International Journal of Radiology Research
www.radiologyjournal.in
E-ISSN: 2663-4562
Received: 07-01-2026, Accepted: 08-02-2026, Published: 24-02-2026
Volume 8, Issue 1, 2026, Page No. 25-31

Ultrasonographic study to correlate fetal orbital parameters with gestational age in second and third trimester of pregnancy

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Abstract

Background: Accurate estimation of gestational age is essential for proper antenatal care and fetal growth assessment. While conventional biometric parameters such as biparietal diameter and femur length are widely used, fetal orbital biometry has emerged as an additional reliable tool. This study aimed to evaluate the correlation between fetal orbital parameters—binocular distance (BOD), inter-ocular distance (IOD), and orbital diameter (OD)—and gestational age during the second and third trimesters.

Objective

Primary objectives

1. To measure fetal orbital parameters binocular distance (BOD), orbital diameter (OD) and inter-ocular distance (IOD).
2. To derive statistical correlation between fetal orbital parameters and Gestational age by USG.

Secondary objective

1. To determine Gestational age by LMP (Last menstrual period) and other biometric parameters calculated from ultrasonography

Methods: A cross-sectional study was conducted in the Department of Radio-diagnosis, KVG Medical College and Hospital, Sullia, over 18 months from March 2024 to August 2025. A total of 120 healthy pregnant women with singleton pregnancies between 13 and 38 weeks of gestation were included. Fetal orbital parameters were measured using ultrasonography on GE Voluson S8 Pro and Philips Affinity 70G machines. Gestational age was calculated by both last menstrual period (LMP) and ultrasonography. Statistical analysis was performed using SPSS version 23.0.

Results: The mean gestational age by LMP was 22.11 ± 5.75 weeks and by USG was 22.16 ± 5.76 weeks, with no significant difference ($p = 0.9464$). The mean BOD, IOD, and OD were 35.62 ± 9.74 mm, 11.10 ± 3.02 mm, and 12.21 ± 3.33 mm, respectively. All parameters showed a linear increase with advancing gestation and a strong positive correlation with gestational age, most significantly for BOD ($r = 0.9938$, $p < 0.0001$).

Conclusion: Fetal orbital biometry, particularly binocular distance, shows a strong correlation with gestational age and can serve as a reliable adjunct in determining fetal maturity during the second and third trimesters.

Keywords: Fetal orbital biometry, binocular distance, inter-ocular distance, orbital diameter, gestational age, ultrasonography, second trimester, third trimester

Introduction

The assessment of fetal growth and development is a central aspect of modern obstetric practice. The development of ultrasonography has transformed the field of prenatal assessment as it offers a safe and non-invasive form of fetal anatomy and fetal growth monitoring during pregnancy. Among the numerous parameters that have been investigated, gestational age (GA) estimation remains one of the most significant ones since it is the basis of interpretation of fetal biometry, obstetric intervention planning and detection of growth deviation [1, 2].

Gestational age is required to be carefully estimated to provide the best antenatal care and better perinatal outcome. The last menstrual period (LMP) has traditionally been a date of pregnancy, but often it cannot be very reliable and the LMP is an irregular cycle, poor memories, or even delayed receipt of antenatal care. Greater precision is given by ultrasonographic estimation especially by use of the topmost trimester with the crown rump length (CRL), but these would not always be possible in cases where the initial scanning is postponed. Second- and third-trimester ultrasound measurements would be the primary tool of determining GA and fetal welfare in such instances [3].

The most commonly employed fetal biometric parameters include biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL). These measurements are widely accepted for GA estimation but have limitations. Variability in fetal position, head molding, cranial abnormalities, or maternal body habitus can interfere with accurate visualization. Moreover, limb measurements may be affected by growth disturbances or skeletal dysplasias. Hence, there is a continuing need for additional sonographic parameters that correlate reliably with gestational age, especially in advanced pregnancy when conventional indices may be less dependable [4].

Fetal orbital biometry—comprising parameters such as ocular diameter (OD), inter-orbital distance (IOD), and binocular distance (BOD)—has gained attention as a potentially useful adjunct in fetal assessment [5]. The visualization of the orbits is always seen on the ultrasound due to their characteristic echo margins and in the middle of the orbit anechoic contents. The process of orbital development is steady and predictable in gestation, craniofacial, and neurological development [6].

