SONAR IN EARLY PREGNANCY

M. Hansmann

Prior to the existence of sonar techniques there was no method to proof the existence of a living fetus early in pregnancy. Hormon assays such as human chorionic gondotropin, human placental lactogen oestriol and pregnandiol could offer only indirect informations relating to the trophoblast and corpus luteum function. Concerning the fetus there was no possibility wether to control its condition nor age or its presence at all. Consequently the attitude towards the treatment of threatened abortion was "wait and see" or more often a blind attempt of therapy before exact diagnosis. Nowadays sonar is the method of choice to prove intrauterine development and live of a pregnancy by objective findings very early. Ultrasound examinations in pregnancy may start already at five weeks postmenstrual age (pm) with the display of the ring-like chorion. Measurements of its diameters and/or determination of of the "gestation sac volumes" as suggested by Robinson (1975) have proven to be most useful guides to the outcome of threatened abortion. In Robinson's observations (1975) live abortions are a very rare condition. His figures are showing only six cases before ten weeks gestation.All had normal or accelerated fetal heart rates, a not affected crown-rump length but diminuished gestational sac volumes. Robinsons growth curve based on 319 examinations on 125 patients shows that gestation sac volume (GSV) increases exponentially on an average of 1 ml at 6 to an average of 100 ml at 13 weeks. The scatter of results increases as exspectable "trumpet"-like with advancing age of the pregnancy. At 13 weeks the 2 SD limits indicate a minimum of 65 and a maximum of 145 ml. Because of this relatively wide scatter the use of the size of the gestational sac as a means of estimating maturity must be of lesser clinical value than direct measurements on the fetus. Nevertheless gestational age can be calculated from the arithmetic average of the diameters of the sac as well. There is an average SD of 1 week. But this is true only as long as the mean diameter does not exceed 40 mm - corresponding to 9 - 10 weeks pm. The main objection against the use of gestation sac diameters results from the observation, that the diameters can be changed by bladder pressure, the position of the uterus in the small pelvis and spontanously slow occuring contractions as well.-

0300-5577/81/0091-0004 $ 2.00

Sonar cephalometry is nowadays the method of choice for the assessment of fetal age during pregnancy. But until recently BPD measurements were not obtainable before 14 weeks. This limited the value of the method to a certain extent. On the one hand because of the always increasing range of normality in dependance of age, measurements should be taken as early as possible - on the other hand by the inaccessibility of the parameter before 14 weeks cephalometry was no help in cases of threatened abortions. On principle it is logical to expect that the biological range of fetal body dimensions is at its smallest during the early stages of development but the preexisting limitations in the resolution and signal processing capability of most of the sonar equipments did hardly permit to take accurate measurements of the embryo . Again it was Robinson (1973) of Ian Donalds group who realized first when the technical preconditions were suffcient to take in vivo measurements of the embryo already at seven weeks. But instead of the head "crown-rump-length" (CRL) became the parameter of choice. On statistical analysis it was foundthat the overall effect of all sources of error expressed by the average standard deviation of three "blind" readings was 1.2 mm and had a maximum standard deviation of 4.5 mm in a case when the fetus had a CRL of more than 70 mm. Concerning fetal age a standard deviation of 1.2 - 2 mm in length results in an error of only one or two days. In a study to evaluate the reproducability and accuracy of the sonar CRL technique Robinson ans Fleming (1975) derived the mean and 2 SD limits from 334 measurements . It was shown, that an estimate of maturity could be made within ±/- 4.7 days with a 95 % probability on the basis of a single measurement. But looking to the scattergram it becomes obvious, that there are only a few measurements after 12 weeks. Probably this was caused by measuring problems in Robinsons static scanning resulting from the increasing mobility of the fetus in advanced age. Nowadays time saving realtime imaging overcomes this problem (Hansmann and coworkers, 1979). Avoiding missreadings as far as possible from 370 measurements a normal growth curve of CRL was derived by means of a non linear regression analyses between 7 and 20 weeks (Fig. 1). For estimation of fetal age CRL was calculated to be independent - on the x-axis - and the time dependant - on the y-axis. The overall correlation coefficient was found to be 0.97. In regard to accuracy it is obvious, that early measurements provide the best results - f.e. if CRL is shorter than 40 mm in 95 % of the cases aberrations in the estimation of age will be less than ±/- 5 days (Fig. 2).

