1.1 Introduction

Ultrasound has become one of the primary tools to evaluate fetus growth during pregnancy, the diagnostic ultrasound high Frequency (3.5 –7.5 MHz) low intensity sound waves which are transmitted through the tissue by the transducer.(Norman,2002).

Fetal biometry is the sonographic measurement of fetal structures, the majority of the obstetric ultrasound scans is performed to document fetal age when clinical date is equivocal or when there is discrepancy between Uterine size and dates by last menstrual period.It is preferable for more than one parameter to be used in the second and third trimesters, the most commonly used fetal measurement is biparietal diameter and femur length.

The problem of research is started from the misapplication of basic role of humerus length (HL) program in the majority of ultrasound machines in the different governmental and private ultrasound department though it is reported more accurate in some situation example HL and FL in second and Third trimesters. Femur length (FL) and humerus length (HL) of great interest in obstetric practice they are helpful in the estimation of fetal age especially in women do not remember that the date of their last menstrual period or whose fundal height on abdominal examination does not corresponding to the date they used the prenatal multiplier method for predication of limb length Discrepancy. FL, HL, tibia and ulna used in combination to allow of good estimation of fetal age that may be useful when the biparietal diameter measurement be unreliable, unobtainable or abnormal, they used in biparietal diameter/femoral length ratio and biparietal diameter /humeral length ratio as categorical variable in down syndrome. (Kshehzad - 2006).

The accuracy of estimating fetal age in 2^{nd} and 3^{rd} trimester as pregnancy progresses due to increasing biological variation, the gestational age estimates done early in the 2^{nd} trimester more accurate than measurement done later in the second trimester or in the third trimester. (Kshehzad– 2006; G.J Romans- 1981).

In general, the accuracy of gestational age prediction in the 2^{nd} trimester is approximately $\pm$7 days before 20 weeks and $\pm$10 days after 20 week, the accuracy of fetal age prediction in the 3^{rd} trimester is about $\pm$21 day(Kshehzad - 2006).There are two primary objectives for fetal parts assign fetal age and diagnose fetal growth(Norman , 2002).

1.2 Objective of the study

1.2.1 General objective

To evaluate the accuracy of humerus length(HL) in estimation of gestational age compared with femeral length (FL) in second and third trimesters of pregnancy.

1.2.2 Specific objective

To estimate fetal age by using humerus length(HL) and femoral length(FL)measurement, identify variation in gestational age by using humerus length (HL) and femoral length(FL) measurement and assess the accuracy of HL in estimation of gestational age compared with Femoral Length (FL).

1.3 Problems of the study

There is no local recorded study using humerus length in estimation of gestational age.

1.4 Justification:

All the parameters used to estimate the gestational age (GA) were adopted from areas other than Sudan where the characteristics of people were different these parameters might have different measurements than indigenous in Sudan; such as application of femoral length (FL) in determination of gestational age (GA) in third trimester. Therefore reliability of the measurement is recommended using last menstrual period (LMP) as well ashumerus length (HL) can be incorporated in this study alone and in combination with femoral length (FL) for more accuracy.

1.5 Thesis outline

This is concerned with accuracy of ultrasound instrumentation in estimation of gestational age by using humerus and femur lengths in second and Third trimester of pregnancy in normal fetus.

According to that, it is divided into the following chapters:

Chapter one included Introduction, problem, objectives and hypothesis,

Chapter two included literature Review, chapter three included materials and methods, chapter four was aresults, and chapter five showed discussion, conclusions, recommendations and future works.

2.1 Anatomy of embryo

2.1.1 The limbs (embryology)

For some times after its general form is well defined the embryo entirely devoid of limbs and during the fifth week slight ridge appear a long on each side of the embryo on this ridge the rudiments of limbs and the limb buds are formed as secondary elevation and the upper limb precedes than the lower limb in the time of appearance and the development of its corresponding feature.(Kshehzad - 2006)

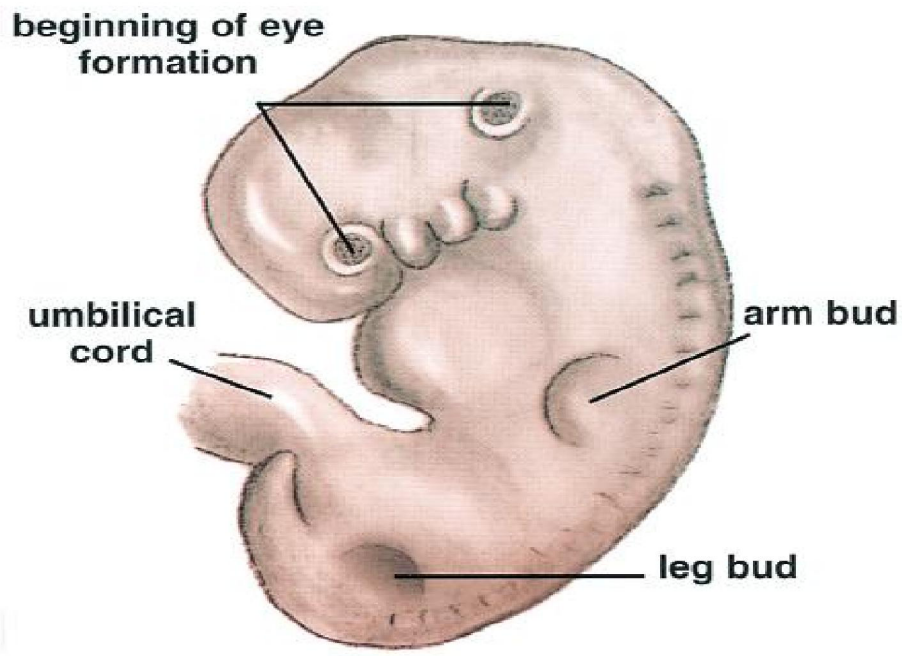

Figure (2. 1) shows: embryo at 6 weeks of the gestation.

Each limb bud early assumes semi lunar outline and projecting at right angle from the surface of the body and possesses dorsal and ventral surface and cephalic or proximal and caudal or proximal borders As the limb rudiment increase in the length and the segments of the limb are differentiated at the same time the limbs are folded ventrally, so that their original ventral surface become medial and their original dorsal surface lateral with the convexities of the elbow and knee directed Laterally.(Kshehzad- 2006). At later period there account of rotation which takes place in opposite directions in the two limbs and the convexity of the elbow is turned towards the caudal end of the body and the knee toward the head and the distal segment of each limb is at first. (Kshehzad - 2006).

The flat plate with around margin but it soon differentiates into proximal or basal part more flattened marginal portion and along its the line where these two parts are continuous that the rudiments of the digits appear as small elevations on the dorsal surface of the limb bud and about the sixth weeks the ridges extend peripherally and by the seventh week the fingers project beyond the margins of the hand segment but the toes do not attain corresponding stage of development until the early part of the eighth weeks The nails are later development. (Kshehzad - 2006).

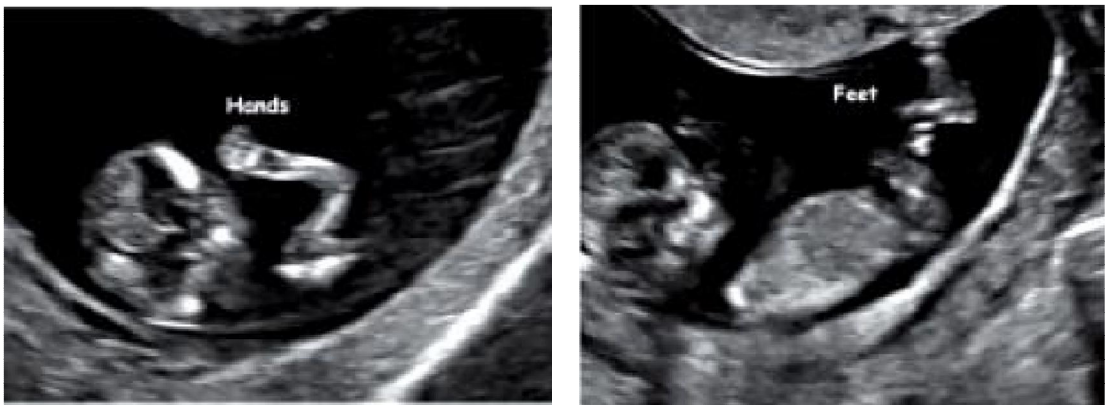

Figure (2. 2) Shows Normal anatomy during first trimester.(P.E.S Palmer- 1995)

Each limb bud is essentially extension from definite number of segment body and it consist at the first of core of mesenchyme covered with ectoderm and it grows of the ventral rami of the spinal nerves of the corresponding segments prolonged into together with branches of number of inter segmental blood vessels. (Kshehzad - 2006).

The nerves remain as the nerves of fully developed limb but the blood vessels are reduced in number and are modified to form the permanent main vascular trunks. The mesenchymatous core of the primitive limb rudiment is derived mainly from somatic mesoderm of the lateral plate and development proceeds and it's divided into the cartilaginous and other connective tissue elements which are the rudiments of the skeletal framework and the fasciae of the fully formed limb. (Kshehzad -2006).

2.1.2 Timing of bone formation

Week 5: lateral plate mesoderm within the limb bud condenses.

Week6: condensed mesoderm chondrofies to form hyaline cartilage model of the upper limb bones.

Week7: primary ossification centers seen in the clavicle, humerus, radius and ulnar bones. The clavicles are the first bone in the entire body to ossify.

Week 9 to birth: primary ossification center seen in the scapula, metacarpals and phalanges. (Arthur C-2004).

Childhood: secondary ossification centers form in the epiphysis end and all carpal bones begin ossification. (Arthur C-2004).

2.1.3 The humerus

The humerus is long bone of the upper limb that extends from the scapula to the elbow joint, it has body and two ends and the upper end includes almost hemispherical head which articulates with glenoid cavity of scapula also with upper end the two tubercles (greater and lesser Tubercles) where they join to the shaft. (Kshehzad - 2006).

