Thesis Title

"ULTRASONOGRAPHIC EVALUATION OF FETAL BIOMETRIC PARAMETERS IN SINGLETON PREGNANCIES: A HOSPITAL BASED STUDY"

An Errata submitted to

KLE Academy of Higher Education and Research, Belagavi

Accredited **'A' Grade** by NAAC (2nd Cycle) Placed in 'A' Category by MHRD (GoI)
[Deemed-to-be-University u/s 3 of the UGC Act, 1956 vide Government of India Notification No.F.9-19/2000-U.3(A)]

Under the guidance of

DR. V. S. SHIROL ***M. S.***

Professor & Former Head, Dept. of Anatomy, J. N. Medical College, KAHER, Belagavi.

In the Faculty of

MEDICINE (Anatomy)

BY

Dr. PRANITA R. VIVEKI ***M.Sc.***

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Errata Submission of the Thesis

Observation 1: As ultrasound is also main component in this work, I would have preferred little more about history, types of machine and its usefulness.

Clarifications / corrected as:

History, Types and Usefulness of Ultrasound:

The history of Ultrasound in Obstetrics and Gynaecology dates from the classic 1958 Lancet paper of Ian Donald, John McVicar, and Tom Brown from Glasgow "The investigation of abdominal masses by pulsed ultrasound."[1] This short history is a personal evaluation of the subsequent timeline of key events and breakthroughs up to the present time.

In 1953 Inge Edler and Carl Hertz in Lund University adapted a metal flaw detector to obtain M-mode recordings from the adult heart. Wild together with his engineer John Read published the first 2D images in 1952. The accolade for producing the first tomographic images of human anatomy must go to Douglass Howry in Denver who published his landmark paper in the same year.[2]

Many great scientists have contributed in the development of medical ultrasound in 19th and 20th Century whose conceptual advances paved the way for the modern ultrasound machine. Thomas Young in 1801 described "phase shifting" in relation to light waves but this concept is used in ultrasound phased array systems to control interference patterns and is used in the production of 3D images. Christian Doppler in 1842 described what we now call the "Doppler effect" is used as the basis for blood flow studies in pelvic vessels and the fetus. Pierre Curie in 1880 described the piezo electric effect whereby mechanical distortion of ceramic crystals would produce an electric charge; the reverse of this effect is used in all transducers to generate ultrasonic waves.[3]

Antenatal Sonography:

The initial studies in fetal biometry began with using a blind A- scan measurement of the biparietal diameter and James Willocks from Donald's department published an interesting paper on head growth in the third trimester showing different rates of growth between growth restricted and normally growing fetuses.[3]

The method was intrinsically inaccurate and precision was needed for meaningful biometry. This was provided by one of Donald's registrars, Stuart Campbell who described the B mode technique in 1968 where the midline echo of the fetal head was visualised in 2D and then an A-scan measurement was made between the parietal eminences at the widest point. It was not until on-screen.[3]

Calipers were introduced several years later that A-scan was no longer required. Campbell demonstrated that the midline echo could be seen reliably from 13 weeks gestation and soon showed that second trimester cephalometry was an effective method of dating pregnancy in women with uncertain dates introducing the concept of an ultrasound expected

date of confinement.[4]

Horace Thompson and Ed Makowsky from Denver in 1971 introduced measurement of the thoracic circumference and combination of this measurement and biparietal diameter.[5] Manfred Hansmann in Bonn confirmed these results and demonstrated an asymmetry between the bi-parietal diameter measurement and the thoracic circumference in intrauterine growth restricted fetuses. In 1975 Stewart Campbell introduced the abdominal circumference measurement at the level of the intra abdominal umbilical vein as a more reliable measurement and this has become a standard measurement since then.[6] The value of routine screening of the obstetric population for accurate dating, early detection of twin gestations and placental location was first demonstrated by Lars Grennert and Per Persson.[7]

The Real Time Revolution and Equipment development:[3]

Mechanical sector real time scanners were introduced by several companies such as Aloka and Kretztechnic in the early to mid 70's which were quickly superseded by the multi-element linear array and phased array scanners in the mid to late 1970's. Due to the huge advances in integrated circuit technology occurring at this time, the machines were small and moveable and as they were less expensive, a department would have several instead of the single large static scanner. Movements of the fetus could now be followed and the probe angle instantly adjusted to identify the plane of interest.

