

Cross Sectional Study to Determine Gestational Age by Metrical Measurements of Hand Length

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Abstract

This was cross sectional study conducted to assess the gestational age by hand length of foeti. This method was used as it is simple and noninvasive. Hand lengths of 126 foeti - (77 live & 49 dead) were included in this study.

The results were encouraging and comparable with other similar studies. The hand length (independent variable) is strongly related with the period of gestation. As this method is simple, economical and accurate it can be used by a basic medical doctor and also paramedical even in a rural setup

Keywords: Gestational age; Hand length; Fetus; Infants.

Introduction

In the recent past, the major factor responsible for infanticide was pregnancy arising out of wedlock, which is now considered to be one of the most common motivating factors. Most of these teenagers seek abortion when pregnancy is advanced.[1] Some strata of the society resort to selective female foeticide either in utero or after being born, so as to avoid the burden of dowry. This is being practiced even after the 'Prenatal Diagnostic Technique' (Regulation and prevention of misuse) Act, 1994. In India neither is infanticide recognized as a separate crime nor is there any separate provision for it in the I.P.C. Infanticide is punishable u/s 302 I.P.C. i.e., infanticide is not differentiated from murder in India.[2]

So, to prove an infanticide, it is essential to prove that the baby has been born "alive" & was capable of separate existence i.e, "Viability". These two form the important parts of the overall medical evidentiary. The former will be determined by the establishment of respiration and the child's reflexes and voluntary acts. The latter is determined by estimating gestational age and foetal maturity. In medico legal practice viability is confirmed purely by the gestational age and courts are reluctant to accept the gestational ages of less than 28 weeks as sufficient to ensure survival.[3]

Abortion has been liberalized since introduction of 'Medical Termination of Pregnancy Act 1971' but it has put forth certain restrictions with regards to the period of gestation. If there are any Criminal or Civil proceedings against the doctor for violating the rules and regulations of M.T.P. Act, again we may have to examine the foetus for estimating the gestational age.

In short, there are three distinct Medico legal situations where in determination of gestational age assumes importance.

1. Where it is alleged that criminal abortion has been procured.
2. Where it is alleged that infanticide has been committed

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3. In cases of abortion procured under M.T.P. Act, the determination of gestational age may become legally important because of the restrictions imposed by the Act.

In India, medicolegal autopsy is performed predominantly by Medical Officers in the Primary Health Centers which are located in the rural areas. The Medical Officers working in Rural Primary Health Centers only have basic Medical qualification. With only a M.B.B.S., degree we cannot expect them to dissect the foetus and look for the ossification centers in the sternum Riach I.C.F[4] or length of the femur Yagel S., *et al*[5] which are quite reliable tools to assess the gestational age. Gestational age can also be reliably assessed by radiological study of ossification centres of sternum Krechowiechi.[6] But as rural P.H.C.'s lack even the basic infrastructure, radiology unit is a big ask. Moreover the Medical Officers are not given any special training to perform such autopsy techniques. Several parameters have been used to estimate the gestational age by different workers. They are:

1. Birth weight, Haddock F.P.[7]
2. Development of convolutional pattern of cerebral cortex, Katerina Dorovini Zis *et al*. [8]
3. Development of tooth germ, Berkouitz B.K.B.[9]
4. Crown Heel length and appearance of ossification centres, Polson *et al*. [10]
5. Assessment of serum placental lactogen, Whittaker P.G., Lind T. and Lawosn J.Y.[11]
6. Microscopic examination of body tissues, Kellet R.J.[12]

In this study, metrical measurements of hand length are used for estimating the gestational age, as it is a simple and non invasive technique. It can be carried out by a doctor even with a basic medical qualification. This study is carried out as there is no such study done in this area.

Aims and Objectives

1. To assess the gestational age by a simple and non invasive method.
2. To assess the gestational by an accurate method this is also economical.

Material and Methods

This study was conducted in the District Hospital, Belgaum with the assistance of Department of Obstetrics and Gynaecology, Jawaharlal Nehru Medical College, Belgaum. Permission for this study was obtained from the Principal, Jawaharlal Nehru Medical College and District Surgeon, District Hospital, Belgaum. This study was conducted between 11th October 1997 and 30th September 1998.

Material

A total of 126 cases were included in this study, of which 77 were live and 49 were dead

Out of 77 live preterm infants, 63 foeti were obtained from preterm vaginal deliveries and the remaining 14 from lower segment caesarian section.

Out of 49 dead foeti that were obtained from abortion, most were due to medical causes like ante partum haemorrhage, hypertension etc and 2 from abortion due to trauma. 11 foeti were obtained from preterm deliveries.