The capsule of the shoulders joint is attached to the anatomical neck above and to the surgical neck inferiorly and the body joints, the upper end to the lower end and the lower end which is the is wide flattened anteroposteriorly and bent slightly forward and its middle third of distal edge is formed by trochlea that articulates with ulna and above the trochlea there is the coronoid fossa anterior and olecranon fossa behind.(Kshehzad - 2006)

Lateral to the trochlea there is the capitulum for articulation with radius and behind the capitulumthere is the lateral epicondyle which projects laterally and marked posteriorly by radial collateral ligaments and the medial epicondyle is very prominent and the posterior surface of the humerus is smooth and has shallow sulcus for the ulnar nerve and collateral vessels (K shehzad - 2006)

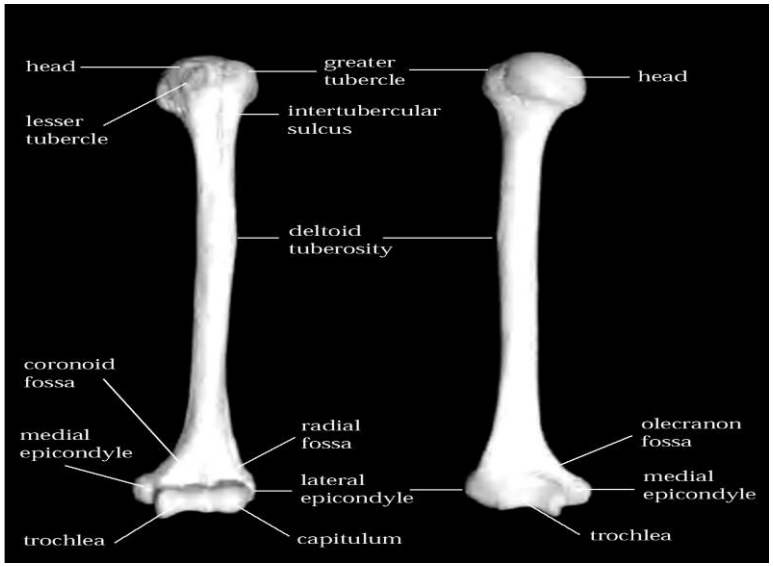

Figure (2. 3) shows the left humerus anterior and posterior views.

2.1.4 The femur

The femur extend from round head which fits the acetabulum down the knee joint where the two large condyles on its inferior end have extensive articular surface of the tibia. (Kshehzad - 2006).

The body of femur is long and strong enough to take the full weight of the trunk and much more and has thick tubular wall and is slightly convex forward with ridge of bone and the lineaaspera which buttresses it posteriorly.(Norman, 2002)

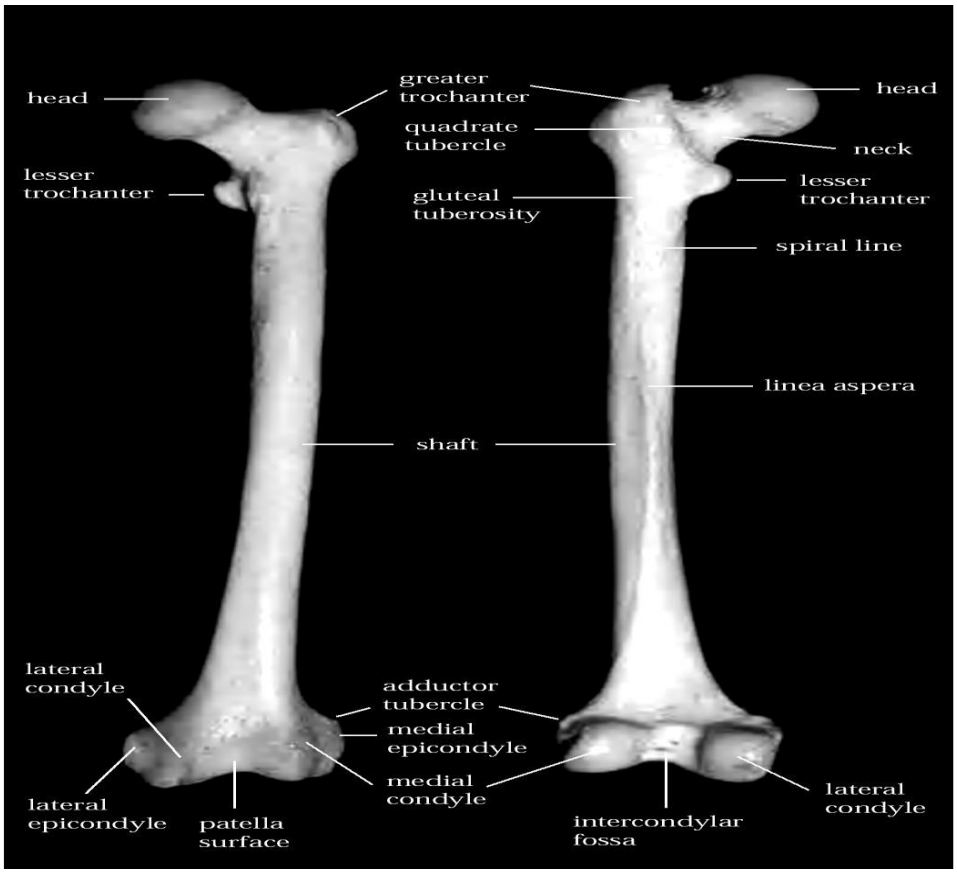

Figure (2. 4) shows the left femur anterior and posterior views.

The head forms about two-third of sphere and is articular except for small superolateral area adjacent to the neck and at pit (fovea capitisfemoris) on its posteromedial aspect where the ligament of the head is attached and the both areas may be transmit blood vessels to the head. (Kshehzad - 2006).

The neck runs inferolateraly to meet the body at angle of about 125 degree and this angle different with age and stature and width of pelvis and begin smaller in adult in short-limbed people in women and the angle is correlated with the width of the pelivs

(l.e the distance separating the two femoral head) and with the obliquity of the shafts when the knees are together in the normal standing position.(Kshehzad - 2006).

The anterior part of the neck is grooved and perforated particularly above and below by small vessels which run in the periosteum and enter the neck and head, the posterior surface is smoother and may be grooved by the tendon of obturator extarnal passing to the trochanteric fossa. (Kshehzad - 2006).

The neck is developmentally part of the body but is marked from it infront by wide rough intertrochanteric line which runs downwards and medially to be continued as spiral line below lesser trochanter. (Kshehzad - 2006).

Medially intertrochanteric line give attachment to the inferior end of the iliofemoral ligament and its end there may be tubercles for parts of Iliofemoralligaments, the neck is covered by synovial membrane and joint Capsule. (Kshehzad - 2006)

The greater trochanter is the large prominence on the upper extremity of the body and its felt at the side of the hip hands breath below the crest of the Ilium and its concave medial surface meets its sloping of the lateral surface At superior border which lie on the same level at the center of the hip joint And the upper border symphysis pubis.(Kshehzad - 2006).

The highest point form the apex of the trochanter and the medial surface just below the apex is hollowed out into the trochanteric fossa which receives the obturator externs tendon and obturator internus is inserted Into the medial surface infront of this fossa. (Kshehzad - 2006).

The grater trochanter also has anterior, lateral and posterior surface which are continous with the body and are largely for attachment of the gluteal muscles, piriformis and gluteus medius pass laterally to reach the Superior border of trochanter and the insertion of gluteus medius is continued down on the lateral surface to the antero – inferior angle. (Kshehzad - 2006).

Gluteus minimums goes to the large impression on the anterior surface at the lateral side the greater trochanter overhangs the body at rough ridge where the origin of vastuslateralis is continued round to the back, the intertrochanter crest pass in inferomedially to the lesser trochanter and near the upper end has rounded eminence and the quadrate tubercle for quadrates femoris. (Kshehzad - 2006).

The lesser trochanter is conical projection at the inferior end of the intertrochanter crest and is situated posteromedially in the angle between thebody and the neck and lateral

to the normal axis of rotation of the femur which pass through the head, although medial to the long axis of The body. (Kshehzad - 2006).

Thus the psoas major muscle which pass backwards to the lesser trochanter medial to the body can produce medial rotation of the intact femur through it is mainly flexor and the iliacus is attached to the posas tendon and to the bone distal to the trochanter and the body of femur as seen from the front is smooth and rounded and it is wider above and below. (Kshehzad - 2006).

When it seen from the side its convex forward and this variable curvature accounts for fullness of the front of thigh and the concavity at the back is filled by ridge of bone, the lineaaspera which give piriform out line transverse section and makes the posterior surface practically straight on it is middle third. (Kshehzad - 2006)

The suface of the body gives attachment to the fleshy fibresvastusintermedius on it is anterior and lateral aspects in its upper two-third, the medial aspects is covered by vastusmedialis the articularis genus muscle arises from the lower quarter of the anterior aspect. (Kshehzad - 2006)The posterior surface of the body narrows in its middle third to form the lineaaspera (rough linear strip with medial and lateral lip), but widens above as it approaches the trochanter and below where the lips diverge as two supracondylar lines enclosing the popliteal surface. (Kshehzad - 2006).

The medial lip of the lineaaspera is continued up as spiral line to reach the intertrochanter line and vastusmedialis is attached to this lip of the lineaaspera and the spiral line as well as to the lower part of the intertrochanteric line and part of iliacus is inserted below the lesser trochanter and pectineus goes to vertical pectineal line leading down to the lineaaspera. (Kshehzad - 2006).

The lateral lip of lineaaspera is continued up as the gluteal tuberosity which reaches the greater trochanter and its prominent and may be sufficiently raised to form third trochanter and the gluteal tuberosity is part of gluteus maximums vastuslateralis arises from its lateral adge as will as from the Lateral lip of the lineaaspera and the root of greater trochanter and upper part of intertrochanterline. (Kshehzad - 2006)

The attachment of adductor magnus is form the lower border of insertion of quadratus femoris down to the adductor tubercle lying medial to the gluteal tuberosity on the middle of the lineaaspera and on medial supracondylar Line. (Kshehzad - 2006).

