Assessment of Gestational Age from Hand and Foot Length

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Abstract

Determination of gestational age is important in civil and criminal cases. Though a reasonable assessment of gestational age can be made by measuring physical parameters such as crown-heel length, weight of fetus and by noting morphological features, organ development and appearance of ossification centers, an alternative parameter is desirable in some instances. The purpose of the present study is to determine the accuracy of fetal hand and foot length in estimating gestational age. The result of present study reveals high correlation of fetal hand and foot lengths with gestational age and these parameters could be utilized to estimate gestational age.

Key words

gestational age, intrauterine age, fetus, foot length Assessment of gestational age from hand and foot length

Introduction

Determination of gestational age is important in civil and criminal cases. Fetal age is usually estimated by measuring physical parameters such as crown-heel length & weight of fetus and by noting morphological features, organ development and appearance of ossification centers[1-3]. Other method for evaluation of age includes fetal biometric measurements by ultrasound. The parameter includes fetal crown-rump length, biparietal diameter, head circumference, abdominal circumference, femoral length, foot length and appearance of fetal heel ossification centers [4-7]. Though, a reasonable assessment of gestational age can be made by foresaid method, an alternative parameter is desirable in some instances, especially in cases of severe hydrocephalus, anencephaly, short limb dysplasia, postmortem destruction or in mutilated cases. Kumar et al[8] showed that the fetal hand and foot has a characteristic pattern of normal growth. These authors proposed that the fetal hand and foot length could be utilized to estimate gestational age. The purpose of the present study is to determine the accuracy of fetal hand and foot length in estimating gestational age.

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Material & methods

A prospective study was conducted at Government Medical College and Indira Gandhi Govt. Medical College, Nagpur through 2004 to 2007. A total 123 normal human fetuses were included in the study. The gestational age ranged from 12 weeks to 40 weeks. The samples were drawn from medicolegal autopsy cases and fetuses obtained from department of Obstetrics & Gynecology. The parameter taken for study includes gestational age, crown-heel length, foot length and hand length of fetus. All measurements were recorded in centimeters and on the right side as per method described by Kumar

et al (8). Fetal foot length was measured in the planter and longitudinal plane from the posterior heel to the tip of longest toe and hand length was taken on palmer surface in longitudinal plane from wrist crease to the tip of the middle finger. The collected data were analyzed with regression analysis.

Results

A total of 123 cases were studied consisting of 70 male and 53 female fetuses. The classification of fetus in age-wise manner is shown in table 1. A nomogram of fetal hand and foot dimensions, standard deviation and percentile distribution versus gestational age is given in table 2 A & 2 B. A statistically significant linear relationship was found between fetal hand length (HL) and gestational age ($r = 0.978$, $p < 0.0001$) (fig 1). Similarly a statistically significant linear relationship was found between fetal foot length (FL) and gestational age ($r = 0.975$, $p < 0.0001$) (fig 2). The correlation coefficient, intercept and standard error is presented in table 3. The gestational age of fetus in weeks from hand and foot length can be obtained by the equation given in table 4. The standard error of estimate for hand length is 1.62 and foot length is 1.76.

Discussion

Obstetricians have been using the fetal foot length to estimate gestational age. The period of gestation by this method appears to be in agreement with other ultrasound parameters (6, 7). The result of our prospective study provides normative data on fetal hand and foot growth throughout the gestation. The data of present study is in accordance with those of Kumar et al. Fetal hand and foot lengths have been found to highly correlate with gestational age and therefore these parameters could be utilized to estimate gestational age.

The utilization of fetal hand length and foot measurements will serve as a useful adjunct data for estimation of age in reliable manner. Moreover, it's utility becomes apparent when other parameters of fetus cannot be utilized due to disease, deformity or destruction by injury or postmortem process or mutilation. Apart from estimation of gestational age, the utilities of foot length measurements have been shown by other studies. Pospisilova-Zuzakora (9) used foot length to determine body length of fetus whereas in a study conducted by Embleton et al (10), it was concluded that foot length of fetus is a reliable and reproducible predictor of nasotracheal tube length, especially in premature babies.

References

1. Dorovini-zis K, Dolman C. Gestational development of brain. Arch Path Lab Med 1977; 101:192-5.
2. Kumar KU, Pillay VV. Estimation of fetal age by histological study of kidney. Med Sci Law 1996; 36:226-30.
3. Piercecchi-Martin MD, Adalian P, Liprandi A, Figarella-Branger D, Dutour O, Leonetti G. Fetal visceral maturation: a useful contribution to gestational age estimation in human fetuses. J Forensic Sci 2004; 49:912-7.
4. Bovicelli L, Orsini LF, Rizzo N, Calderoni P, Pazzaglia FL, Michelacci L. Estimation of gestational age during the first trimester by real-time measurement of fetal crown-rump length and biparietal diameter. J Clin Ultrasound 1981; 9:71-5.
5. Reece EA, Scioscia AL, Green J, O'Connor TZ, Hobbins JC. Embryonic trunk circumference: a new biometric parameter for estimation of gestational age. Am J Obstet Gynecol 1987; 156:713-5.
6. Mercer BM, Sklar S, Shariatmadar A, Gillieson MS, D'Alton ME. Fetal foot length as a predictor of gestational age. Am J Obstet Gynecol 1987; 156:350-5.