The first commercial linear array real time scanner initially it had only 64 lines so the resolution was poor but the second version in 1975 had over 500 lines and phased focusing and could compete with static scanners in terms of resolution. The development of the Acuson 128 by Sam Maslak in 1983 with its advanced beam forming software (called "computed sonography") set new standards in both spatial and contrast resolution.

In 1985 Kretztechnic produced the first practical endovaginal mechanical sector transducer which was designed to improve the technique of oocyte collection. These transducers provided excellent images but probe vibrations were a disadvantage and by the end of the 1990's most manufacturers had developed small multi-element probes which provided excellent resolution.

3D/4D Ultrasound:[3]

Early workers in the field and strong advocates of 3D ultrasound are Dolores Pretorius from Los Angeles, Kazunori Baba from Japan and Eberhard Merz from Germany.

Much of the credit for promoting the new technology goes to Bernard Benoit a French doctor working in Nice who published stunning 3D images of the fetus especially in the first trimester. It could thus be said that (apart from a few refinements) the modern real time scanning machine with high resolution abdominal and endovaginal transducers, harmonic

imaging, colour and power Doppler facilities with a 3D/4D option was on the market by the year 2000.

3D ultrasound is superior in demonstrating superficial fetal defects such as facial clefts and studies from several groups have shown that the technique has a high sensitivity for diagnosing defects of the secondary palate which are rarely detected by 2D ultrasound.[8]

Real Time 3D ultrasound imaging (i.e. 4D) is most useful in showing fetal movements and there is evidence that this has real benefit in improving maternal-fetal bonding. 3D/4D ultrasound is very much "work in progress" and further technical developments such as the matrix probe will undoubtedly pave the way for further advances in obstetrical and gynaecological imaging in the future.[3]

Different modes of ultrasound used in medical imaging[9]

There are following four modes of ultrasound used in medical imaging:

1. **A-mode:** A-mode is the simplest type of ultrasound. A single transducer scans a line through the body with the echoes plotted on screen as a function of depth. Therapeutic ultrasound aimed at a specific tumor or calculus is also A-mode, to allow for pinpoint accurate focus of the destructive wave energy.
2. **B-mode:** In B-mode ultrasound, a linear array of transducers simultaneously scans a plane through the body that can be viewed as a two-dimensional image on screen.
3. **M-mode:** M stands for motion. In m-mode a rapid sequence of B-mode scans whose images follow each other in sequence on screen enables doctors to see and measure range of motion, as the organ boundaries that produce reflections move relative to the probe.
4. **Doppler mode:** By 1985, Aloka had incorporated colour Doppler imaging (originally called colour flow mapping) into their real time equipment and this was quickly followed by other major manufacturers. By 1990 colour was available on the

transvaginal probe for gynaecological investigation. By the end of the 1990's harmonic imaging was introduced which even further improved image resolution.

The advent of colour Doppler as an integral part of the ultrasound machine made visualisation of fetal vessels much easier and studies of virtually every fetal artery (such as the renal, splanchnic, cerebral) was investigated. Doppler was reported as early as the mid 1960's from Osaka, Japan and in 1977 by D.E. Fitzgerald and John Drumm from Dublin using 2D static scans to identify where the probe should be placed but neither of these two groups followed up their observations.

Usefulness of Ultrasound:[3,9]

Technological developments such as solid state circuitry, real time imaging, colour and power Doppler, transvaginal sonography and 3/4D imaging have been seized by clinical researchers to enhance the investigation and management of patients in diverse areas such as assessment of fetal growth and wellbeing, screening for fetal anomalies, detection of ectopic gestation, prediction of pre-eclampsia and preterm birth, evaluation of pelvic masses, screening for ovarian cancer and fertility management. Ultrasound guided procedures are now essential components of fetal therapy and in-vitro fertilization treatment.

