

## A morphometric study of anterior fontanel in eastern Indian population and its clinical correlation

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### Abstract

**Introduction:** The fontanels are soft membrane covered gaps and the meeting of more than two cranial bones placed side by side. There are six fontanels, of which anterior fontanel is most prominent. We tried to determine the anterior fontanel dimension of the neonates of different gestational age. This in turn will help in diagnosing newborns with serious medical conditions and ensuring their prompt care.

**Objectives:** Estimation of neonatal anterior fontanel area, for use in neonatal screening.

**Methods:** A cross sectional study was conducted in a tertiary care hospital with 530 consecutively live born new born of 28 -41 weeks gestation. After three days of life anterior fontanel area was measured. The values were summarized using descriptive statistics, including percentile values.

**Results:** In index study, we deduced anterior fontanel dimensions of newborns of gestational age ranging from 28 to 41 weeks. The mean anterior fontanel size was  $3.20 \pm 1.71$ . Anterior fontanel variation with gestational age showed that anterior fontanel area increases with increase in gestational age. However, another study with greater number of participants and in a community setting may be helpful.

**Conclusion:** Anterior fontanel area can be used as a tool for identifying newborns with grave ailments. Abnormal fontanel measurement can be either large or small anterior fontanel. These are associated with many important consequences. Detecting them early will help in seeking appropriate medical guidance.

**Keywords:** Morphometric study; Anterior fontanel; Neonates; Fontanel anomaly; Eastern India

### 1 Introduction

The fontanels are soft membrane covered gaps and the meeting of more than two cranial bones placed side by side. There are six fontanels in a new born. Of these six, anterior fontanel is most variable in size, most prominent and clinically important <sup>(1)</sup>.

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Out of the 3.072 million neonatal deaths reported worldwide by the WHO in 2010, nearly 1/3<sup>rd</sup> (8, 75,000) occurred in India<sup>(2)</sup>. Anterior fontanel measurement soon after birth is an easy and judicious way to understand the infants developing brain and health status.

Variation is a key feature of a normal anterior fontanel. The dimension of anterior fontanel ranges from 0.6 cm to 3.6cm, with a mean of 2.1 cm<sup>(3)</sup>. This is true for the day one of an infant's life.

Anterior fontanel size can help us predict different maladies of the newborn. A large anterior fontanel may be associated with Down syndrome, increased intracranial pressure etc. Though, it can be a normal variation also.

Craniosynostosis and abnormal brain development are associated with a small fontanel or early fontanel closure<sup>(5)</sup>.

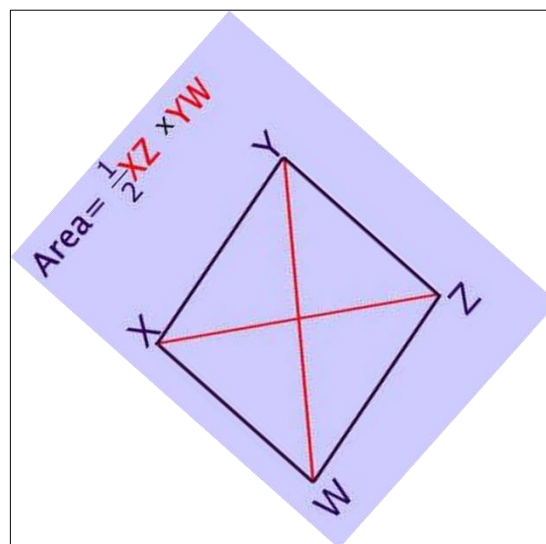
We conducted a study using anthropometric estimate i.e. area of anterior fontanel at birth by a simple method. This study was done to estimate the anterior fontanel area of the new born. The novelty is that we estimated the mean area for each of the gestational ages i.e. 28 to 41 weeks.

This study is a part of a greater study conducted by us, which has been published in Oman Medical Journal in the year 2018<sup>(6)</sup>. In that study we tried to establish a correlation between gestational age and anthropometric parameters i.e., Head circumference and Crown heel length.