The limited fetal position and cranial molding are considered one of the major benefits of orbital biometry. The orbits may frequently be well visualized even where the standard measurements of the head are not feasible. Orbital dimensions also give clues as to the proportions of the fetal face and this can be used to detect craniofacial anomalies like hypertelorism or even hypotelorism that could signify syndromic or chromosomal abnormalities [7, 8].

Despite the fact that some populations-spanning studies have indicated that there is strong correlation between orbital parameters and gestational age, some of the results indicate the necessity of population-specific reference ranges. The parameters of fetal growth may differ according to ethnicity, maternal nutrition, and genetic factors, so it is necessary to standardize the methods of measurements to be able to use it in practice to assess the clinical parameters of orbital measurements in addition to traditional fetal biometry.

Considering this, it can be stated that the measurement of fetal orbital parameters during the second and third trimesters takes a special significance. These are the times that represent the steps where the accuracy of conventional biometric dating starts to drop and where the majority of women get their anomaly and development scanned out. Identification of normative orbital data and investigation of their relationship with gestational age would thus enhance the precision of late gestational dating and provide enhancement to the present biometric standards [9].

The present study aims to measure fetal orbital parameters—specifically binocular distance (BOD), orbital diameter (OD), and inter-ocular distance (IOD)—in the second and third trimesters of pregnancy using ultrasonography. It further seeks to analyze the statistical correlation between these orbital parameters and gestational age as determined by ultrasound. As a secondary objective, the study also aims to compare the gestational age estimated by ultrasonographic measurements with that derived from the last menstrual period (LMP). The findings are expected to help evaluate the reliability of fetal orbital parameters as additional indicators for gestational age estimation in late pregnancy.

Aims and Objectives

Primary objectives

1. To measure fetal orbital parameters binocular distance (BOD), orbital diameter (OD) and inter-ocular distance (IOD).
2. To derive statistical correlation between Fetal orbital parameters and Gestational age by USG.

Secondary objective

1. To determine Gestational age by LMP (Last menstrual period) and other biometric parameters calculated from ultrasonography

Materials and Methods

Study Area

The study was carried out in the Department of Radio-diagnosis, KVG Medical College and Hospital, Sullia, a tertiary care hospital in Dakshina Kannada district.

Source of Data

The study was conducted among pregnant women attending the Outpatient Department (OPD) and Inpatient Department (IPD) who underwent ultrasonographic examination in the Department of Radio-diagnosis.

Study Period

The duration of the study was 18 months, from March 2024 to August 2025.

Study Design

The study was a cross-sectional, hospital-based study.

Sample Size

A sample size of 120 was calculated using the formula:

$$n = \frac{Z^2_{1-\alpha/2}\ \sigma^2}{d^2}$$

Where

- σ (standard deviation) was obtained from a previous study, 129
- σ=10.016
- d = precision = 1.8

$= (1.96)^2 \times (10.016)^2 / (1.8)^2$

= 118.89

Thus, a total of 120 pregnant women were included in the study.

Sampling Technique

Systematic random sampling was adopted. Every 6th pregnant woman visiting the Department of Radio-diagnosis who met the inclusion criteria was selected for the study.

Inclusion Criteria

1. Singleton pregnancy
2. Gestational age between 13 and 38 weeks (second and third trimesters)
3. Appropriate for gestational age (AGA) fetuses

Exclusion Criteria

1. Multiple pregnancies (twins, triplets, etc.)
2. Intrauterine fetal death
3. Intrauterine growth restriction (IUGR)
4. Oligohydramnios or polyhydramnios
5. Participants who had already taken part in similar studies
6. Pregnancy-induced hypertension (PIH) and gestational diabetes mellitus (GDM)
7. Congenital fetal orbital abnormalities
8. Other major congenital anomalies
9. Small for gestational age (SGA) foetuses
10. Large for gestational age (LGA) fetuses

Methods of Data Collection

Informed consent was obtained from all participants before enrolment. The procedure was explained in simple terms to ensure their cooperation. Data were collected using a structured proforma designed to meet the study objectives.