References:

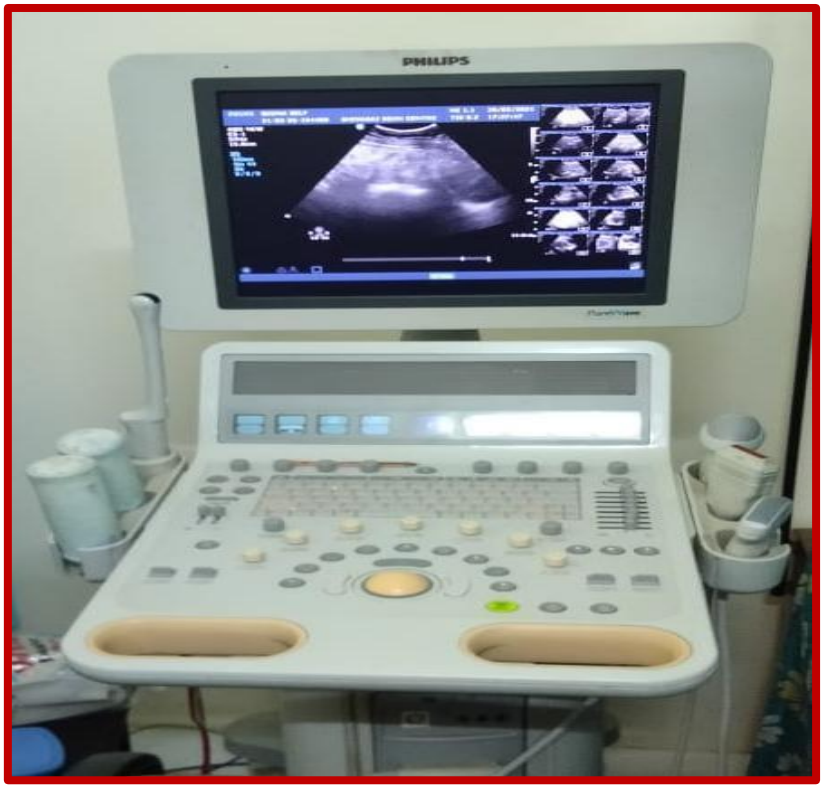
1. Donald I, MacVicar J, Brown TG. Investigation of abdominal masses by pulsed ultrasound. Lancet. 1958;1:1188-1195.
2. Howry DH. The ultrasonic visualization of soft tissue structures and disease processes. J Lab Clin Med. 1952;40:812-813.
3. Campbell S. A short history of sonography in Obstetrics and Gynaecology. Facts Views Vis Obgyn. 2013;5(3):213-229.
4. Campbell S. Prediction of fetal maturity by ultrasonic measurement of the biparietal diameter. J Obstet Gynaec Br Commonw. 1969;76:603-619.

5. Thompson, Makowski. Estimation of birthweight and gestational age. Obstet Gynecol. 1971;37:44-47.
6. Campbell S, Wilkin D. Ultrasonic measurement of the fetal abdomen circumference in the estimation of fetal weight. Br J Obstet Gynaecol. 1975;82:687-689.
7. Grennert L, Persson P, Gennser G. Benefits of ultrasound screening of a pregnant population. Acta Obstet Gynecol Scand Suppl. 1978;78:5-14.
8. Campbell S. Prenatal ultrasound examination of the secondary palate. Ultrasound Obstet Gynecol. 2007;29:124-127.
9. Aladin C, Fahrudin S, Dzelaudin J. Application of Ultrasound in Medicine. Acta Informatica Medica 2011;19(3):168-171.

Corrected thesis copy page number: 7

Observation 2. In methodology (material and method) I would like to see the photo of the USG machine used for doing sonography and if possible, Doctor doing examination of antenatal case done at your centre.

