DISCUSSION

Various methods have been devised to estimate fetal maturity in utero. None of the methods can predict fetal maturity with certainty. Under certain circumstances radiological estimation of fetal maturity becomes necessary. These include -

1. When the menstrual history is uncertain or unknown and prolongation of pregnancy may be contraindicated for any reason.

2. In the presence of fetal or maternal complications, to estimate an appropriate time for possible termination of the pregnancy.

3. To ascertain the correctness of the menstrual history in anticipation of repeat Cesarean section.

4. In sensitized Rh- negative mothers with a rise in antibody titer, anticipating the possibility of rapid obstetric action (Intrauterine transfusion, termination of pregnancy).

5. When there is reasonable suspicion of prolongation of pregnancy beyond the expected date of confinement to determine the possibility of postmaturity.
6. When there is a significant age-size discrepancy in the fetus, to estimate fetal maturity and the possibility of fetal abnormalities.

While there may be other reasons for obtaining antepartum films of the abdomen in pregnancy like lie, presentation, number of foetuses or any congenital abnormalities.

In this series, the clinical data were carefully scrutinized and patients were excluded from the series if there was any doubt as to the date of the last menstrual period, or if their menstrual cycle had been irregular.

Hodges (1937), reported on parallax radiological measurement of the femoral shaft in approximately 100 human fetuses, the age ranging from 16 to 38 weeks. The method was mathematically complicated and the number of cases after 30 weeks was small. However, these methods have not stood the test of general clinical usage because of the various problems concerning radiological techniques, the use of complicated formulas or the unavailability of charts and tables.

Brandfass and Howland (1967), describe a simple method of "Determination of fetal weight by long bone measurements". By measuring the long bones on pelvimetry or anteroposterior maternal abdominal films, and comparing
them with measurements obtained from films of new born infants, they predicted whether an infant would weigh more or less than 2,250 gm with about 90 percent accuracy.

According to them, for femur lengths measuring 8.6 cm or more, the foetus should weigh 2,250 gm or more.

In our study no foetus had femur measuring more than 8.2 cm. The difference may be due to difference of positioning.

R.H. Owen (1970), took the PA film with anode film distance of 36 inches or 90 cm. Measurements were taken directly from the films with no corrections for magnification. Owen reported that in the last weeks of pregnancy the femur grew at 1 mm a week. In present study the method used was the same except that the FFD used was 40 inches or 100 cm. Rate of growth of femur length was observed to be approximately 2 mm per week which is about 1 mm per week more than that reported by Owen.

Martin and Higginbottom (1971), studied only the femur. They stated that a 15 degree angulation can be ignored without introducing a significant error. They also suggested that a repeat film can be exposed after external manipulation, if desired. The growth rate of femur as reported by these authors is 3.0 mm per week. In our study,
the rate of femur growth observed was less by about 1.0 mm per week as compared to that reported by these authors.

J.G.B. Russell et al (1972), examined films of 217 women in a prone position and measurement were made directly from the films. Length of fetal long bones were measured. They reported a mean rate of growth of about 1.5 mm per week. This is about 0.5 mm per week less than that observed by us.

Kumar and Chawla (1978), measured femur length in films of 86 cases taken in postero-anterior oblique position. Film focus distance was 100 cm. They observed wide variation in the length of the femoral shaft and the period of gestation but made a conclusion that femoral shaft measuring more than 7.6 cm was of more than 36 weeks of gestation. In present study, we also observed a wide variation in the lengths of femoral shafts and the corresponding periods of gestation and that femoral shafts measuring 7.2 cm or more corresponded to 36 weeks of gestation. This deviation may be due to difference of positioning of the patient in the two studies. Moreover their findings were based on the examination of the X-ray plates taken during third trimester of pregnancy, for various indications other than fetal maturity.
Fagerberg and Ronema (1957), deduced the gestational age from crown to heel length obtained by measuring the length of lumbar spine. Alan J. Margolis (1967), measured the lumbar vertebral length from postero-anterior radiographs of pregnant women. They stated that the measured lumbar vertebral length yields a mean figure (15 cm) for total length; reference to an intrauterine growth chart will yield an approximation of fetal maturity. They reported that fetal lumbar length of 52 mm or more was clinically significant.

In the present study, we have calculated the gestational age directly from the measurements of length of lumbar curve. Thus, our method differs from that adopted by Fagerberg and Ronema (1957), and Alan J. Margolis (1967), where the gestational age was calculated from crown to heel length obtained by measurement of the lumbar spine.

Kumar, S. and Chawla (1978), measured the lumbar vertebrae from the upper border of L1 to lower border of L5 in 86 films taken postero-anterior oblique position. They found that a foetus whose lumbar vertebral length was more than 5.1 cm was of more than 36 weeks of gestation. In present study this figure was 4.7 cm. Discrepancy may be due to the position of patient during the exposure of films.
Amos Christie et al (1950), studied X-ray of the knees in 1,112 newborn infants and concluded that distal femoral epiphysis appear at 36 weeks of gestation and weighing more than 2,500 grams. In the second part of their study by examining the 100 antepartum X-ray films they made an observation that if maturity of the foetus was determined solely from the presence or absence of the centre, one would make an appreciable error in about 20 percent of the cases when only the distal femoral epiphysis was present.

In the present study the time of appearance of the distal femoral epiphysis was at 36 weeks of gestation being similar to that observed by Amos Christie et al. Out of 20 patients in whom only the distal femoral epiphysis was present, 2 were below 36 weeks of gestation giving an error of 10% in the estimation of fetal maturity.

