

USEFUL ULTRASONIC PARAMETERS PERTAINING TO INTRA UTERINE FETAL WELL BEING AND GROWTH RETARDATION

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ABSTRACT

The true gestational age of the fetus is of great importance especially when there is an apparent discrepancy between the size of the fetus and the period of amenorrhoea.

Various Ultrasonic measurements of the fetus have been used at different gestational periods to help arrive at the true gestation and to confirm or exclude intra uterine growth retardation. Recently, dynamic studies on the fetal blood flow through the umbilical artery and also the uterine vessels have provided an additional measurement of the internal milieu. These tests have been found to be extremely useful and of prognostic value even before changes occur in the CTG patterns.

Keywords: Growth Retardation, Doppler Scan for umbilical flow

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INTRODUCTION

In Obstetrics, the importance of an accurate determination of the true gestational age of the fetus cannot be over-emphasised. However, it is seldom that one has an accurate Basal Body Temperature chart showing the exact time of ovulation for the pregnancy or a hormonal profile with the LH surge for the month concerned. Pregnancies resulting from Ovulation induction procedures eg. GIFT and IVF and other methods of assisted conception will not suffer from the problem of "uncertain dates".

Ultrasound allows accurate measurements to be made on various parameters of the fetus and its gestational sac, allowing an estimate of the true gestation - the word 'estimate' is used because there is always a range of normality to be taken into account and a particular fetus may be normal, small or large for gestational age due to its particular inherent growth potential.

As the range gets wider with increasing gestational age, it is obvious that the estimated age would be less accurate with increasing size of the fetus, and in fact, any single measurement in the late third trimester would per se be of very limited application. Thus the concept of using the fetus as its own control, the use of multiple parameters and the use of ratios of one measurement to

another, allow asymmetric growth retarded fetuses to be identified.

The value of Ultrasound in cases of Intra uterine Growth Retardation has been recognised from over a decade ago (Wittman & Robinson 1979)(1).

The following are some of the parameters that are currently in use:

CROWN RUMP LENGTH

In 1973 Robinson(2) proposed the measurement of the Crown-Rump Length of the fetus as a means of assessing the fetal age. This measurement is of value from 6 to 14 weeks after which the degree of flexion of the body significantly affects the measurement and thus the biparietal diameter becomes the preferred measurement.

This technique has the advantage of being quickly obtainable and the reproducibility of measurement is high.

Correlation with true gestation is high because of the following factors:

(1) The CRL increases rapidly from 10 mm (mean) at 7 weeks to 83 mm (mean) at 14 weeks making minor errors in measurement less significant.

(2) The biological variation at this stage of pregnancy is small.

(3) The dimension is relatively easy to obtain especially with real-time equipment.

The major factors leading to errors in measurement of the CRL are:

(1) Underestimating the CRL due to flexion of the fetal trunk.

(2) Overestimation by wrongly including the yolk sac in the measurement.

(3) Errors due to beam width or poor lateral resolution

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of the equipment.

Robinson & Fleming (1975)(3) reported that in 95% of cases a single CRL measurement gave a good prediction of the Delivery date within ± 4.7 days. This was improved to 3 days if 3 different measurements were made. However, studies by others: Deter (1981)(4), Nelson (1981)(5) had less impressive results.

It is however conceded by most that a *properly performed ultrasonic measurement of the CRL in the first trimester is probably the most accurate method* for determining the gestational age.

BIPARIETAL DIAMETER

Ian Donald's original method using the A-Scan technique was replaced by combined A and B mode techniques. The leading edges on the A scan allowed very precise measurements to be made. Presently widespread use of real-time scanners with improved grey scale capability allow a significant amount of intracranial anatomy to be visualised and a more exact and reproducible level of the head is obtainable. Many real time scanners have dispensed with the A scan modality and this may be a source of error (vide infra.)

Errors in measurement may arise from:

- (1) Measurements at different levels of the fetal head.
- (2) Observer error especially using different gain settings (absence of A - scan modality).
- (3) Different caliper Velocity settings.
- (4) Different Populations - the significance of this appears to lessen as the socio-economic status of the population improves.
- (5) Fetal head shape: brachycephaly and dolichocephaly. In dolichocephaly the reading can be 'corrected' by applying a formula (Samuels 1988)(6).

The Biparietal diameter is relatively accurate and is easily performed from 11 weeks till delivery. However the accuracy of prediction decreases as gestational age increases from ± 1 to 1.5 weeks (first trimester) to ± 3 to 4 weeks in the late third trimester. Therefore in many instances serial readings are necessary to assess growth and exclude intra uterine growth retardation. (In a significant percentage of cases of growth retardation the biparietal growth may remain within the 'normal range' until very late.)

ABDOMINAL CIRCUMFERENCE

By convention the fetal abdominal circumference is measured using a section of the fetal abdomen that includes the horizontal portion of the portal sinus. An oblique section would show a long length of the sinus and should be avoided - it gives rise to the so called 'Salami effect'. If the fetus is prone it is more difficult to get the proper section. In such cases a satisfactory section is obtained at the level of the stomach cephalad to the kidneys.

LIMB LENGTHS

The femur with its limited mobility, distinctive shape and position is easy to recognise and measure. In fact it is more often possible to measure it than the Biparietal diameter. Owing to fetal movements the end points are sometimes not well defined and it is best to take the average of several measurements.