Clarifications/Corrected as:



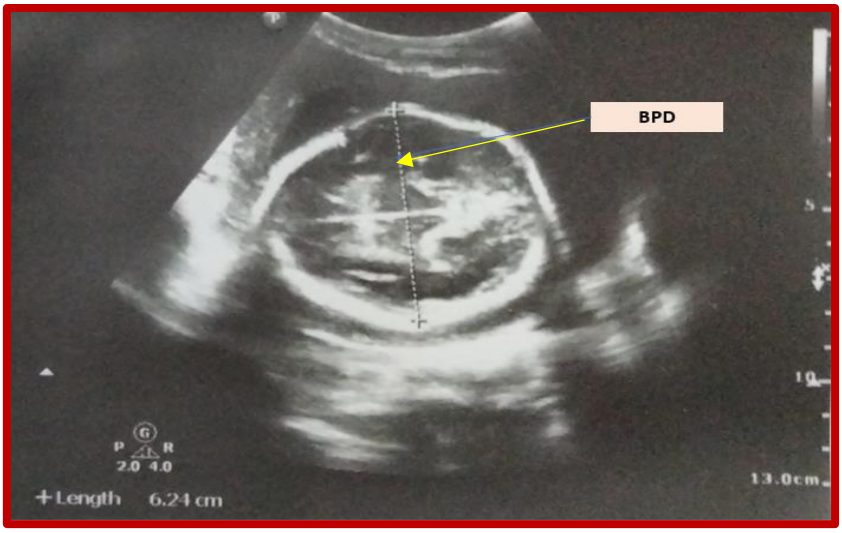
Photograph-1 Showing USG machine used for ANC scanning

Photograph-2 showing radiologist doing examination of ANC case at the centre

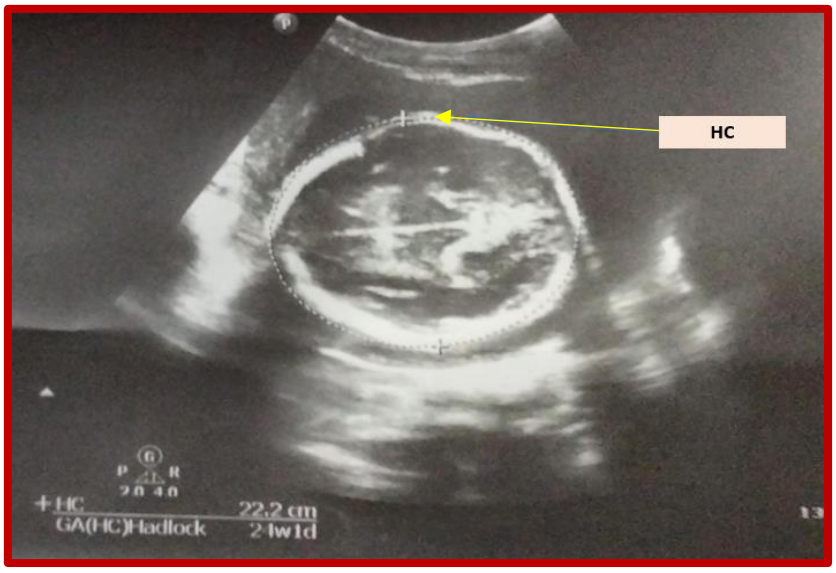
<u>Corrected thesis copy page number</u>: 27

Observation 3. Photos which are present in the material and method would have been more authentic if it was arrowed to show BPD, HC and AC.