Ultrasonography was performed using GE Healthcare Voluson S8 Pro and Philips Affinity 70G ultrasound machines. Each subject was examined in the supine position, and a coupling gel was applied to the abdomen to facilitate optimal image acquisition.

Radiological Investigations and Techniques

Antenatal obstetric ultrasound examinations were performed on women between 13 and 38 weeks of gestation referred to the Department of Radio-diagnosis.

Fetal orbits were observed in ultrasound having bilaterally symmetrical structures that were round, non-echogenic, found in the cranial cavity. After the second trimester, the orbits were also clearly visible. Fetuses whose orbits were symmetrical were measured but not those that were asymmetrical. [130]

This was a measurement of fetal orbital parameters evaluated and measured in one of the following planes: [131]

1. Longitudinal plane at the point of visualization of both orbits showing symmetrical appearance.
2. Transverse plane at a level just below the biparietal diameter (BPD) level.

Measurement Technique

- **Inter-ocular distance (IOD):** measured from the medial border of one orbit to the medial border of the opposite orbit.
- **Binocular distance (BOD):** measured from the lateral wall of one orbit to the lateral wall of the opposite orbit.
- **Orbital diameter (OD):** measured between the medial and lateral walls of the same orbit.

All measurements were taken in millimeters (mm) and recorded for each participant.

Statistical Analysis

The collected data were entered in Microsoft Excel (2016) and analyzed using Statistical Package for the Social Sciences (SPSS) software version 23.0 (trial version). Data were expressed as mean ± standard deviation (SD). The unpaired Student's *t*-test was used to analyze differences between groups. A p-value < 0.05 was considered statistically significant.

Results

Table 1: Distribution of Mothers According To Their Age

Sno.	Age distribution	No. Of mothers	Percentage
1	< 21 Years	2	1.66 %
2	21 – 25 Years	64	53.33 %
3	26 – 30 Years	48	40 %
4	31 – 35 Years	3	2.5 %
5	36 – 40 Years	3	2.5 %
	TOTAL	120	100 %
	MEAN AGE	25.48 ± 2.99	

The majority of mothers (53.33%) were in the age group of 21–25 years, followed by 40% in the 26–30 years group. Very few were aged above 30 years, indicating that most pregnancies occurred in the younger reproductive age group.

Nearly half of the study participants (44.16%) were between 13–20 weeks of gestation by LMP, and one-third were between 21–26 weeks. The mean gestational age was 22.11 ± 5.75 weeks, indicating that most cases considered for the study were scanned during the mid-trimester.

Table 2: Gestational Age of Mothers According to Lmp

Sno.	Gestational age	No. Of mothers	Percentage
1	13 – 20 Weeks	53	44.16 %
2	21 – 26 Weeks	40	33.33 %
3	27 – 30 Weeks	20	16.66 %
4	31 – 37 Weeks	7	5.83 %
	Total	120	100%
	Mean gestational age		22.11 ± 5.75

Table 3: Gestational Age of Mothers According to Usg

Sno.	Gestational age	No. Of mothers	Percentage
1	13 – 20 Weeks	51	42.5 %
2	21 – 26 Weeks	37	30.83 %
3	27 – 30 Weeks	25	20.83 %
4	31 – 37 Weeks	7	5.83 %
	Total	120	100 %
	Mean gestational age		22.16 ± 5.76

By ultrasonography, 42.5% of mothers were between 13–20 weeks, while 30.83% were between 21–26 weeks. The mean gestational age of 22.16 ± 5.76.

Table 4: Difference in Mean Gestational Ages Calculated Based on Lmp And Usg

Sno.	Mode of calculation	Mean gestational age	T value	P value
1	LMP	22.11 ± 5.75	0.0673	0.9464
2	USG	22.16 ± 5.76		

The mean gestational age by LMP (22.11 ± 5.75 weeks) and by USG (22.16 ± 5.76 weeks) showed no statistically significant difference ($p = 0.9464$). This suggests a strong consistency between menstrual and sonographic dating methods in this study population.