As followed by Kulkarni and Rajendran,[13] in this study also all live infants and dead foeti were examined within 48 hours after being expelled or extracted.

Inclusion criterion

- 1) All cases (live preterm infants and dead foeti) between 24 and 36 weeks of gestation with reliable dates of last menstrual period dates.
- 2) All cases irrespective of their socioeconomic status, religion or region

(urban/rural) were included.

Exclusion criterion

- 1) Cases diagnosed as intrauterine growth retardation.
- 2) Babies of mothers suffering from diabetes mellitus (as incidence of big babies is more in diabetic mothers).
- 3) Cases in which reported period of gestation and estimated gestational age by clinical examination differed by more than +2 weeks.[14]

Method

Written consent was obtained from the parents. In most of the cases in this study, only mothers' consent was obtained due to unavailability of the other parent during the examination. Staff in charge was requested to give consent for examination in cases where parents left behind the dead foeti.

Apart from the name and address, brief antenatal history which included the date of last menstrual period was obtained. Date, time and mode of delivery were noted.

Gestational age estimated by clinical examination was noted. General physical examination of foetus was done looking particularly for presence of vernix caseosa in the folds, presence and distribution of lanugo hair and development of external genitalia.

Hand length

As there was no statistical difference between right or left hand length, all measurement was done on the right side.

Hand length measurement was done using a vernier caliper within 48 hours after the foetus/infant being born, expelled or extracted. Vernier calipers used is of sliding type, graduated in cm upto 12 cm.

Hand length was measured between wrist crease and tip of the middle finger Kulkarni and Rajendran[13] and Kumar and Kumar[15] and recorded on a graph paper

using a pencil with the help of compass.

Results

Statistical abbreviations

RPG = Reported period of gestation in weeks (Dependent variable)

HL = Hand length in cm (Independent/explanatory variable)

R = Correlation coefficient

R² = Extent of variation in dependent variable explained by the changes in explanatory variable

DF = Degree of freedom

F = Variance ratio

b = Regression Coefficient

K = Constant

SEb = Standard error of regression coefficient

T = Derived from students 'T' test

Statistical analysis

Statistical analysis was done using the Statistical Package for Social Service (SPSS Plus) software on the computer.

The analysis of regression coefficient method was adopted for this data and is evaluated in terms of 'variance ratio test' or 'F' test, value of R² and statistical significance of 'b' *i.e.*, regression coefficient. The change of gestational age (dependent variable) with respect to changes in the hand length (explanatory variable) is known as regression. The 'F' test as well as statistical significance of 'b' are judged by the value of 'P' obtained from the respective tests. If 'P' value is less than or equal to 0.05, it was considered to be statistically significant.

The second criterion for evaluation of regression is by 'R²', which indicates the extent of variation in gestational age (dependent variable), explained by the 'changes in hand length (explanatory variable). In our study R²

= 0.97. It indicates that 97% of the variation in dependent variable is due to its relationship with explanatory variable.

The square root of R^2 indicates the magnitude of the correlation coefficient R . The value of 'R' may vary between - 1 and +1. A positive correlation coefficient means that increase in one variable is usually associated with increase in another variable. Similarly a decrease in one variable is associated with decrease in another variable. A negative correlation shows that while one variable increases the other decreases and vice versa. If $R=0$, it indicates that there is no relation. In our study 'R' value for hand length is 0.988 indicating a positive correlation.

Hand length was used as an explanatory variable. Taking the reported period of gestation as the dependent variable (predicting value), the regression between the explanatory variable (independent variable) ie. Hand length and dependent variable, reported period of gestation was calculated using simple linear regression analysis. The independent variable was strongly related with reported period of gestation. This has been brought out by high 'R' and R^2 . The regression coefficient was tested for statistical significance by analysis of variance. It was found to be highly significant $P<0.001$.

'b' is the regression coefficient which is equivalent to change in the gestational age for increase in hand length. That is, if there is an increase in 1 cm in the hand length, there will be an increase in 5.399 gestational weeks according to the present study. 'K' (constant) is the interceptor or correlation factor.

Multiple R	0.98361
R Square	0.96748
Adjusted R Square	0.96722
Standard Error	0.91656

Multiple Regression

The above analysis shows the relationship between the reported period of gestation and hand length. The correlation coefficient $R =$

0.983 indicating a positive correlation.

P is <0.001 and standard error of regression coefficient is 0.88, which is statistically significant.