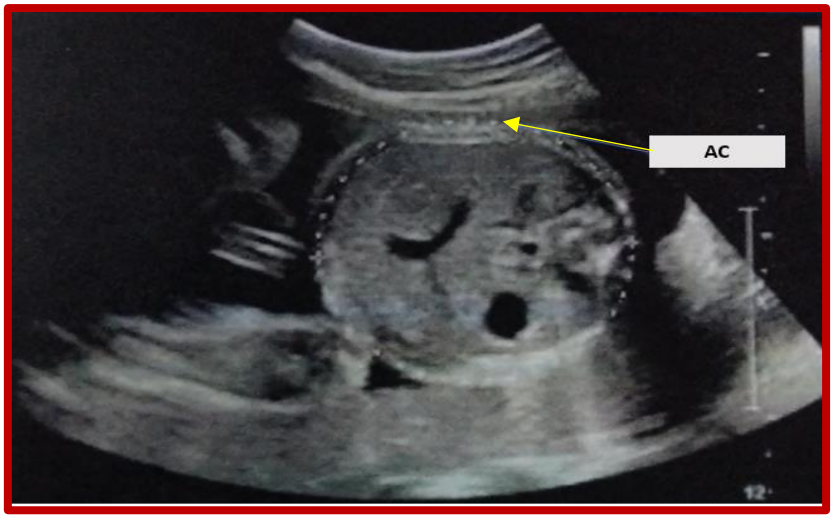
<u>Clarifications/Corrected as:</u>



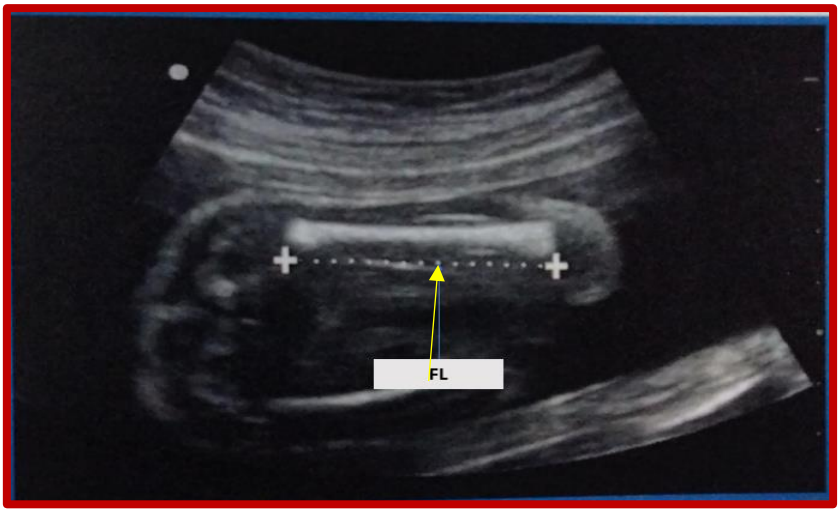
Ultrasound Image 1- showing BPD measurement