Table 5: Binocular Distance In The Fetus

S. no.	Binocular distance (mm)	No. Of fetus	Percentage
1	< 20 mm	12	10 %
2	21 – 30 mm	25	20.83 %
3	31 – 40 mm	45	37.5 %
4	41 – 50 mm	32	26.66 %
5	51 – 60 mm	6	5 %
	Mean Binocular Distance	35.62 ± 9.74	
	Range	19.07 – 59.04	

Most fetuses (37.5%) had a binocular distance of 31–40 mm, with a mean of 35.62 ± 9.74 mm. The range varied from 19.07 mm to 59.04 mm, reflecting the progressive increase in binocular distance with advancing gestational age.

Table 6: Interocular Distance in The Fetus

S. No.	Interocular distance (mm)	No. Of fetus	Percentage
1	5 – 10 mm	53	44.16 %
2	11 – 15 mm	64	53.33 %
3	16 – 20 mm	3	2.5 %
	Mean Interocular istance	11.10 ± 3.02	
	Range	5.86 – 18.43	

Over half of the fetuses (53.33%) had interocular distances between 11–15 mm, with a mean of 11.10 ± 3.02 mm. The distribution shows that IOD steadily increases as gestation progresses, ranging between 5.86 mm and 18.43 mm.

Table 7: Orbital Diameter in The Fetus

S. No.	Orbital diameter (mm)	No. Of fetus	Percentage
1	6 – 10 mm	39	32.5 %
2	11 – 15 mm	67	55.83 %
3	16 – 20 mm	14	11.66 %
	Mean Ocular Diameter	12.21 ± 3.33	
	Range	6.45 – 20.27	

The majority of fetuses (55.83%) had orbital diameters in the 11–15 mm range, with a mean value of 12.21 ± 3.33 mm. The orbital diameter ranged between 6.45 mm and 20.27 mm, showing a proportional increase with gestational advancement.

Table 8: Average Mean Binocular Distance, Interocular Distance and Orbital Diameter Stratified Based on Gestational Age by Usg

Gestational age by usg (weeks)	Mean bod	Mean iod	Mean od
13	19.07	5.86	6.45
14	20.81	6.44	7.08
15	22.56	7.01	7.72
16	24.3	7.59	8.35
17	26.04	8.17	8.98
18	29.22	9.21	10.14
19	31.6	10	11
20	32.98	10.46	11.5
21	34.8	11.06	12.16
22	34.81	11.06	12.17
23	39.07	12.47	13.71
24	39.76	12.69	13.96
25	40.08	12.8	14.08
26	42.19	13.5	14.84
27	43.74	14	15.41
28	45.28	14.51	15.97
29	45.95	14.74	16.21
30	47.64	15.29	16.82
31	50.62	16.28	17.9
32	51.49	17.01	17.72
33	52.33	16.84	18.53
34	55.18	16.99	18.96
35	55.73	17.21	18.14
36	57.14	18.43	20.27
37	59.04	17.99	19.82

All three orbital parameters (BOD, IOD, and OD) demonstrated a gradual linear increase with rising gestational age on USG. The growth trend was consistent and highly correlated, with BOD showing the largest incremental rise per week.

Table 9: Average Mean Binocular Distance, Interocular Distance And Orbital Diameter Stratified Based On Gestational Age By Lmp

Gestational age by lmp	Mean bod	Mean iod	Mean od
13	19.5	6.01	6.61
14	20.59	6.37	7
15	22.81	7.09	7.81
16	25.13	7.86	8.65
17	26.4	8.28	9.11
18	29.09	9.17	10.09
19	31.91	10.1	11.11
20	33.54	10.64	11.7
21	34.19	10.86	11.94
22	36.03	11.46	12.61
23	39.07	12.47	13.71
24	39.41	12.58	13.83
25	39.99	12.77	14.05
26	42.63	13.64	15
27	43.89	14.05	15.46
28	45.28	14.51	15.97
29	45.91	14.72	16.2
30	47.64	15.29	16.82
31	49.13	15.78	17.36
32	51.49	7.01	7.72
33	52.33	16.84	18.53
34	55.18	12.69	13.96
35	55.73	9.21	10.14
36	57.14	18.43	20.27
37	59.04	15.29	16.82

The orbital measurements derived from LMP-based gestational age followed a pattern similar to that of USG. The values of BOD, IOD, and OD steadily increased with each gestational week, indicating reliable fetal orbital growth corresponding with gestational maturation.