Gestational age (GA) can be calculated using the formula, $GA = b \times HL + K$. In the present study:

$$GA = 5.399 \times HL + 5.577$$

Discussion

In the present study, hand length in cm (HL) of foetus of 126 cases both live preterm infants and dead foeti were recorded. The reported period of gestation ranged between 24 and 36 weeks. Using linear regression analysis, regression coefficient (b) and constant (k) were estimated with gestational age as the dependent variable and HL as independent / explanatory variables. Gestational age (GA) can be estimated using the formula:

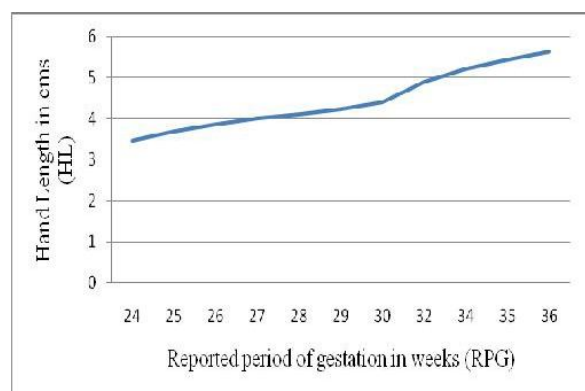
$$GA = b \times HL + K$$

When a graph were plotted with gestational age as X axis and mean values of hand length, as Y axis, a linear association was obtained.

The independent variable HL is strongly related with reported period of gestation, which has been supported by high R and R^2 values.

Yakovsivan, Paul Merlob and Salmon H.Reisner[16] studied 198 term and preterm

Fig 1: Linear relationship between Reported period of gestation (RPG) and Hand Length (HL) in the present study



Analysis of Variance

	D F	Sum of Squares	Mean Square
Regression	1	3099.54420	3099.5442
Residual	124	104.17009	0.84008

F = 3689.57631

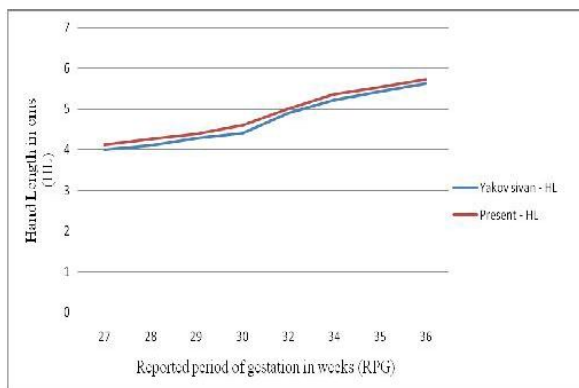
Sgnif F = 0.0000

foeti with reported period of gestation ranging from 27 to 41 weeks. They used hand lengths of foeti to estimate the gestational age. Mean values of hand length obtained from Yokovsivan’s study was compared with those from the present study. Comparison was only possible between gestational age range of 27 to 36 weeks (as this is the common age range). The mean values of hand length in the present study are slightly less in comparison to the corresponding weeks in Yokovsivan’s study.

However in Yakovsivan’s study, a curvilinear association is also obtained when mean values of hand length and gestational age are plotted on a graph, which is similar to the present study .

Kulkarni and Rajendran[13] studied 817 full term and preterm foeti with reported period of gestation of 26 to 42 weeks. Foeti with gestational range of 26 to 36 weeks were 107 in number. The gestational age was estimated using hand length. All the measurements were done within 48 hours as in the present study. The mean values of hand length in the range of 26 to 36 weeks of gestation of the two studies (i.e., Kulkarni and Rajendran’s study and the present study) were compared. Mean values of hand length were found to be slightly lower in the corresponding weeks than in the

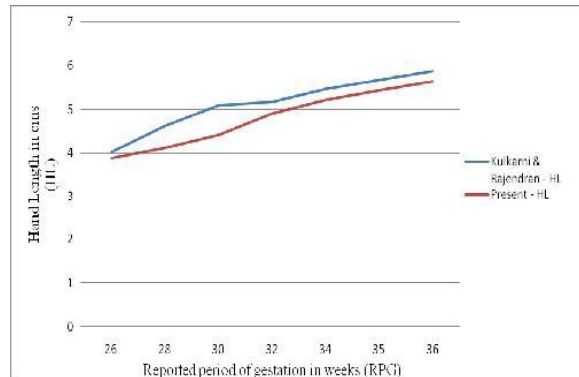
Fig 2: Comparison of mean values of Hand Length in cms against Reported period of gestation in weeks between Yakov Sivan’s study and Present study



Variables in the Equation

Variable	B	SE b	Beta	T	Sig T
HL	5.399992	0.088901	0.983608	60.742	0.0000
(Constant)	5.577654	0.420268		13.272	0.0000

Fig 3: Comparison of mean values of Hand Length in cms against Reported period of gestation in weeks between Kulkarni & Rajendran’s study and Present study



present study.