The adductor brevis and longus are attached to the medial to magnus and in the case of bervis behind the pectineal line, the short head of biceps is attached to the lateral tip and lateral to adductor magnus and medial to vastuslateralis and to vastusintermedius

inferiorly and the bone may be grooved by the for four perforating arteries. (Kshehzad - 2006).

Inferiorly the lineaaspera expand into the flat triangular popliteal surface bounded as the sides by the supracondylar lines and the lateral condyle, the medial supracondylar line is less well defined because it is smoothed in it is upper part by femoral vessels passing between the bone and adductor magnus to enter the popliteal space as the popliteal vessels. (Kshehzad - 2006).

Inferiorly this line reaches the adductor tubercle and the sharpprominance on the upper part of the medial condyle for the insertion of tendinous, hamstring part of adductor magnus, the tubercle can be find by the following down the tendon with the knee flexed. (Kshehzad - 2006).

Inferiorly the popliteal surface curves back to condyle on each side and to prominent intercndylar line between them and this lower part of the surface is pitted by formina and its medial side has rough mark for the medial head of gastrocnemius and the plantaris arises from the corresponding area at the lateral side. (Kshehzad - 2006).

The structure attached to the lower part of the lineaaspera are continued down on the supracondylar lines, vastusmedialis and adductor magnuson the medial line and biceps and vastusintermedius on the lateral line. (Kshehzad - 2006).

The medial and lateral intramuscular septa pass to the bone the former between the anterior and extensor comparment and medial adductor group of muscles and the latter between the same extensor compartment and hamstring group of muscles posteriorly and the septa reach both the lineaAspera and the supra condylar lines and increase the area of muscular attachment. (Kshehzad - 2006).

The inferior end of the femur consist of two large condyles which blend with each other anteriorly and with the body superiorly, they project backwards and are separated posteriorly by deep intercondylar fossa and can be felts as large prominances at the sides of the knee when the femur in the normal position and the distal surface of the two condyles should be touch the same horizontal place so that the body is directed obliquely outwards and upwards from the knee to the hip.(Kshehzad - 2006).

The articular surface of the condyles for the tibia and its menisci extend over the distal and posterior aspects to provide full flexion and from below and behind the surface of the lateral condyle is rounded although the parallel medial and lateral edges may be give outline oblong appearance. (Kshehzad - 2006).

The medial condyle is elongated anteroposteriorly and turning laterally at anterior end is curved in horizontal plane and the round center situated on The middel of lateral condylar surface and the anteroposterior curvature of The articular surface is spiral with the inferior part flatter and the posterior Part convex. (Kshehzad - 2006).

Anteriorly the two articular surface are confluent but each is separated from this patellar surface by slight grooves and in the flexion of the knee Joint the patella articulate with the distal aspect immediately anterior to The grooves but in the extension is contact with the anterior aspect, the middle of patellar surface is deeply grooved and its lateral part is more prominent and extensive than the medial part.(Kshehzad - 2006)

The lateral and medial margins of patellar surface can be felt when the knee is bent, the medial surface of the lower end of femur has prominent medial epicondyle which gives attachment to the tibial collateral ligament above the adductor tubercle. (Kshehzad - 2006).

The lateral surface has prominent lateral epicondyle on its posterior half often seen smooth hollow where the fibular collateral ligament attached, above this impression markes the attachment of the lateral head of gastrocnemius. (Ronald w.D udek 2005).

Below and behind this markings running parallel to the margin of articular surface is groove for popliteus and the tendon of popliteus is attached to the antero-inferior end of the groove and lies only in the flexion and the notch in the edge of the articular surface below the attachment of the tendon may be seen where it crosses the edge during extension of the joint (Kshehzad - 2006).

Posteriorly the anterior wall of the intercondyle fossa is rough and marked by vascular foramina it is limited above by the intercondylar line and below by articular edge at this sides its wall are the condyles. (Kshehzad - 2006).

The posterior part of the lateral wall of the fossa (lateral condyle) is smooth for the upper attachment of the anterior circulate ligaments,the anterior part of medial wall (medial condyle) similary is smooth for the posterior circulate Ligament; the oblique popliteal ligament reaches the intercondylar line and is attached to it. (Kshehzad - 2006).

2.2 Fetal biometry

Fetal biometry is estimation of fetal size and age, before the development of ultrasound the fetal dimension were measured by using radiological technique but the development of ultrasound made it possible to measure the bones and soft tissue structure of the fetal faster and more reliability than with x-rays .(Sandler-2006)

2.2.1 The principle of fetal biometry

The normal value are defined by measuring that parameter in fetuses of normal patient with well – established gestational age and given parameter as different gestational age and the data collection for this purpose can be either cross – sectional or longitudinal. (John H- 1997)

2.2.2 Estimation of gestational age

The conceptual age is calculated from ovulation and the menstrual age is calculated from first day of last menstrual period (LMP) and the gestational age is calculated from theoretical time of ovulation plus 2 weeks for this has advantage over menstrual age of eliminating the problems associated with oligomenorrhea and delayed ovulation. (John H- 1997.).

The most accurate way to calculated the length of pregnancy by known the date of conception and expected date of delivery at 38 weeks (266 days) later and most women are unknown the date of conception so the first day of (LMP) is used to calculated the expected date of delivery (EDD) this done by using Nagele's formula to the LMP. (Andrzej M-2004).

The accuracy of the ultrasound dating can be assessed in two ways firstly the mean gestational for each ultrasound size can be compared with gold standard‖ such as IVF pregnancy whereas the date is known certainly when the embryo replacement; secondly the (EDD) as predicated by the ultrasound scan can be compared with the actual date of delivery. (Asum-2007)

If gestational age and fetal development are estimated and the measurement must be obtained then compared with local standard values although there are many alternative measurements that can be made only few are accurate and reliable. (Andrzej M-2004) prediction of gestational age by ultrasound cannot be accurately made after 24 weeks gestation. (Andrzej M-2004)

2.2.3 Selection of appropriate parameter

Different parameters have different reliability and easily for measurement at different gestational age:-

CRL: use from (7 – 10 weeks).

CRL, BPD, FL, HL: use from (10- 14 weeks).

BPD, FL, HL, HC: use from 15- 28 weeks.

After 28 weeks (more accurate dating): FL, HL, bin ocular distance and other long bone length. (John H- 1997.).

2.2.3.1 Crown-rump length measurement (CRL)

The crown-rump length is the most reliable parameter for estimating the gestational age up to 7 weeks and there is excellent correlation between the crown-rump length and gestational age from the (7- 11 weeks) of pregnancy and the biological variability is minimal and growth is not affected by pathological disorders. (Andrzej M-2004).

Figure (2. 5) shows crown-rump length (CRL) measurements.(palmer,1995)

2.2.3.2 Biparital diameter (BPD)

Is the most reliable method for estimating the gestational age between (12- 26 weeks) , after that it is accuracy may lessened by pathological disorders and biological variation that affected on the fetal growth and it must be considered together with other measurements such as femoral length and Abdominal circumference. (Andrzej M-2004).

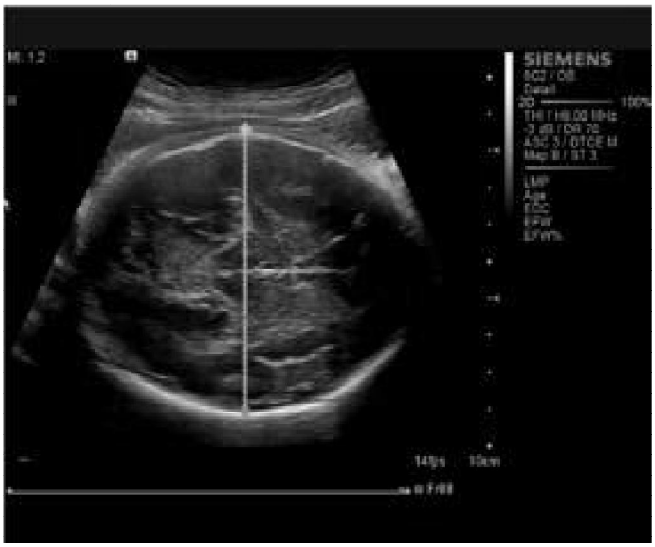

Figure (2. 6) shows biparital diameter (BPD) measurement. (Andrzej M-2004)

2.2.3.3 Fronto-occiptal diameter

Ismeasured along the longest axis of the skull at the level of the biparital diameter (BPD) from outer edge to outer edge. (Andrzej M-2004)

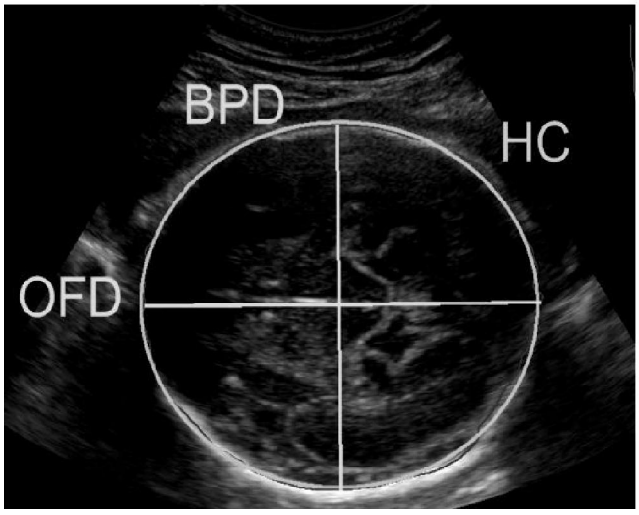

Figure (2. 7) shows occipto-frontal diameter measurement. (Andrzej M-2004)

2.2.3.4 Cephalic index

The BPD is reliable for gestational age except when the shape of the head is abnormal or there is abnormality of the intracranial content. (Andrzej M-2004).

$$\text{Cephalic index} = \frac{\text{Biparital diameter}}{\text{Fronto} - \text{occiptal diameter}} * 100$$

Normal range (± 2 Standard deviation) = ±70 -86.