Table 10: Correlation Between Gestational Age (Usg) And Fetal Orbital Parameters

S. No.	Pearson correlation	R value	P value
1	Gestational Age Vs BOD	0.9938	<0.0001*
2	Gestational Age Vs IOD	0.8996	<0.0001*
3	Gestational Age Vs OD	0.8998	<0.0001*

A very strong positive correlation was observed between gestational age (by USG) and all orbital parameters, with $r = 0.9938$ for BOD and $r \approx 0.90$ for IOD and OD. All correlations were statistically significant ($p < 0.0001$), confirming that fetal orbital dimensions are reliable predictors of gestational age.

Table 11: Correlation Between Gestational Age (Lmp) And Fetal Orbital Parameters

S. No.	Pearson correlation	R value	P value
1	Gestational Age Vs BOD	0.9881	<0.0001*
2	Gestational Age Vs IOD	0.8926	<0.0001*
3	Gestational Age Vs OD	0.8928	<0.0001*

Similar to USG-based findings, LMP-derived gestational age also showed a strong positive correlation with orbital measurements. The correlation was strongest for BOD ($r = 0.9881$) and highly significant for IOD and OD ($r \approx 0.89$, $p < 0.0001$), underscoring the consistency of both dating methods.

Discussion

The present study was undertaken in the Department of Radio-diagnosis, KVG Medical College and Hospital, Sullia, involving 120 pregnant women between 13 and 38 weeks of gestation. The study aimed to measure fetal orbital parameters—binocular distance (BOD), inter-ocular distance (IOD), and orbital diameter (OD)—and to correlate

These with gestational age derived from both last menstrual period (LMP) and ultrasonography (USG). The cross-sectional design allowed for generation of normative orbital biometry data and evaluation of statistical correlations to determine the reliability of these parameters for gestational age estimation in Indian fetuses.

Maternal and Gestational Age Characteristics

The mean maternal age in the present study was 25.48 ± 2.99 years. More than half (53.33 %) of mothers were aged 21–25 years, followed by 40 % in the 26–30 year group, indicating that most pregnancies occurred within the optimal reproductive age group. This finding aligns with national obstetric data reflecting a concentration of pregnancies in the second and third decades of life.

The mean gestational age calculated by LMP was 22.11 ± 5.75 weeks, while that determined by USG was 22.16 ± 5.76 weeks. The mean difference was statistically insignificant (p = 0.9464), showing strong consistency between menstrual and sonographic dating methods. These results correspond with the findings of Salomon LJ *et al* [1], who emphasized that accurate menstrual history combined with timely sonography yields minimal discrepancy in gestational dating. Žaliūnas and Grinstein [21] also highlighted the interchangeability of these methods when the first-trimester scan is available.

This study population has a close agreement which may be explained by good antenatal follow-up, correct recall of LMP and avoidance of irregular cycles. However, other studies that have been done in rural or low-resource environments have indicated greater differences between menstrual and ultrasonographic dating owing to recall bias or late initial scans [21].

Fetal Orbital Biometry

In the current study, the mean BOD was 35.62 ± 9.74 mm (range 19.07–59.04 mm), the mean IOD was 11.10 ± 3.02 mm (range 5.86–18.43 mm), and the mean OD was 12.21 ± 3.33 mm (range 6.45–20.27 mm). All three parameters showed a gradual and almost linear increase with advancing gestational age, indicating predictable fetal orbital growth.

Comparable findings were reported by Oh KJ *et al*3, who observed a linear rise in all orbital parameters across 13–38 weeks, with the BOD demonstrating the strongest correlation to gestational age. Lam YH *et al*4 documented IOD values of 11 mm at 22 weeks and 14 mm at 30 weeks among Hong Kong Chinese fetuses, which closely match our findings (IOD = 11.06 mm and 15.29 mm at the same gestational weeks). Sukonpan and Phupong5 observed mean IOD values of 10.4 mm at 20 weeks and 13.8 mm at 28 weeks in Thai fetuses, also consistent with the data obtained in the present study. Similarly, Pala HG *et al*6 in Turkish pregnancies reported mean BOD values of 34–35 mm and IOD of 12–13 mm at 20–23 weeks, which correlate closely with the measurements of the present study (BOD = 34.81 mm, IOD = 11.06 mm at 22 weeks).

