4	5	3'	5	37	5	37
<20 yea	20	PRIMI	PRIMI	157	61	NAD	Term	TERN	36	91.44	39+0	38+2	38	38+4	30+0	5	3!	5	37	5	38
21-25 y	21	PRIMI	PRIMI	155	58	NAD	Term	TERN	35	88.9	39+6	39+0	38	38-3!	39+0	5	3{	5	38	5	38
21-25 y	24	Multi	G4P1L	149	48	NAD	34-3(	34-3(	34	86.6	34+3	34+6	34	34-3!	34+3	3	3‹	3	32	3	33
<20 yea	19	PRIMI	PRIMI	150	62	NAD	34-3(	~36	35	88.9	35+6	35+3	34	35-3(	35+3	3	3(	3	34	3	35
<20 yea	20	PRIMI	PRIMI	156	59	NAD	Term	TERN	36	91.44	39+0	38+4	38	39+4	39+0	5	3!	5	37	5	38
21-25 y	23	Multi	G2P1L	152	53	NAD	Term	TERN	35	88.9	40+0	39+4	38	39+6	40+0	5	3!	5	39	5	39
21-25 y	24	PRIMI	PRIMI	156	50	NAD	34-3(	34-3(	35	88.9	34+6	35+3	34	35+6	34+6	3	3!	3	33	3	34
26-30 y	28	Multi	G3P2L	149	58	NAD	Term	TERN	35	88.9	38+6	39+0	38	38+4	38+6	5	3{	5	39	5	38.5
<20 yea	20	PRIMI	PRIMI	155	59	NAD	Term	TERN	36	91.44	39+3	39+1	38	38-3!	39+3	5	3!	5	38	5	38.5
21-25 y	22	Multi	G2P1L	145	50	NAD	34-3(	34-3(	33	83.68	34+3	34+0	34	34+6	34+3	3	3‹	3	32	3	33
21-25 y	23	Multi	G2P1L	159	62	NAD	Term	TERN	35	88.9	38+6	39+4	38	39+4	38+6	5	3!	5	37	5	38
26-30 y	26	Multi	G3P2L	155	58	NAD	Term	TERN	36	91.44	39+4	39+0	38	39	39+4	5	3!	5	38	5	38.5

1-25 y	21	Multi	G2A1	158	63	NAD	Term	TERN	35	88.9	37+6	37+0	38	37-3	37+6	5	3	5	36	5	35.5
1-25 y	23	Multi	G2P1L	152	65	NAD	Term	TERN	35	88.9	38+6	39+2	38	39-4	38+6	5	3	5	35	5	37
1-25 y	24	PRIMI	PRIMI	155	50	NAD	28-3	28-3	29	73.6	28+6	29+2	28	28-2	28+6	1	3	1	32	1	30.5
30 yea	35	Multi	G3P2L	152	58	NAD	28-3	28-2	28	71.12	29+4	28+6	28	28-2	29+4	1	3	1	28	1	29
1-25 y	23	PRIMI	PRIMI	156	49	NAD	Term	TERN	36	91.44	38+6	38+2	38	38-3	38+6	5	3	5	38	5	37.5
6-30 y	28	Multi	G3P2L	152	56	NAD	Term	TERN	35	88.9	38+4	39+2	38	38-3	38+6	5	3	5	39	5	38.5
6-30 y	26	Multi	G2P1L	155	53	NAD	Term	TERN	36	91.44	37+6	38+0	38	37-3	37+6	5	3	5	36	5	35.5
20 yea	20	PRIMI	PRIMI	152	54	NAD	Term	TERN	35	88.9	37+4	36+6	38	37-3	36+6	5	3	5	38	5	37
20 yea	20	PRIMI	PRIMI	156	55	NAD	34-3	34-3	34	86.6	34+6	34+3	34	34-3	34+6	3	3	3	32	3	33
30 yea	31	Multi	G3P2L	155	58	NAD	32-3	32-3	32	81.28	32+4	32+0	32	32+0	32+4	2	3	2	31	2	31.5
6-30 y	30	Multi	G3P2L	152	58	NAD	Term	37-3	35	88.9	37+4	37+0	38	37-3	37+0	5	4	5	40	5	40
6-30 y	30	Multi	G3P1L	158	54	NAD	34-3	~36	35	88.9	36+2	36+6	36	36+1	36+2	4	3	4	33	4	34
1-25 y	25	Multi	G2P1L	156	57	NAD	Term	TERN	35	88.9	38+6	38+0	38	37-3	38+6	5	3	5	36	5	37
1-25 y	25	PRIMI	PRIMI	158	58	NAD	34-3	34-3	33	83.6	36+0	35+2	36	36-3	36+0	4	3	4	34	4	35
1-25 y	21	PRIMI	PRIMI	149	50	NAD	Term	TERN	36	91.44	38+4	38+0	38	37-3	38+4	5	3	5	37	5	37.5
1-25 y	25	Multi	G2P1L	157	56	NAD	Term	TERN	35	88.9	38+2	37+6	38	38-3	38+2	5	2	5	26	5	37
1-25 y	21	PRIMI	PRIMI	158	60	NAD	34-3	34-3	34	86.6	36+3	35+6	36	36-3	36+3	4	3	4	34	4	35
1-25 y	25	Multi	G3P2L	155	52	NAD	Term	39+1	35	88.9	39+1	38+6	38	38-3	39+1	5	3	5	38	5	38
6-30 y	26	Multi	G2P1L	150	58	NAD	Term	TERN	35	88.9	38+6	38+0	36	37+6	38+6	4	3	4	39	4	38
1-25 y	21	Multi	G2P1L	152	50	NAD	Term	TERN	36	91.44	39+2	39+0	38	38-3	39+2	5	3	5	38	5	38.5
6-30 y	28	PRIMI	PRIMI	157	59	NAD	Term	TERN	35	88.9	37+2	38+0	36	37+2	38-39	4	3	4	36	4	37
1-25 y	21	Multi	G2A1	150	53	NAD	Term	TERN	35	88.9	37+5	38+1	38	37-3	37+5	5	3	5	37	5	37.5
1-25 y	25	Multi	G3P2L	146	57	NAD	Term	TERN	36	91.44	38+3	38+6	38	38+0	38+6	5	3	5	37	5	37.5
1-25 y	24	PRIMI	PRIMI	158	50	NAD	Term	TERN	35	88.9	37+1	37+6	38	37-3	37+1	5	3	5	35	5	35.5
1-25 y	23	PRIMI	PRIMI	148	58	NAD	Term	TERN	36	91.44	39+1	38+6	38	38-3	39+1	5	3	5	37	5	38
1-25 y	21	PRIMI	PRIMI	156	62	NAD	Term	TERN	36	91.44	39+4	39+0	38	38+6	39+4	5	3	5	36	5	37

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NAME OF THE STUDENT/PRINCIPAL INVESTIGATOR: DR.RENUKANANDAN PATIL

NAME OF THE GUIDE: DR.SANGAMESH MATHAPATI, ASSOCIATE PROFESSOR, DEPT. OF OBSTETRICS AND GYNAECOLOGY.

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