When gestational age and mean values of hand length were plotted on a graph on X and Y axis respectively a linear line of association was obtained in both the studies.

Kumar and Kumar[15] studied a total of 108 healthy human foeti of various age groups ranging from 14 to 36 weeks of gestation. They used hand lengths for assessing the gestational age. The mean values of hand length derived from the study conducted by Kumar and Kumar was compared with mean values of hand length obtained from the present study. Hand lengths of both the studies compared favorably with each other.

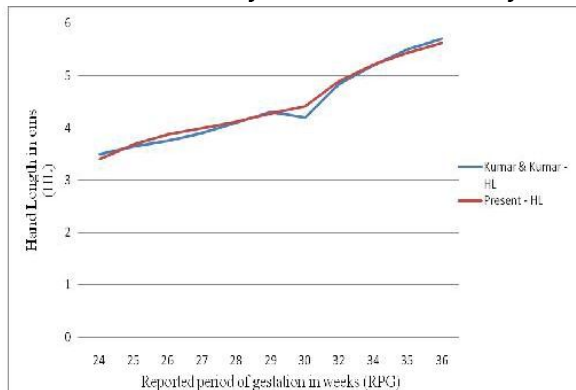
A linear association was obtained when hand length was plotted against gestational age, which is similar to the linear curve obtained in the present study .

When the statistical data of present study was compared with those of Kumar and Kumar the following inferences were drawn.

The R and R² values (0.97 and 0.95 respectively in Kumar and Kumar’s study and 0.98 and 0.96 respectively in the present study) are both very high. They indicate that there is a strong correlation between gestational age and hand length. P value in both the studies is <0.001, which is statistically significant.

Gestational age can be calculated using the formula: Gestational age = b (Regression coefficient) x Hand length + K (constant)
In Kumar and Kumar's study Gestational age = 4.62 x Hand length + 8.05
In the present study Gestational age = 5.39 x Hand length + 5.57

Fig 4: Comparison of mean values of Hand Length in cms against Reported period of gestation in weeks between Kumar & Kumar's study and Present study



Standard error was 1.04 for the estimation of hand length in Kumar and Kumar's study, whereas in the present study, it is 0.088.

Summary

This study was conducted in District Hospital, Belgaum in the year 1997-98. It was a cross sectional study (not involving follow-up of the cases), where gestational age was estimated using hand length. Measurements of 126 cases (both live and dead) were included in this study. Reported period of gestation considered in this study was in the range of 24 to 36 weeks. Measurements of both live and dead cases and of either sex were combined as no statistical difference was found. Hand length measurement was obtained using a vernier caliper.

Applying regression analysis, statistical data was derived. Statistical values like R (correlation coefficient) and R² (Extent of variation with gestational age which is explained by changes in hand length) were high, indicating a strong relation between gestational age and hand length.

Tests of significance like,

- 1) 'F' test
 - 2) Students 'T' Test
 - 3) 'P' value
 - 4) Standard error of regression coefficient
- were all found to be statistically significant.

A linear association was obtained when mean values of hand length were plotted against gestational age on a graph.

Applying the statistical data derived from hand/length, gestational age can be calculated using the formula:

$$\text{Gestational age} = b (\text{Regression coefficient}) \times \text{Hand length} + K (\text{Constant})$$

$$\text{Gestational age} = 5.39 \times \text{Hand length} + 5.57$$

The findings and results of this study are well supported by similar studies by other workers. Only a slight discrepancy was found when mean values of hand length of the present study was compared with those of western workers. That is, mean values of hand length of the present study were marginally lesser. This difference can be explained by variations in socioeconomic status, environmental and nutritional factors.

Conclusion

Establishing precise duration of pregnancy is of paramount importance for a forensic pathologist. Hand length of both live preterm infants and dead foeti has shown a high correlation with gestational age, which reflects the accuracy of this study.

It is a non invasive technique. There is no need for any special training to calculate gestational age by this method as the methodology is simple. As the expenditure involved in this study is minimal, it can be considered as an economical one. As it is a simple and economical method, it can be used even in rural areas by doctors with a basic

medical qualification. Another advantage of this study is that it is not lengthy and time consuming. This study can also be of help in cases where only fragmented remains of the foetus is available; where other parameters like crown heel length, weight etc cannot be applied. In most of the cases it is unlikely to have both hands destroyed either due to extraction of foetus during delivery/abortion or due to attack by carnivorous animals. Out of the various parameters available to assess the gestational age, this appears to be equally accurate, less tedious and highly practical for the reasons already explained.

Enough work has been made by many workers and the accuracy and its benefits have been already highlighted. Many workers are of the opinion that it is very practical and reliable. It is felt that this technique must be popularized by using it more frequently in day to day practice.

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