## 2 Material and methods

The cross – sectional study was conducted in a tertiary neonatal unit of a teaching hospital from March 2015 to May 2016. Five hundred and thirty singleton live born babies were selected between GA of 28 to 41 weeks after obtaining informed written consent from the parents/guardians. Ethical clearance was obtained from the Institutional ethical committee for Human Research of Medical College Kolkata (Registration No. ECR/ 287/Inst/WB/2013). This study was conducted in accordance with the declaration of Helsinki. The following were the exclusion criteria – neonates for whom reliable information about GA was not available (mother not aware of the beginning of her last menstrual period; menstrual cycles were irregular prior to pregnancy; first two months of pregnancy associated with bleeding; gross discrepancy between gestational ages calculated by LMP & Ballard's score by > 2 weeks). Babies with congenital anomalies, persistent convulsions and systemic illness were excluded along with those with severe perinatal asphyxia. Intrauterine growth restricted (IUGR) and large for gestational age (LGA) new born babies, were also excluded from the study.

The skull of a newborn was evaluated for circumference, suture ridges, shape and size of anterior and posterior fontanels. Area was calculated as per the Figure1.



**Figure 1** Calculation of anterior fontanel area, where XZ and YW are diameters of Rhomboid

The fontanels were examined while the infant was calm and was held in both supine and upright positions.

For measurement of anterior fontanel, the boundaries were traced by careful palpation of Fronto – Parietal area in midline.

The four points X,Y,W,Z were marked on the scalp with a sharp point sketch pen, where the boundaries tend to meet at left lateral, anterior, right lateral and posterior angles of the fontanel, respectively. Then fontanel antero – posterior diameter or length (YW) and transverse diameter or width (XZ) were measured by using the blunt ends of a sliding calliper in a sitting child. An attendant restrained the head and arms of the child. Any fontanel too small to be measured was considered closed.

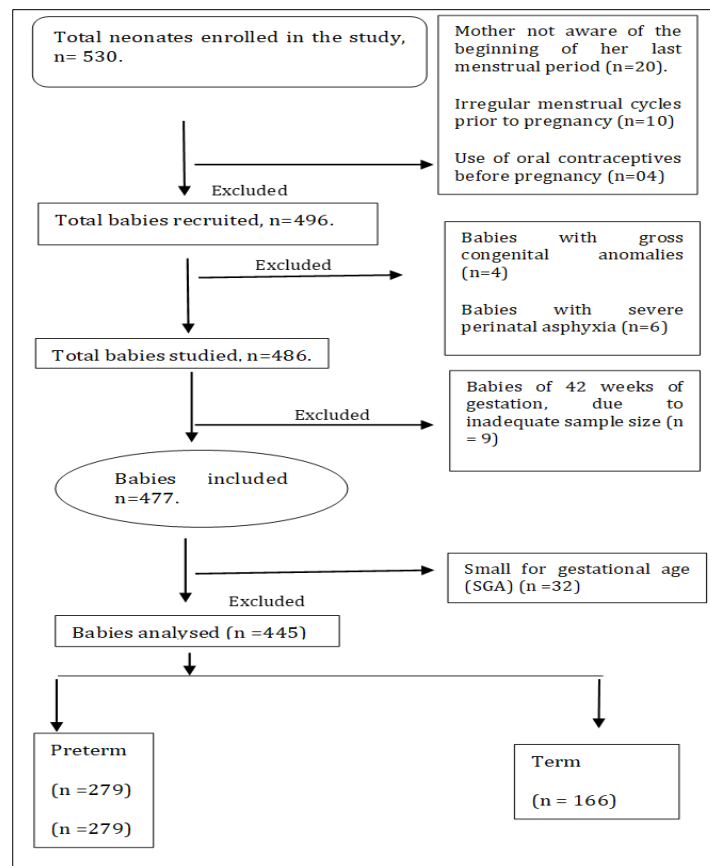
GA of the study subjects was calculated from the history sheets of their mother, using Naegele’s formula,<sup>(7)</sup> i.e. addition of 9 months and 7 days to the first day of the last menstrual period (LMP) and by NBS<sup>7)</sup> which was regarded as the gold standard for our study. To avoid inter- observer bias, measurement of anterior fontanel area and assessment of GA by NBS were carried out by only one of the investigators.

Statistica version6 [Tulsa Oklahoma: Stat Soft Inc., 2001], was used to analyze data after tabulating the same in Microsoft.

Mean, standard deviation, 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup>, 90<sup>th</sup> percentiles were generated and then their curves were drawn.

### 3 Results

Out of 530 neonates, 445 were recruited for the study as the rest did not meet the inclusion criteria. This data is a part of previous study conducted by us<sup>(6)</sup>. Figure 2 provides a flowchart of analysis numbers. The demographic summary of the study population is given in Table 1.