7. Goldstein I, Reece EA, Hobbins JC. Sonographic appearance of the fetal heel ossification centers and foot length measurements provide independent markers for gestational age estimation. Am J Obstet Gynecol 1988; 159:923-6.
8. Kumar GP, Kumar UK. Estimation of gestational age from hand and foot length. Med Sci Law 1993; 33:48-50.
9. Pospisilova-Zuzakora V. Determination of the body length of fetus with the aid of the length of the sole of the foot. Biologia 1962; 17:49-52.
10. Embleton ND, Deshpande SA, Scott D, Wright C, Milligan DWA. Foot length, an accurate predictor of nasotracheal tube length in neonates. Arch Dis Child Fetal Neonatal Ed 2001; 85:60-4.

Table 1: classification of fetuses in various age groups

Period of gestation (in weeks)	No. of fetuses
12-16	7
17-20	26
21-24	18
25-28	20
29-32	15
33-36	18
37-40	19

Table 2 A: nomogram of fetal hand size throughout the gestation

Gestational age (in weeks)	Length (cm)		Percentile (cm)		
	Mean	SD	5^{th}	50^{th}	95^{th}
12-16	1.4	0.690	0.8	1	2.17
17-20	2.52	0.421	1.85	2.6	3
21-24	3.31	0.350	2.88	3.2	3.76
25-28	4.81	0.377	3.6	4.3	4.6
29-32	4.81	0.396	4.27	5	5.43
33-36	5.85	0.427	5.25	5.9	6.54
37-40	6.32	0.230	6	6.3	6.71

Table 2 B: nomogram of fetal hand and foot size throughout the gestation

Gestational age (in weeks)	Length (cm)		Percentile (cm)		
	Mean	SD	5^{th}	50^{th}	95^{th}
12-16	2.14	0.884	1.3	1.8	3.17
17-20	3.21	0.540	2.27	3.15	4
21-24	4.26	0.451	3.78	4.1	4.96
25-28	5.09	0.255	4.6	5.1	5.5
29-32	5.82	0.495	5.27	5.6	6.53
33-36	7.10	0.494	6.37	7.1	7.8
37-40	7.56	0.417	7.09	7.5	8.2

Table 3: regression statistics derived from gestational age (in weeks) versus hand & foot lengths (in cm)

Variables	Multiple R	R square	Intercept	Slope	Standard error
Hand length	0.978	0.958	6.5582	4.9504	1.62
Foot length	0.975	0.950	4.9381	4.3383	1.76

Table 4: formula to determine gestational age (GA) in weeks from hand length (HL) and foot length (FL) in cm

Using hand length GA = 6.5582 + 4.9504 X HL SE = 1.62
Using foot length GA = 4.9381 + 4.3383 X FL SE = 1.76

SE = standard error of the estimate

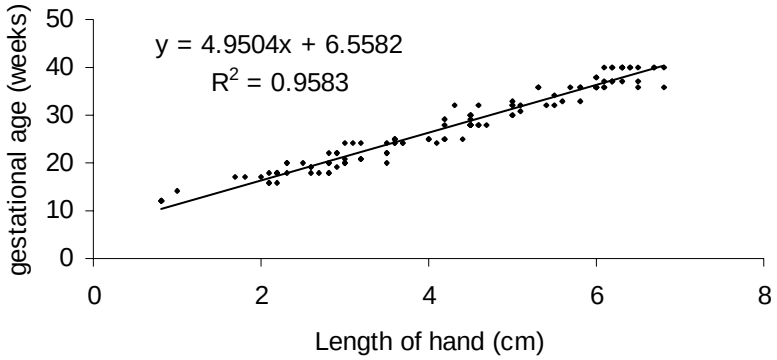

Fig 1**:** scatter plot of fetal hand (in cm) versus gestational age (in weeks) demonstrates a linear relationship

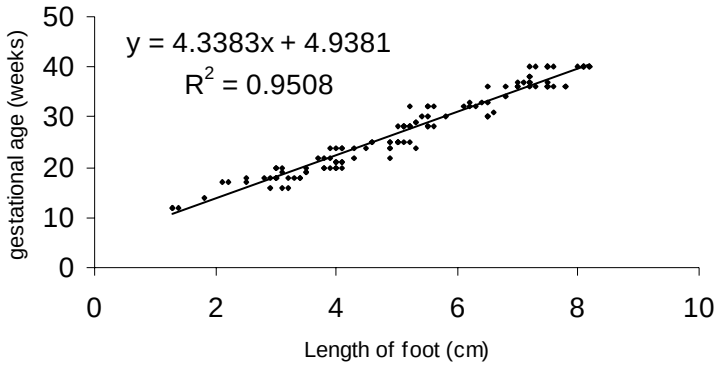

Fig 2: scatter plot of fetal foot (in cm) versus gestational age (in weeks) demonstrates a linear relationship