2.2.3.5 Head circumference (HC)

If the cephalic index within the normal range the (BPD) is acceptable for estimate of gestation age but if the cephalic index is outside this range the
(BPD) should not used and instead the head circumference can be used. (Andrzej M-2004).

Head circumference = (BPD + fronto-occiptal diameter) x 1.57

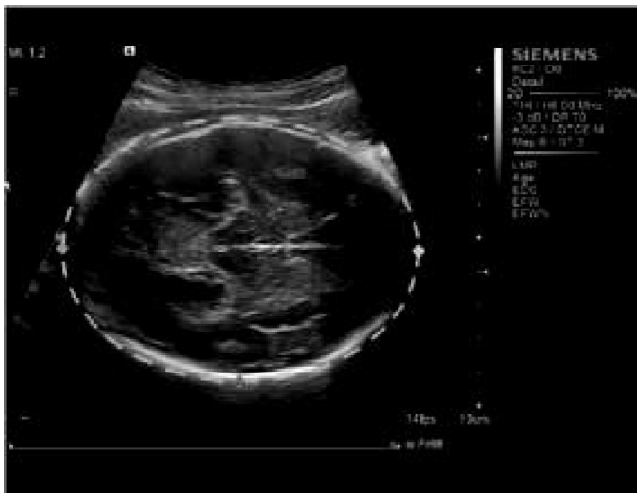

Figure (2. 8) shows Head circumference measurement. (Andrzej M-2004)

2.2.3.6 Abdominal circumference (AC)

It is used to detect the intrauterine growth disturbances, the measurement should be at the level of the fetal liver which is very sensitive to deficient nutrition and the scan show cross-sectional of the fetus that as round as possible, the measurement from outer edge of the fetal abdomen to the Outer edge on the other side of the fetal abdomen. (Andrzej M-2004).

abdominal circumference = (AP diameter + transverse diameter) x 1.57

(If> 5th percentile it is small and < 95th percentile it is large).

Figure (2. 9) shows abdominal circumference (AC)measurement. (Andrzej M-2004)

2.2.4 Fetal long bone measurements

It usually easy to see the fetal long bones from (13 weeks) onwards, the length of bone particularly the femoral length can be used as measure of gestational age when the head measurement is unreliable due to intracranial pathology. (Andrzej M-2004).

This measurement most frequently use in third trimester and the bone length may be also compared with biparital diameter, the femoral or humeral measurement can be considered normal if it falls within two standard deviation of the mean for known the gestational age. (Andrzej M-2004).

The fetal humerus, radius/ulna, femur, tibia/fibula and foot were measurelengt70 pregnant women at (64---- 108 days) of menstrual age using vaginal sonography , all limbs measurement correlated significantly with the gestational age and the biparital diameter independently, the ratio of limbs segment length did not change with gestation. (Mimi Maggio et al, 1998).

The reference range (mean and 95% data intervals) were constructed for each limb segment and these data may be useful in prenatal diagnosis of the skeletal dysplasia and the antenatal assessment of patient at risk chromosomal abnormalities. (Mimi Maggio et al, 1998).

In the second and third trimesters the recommended approach to gestational age assignment, the choice depended on which measurement are available because two or more parameter may be equivalent in the accuracy.(Merz E. et al 1987) if the technical problem arise with the biparital diameter due to fetal head abnormalities either hydrocephalus or microcephalic, the femoral length (FL) can be employed as alternative method of estimating the gestational Age.(K. Rothe-1984) If the

measurement of both biparital diameter and head circumference is seriously hampered by deeply engaged head position in boards – presentation fetus and good gestational age assignment can be made on the Basis of femur length, the gestational age can be estimated more accurately in third trimester by using multiple fetal growth parameters instead of single parameter.(D. Sharma, et al 1990) In the second and third trimesters the gestational age should be assessed by using the combination of biparital diameter and femur length or head circumference and femur length.(Khalid shehzad et al -2006).

2.2.5 The long bones technique

The published measurement of the long bones corresponding to measurement of the ossified diaphysis and exclude the hypoechoic epiphyseal cartilages, the long bones must be scanned in plane that includes both the proximal and distal epiphyseal cartilages to ensure that the maximum length of the ossified diaphysis is visualized and the true length can be overestimated if measurement includes the epiphyseal cartilages.(SADLER, et al -2006).

The distal point is bright reflector arising from the distal femoral epiphyseal cartilages and is not part of the ossified diaphysis and it should not included in the measurement of the femur because it result in over estimation of the femur length and also the measurement should not include the secondary ossification centers of the distal femur and proximal tibia which ossify in the Late third trimester.(SADLER, et al -2006).

Oblique measurement through the long bones result in under estimation of the true length , the medial aspect of the normal femur has curved margins and should not be misinterpreted as pathological bowing. (sadier, et 2006).

The overage absolute error in lateral measurement which obtained perpendicular to the ultrasound in consistently greater than the absolute errors in axial measurement which obtained parallel to the ultrasound beam, the measurement errors can be minimized by increasing transducer frequently and focal zone scanning and axial measurement. (Sadler, et 2006).

However the femur length charts commonly used are based on measurements taken perpendicular to the transducer beam this result in some inherent in the accuracy of the established charts for estimating menstrual age, the femur length should be include routinely recorded in all pregnancies after the first trimester and compared with table of normal long bone length for estimation of menstrual age (Sadler, 2006).

The measurement within 2 SD of the mean is usually regarded as normal and other long bone can also be measured for estimation menstrual age, extremity measurement should be compared with other growth parameters to
Differentiate between skeletal dysplasia and other abnormalities. (Sadler, 2006).

2.2.6 The longitudinal axis of the fetus

Place the transducer on the maternal abdomen to obtain the midline of the longitudinal section of uterus then slide the transducer to each side of the abdomen until the fetal head is visualized and repeat the process to identify the fetal heart within the fetal chest.

Slowly rotate the transducer and keeping the heart in the vie until the longitudinal section of fetal spine will be obtained then rotate the transducer until the fetal head and body are visualized on the screen together, knowing the relationship of the longitudinal axis of the fetus to maternal abdomen and established the fetal lie that is important preliminary to obtaining accurate measurement of fetal head and abdomen.(Andrzej M, et al -2004)

2.2.7 The upper extremity

2.2.7.1 Humerus

Sligthlyoff axial section through the shoulder girdle shows contiguous hypoechoic musculature and skin surface around the fetal scapula and proximal humerus, the scapula is identified with cartilaginous humeral head adjacent to the glenoid fossa then rotation the scanning plane around the humeral head to include the shaft of humerus. (Khalid shehzad, et al- 2006) identification of humerus should be made by scanning through the fetal ribs/thorax and shoulder girdle adjacent the humerus. (Khalid shehzad, et al- 2006) .

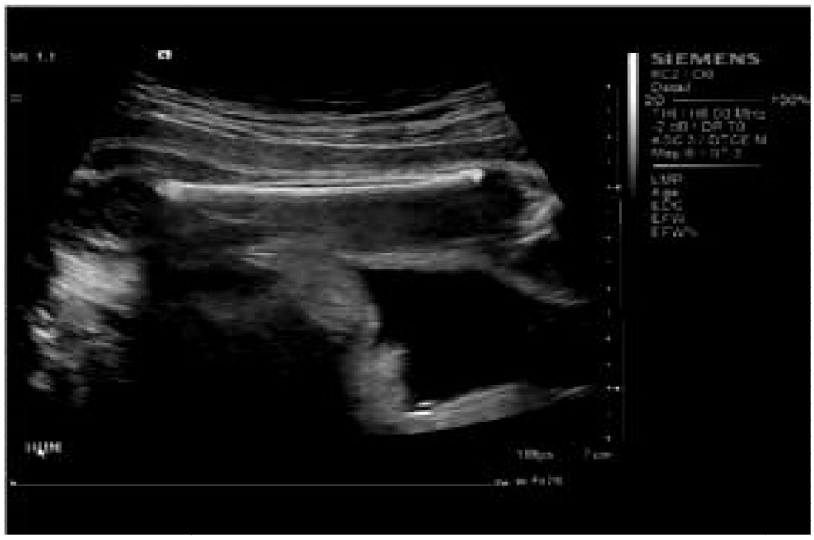

Figure (2. 10) shows the humerus length measurement. (john wily,sons2010)

2.2.7.2 The forearm

The forearm can be localized by scanning to the distal humerus and rotating the transducer through the elbow to images the radius and ulna, the ulna is identified by the proximal end it is extend whereas both radius particular the distal end it is extend this may be important in different syndrome with the radial dysplasia. (Khalid shehzad, et al- 2006).

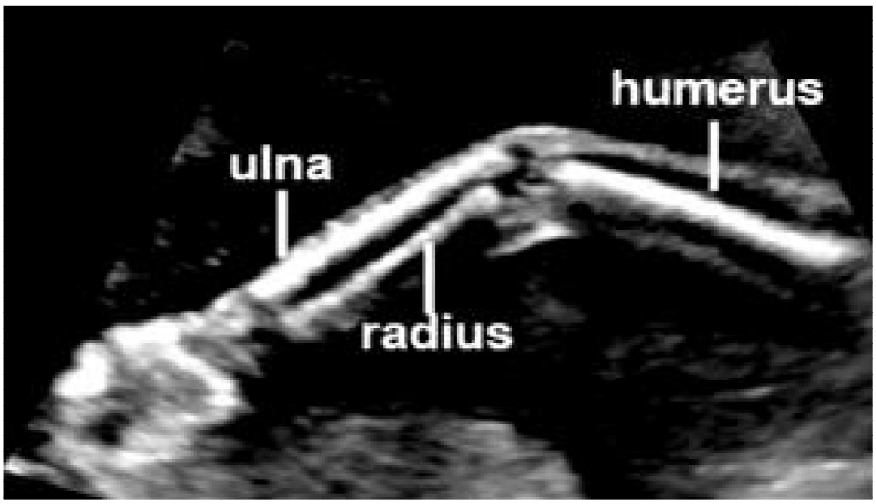

Figure (2. 11) shows the fetal upper extremity. (Khalid shehzad, et al- 2006)

2.2.7.3 The hand

Detailed examination of the hand is possible early in the gestation with high resolution equipment, the longer ulna and shorter radius are identified within the forearm and terminating at the same level within the wrist, whilst metacarpals are noted, in cross-sectional through fifth metacarpals and separate thumb are delineated as discreet

structure, the soft tissue are seem in greater detail Including bright specular reflector at fluid-skin interfaces.(Khalid shehzad, et al- 2006).