**Figure 2** Flow diagram of new born recruited for Study

The mean, standard deviation and percentiles of Anterior Fontanel was tabulated with respect to GA as in Table2. This is given for each gestational age starting from 28 to 41 weeks.

**Table 1** Mean standard deviation and percentiles for Birth weight (kg); Anterior fontanel area (cm<sup>2</sup>); Gestational age (weeks). (N= 445)

Parameters	Mean± SD	PC 25	PC 50	PC 75
Age (days)	3.34± 0.72	3.00	3.00	3.00
Birth weight (Kg)	1.95 ± 0.66	1.40	1.80	2.42
Anterior Fontanel area (cm <sup>2</sup> )	3.20 ± 1.71	2.00	2.80	4.05
Gestational age (weeks)	34.54 ± 3.80	31.00	35.00	38.00

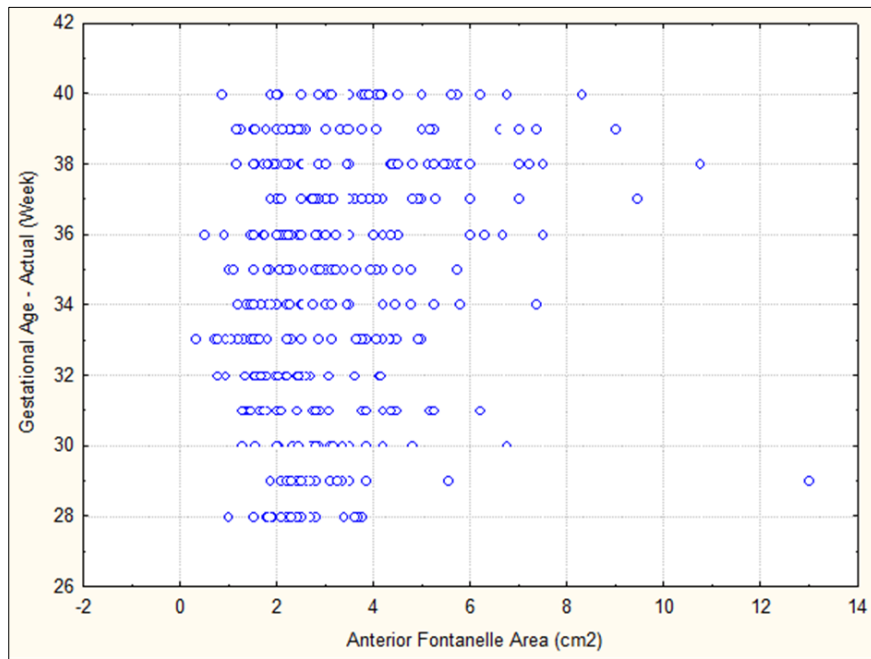
Abbreviations: N= Number; SD= Standard Deviation; PC = Percentile.

**Table 2** Variation of Anterior Fontanel area with gestational age (N= 445)

Gestational Age ( weeks)	N	Anterior Fontanel Area (cm <sup>2</sup> )					
		Mean ±SD	PC 10	PC 25	PC 50	PC 75	PC 90
28	27	2.36 ± 1.49	1.76	1.90	2.41	2.10	3.60
29	31	3.02 ± 1.98	2.20	2.30	2.50	3.10	3.50
30	27	3.03 ± 1.15	1.53	2.43	2.87	3.36	4.80
31	30	2.86 ± 1.40	1.35	1.70	2.58	4.20	4.83
32	28	2.17 ± 0.82	1.35	1.63	2.04	2.51	3.60
33	35	2.62 ± 1.41	0.93	1.30	2.30	4.05	4.37
34	31	2.80 ± 1.46	1.44	1.80	2.25	3.45	4.75
35	29	2.76 ± 1.17	1.50	1.87	2.55	3.37	4.50
36	41	2.89 ± 1.65	1.50	1.70	2.30	3.51	6.00
37	36	3.74 ± 1.54	2.07	2.76	3.55	4.50	5.28
38	41	3.93 ± 2.01	1.70	2.25	3.50	5.12	6.00
39	28	3.52 ± 2.07	1.50	2.06	2.80	5.09	7.00
40	33	3.82 ± 1.61	2.00	2.85	3.80	4.50	5.70
41	28	5.11 ± 1.31	3.40	4.40	5.00	6.00	6.75

Abbreviations: N= Number; SD= Standard Deviation; PC = Percentile.