Ultrasound Image 2- showing HC measurement



Ultrasound Image 3- showing AC measurement

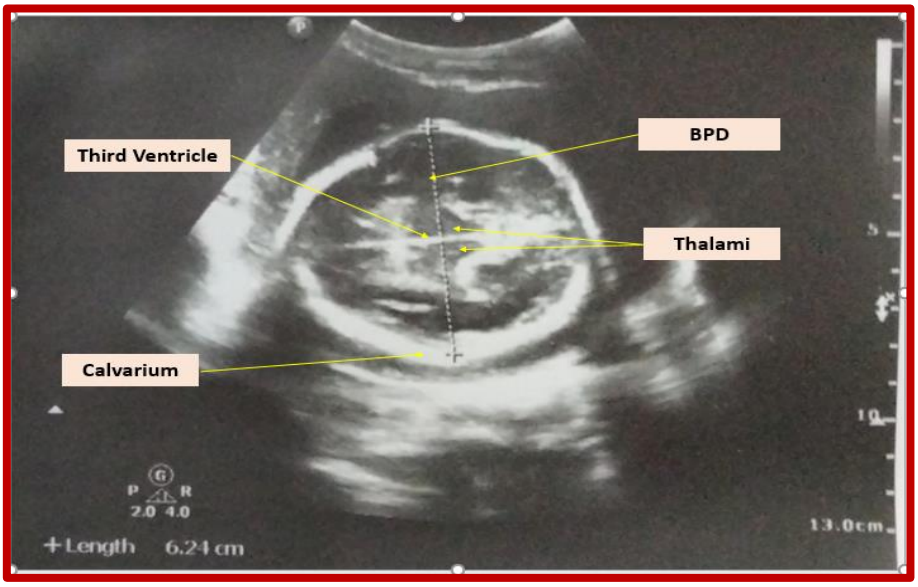


Ultrasound Image 4- showing FL measurement

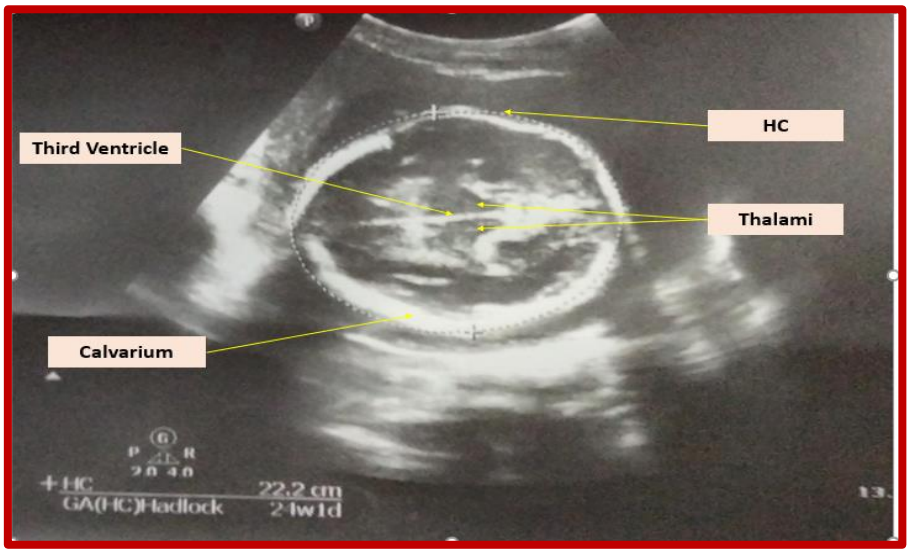
Corrected thesis copy page number: 33, 34, 35

Observation 4. Arrow to show third ventricle and thalami in cases for BPD and HC and left and right portal veins were continuous in AC.

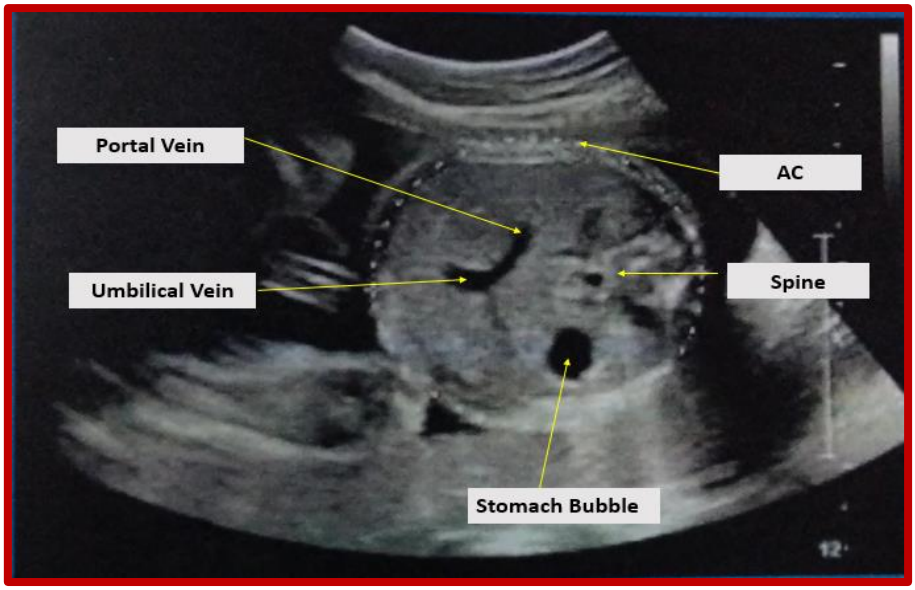
Clarifications/Corrected as:



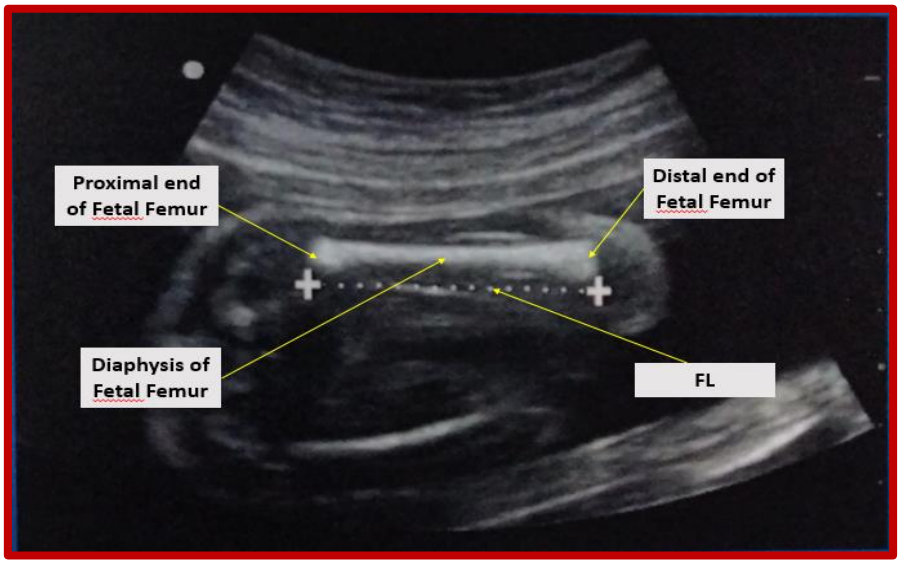
Ultrasound Image 1- showing BPD measurement with labelling of different parts