A B

Figure (2. 12): shows the hand of fetus,3D ultrasound images (A) .(Khalid shehzad, et al- 2006)

2.2.8 The lower extremity

2.2.8.1 The femur

Find the transverse section of the fetal abdomen and slide the transducer caudally until the iliac bones are visualized at this point cross-sectional of the femur is usually seen by keeping this bright echo from the femur in the view rotate the transducer until the full length of femur obtained, to ensure that you have the full length and that your section is not oblique and soft tissue should not appear to merge with the skin of the thigh at any point.(Khalid shehzad, et al- 2006)

The measurement of femur is made from the center of the U‖-shape at each end of the bone this represent the length of the metaphysic and it is good practice to obtain the measurement from three separate images of femur these should be within (1mm) of each other. (Andrzej M-2004)

The femur is best localized by scanning transversely through the pelvis until the thigh are reached and the femur is seen and followed by appropriate rotation to obtain the longitudinal section of femur , the optimal femur image for the measurement show the femur of uniform echogenecity and thickness With well-seen shadow and bright skin. (Khalid shehzad, et al- 2006).

The surface echoes should not be mistaken for osseous structure – shadowing by near femur or difficultly in imaging maximal length of both bone simultaneously makes it

necessary to image only one bone at time for accurate measurement.(Khalid shehzad, et al- 2006).

The normal femur has straight lateral surface than the medial surface and this appreciated by comparison of the lateral margin of near femur versus the medial margin of deeper bone and to assure imaging of entire length of the femur, ideally hypoechoic cartilages of the femoral head and condyle that cap ends of femur should be identified. (Khalid shehzad, et al- 2006).

The calipers should be placed to encompass ossified ends of femur from approximal level of greater trochanter to condyle- femur ―spike‖ is not included. (Khalid shehzad, et al- 2006).

Figure (2. 13) shows the femur length measurement. [Khalid shehzad, et al- 2006)

2.2.8.2 Tibia and fibula

the tibia and fibula of the near leg imaged distal to cartilages within knee when specifically measuring the long bone of the leg , they should be identified by first delineating the femur then scanning through it to the knee to note the orientation of leg caudally and proceeding to image either flexed or extended distal bones and scanning through flexed knee and angling to image the leg reveals ossified fibula and tibia with their cartilaginous end noted. The fibula is lateral and slightly inferior to the tibia and it is difficult to measure or image both leg bones simultaneously in longitudinal section because of shadowing by the more superficial one particularly when it is the more substantial tibia for specific long bone measurements, selected images of long bones

are suggested whereas for orientation and delineating specific anatomic relationship.(Khalid shehzad, et al- 2006)

Roughly coronal images in slightly different planes document correct position of foot extending from the leg when coronal imaging of the leg is extending to the foot and axial image of foot will be roughly perpendicular to the long axis of the leg whereas sides of foot will be in line with sides of the leg and in the late third trimesters sagittal and axial low and high views show the calcaneous and talus at different level within hind foot.(Khalid shehzad, et al- 2006)

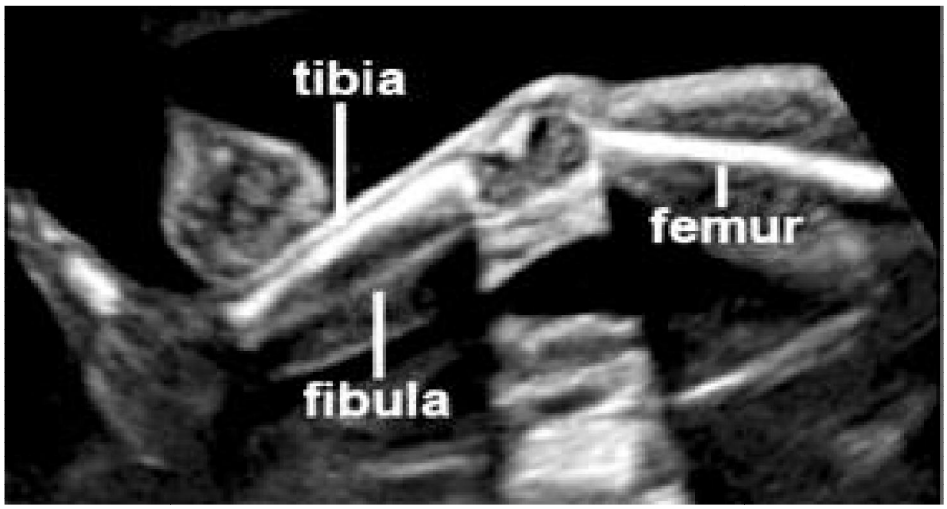

Figure (2. 14) shows sonography of fetal lower extremities.(Khalid shehzad, et al- 2006)

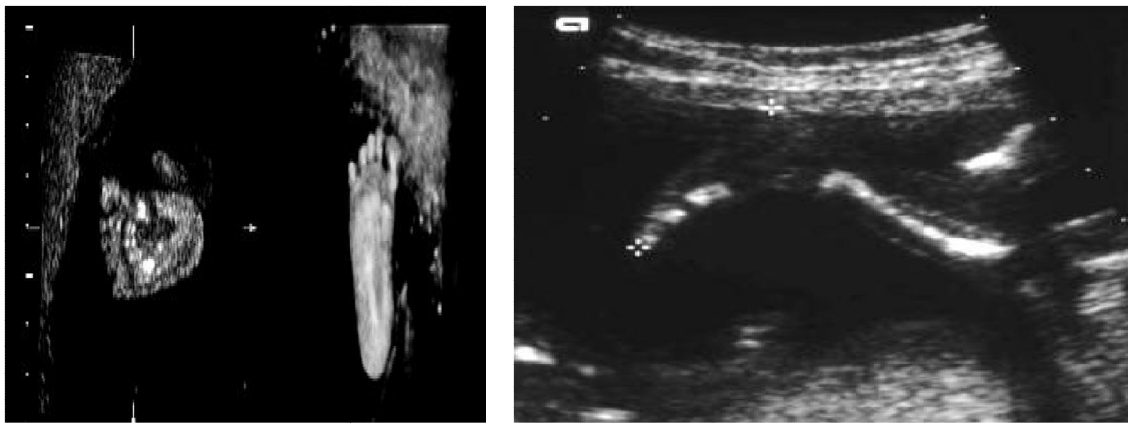

Figure (2. 15) shows the foot of fetus. (Khalid shehzad, et al- 2006)

2.3 Previous studies:

The long bones are measured with the bone across the beam axis, the strong acoustic shadow behind the femoral or humeral shaft and the visualization of both cartilaginous ends indicates that the image plane is on the longest axis and is the optimal measurement plane. (Richard, et al, 1991).

There are three equation for calculation fetal gestational age by using Humerus length (HL) and femur length (FL):-

1.The quadratic regression formula used to describe the relationship between FL, HL and gestational age are: (Richard, et al, 1991).

$FL = -0.0004 (GA)^3 + 0.0032 (GA)^2 + 3.1263 (GA) - 28.489$ ($r^2 = 0.974$).

$GA = 0.41 (FL) - 0.002884 (FL)^2 + 0.00003924 (FL)^3 + 8.284$.

$HL = -0.0001 (GA)^3 - 0.0235 (GA)^2 + 3.5386 (GA) - 29.452$. ($r^2 = 0.956$).

$GA = 0.406 (HL)\ mm - 0.002804 (HL)^2\ mm + 0.0000563 (HL)^3\ mm + 8.411$ ($r^2 = 0.999$). (Richard, et al, 1991).

2. Gestational Age (wk + day) via Jeanty using Femur Length (FL range:

to 8.0 cm) equation is: (John Wiley, et al- 2010).$GA = 9.5411757 + 2.9774510\ FL + 0.10388\ FL^2$

Gestational Age (wk+day) via Jeanty using humerus length (**HL** range: 1.0 to 6.9 cm) equation is :(John Wiley, et al- 2010).

$GA = 9.6519438 + 2.6200391\ HL\ (cm) + 0.26105367\ HL^2\ (cm)$. (See appendix {5}).

3**.** Gestational age of humerus length in weeks calculated by :(John Wiley, et al- 2010).

$GA = 0.5611\ HUM^2 + 0.1690\ HUM + 13.247$. See table {2.5.1} below. Extremity bones in their entirety can be determined from the (10th week) on crown rump length (2.5 cm) when their length is about (1.0 cm), after the 12th week it is possible to differentiate upper and lower arms and legs, only in exceptional cases were we able to isolate radius from ulna before the 13th week. (John Wiley, et al- 2010).In contrast to other investigators, we find that the accuracy of measurement before the 14th week is too poor for use in dating pregnancies, In the 14th— 16th weeks reproducible data for the long bones can usually be obtained but the accuracy of the measurement is in the range of the biological variability: (John Wiley, et al- 2010).

A normal pregnancy was defined as a gestation in which the mother was free of serious illness, in which there was no fetal anomaly and in whom the biparietal diameter as

well as the mid thoracic diameter (at the plane of The insertion of the umbilical vein into the hepaticsinus) was between the 25th and 75th percentiles, this correlates approximately to standard deviation of + one week in the second trimester and (+2 weeks) in the third trimester of gestation. (John Wiley, et al- 2010)

Only in one case of the 16 bones measured was there a deviation of 3 mm, and in six other cases there was a deviation of (2mm) between the sonographic and the real measurements, The other nine cases deviated by ± 1mm, after obtaining similar long bones between the 17th and 41st complete results in 50 cases with a deviation of +1 mm.