In index study, anterior fontanel variation with gestational age showed that anterior fontanel area increases with increase in gestational age. However, there is poor correlation of gestational age with anterior fontanel area. The correlation coefficient  $r = 0.275$ . Figure 3.



**Figure 3** Correlation of Anterior Fontanel area with Gestational age in study cohort

Scatter plot showing non-association between neonatal anterior fontanel area and gestational age on 3<sup>rd</sup> postnatal day.

#### 4 Discussion

Anterior fontanel measurement is a quick and uncomplicated way to diagnose serious medical conditions of the newborn. However, for this we have to understand the normal variations of the anterior fontanel. In developing countries, less than half of the neonates undergo any evaluation within 24 hours of birth<sup>(8)</sup>.

Anterior fontanel is considered small if it is less than 0.6 cm; normal if it is 0.6 – 3.6 cm; and large if it is greater than 3.6 cm<sup>(1)</sup>. In index study we found the mean anterior fontanel size to be  $3.20 \pm 1.71$  (Table 1). So it corroborated with the above study. Black infants however, have a larger fontanel (1.4 – 4.7 cm)<sup>(9)</sup>.

A large anterior fontanel is associated with Down syndrome, Rickets, Increased intracranial pressure, Achondroplasia and congenital hypothyroidism. Though, *it can be a normal variation too*.

Down syndrome and hypothyroidism is sometimes associated with a third fontanel between the anterior and posterior fontanels<sup>(4)</sup>.

Craniosynostosis results in an abnormal head shape. It is caused due to premature closing of one or more cranial sutures. The aetiology can be hyperthyroidism, hypophosphatasia, Rickets and sometimes even no cause can be found<sup>(5)</sup>. There can be other causes for small anterior fontanel i.e., maternal alcohol abuse, birth asphyxia etc.

Shajari H, Rashidiranjbar N, Ashrafy M (2011)<sup>(10)</sup> conducted a study on 400 term and healthy neonates. A significant difference between the mean anterior fontanel size in boys and girls was found. However, we found no such correlation in our study, p value = 0.714. There was no significant difference in anterior fontanel size between infants born with a normal vaginal delivery and those with Caesarean section. This observation also corroborated with our finding, p value = 0.07.

No significant correlation was found between mean sizes of anterior fontanel with gestational age of neonate. We also arrived at the same conclusion.

Scatter diagram (Figure3), shows that the variation of Anterior Fontanel area increases with increase in gestational age. However, there is poor correlation of gestational age with Anterior Fontanel area. However, according to Popich and Smith (1972)<sup>(3)</sup>, the values obtained for normal anterior fontanel size shows an enlargement with increasing gestational

age. The much larger fontanel in small for date infants is, however, an interesting observation. It could not be compared by us as we have excluded small for gestational age babies for our study.

The strength of our study is that the entire examination was conducted by a medical personnel trained in examining the newborns and not by any peripheral health worker or traditional birth attendant. Each week of gestational age between 28 -41 weeks was adequately represented. To the best of our knowledge there are very few studies conducted in India and we have included the entire gestational age range excepting 42 weeks.

This study also has its share of limitations. This sample may not be a true representation of community settings as we conducted it in a tertiary care setting. We had to exclude 42 weeks of gestation newborns due to inadequate sample size. Finally, we did not do a longitudinal follow up of the neonates to determine whether the associations hold at a later stage.

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## 5 Conclusion

Anterior fontanel is like a window to the neonate's brain development and wellbeing. It can be measured swiftly and easily. It can help us in identifying serious medical conditions of the newborn. However, for this we have to understand the normal variations of anterior fontanel.

In this study we have provided the normal variations of anterior fontanel according to the gestational age of the neonate. We think this can be of great utility to the persons associated with newborn care by diagnosing the serious medical conditions early with prompt referral for necessary action.

However, further studies with larger sample size involving preterm neonates mainly, are required to validate our results in community settings.

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## Compliance with ethical standards

### *Acknowledgments*

The manuscript has not been published and is not under consideration for publication in any other journal.

All the authors have approved the manuscript and its submission to the journal.

### *Disclosure of conflict of interest*

There's no conflict of interest among the authors.

### *Statement of informed consent*

Informed consent was obtained from all individual participants included in the study."

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