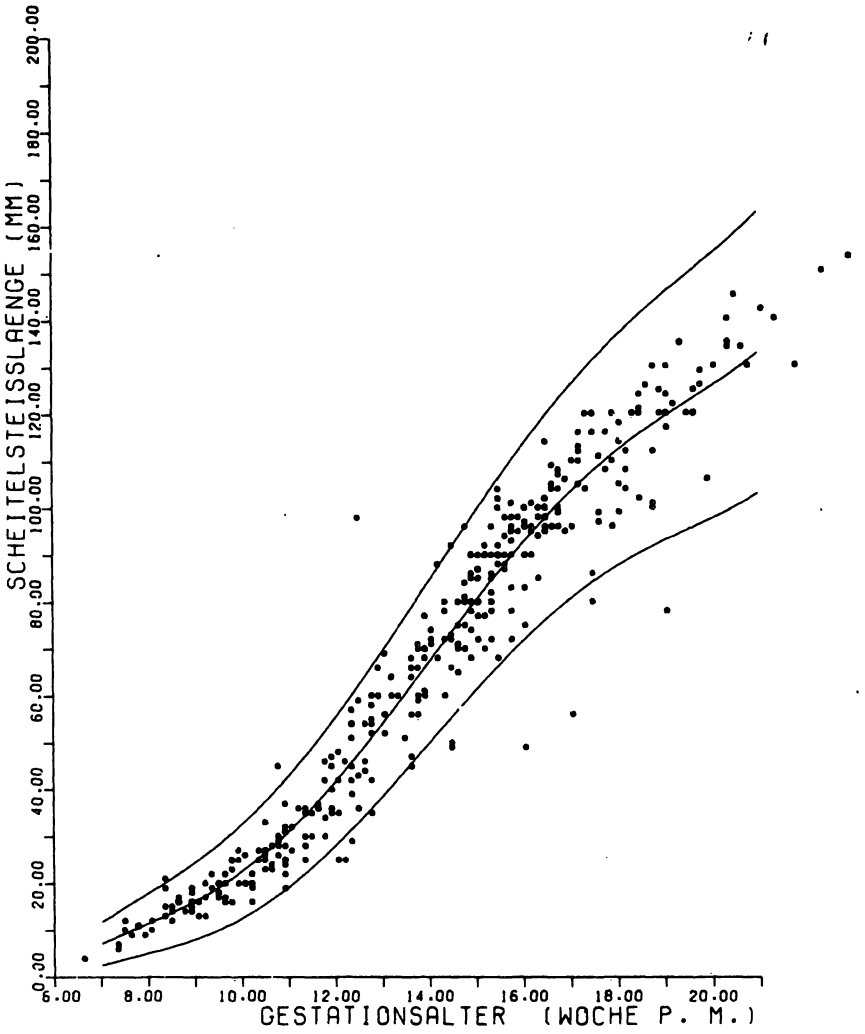

Fig. 1 Growth curve of fetal crown rump length.
Scatter of results (N = 370), Smoothed mean and 2 SD values.
(Hansmann et al., 1979)

The derivation of a velocity - curve resulted in a bell-shaped figure. It shows a rise from a minimum to a maximum rate of growth with daily ingrements of 1.74 mm at 14 weeks. Later there is a fall again (Fig. 3). This curve resembles very strongly to the data of His (1874) which show also a high peak velocity at 4 month in prenatal growth of the length (in: Thompson, 1942).

Concerning accurracy our results show despite the fact of a correlation coefficient of 0.97 a remarkable wider range of scatter than the data of Robinson and Fleming (1975) and that of Drumm et al. (1976). The possible error in the estimation of age increases from +/- 5 days

at a given length of 1o - 2o mm to +/- 11 - 14 days at a given length of 1oo to 13o mm on the base of a 95 % probability. To a certain extent this may be due to technical problems and a less sophisticated selection of the cases but overall the widening range of "normality" reflects one of the fundamentals in biology of growth. It is the increase of variability in dependance of age. In regard to the estimation of fetal age the conclusion may be drawn. "The earlierer measurements are taken the better will be the results". But in daily routine there is no chance to perform all sonar examinations in pregnant women early in time. Furthermore it has to be realized that early measurements of fetal head size may run into problems. These are very often caused by an unfavourable position of the head of the fetus at the age of 14 to 2o weeks. In many of these cases CRL measurements are obtainable without any problem. Therefore we recommend to use the obtainable parameters CRL and/or BPD alternatively at this age under the aspect of high standards in quality control. In other words: No acceptance of measurements as long as picture quality is poor or the reference plane is not adjustable. Concerning the use of real-time in fetal biometry on principle there are no longer serious objections to use it as long as the operator is aware of its discret limitations.