It is important not to include the distal femoral

epiphysis (if visible) in the measurement.

The femur growth is linear at about 2 to 3 mm per week. In intra uterine growth retardation it appears that limb length is less severely affected than trunk circumference or body weight.

In dwarfism most of the short limb syndromes can be detected before 20 weeks but heterozygous achondroplasia may not be detected at this stage (Filly 1981)(7).

OTHER PARAMETERS

Other parameters have been proposed e.g. Total Intra Uterine Volume by Gohari and Inter orbital distance by Jeanty. However the accuracy of positive prediction for intra uterine growth retardation is not very satisfactory.

RATIOS

The concept of using the fetus as its own control has given rise to the use of ratios:

(1) Head Circumference/Abdominal Circumference Ratio allows identification of asymmetrically growth retarded fetuses but may be less useful in symmetrically growth retarded fetuses where the true gestation is uncertain.

(2) Femur Length/Biparietal Diameter Ratio may be high in IUGR where the femur length is less affected than the BPD. In Down's syndrome there is often brachycephaly and the ratio may be low.

(3) Femur Length/Abdominal Circumference Ratios may also be found useful.

BODY WEIGHT ESTIMATIONS

Body weight is dependent on subcutaneous tissue, muscle mass, body length and bone density. Hence it is not surprising that there is no extremely accurate method of estimating the fetal weight in utero. Most methods use formulae which include the Biparietal diameter, Abdominal circumference (or area) and the femur length. The results are usually proportionate to the fetal weight. Using Shepard's equation for example, the accuracy is quoted to be within 106 gm/kg (10%). Fortunately, with intra uterine growth retardation, the accuracy with low birthweight fetuses is acceptable.

MULTIPLE PREGNANCIES

With twin pregnancies, there are further problems:

(1) Technical difficulty due to fetal head position. Milne was unable to obtain an accurate biparietal diameter in 26.3% of twins as opposed to 8% in singletons.

(2) Dolichocephaly is more common in multiple pregnancy.

(3) Prolonged scanning causes maternal Supine Hypotension.

(4) Discordant growth occurs in from 15-29% and may not be detected by the biparietal diameter alone. (Erkkola 1985)(9).

With triplets or higher order pregnancies, the technical problems in scanning are further compounded and additional scanning techniques eg. Doppler become increasingly useful to detect differences in blood flow (vide infra).

UMBILICAL BLOOD FLOW

Doppler Scanning techniques on fetal blood flow have been utilised since 1977 (Fitzgerald & Drumm)(10). At that time quantitative measurements of blood flow in the umbilical artery, vein and aorta were carried out. Early studies included uteroplacental flow (Campbell et al 1983)(11), fetal aortic flow (Eik-Nes et al 1980)(12) and blood flow in the intra abdominal portion of the umbilical vein (Gill and Kossoff 1979)(13).

In many of the early studies, quantitative blood flow was made, but these calculations were beset by inaccuracies as the exact angle of insonation plus the diameter of the vessel had to be accurately determined. Furthermore, the blood flow was assumed to be laminar, and the final results were expressed as a ratio over the estimated body weight of the fetus - again another source of inaccuracy.

More recently, the analysis of time-velocity waveforms using Pulsed Doppler were introduced (Campbell et al 1983)(11). The different methods of analysis were discussed by Erskine & Ritchie (1985)(14). The technique involves analysis of the waveform and does not require accurate determination of the baby's weight or of the calibre of the vessel.

It was found that a very rapid measurement of the fetal blood flow in the Umbilical Artery as described by Erskine & Ritchie (1985)(14) could be performed and that this has been tested for screening in suspected intra uterine growth retardation.

Problems were occasionally found when there was extreme oligohydramnios and a suitable loop of cord was not available. The method was found very useful and was excellent for differentiating the small for dates from the constitutionally small fetuses. In multiple pregnancies, it proved especially useful in helping to support the diagnosis of discordant growth. Fig 1 shows a normal trace and Fig. 2 shows an abnormal tracing.

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Fig 1
Normal Tracing of Umbilical Arterial Flow.

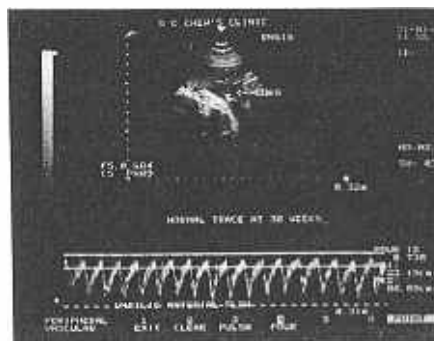
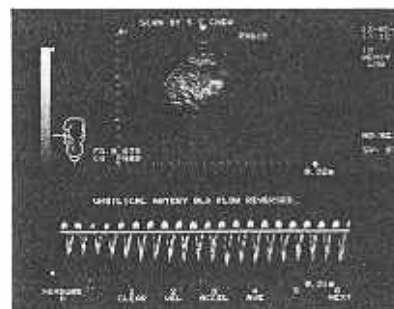


Fig 2
Blood flow shows negative diastolic component (reversal)



DISCUSSION

Growth retardation is insidious and not always apparent. When the time of conception or ovulation date is known accurately, the fetal parameters can be compared with normograms for the equivalent gestation. Otherwise, many parameters have to be measured (usually serially) and the recent use of Doppler blood flow will be found to be useful in the continued monitoring of the patient.