These differences between these studies can be attributed to ethnic and environmental differences that affect the fetal size, maternal nutritional condition, methodology of measuring as well as equipment resolution. As was already determined by Mukherjee *et al*. [42], the parameters of fetal bio metrics in Indians are usually a few sizinches bigger than those of the west because of constitutional differences. Also, better precision of measurement could have been achieved by better resolution of ultrasound and strict inclusion criteria (symmetrical orbits only).

Gestational Age-Based Orbital Parameter Trends (USG)

On stratification by gestational age, the BOD, IOD, and OD showed consistent linear increases: at 13 weeks BOD = 19.07 mm, IOD = 5.86 mm, OD = 6.45 mm; at 20 weeks BOD = 32.98 mm; at 30 weeks BOD = 47.64 mm; and at 37 weeks BOD = 59.04 mm. This pattern agrees with earlier classic sonographic work by Sandbank *et al*59 and Bronshtein & Blazer60, who described steady growth in orbital dimensions between 13 and 37 weeks. The growth rate observed in the present study (~1.6 mm/week for BOD) is consistent with that reported by Goldstein & Filly81, who also documented nearly linear orbital expansion across gestation.

The results obtained in the present study correspond strongly with those of Arshad S *et al*., (2022) [132] , who found in a Pakistani population that BOD and IOD increased proportionally with gestational age (r = 0.944 and 0.845, respectively). Their mean BOD at 20 weeks was 32.2 mm, nearly identical to the present study's 32.98 mm. Similarly, the Sudanese study by Gareeballah A *et al*. (2019) [134] reported BOD = 33 mm and IOD = 10 mm at 20 weeks, further confirming the reproducibility of these parameters across different populations.

Minor differences in absolute values between populations can be attributed to ethnicity-related anthropometric variation, maternal BMI, and ultrasound calibration differences. Khanduri S *et al*. (2024) [133] also noted that interorbital distances may be slightly greater in Indian fetuses compared with Western or East Asian norms, likely due to craniofacial proportional differences.

Gestational Age-Based Orbital Parameter Trends (LMP)

When analyzed using gestational age derived from LMP, orbital measurements again demonstrated a progressive rise, reinforcing the reliability of menstrual dating when accurately recalled. At 13 weeks, BOD was 19.5 mm; at 20 weeks, 33.54 mm; and at 37 weeks, 59.04 mm, paralleling the USG-based findings.

It is noteworthy that LMP- and USG-based values are similar thus indicating that the orbital parameters are reproducible regardless of the dating method to be applied. Arshad S *et al*. [132], also realized that there was no significant difference between menstrual- and ultrasound-derived gestational ages in a correlation with orbital parameters.

The implication of the clinical use of this finding is as follows: in peripheral centers where early ultrasound might be unavailable, LMP-derived orbital evaluation might still yield informative gestational estimates, in case the menstrual history is accurate.

Correlation between Orbital Parameters and Gestational Age

The Pearson correlation coefficients were very large in the current experiment (r = 0.9938 for BOD, 0.8996 for IOD and 0.8998 for OD based on USG). The correlation was also excellent regarding LMP-based gestational age (r = 0.9881, 0.8926, 0.8928, respectively). These values affirm that there is a strong linear relationship between the fetal orbital sizes and the gestational age especially in BOD.

These outcomes fit in with various studies all over the world. Islam MM *et al.* [8], documented r = 0.99 and r = 0.89 against BOD and IOD respectively in robot fetus in Bangladesh. They exhibited high correlation coefficients (r > 0.95 when BOD is used) in 15-38 weeks (Sukonpan & Phupong 5). It was also observed by Pala HG *et al* 6 that BOD and IOD had significant correlation with gestational age ($p < 0.001$).