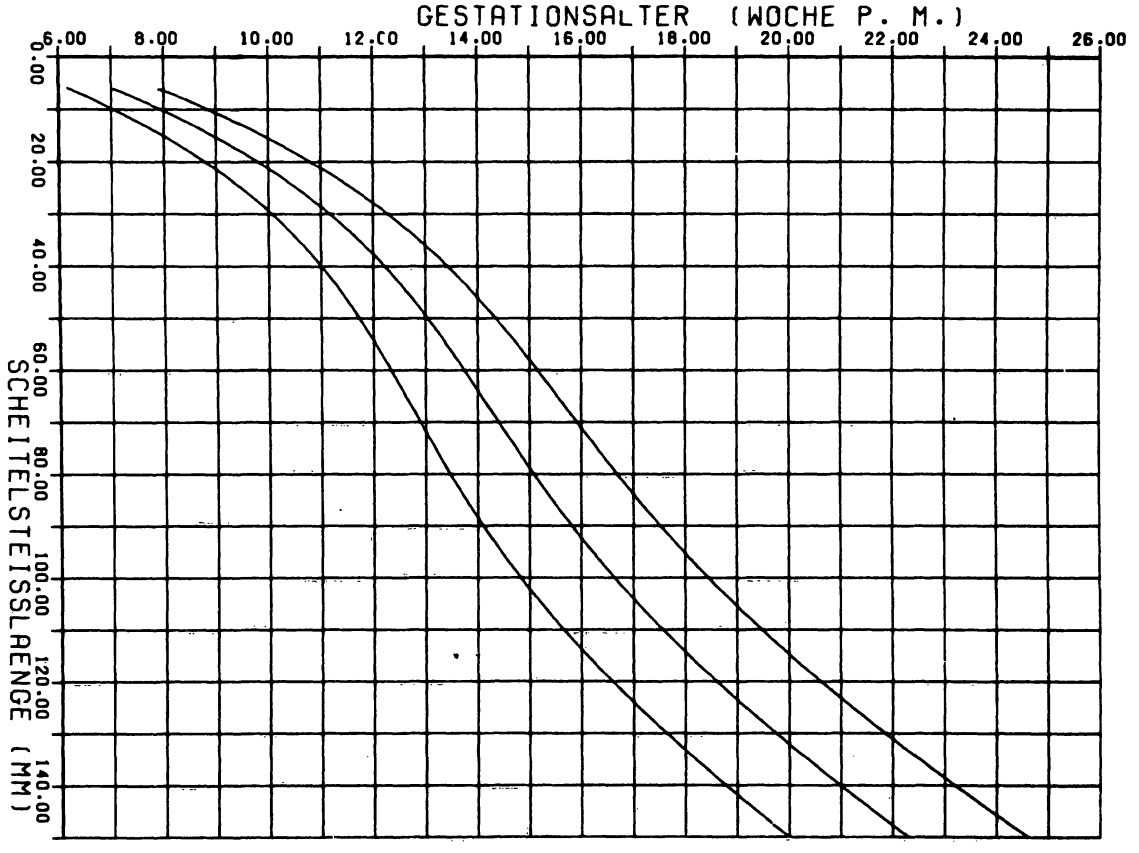

Fig. 2 Mean postmenstrual age (weeks) ± 2 SD related to the CRL "Curve of best fits")
(Hansmann and Coworkers, 1979)