Duncan Murdoch and Cope (1957), examined radiographs of the knees in 100 new born mature infants and reported the presence of lower femoral epiphysis in 99 of the 100 cases examined. In present study lower femoral epiphysis was present in 100% of cases examined at 40 weeks of gestation who were delivered with in a week of radiography.
Hartley (1957), observed that lower femoral epiphysis appear at 36 weeks and was present in over 80 percent of infants from the thirty sixth week of gestation onwards. In present study distal femoral epiphysis appeared at 36 weeks of gestation and was present in 90 percent of foetuses from the 36 weeks onward.

Berdige, F.R. (1958), reported absence of lower femoral ossification centres after 36 weeks of gestation in 3 out of 200 foetuses examined at antepartum films. However the lower femoral ossification center was reported to be present in 5 of the 200 cases studied before 36 weeks. In the present study, absence of lower femoral epiphyseal center, after 36 weeks of gestation was noticed in 3 out of the 50 foetuses studied at antepartum films. Presence of these centers before 36 weeks was seen in 2 of the 50 cases studied.

Melvyn H. Schreiber (1962), have estimated 98.6 percent reliability in the prediction of maturity from visualization of the lower femoral epiphysis on a film of knee joints of newly born infants. However in present study an accuracy of 93.9 percent has been estimated for the presence of lower femoral epiphysis.
The difference between the study of Schreiber and present study is that, the former was carried out postnatally on newborns while the present study involved antenatal radiographic assessment.

Schreiber et al (1963), reported that when antenatal radiographs were taken, lower femoral epiphysis was identified in 80% cases while postnatal radiographs of same foetus showed presence of femoral epiphysis in 100% of cases. This variation was probably due to lack of clarity of epiphysis in antenatal radiograph.

In present study this center was present in 90.6 percent of the radiographs obtained prenatally from 36 weeks of gestation onward.

Dee, P.M. and Parkin, J.M. et al (1966), studied postpartum knee radiographs of 109 cases limited to the age group of 36 weeks and after. The lower femoral ossification center was found to be absent in two cases before 38 weeks of gestation while it was universally present after 38 weeks of gestation. In present study this center was not seen in one case at 37 weeks of gestation and was also found absent in one case at 38 and another at 39 weeks of gestation.
J.G.B. Russell (1967) stated that the time of appearance of the lower femoral ossification center was 37 weeks rather than 36 weeks of gestation. In the present study however presence of this center was noted as early as 34 weeks of gestation in one case. However from 36 weeks of gestation, a large majority of cases showed the presence of distal femoral epiphysis.

Kumar and Chawla (1978) studied 100 films of pregnant women in third trimester of pregnancy and observed that the centers for the lower end of femur appear at 36 weeks of gestation. In our study, similar findings were observed except in 2 cases where the appearance of this epiphysis was noted at 34 and 35 weeks of gestation respectively.
Amos Christie (1950), studied X-ray of the knees in 1,112 newborn infants and concluded that proximal tibial epiphysis appear at 39 to 40 weeks of gestation. In present study time of appearance of the proximal tibial epiphysis was at 38 weeks which is a week earlier to that reported by Amos Christie.

Duncan Murdoch and Cope (1957), examined radiographs of the knees in 100 new born mature infants and reported the presence of upper tibial epiphysis in 72 of the 100 cases examined. In no case was it present in the absence of the lower femoral epiphysis. In present study it was present in 5 out of 6 cases (83%) at 40 weeks of gestation.

Hartley (1957), observed that proximal tibial epiphyseal ossification center appears at about 38 weeks of gestation. Findings similar to those reported above were observed in the our study.

Beridge, F.R. (1958), studied 200 fetuses at antepartum films and reported the appearance of upper tibial ossification centers as early as 32 weeks of gestation. This was in variance with findings of the present study in which appearance of this center was noted at the earliest in 38th week of gestation.
Dee, P.M. and Parkin, J.M. et al (1966), studied 190 radiographs of infants knee taken just after birth. The upper tibial ossification center was absent in 12 out of 95 cases after 38 weeks and it was present in 8 out of 14 cases. In present study the center was absent in 8 out of 18 cases studied from 38 weeks onwards. In no case this center was found to be present before 38 weeks of gestation.

Kumar, S. and Chawla (1978), studied 100 films of third trimester and observed that the centers of upper end of tibia appear at 38 weeks of gestation, observations similar to those of our study.

Many authors utilize a combination of measurements in an effort to increase reliability. Ball (1935), used the circumference of the head measured with a "Pelvicephalometer". His work was extended by Hodges (1937), who used in addition, the occipitofrontal and biparietal diameters and the length of the calcified femoral shaft. It requires stereo pairs and the use of distortion charts. Their figures are derived from data on fetal growth rates by Scammon and Calkins (1929). Stockland (1961), produced tables using the length of the spine, the length of the skull, the antero-posterior and transverse diameters of the uterus, in addition to the biparietal and occipitofrontal diameters and their combinations.
A closer weight estimation results from these multiple parameter analyses. The procedure is time consuming and the low feasibility rate limit a wide application of all these procedures.

In the present study it was seen that all the four parameters can easily be obtained from a single film of the mother's abdomen, and composite age estimation can be done using simple calculation. The overall accuracy and the reliability of the radiological estimation may be enhanced by using composite age estimate which significantly improves the observed variability in predicting foetal age from foetal measurements than from any single parameter alone.