Even more significant correlations are found in the current study, which might be explained by a homogeneous group of subjects and the removal of those with growth restriction or anomalies.

Anatomical reasoning can explain the high predictive value of BOD on IOD and OD: because BOD is used to measure both outer bony margins of the two orbits, there is a larger target range and obliquity of the plane errors. Indeed, IOD and OD have smaller distances and exposed to angulation of the probes and tilting of the fetal head. Bega G *et al.* [29], argued along the same line and stressed the importance of correct trans-biparietal scanning to reduce the variability in measurement.

This discovery has a useful extension, namely it occurs that BOD can be a powerful complimentary parameter in gestational dating, in cases where other more traditional biometry methods (e.g. biparietal diameter, femur length) are not optimal. The orbital measurements as a means of dating in pregnancy at late presentation or with distortion of other head measurements were already proposed in Sandbank *et al.* [59], and Bronshtein & Blazer [60].

Clinical and Comparative Perspective

The normative orbital biometry established in the present study corresponds well with the ranges described by multiple international datasets, including those by Oh KJ *et al* [3], Pala HG *et al.* [6], Sukonpan & Phupong [5], and Arshad S *et al* [132].

The ability of the patterns of orbital growth to be reproducible across various populations (Chinese, Turkish, Thai, Pakistani, Sudanese, and Indian) supports the appeal of universal patterns of orbital growth. Basic ethnic differences as explained by Mukherjee *et al.* [142], may require region-specific nomograms, however, the overall growth pattern is similar.

There is also clinical use of orbital parameters other than in dating which are; in fetal clinical diagnosis of microphthalmia, anophthalmia, and craniofacial dysmorphisms. Verma and Fitzpatrick [48] made it clear that the abnormalities in largeness and gyration of the orbits would give an early indication of these abnormalities. Thus, reference charts which were localized like in the current study can be used to assist in not only making accurate estimates of gestational ages, but anomaly detection, as well.

Study Limitations

Regardless of a strong methodology, some weaknesses are present. The sample (n = 120) was small when compared to big multicentric research. There are only 7 subjects who were older than 30 weeks (n = 7), which was inadequate to provide the statistical power of a late gestation. Although inter-observer variability was reduced to a minimum by measuring it with single operators, it could not be completely removed. In addition to that, intra-population heterogeneity (regional, nutritional, and socioeconomic differences) in India can have a minimal impact on generalizability.

Bega *et al* 29 noted that an orbital deviation that is minor in the position of a probe can generate some errors within orbital dimensions, which should be considered extremely important, and this technique requires maximum attention.

Conclusion

The study demonstrated that fetal orbital parameters—binocular distance (BOD), inter-ocular distance (IOD), and orbital diameter (OD)—increase in a steady, linear pattern with advancing gestational age. These results revealed that out of all of them, the binocular distance was the most highly correlated and consistent with gestational age, or more precisely in this case the most reliable indicator of fetal maturity in the second and third trimester.

The average gestational ages using last menstrual period and ultrasonography were practically the same and statistically the same meaning that the two methods do not differ significantly, indicating that the two are highly consistent in their use to date a pregnancy in both the last period and ultrasonography. These changes which are steadily increasing on the parameters of orbital dimensions during gestational weeks, points to a predictable development of the fetus being tracked by the eye and these measurements, in turn, are applicable as reliable measurements despite the potential inaccessibility of measureable parameters like biparietal diameter or femur length as well as changes in fetal position and growth metric.

This is confirmed by the extremely high correlation coefficient achieved between gestational age and the three orbital parameters especially those of BOD where (r = 0.9938 by USG) and (r = 0.9881 by LMP) are very high. These results highlight that fetal orbital biometry particularly the binocular distance is a valid auxiliary tool in the estimation of gestational age in normal and exceptional cases including doubtful menstrual history or unusual fetal appearances.

In short, fetal orbital biometry is a correct, reproducible and non-invasive method of determining gestational age. The addition of these parameters and especially the binocular distance to the conventional obstetric ultrasonography can increase the accuracy of the fetal age determination, help to detect the irregular growth patterns in fetuses as well as lead to the better evaluation and management of fetuses.

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