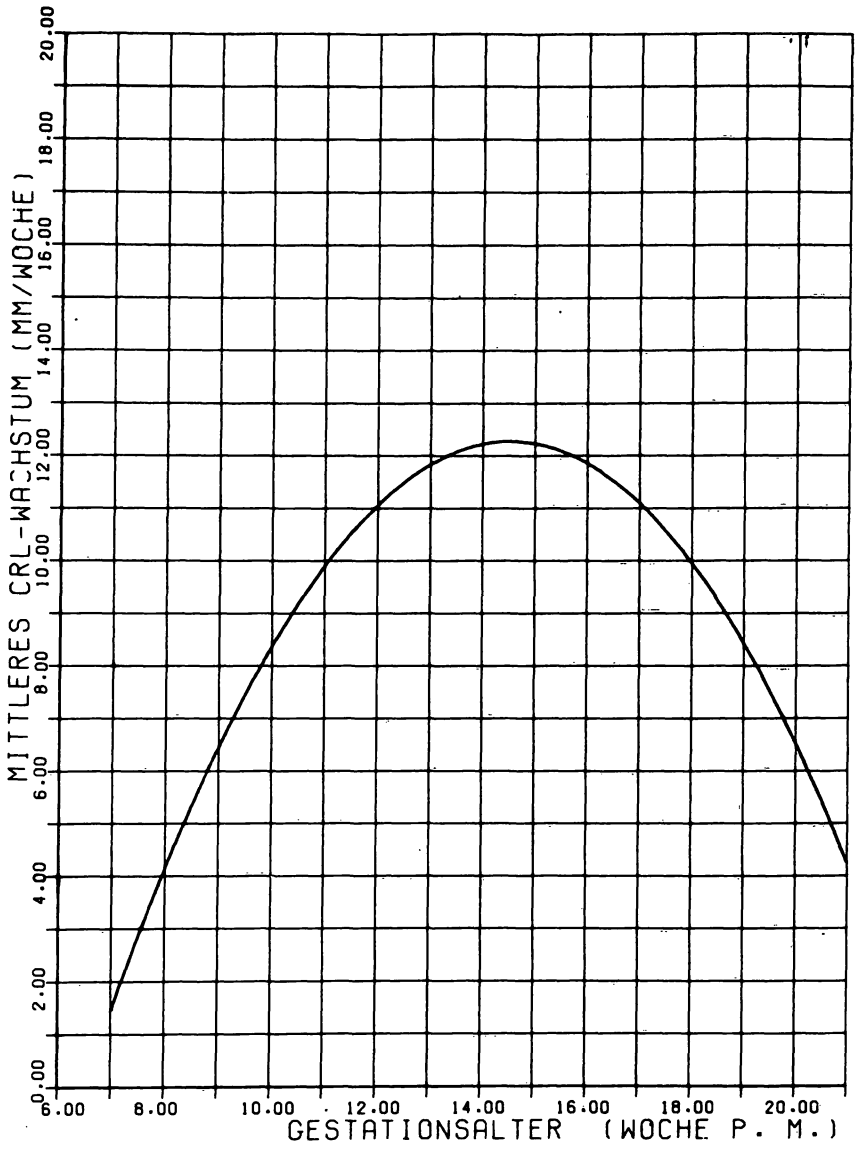

Fig. 3 Mean growth velocity related to gestational age (postmenstrual weeks) (Hansmann and Coworkers, 1979)

Recently a report on a so called Length-Head-index was given by Hansmann and Schuhmacher (1979). It was calculated from 244 individuals in which BPD and CRL measurements were taken in the same session between 8 and 24 weeks. The quotient (CRL divided by BPD) is showing an increase from 2.25 at 8 weeks to 2.7 at 24 weeks (Fig. 4). For any given age the mean standard deviation was calculated to be o.25 which corresponds to a variation coefficient of about 1o %. This result expresses that in cases with normal development at a given age head size and crown-rump length are closely related in a determined proportion. Thus if the index is found to be out of normal range one