The deviations for the minimum and maximum values are mostly within (2- 4mm) and only in four cases was this deviation 5 mm and in one 6 mm; thus, our results appear that they can be considered as within normal limits. (John Wiley, et al- 2010).

The growth rate for the femur is greater than that for the other four bones (Humerus, radius, ulna, tibia) which have similar growth rates, The latter four bones have a growth rate of (3 mm per week)in early pregnancy when it is noticeably greater than towards the end of pregnancy where there is only mm growth per week. (John Wiley, et al- 2010) the smoothened normal curves for the long bones are shown in diagram below: (John Wiley, et al- 2010).

Figure (2. 16) shows: Normal curves for growth of the humerus. (John Wiley, et al- 2010)

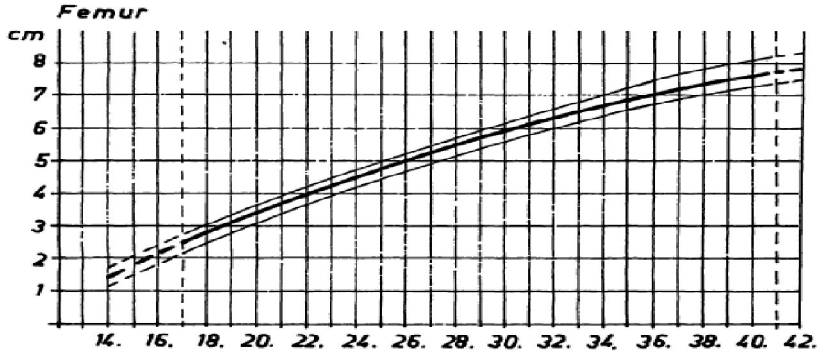

Figure (2. 17) shows: Normal curves for growth of the femur. (John Wiley, et al- 2010)

In order to calculate the relation between gestational age and bone length, polynomial formulas must be applied to all long bones in order to be valid for the entire duration of pregnancy, the correlation between the duration of gestation and the longitudinal measurements of the bones are seen in table (2.1) and table(2.2). (John Wiley, et al- 2010).

Table (2. 1) Calculation of gestational age from extremity bones:-

HUMERUS IN WEEKS	$= 0.5611\ HUM^2 + 0.1690\ HUM + 13.247$
ulna in weeks	$= 0.6275\ ULNA^2 + 0.2313\ ULNA + 13.647$
Radius in weeks	$= 0.7692\ RAG^2 + 0.3370\ RAD + 13.856$
Femur in weeks	$= 0.3134\ FEM^2 + 0.1276\ FEM + 11.883$
Tibia in weeks	$= 0.5312\ TIB^2 + 0.6766\ TIB + 13.223$

Table(2. 2) Calculation of the length of the extremity bones from the Gestational week :- (John Wiley, et al- 2010)

HUMERUS IN CM	$= 0.4406\ W - 0.00442\ W^2 - 3.85$
Ulna in cm	$= 0.4391\ W - 0.00451\ W^2 - 4.11$
Radius in cm	$= 0.4010\ W - 0.00413\ W^2 - 3.87$
Femur in cm	$= 0.4546\ W - 00405\ W^2 - 4.11$
Tibia in cm	$= 0.4410\ W - 0.00439\ W^2 - 4.18$

Multiple regression model for predicted the gestational age by single ultrasonographic examination was developed by forward selection method after eliminating multi co-linearity; as high degree of inter correlation was found between femur length (FL) and humerus length (HL) and (HL) was eliminated from the data, the biparital diameter (BPD) does not have significant role in predicting the gestational age in the later pregnancy.(John Wiley, et al- 2010)Contemporary anatomy studies require methods for determining the fetal age, the menstrual age is often found to in-adequate and combination of several feature showing the age, the dependency on the both may be result in exact age approximately and pathology detection.(John Wiley, et al- 2010)

The authors compared the manual foot length measurement with femur and humerus length measurementof fetuses for calculation of fetal age, the correlation between femur length and foot length as well as humerus length and foot length were statistically significant, the authors conclude that fetal age assessment based on foot

length metering is reliable before the seventh calendar month of pregnancy and corrected with ultrasound measurement of the humerus and femur. (John Wiley, et al- 2010).

The femur length is very useful biometric parameter used in second and third trimesters of pregnancy and is best measured after (14 weeks) of gestational, the fetal long bones are also used for assessment the gestational age but are more use for detecting the divergence from the normally e.g suspected cases of skeletal dysplasia.(John Wiley, et al- 2010).

The long bones used for estimation of gestational age include fetal humerus, radius, ulna, femur, tibia and fibula and the correct evaluation of gestational age is possible every (2 weeks) by assessing all these bones except the femur where it possible every (week) before (28 weeks) and every(2weeks) after (28 weeks). (John Wiley, et al- 2010).

The real- time ultrasound scanners have given number of ultrasonic biometric parameters but the most commonly used among these parameters are fetal biparital diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL) . (John Wiley, et al- 2010).

In the absence of the known date of last menstrual period or where fundal height does not agree with the date these parameters are valuable for growth of these Parameters in different population. (John Wiley, et al- 2010).

They found the prenatal multipliers to be independent of race, percentile as and gender from as early as (12 weeks), the prenatal multipliers are like for femur and tibia and also methods allows for quick predication of limb length discrepancy at term and skeletal maturity from as early (12 weeks) of gestation, future study is needed to validate this method clinically.(John Wiley, et al- 201 .this descriptive study was carried out at ultrasound department in Bahri hospital in the period from April 2015 – September 2016, in which 80 pregnant women .This study done on 80 pregnant Sudanese healthy women, surely about their LMP, had regular menstrual cycle and normal fetus to describe accuracy of ultrasound in estimation of gestational age by using HL and FL which is the main objective of the study. The period of gestation was calculated from LMP and clinical examination. With each patient, several biometric parameters were obtained including BPD, AC, FL, and HL. The age of pregnant women distributed into three, the majority group was in range of (26-35) yrs because the fertility rate increases during this age group. The study revealed that there was no

significant difference between FL and HL, the correlation is significant =.93, also there was strong correlation between HL and GA; this correlation is not so different from the correlation of GA estimated by FL (mm) with GA calculated by (LMP) (0.92). The GA (Ws) match the international estimated age closely the Standard nomogram.

In pairing T-test to test the relation between FL and HL; the study found thatthe correlation is significant = (.937). Other correlation between (LMP),FL, HL, AC, BPD (Ws); between GA (LMP) & FL (.917), LMP & HL (.886), FL & HL(.940), HL& BPD (.869) and HL & AC (.885) all this correlation showed good correlationat the 0.01 level (2-tailed), also showed the BPD less significant role in prediction age in late second and third (.788) compare to other parameters.

Materials and Methods

3.1 Materials:

Esaote my lab 40 was the machine and the transducer frequency was used 3.5 MHZ.

3.2 Area of the study:

Dream specialized hospital.

3.3 Method

This is experimental study of 70 normal pregnant women was done during 6 / 6/ 2019 to 10 /8 /2019.

This study aimed to evaluate the accuracy of humerus length (HL) and femur length (FL) in assessing the gestational age in normal Sudanese Pregnant women.

3.3.1The method use to collect the data

Data analysis.

Data storage.

Ultrasound image presenting.

3.3.2Study populations

Sudanese pregnant women in dream specialized hospital in Khartoum area were come were routine examination, pregnant women under study informed, consent confirmed and clear notation about the sonographic examination longer time than usual in routine examination was explained to the pregnant women.

3.3.3Sample

The sample were taken randomly and any individual who satisfy the inclusion criteria was registered and the data collecting of the sample during 6 /6/2019 To 10 /8 / 2019.

3.4 The inclusion criteria and exclusion criteria

3.4.1 The inclusion criteria

Pregnant women with certain date of the first day of the last normal menstrual period. single or multiple without congenital.

3.4.2The exclusion criteria

Any individual was not satisfying the inclusion criteria.

3.5The technique

The pregnant from 20th gestational week up to full term of pregnancy are examined supine and sagittal view of fetus was obtained marking in fetal heart pumping in the chest and through fetus chest full length of humerus is visualized and through fetal pelvis full length of femur is visualized.

3.5.1Humerus scanning technique :

Slide the transducer until the fetal heart is identified within the fetal chest and scanning through fetal ribs/thorax and shoulder girdle leading to the adjacent humerus and rotation the transducer until the full length of humerusis obtained.

The measurement of humerus length between two point at either end of the bone shaft and three or more measurements are taken in each examination to obtain the accurate measurement and the value more repeated is selected as accurate value and one humerus was examined only.

3.5.2Femur scanning technique:

By scanning through the transverse section of the fetal lower abdomen until the iliac bones are visualized and the cross-sectional of femur is seen at this point then rotation the transducer until the full length of femur is visualized. the measurement of femur is made from the center of each end bone which represent the length of metaphysic , three or more measurement are taken in each examination to obtain accurate measurement and the accurate ones should be within 1mm of each other and one femur only was examined. All fetus had one scan examination each scan sweep was take approximately 10 second and data of humerus length (HL) and femur length (FL) of fetus were stored on removable digital media.

3.6Method of data analysis:

This study had been solved by using computer analysis.

3.7Duration of study

June –August 2019.

3.7 The ethical Consideration:

There will be no patient or individual identification in this study, written consents and ethical approve for hospital.