Ultrasound Image 2- showing HC measurement with labelling of different parts



Ultrasound Image 3- showing AC measurement with labelling of different parts



Ultrasound Image 4- showing FL measurement with labelling of different parts

Corrected thesis copy page number: 33, 34 and 35

Observation 5. Results presentation is very well statically explained. Bar graph, Histogram

and scatter graph well explained. In table no. 26 (pg no 79) no comments are written and also table no 28 (pg no 82) it's not clear.

Clarifications/Corrected as:

Table 26 - The SPSS has shown the sensitivity and specificity at each value of various fetal parameters. Table 26 reveals the sensitivity and specificity at main four points of EFW at 29 weeks of gestation, which is observed to be 78.6% and 78.4% respectively. At 1272.1 gm or less EFW, the sensitivity and specificity were 64.3% and 82.4% respectively. However, at 1333.3 gm or less EFW, the sensitivity and specificity were 92.9% and 64.7% respectively.

Table 28 - Table 28 indicates sensitivity and specificity at different points of probability distribution of BPD, HC, AC, FL, EFW and fundal height. The sensitivity and specificity for BPD was found to be 76.7% and 44.9% respectively and it was 76.7% and 42.8% respectively for HC measurements. The sensitivity and specificity was observed to be 46.7% and 83.3% respectively for AC, FL and EFW values. However, the sensitivity and specificity for fundal height was 76.7% and 42.8% respectively.

Corrected thesis copy page number: 80, 82

Observation 6. Table no 4 (pg no 40) and table no 6 (pg no 42) how it is going to help in five parameters estimation.

Clarifications/Corrected as:

The details of parameters in Table 4 and Table 6 were included in the study just to understand the general information of study subjects. They were not studied to estimate the fetal parameters as it was not the study objective.

Corrected thesis copy page number: Not applicable

Observation 7. Education status and general information has not correlated with five parameters.

Clarifications/Corrected as:

The education status and general information of study subjects were not correlated with five parameters of fetus as it was not our study objective.

Corrected thesis copy page number: Not applicable

Observation 8. In discussion part education status and general information not discussed.

Clarifications/Corrected as:

The mean age of study subjects was found to be 24.02 ± 3.53 years ranging from 18 to 35 years. Majority (56.08%) of them were from 20 to 24 years of age group with mean height of 149.57 ± 3.86 cm ranging from 141 to 164 cm. An average weight of study cases was 54.17 ± 6.10 kg ranging from 37.5 kg to 68.5 kg. The education status of the study cases revealed that more than half of them (51.29%) had education up to secondary school level and 5.80 % of them were illiterates. The average education status was found to be only up to high school level. Majority of the study subjects (84.90%) were having less than two parity.

Around two third of the study subjects (63.54%) were from rural areas and 94.29% of them were housewives. The information regarding poverty line found that more than half of the subjects (61.88%) were from below poverty line. Majority (77.26%) of the subjects delivered in government health institutions like primary health centres, community health centres,

taluka or district hospitals. The information regarding mode of delivery of study subjects revealed that majority (88.77%) of them delivered normally and 52.58% of the participants delivered male babies.

Corrected thesis copy page number: 83

Dr. Pranita R. Viveki	**Dr. V. S. Shirol**
Name and Signature of Research Scholar	**Name and Signature of Guide**