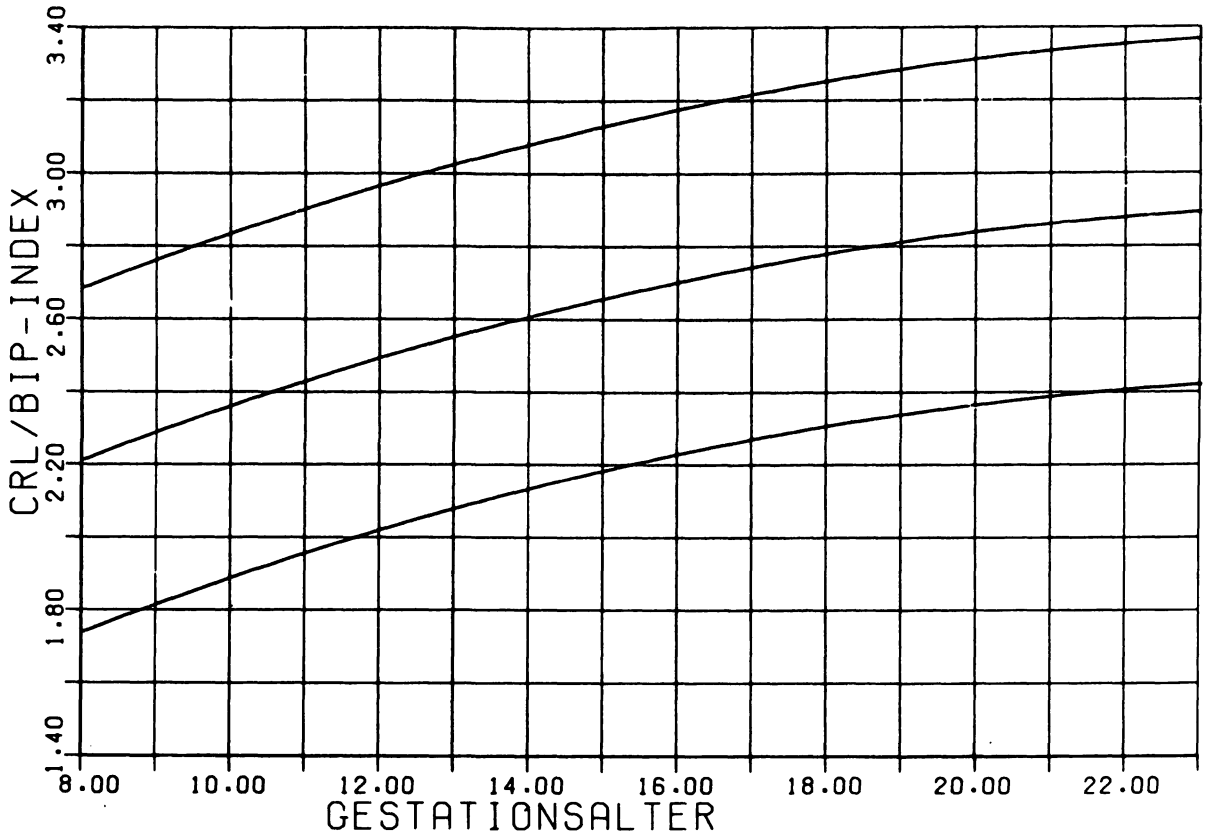

Fig. 4 Length-Head-Index (CRL:BPD) related to gestational age (Hansmann a. Schuhmacher, 1979)

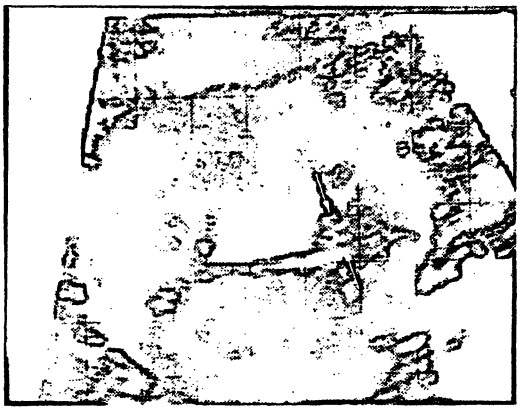

Fig.5 Pregnancy at 9 weeks p.m. fetal head in transverse section showing a true midline, BDP = 10 mm (arrows)

could exspect any abnormality in the growth. But in regard to the authors experience in most of the cases an erroneons measurement of one of the parameters is the cause. In other words: Abnormalities in the calculation of the length-head index unmask errors in the determination of one of the parameters. In contrast if CRL and BPD measurements are too small or too large for an exspected age but fit together by exact normality of the index an equivalent shift of the pregnancy's age determination is justified in the majority of cases.

Literature on request by the author.

Prof.Dr.M.Hansmann
Univ.-Frauenklinik
Venusberg
D-5300 Bonn 1 /Germany