Results

Table (4. 1) Participants distribution with respect to age:

Maternal age	Frequency	Percent
Less than 20 years	1	1.4
21-25 years	25	35.7
26-30 years	27	38.6
31-35 years	12	17.1
36-40 years	4	5.7
More than 40 years	1	1.4
Total	**70**	**100.0**

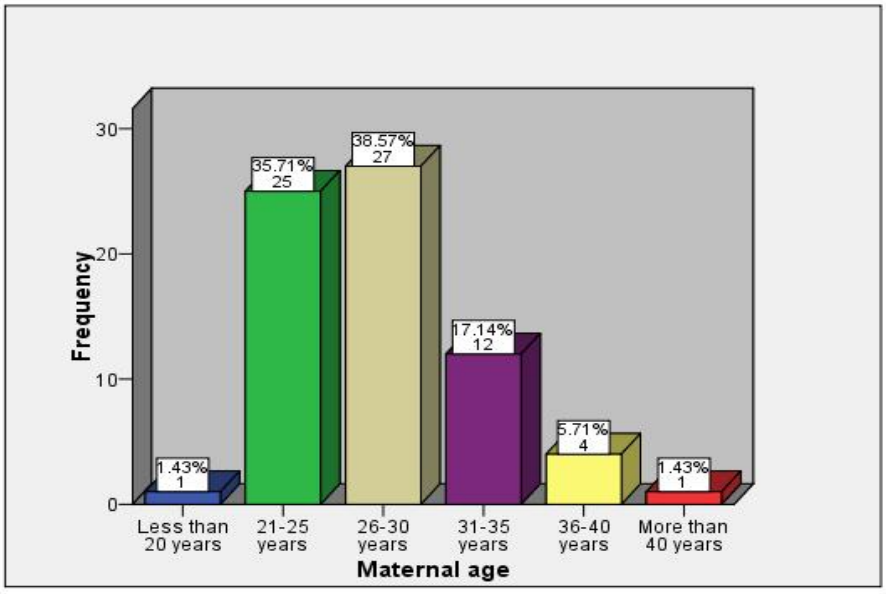

Figure (4. 1) Participants distribution with respect to age

Table (4.1) and figure (4.1) show that (38.6%) of participants were 26-30 years old, since (35.7%) of them were 21-25 years and (17.1%) of them 31-35 years, while (5.7%) of them were 36-40, whereas only (1.4%) were less than 20 or more than 40 years old.

Table (4. 2) Participants distribution with respect to parity:

Parity	Frequency	Percent
Null-Para	32	45.7
Multi-Para	38	54.3
Total	**70**	**100.0**

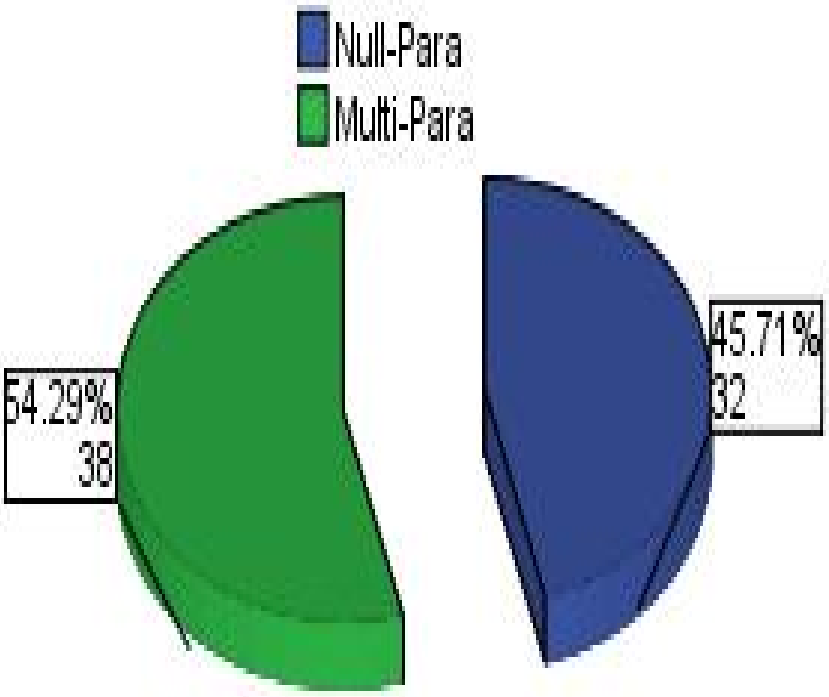

Figure (4. 2) distribution of participants according to parity.

Table (4.2) and figure (4.2) show that (45.7%) of participants were null-para, while (54.3%) of them were multi-para.

Table (4. 3)describe the gestationage by femur length and humer length and the last menstrual peroid:

N = 70	Minimum	Maximum	Mean	Std. Deviation
Gestational age by humerus length	20	51	32.26	6.180
Gestational age by femur length	20	41	32.66	5.474
Gestational age by last menstrual period	22	38	30.63	4.243

Table (4.3) shows that a total of (70) maternal were selected, whom present (20-50) weeks with mean (32.26±6.18) weeks of gestational age by humerus length, (20-400) weeks with mean 32.66±5.47 weeks of gestational age by femurs length), and (22-38 weeks with mean 30.63±4.24 weeks of gestational age by last menstrual period.

Table (4.4) Measure of humerus length to gestational age:

R	R Square
0.993	0.985

Table (4.4) provides the *R* and R^2 values. The *R*-value represents the simple correlation is (0.993) (the "R" Column), which indicates a very strong degree of positive correlation between gestational age and humerus length. The R^2 value (the "R Square" column) indicates how much of the total variation in the gestational age, can be explained by humerus length. In this case, (98.5%) of variations in gestational age participated by humerus length.

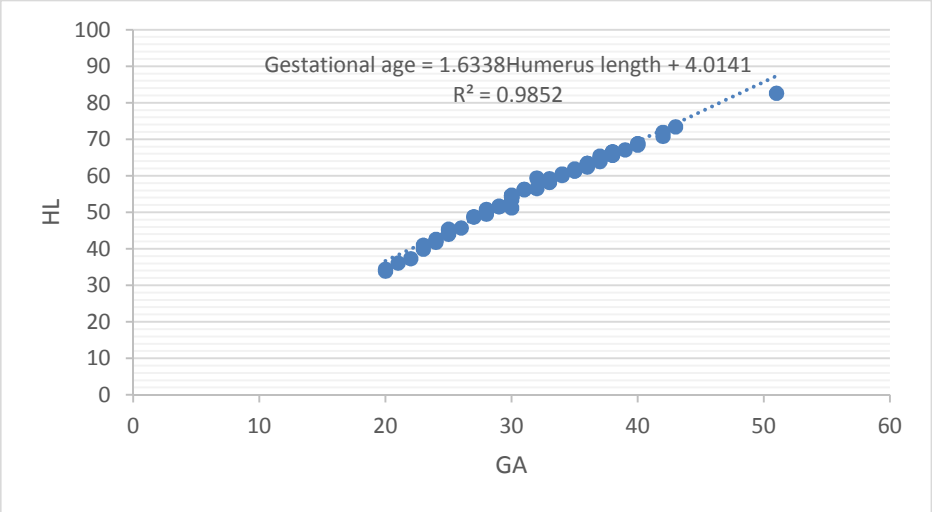

Figure (4. 3) the linear relationship between gestational age and humerus length

Table (4. 4) regression mode of gestational age on humerus length:

	Unstandardized Coefficients		T	Sig.
	B	Std. Error		
(Constant)	1.943	0.516	-3.763	0.000
Humerus length	0.603	0.009	67.278	0.000

The **Coefficients** in table (4.5) provide us with the necessary information to predict gestational age from humerus length and determine whether humerus length contributes significantly to the gestational age ("Sig." = 0.000 < 0.05) which indicates that statistically a significant correlation between gestational age and humerus length. Furthermore, we can use the values in the "B" column for humerus length to estimate the gestational age, then (gestational age is 1.943±0.516 weeks, while it increases 0.603±0.009 per (mm) in humerus length.

Table (4. 5) Measure of femur length to gestational age:

R	R Square
0.997	0.993

Table (4.6) provides the R and R^2 values. The R-value represents the simple correlation is (0.997) (the "R" Column), which indicates an extremely strong degree of positive correlation between gestational age and fumer length. The R^2 value (the "R Square" column) indicates how much of the total variation in the gestational age, can be explained by fumer length. In this case, (99.3%) of variations in gestational age participated by femur length.

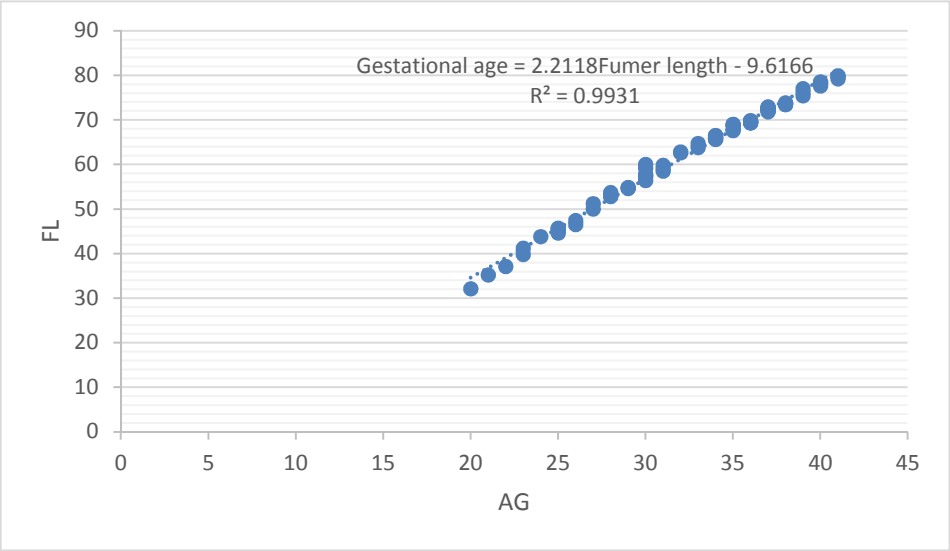

Figure (4. 4) the linear relationship between gestational age and femur length

Table (4. 6)regression mode of gestational age on fumer length:

	Unstandardized Coefficients		T	Sig.
	B	Std. Error		
(Constant)	2.2118	0.290	15.651	0.000
Femur length	0.449	0.005	98.599	0.000

The Coefficients in table (4.7) provide us with the necessary information to predict gestational age from femur length and determine whether femur length contributes significantly to the gestational age ("Sig." = 0.000 < 0.05) which indicates that statistically a significant correlation between gestational age and femur length. Furthermore, we can use the values in the "B" column for femur length to estimate the gestational age, then (gestational age is 4.544±0.290 weeks, while it increases 0.449±0.005 per (mm) in femur length.

Table(4.7) Mean gestational age with respect to method of measurement:

	Mean	**N**	**Std. Deviation**
Gestational age by humerus length	32.26	70	6.180
Gestational age by femur length	32.66	70	5.474

Table (4.8) provides useful descriptive statistics for the two methods that we compared, including the mean and standard deviation.

Table (4. 8) t-test for equality of mean gestational age by humerus length and femur length:

	Paired Differences					
	Mean	Std. Deviation	Std. Error Mean	t	Df	Sig. (2-tailed)
Gestational age by humerus length - Gestational age by fumer length	-0.400	2.556	0.306	-1.309	69	0.195

T-test results will tell us if the mean gestational age by two methods were statistically different (significantly different) or they were relatively the same.

We can see that the gestational age by humerus length and gestational age by femur length are statistically, non-significantly different because the value of P-values in "Sig. (2-tailed = 0.195) is more than 0.05. Looking at the Distributions of two methods table (4.8) above, we can conclude statistically that there is no significant difference between gestational age by humerus length and gestational age by femur length.

Table(4.9) Meangestational age with respect to method of measurement:

	Mean	N	Std. Deviation
Gestational age by humerus length	32.26	70	6.180
Gestational age by femur length	32.66	70	5.474
Gestational age by last menstrual period	30.63	70	4.243

Table (4.10) provides useful descriptive statistics for the methods that we compared, including the mean and standard deviation.

Table (4. 10)t-test for equality of mean gestational age by humerus length and last menstrual period, and gestational age by femur length and last menstrual period:

	Paired Differences					
	Mean	Std. Deviation	Std. Error Mean	t	Df	Sig. (2-tailed)
Gestational age by humerus length - Gestational age by last menstrual period	1.629	3.431	0.410	3.971	69	0.000
Gestational age by femur length - Gestational age by last menstrual period	2.029	2.187	0.261	7.761	69	0.000

T-test results will tell us if the mean gestational age by every two methods were statistically different (significantly different) or they were relatively the same. We can see that both the gestational age by humerus length and gestational age by femur length are statistically, significantly different from gestational age by last menstrual period because all the values of P-values in "Sig. (2-tailed = 0.000) is less than 0.05. Looking at the Distributions of two methods table (4.10) above, we can conclude statistically that there is significant difference between gestational age by humerus length and gestational age by last menstrual period as well as gestational age by femur length and gestational age by last menstrual period.

5.1 Discussion

Although the data is implemented in the research was collected in relatively Short period of time about two month ultrasound proved as non-invasive and accurate tool to estimate the gestational age.

This study done on 70 pregnant Sudanese healthy women surely about last Menstrualperiod (LMP) and have regular menstrual cycle and normal fetus to Describes accuracy of ultrasound in estimation of gestational age by femur And humerus length which is the main objective of the study.

All cases in these studies had amenorrhea and abdominal enlargement to different degree.

There were (38.6%) of participants were 26-30 years old, since (35.7%) of them were 21-25 years and (17.1%) of them 31-35 years, while (5.7%) of them were 36-40, whereas only (1.4%) were less than 20 or more than 40 years old.So that fertility ratedecrease with increase the age ,table and figure(4.1)

(45.7%) of participants were null-para, while (54.3%) of them were multi-para , table and figure (4.2).

Describe the gestationage by femur length and humer length and the last menstrual period, a total of (70) maternal were selected, whom present (20-50) weeks with mean(32.26±6.18) weeks of gestational age by humerus length, (20-40) weeks with mean(32.66±5.47) weeks of gestational age by femur length and (22-38) weeks with mean(30.63±4.24) weeks of gestational age by last menstrual period. Figure and Table (4.3)

Demonstrates measure of humerus length to gestation age provides the R and R2 values. The R-value represents the simple correlation is (0.993) (the "R" Column), which indicates a very strong degree of positive correlation between gestational age and humerus length. The R2 value (the "R Square" column) indicates how much of the total variation in the gestational age, can be explained by humerus length. In this case, (98.5%) of variations in gestational age participated by humerus length. Table (4.4) and figure(4.3)

The Coefficients demonstrated regression mode of gestational age of humerus length coefficientsin , provide us with the necessary information to predict gestational age from humerus length and determine whether humerus length contributes significantly to the gestational age ("Sig." = 0.000 < 0.05) which indicates that statistically a significant correlation between gestational age and humerus length. Furthermore, we can use the values in the "B" column for

humerus length to estimate the gestational age, then (gestational age is 1.943±0.516 weeks, while it increases 0.603±0.009 per (mm) in humerus length. table (4.5)

Measure of femur length to gestational age provides the R and R2 values. The R-value represents the simple correlation is (0.997) (the "R" Column), which indicates an extremely strong degree of positive correlation between gestational age and femur length. The R2 value (the "R Square" column) indicates how much of the total variation in the gestational age, can be explained by femur length. In this case, (99.3%) of variations in gestational age participated by femur length. Table (4.6) and figure (4.4)

The Coefficients demonstrate regression mode of gestational age provide us with the necessary information to predict gestational age from femur length and determine whether femur length contributes significantly to the gestational age ("Sig." = 0.000 < 0.05) which indicates that statistically a significant correlation between gestational age and femur length. Furthermore, we can use the values in the "B" column for femur length to estimate the gestational age, then (gestational age is 4.544±0.290 weeks, while it increases 0.449±0.005 per (mm) in femur length. table (4.7)

useful descriptive statistics for the two methods that we compared, including the mean and standard deviation. Table (4.8)

t-test for equality mean gestational age by humerus length and femur length T-test results will tell us if the mean gestational age by two methods were statistically different (significantly different) or they were relatively the same. We can see that both the gestational age by humerus length and gestational age by femur length are statistically, non-significant different because the value of P-values in "Sig. (2-tailed = 0.195) is more than 0.05. Looking at the distributions of two methods. table (4.8), above author can conclude statistically that there was no significant difference between gestational age by humerus length and gestational age by femur length, table (4.9).

Mean gestational age with respect to methods of measurement provides useful adescriptive statics for the two methods that we compared, including the mean and standard deviation. Table (4.10)

T-test for equality of mean gestational age by humerus length and last menstrual period and gestation age by femur length and last menstrual period, T-test results will tell us if the mean gestational age by two methods were statistically different (significantly deferent) or they were relatively the same. We can see that the gestational age by humerus length and gestational age by

femur length are statistically, significantly different because the value of P-values in "Sig. (2-tailed = 0.000) is less than 0.05. Looking at the Distributions of two methods table (4.10) above, we can conclude statistically that there is significant difference between gestational ages by humerus length and gestation age by last menstrual period as well as gestational age by femur length and gestation age by last menstrual period.(4.11)

FL as constant predicator with under standardized coefficient = 0.449 and 4.5444 from which regression equation for gestational age by FL

Constant + factor (FL) and STD Error= 290

Gestational age by FL= 2.2118 FL-9.6166

Also seen HL as constant predicator with under standardized coefficient -1.9432 and 0.603 from which the regression equation for gestational age by: HL= Constant + faction (HL), and error 0.516.

Gestational age by HL = 1.6338 HL length (mm) -4.0141

In previous study in one case of 16 bens measured was there a deviation of 3 mm and in six other cases there was a deviation of (2mm) between the sonographic and red measurements. The other nine cases devisied by ± 1mm, after obtaining similar long bones between the 17th and 41st complete results in 50 cases with deviation +1 mm the deviation for the minimum and maximum values are mostly within (2-4 mm) and only in four cases was this deviation 5mm and one 6mm thus, our result that can be considered as within normal limits.

The authors compared the manual foot length measurement with femur and humerus length measurement of fetuses for calculation of feta age, the correlation between femurs length and foot length us well as humerus length and foot length were statistically significant.

Finally this study and previous study have positive finding to confirm the main objective of the study by demonstrate strong correlation between FL and HL and have no significant difference and also found the FL and HL more accurate parameter use in third trimester than second trimesters that lead me to sag that the ultrasound instrumentation has more accurate in estimation of gestational age by using FL and HL in trimester tend second trimester normal fetus.

My finding agree with the previous study who measured the HL and FL in order to confirm the role of fetal HL as biometric parameter which could be used to determine the GA, concluded that

both FL and HL were similar and reliable to estimate the GA. There was strong positive correlation between HL and GA. The HL is a basic fetal bone biometry in determination of the GA and could be used in accompanied with FL to detect fetal bone abnormalities.

Finally this study have positive finding to confirm the main objective of the study by demonstrate strong correlation between FL and HL, HL and GA (LMP) that lead me to say that the US has more accurate in estimation of GA by using HL and FL in late second and third trimesters.

5.2 Conclusion

Ultrasound was accurate diagnostic technique in evaluation of gestational Age and non –invasive and reliable.

Using multiple parameters in estimation of gestational age will increase accuracy to estimate the gestational age.

About 98.5% of gestational age participated by humers, 99.3% of variations in the gestational age by femurs length.

The HL is a basic of fetal biometry in determination of the GA and could be used in combines with FL to detect fetal bone abnormalities.

The ultrasound was accuracy method to evaluate the gestational age by the humers length.

Study found two formulae for calculation gestation age

by Femoral Length as = 2.2118 FL-9.6166

and by humerus length as 1.6338 HL length (mm) -4.0141

5.3 Recommendations:

With reference to the result and conclusion, this research recommends the following:

Ultrasound should be the first tool to match the uterine fundal level with GA.

Estimation of GA should be estimated as a routine in practice by using FL &HL (mm).

Femoral length (FL) measurement is an essential and accurate method in prediction of gestational age(GA), recommended to be used in prediction at late second and third trimester with HL.

Further studies should be done used HL with more than one parameter to estimate the GA.

Further studies should be done using both cross-sectional and longitudinal study employing large sample to search relationship between HL and GA.

The medical staff should be trained for estimation of gestation age using humerus length in hospitals.

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