

HEAD CIRCUMFERENCE GROWTH AND CLOSURE OF ANTERIOR FONTANELLE

G. O. Latis, I. Cortinovis, and A. Bossi

Institute of Medical Statistics and Biometry, University of Milan, Milano, Italy

Abstract: Measurement of head circumference and in particular the evaluation of the size of the anterior fontanelle is part of the routine practice during pediatric visits over the first two years of life. The closing of the fontanelle, estimated using palpation, normally takes place between 9 and 20 months according to important pediatric and pediatric neurology textbooks.

In pediatric practice, however, it often happens that the anterior fontanelle closes before the above mentioned period. Since, to our knowledge, literature presents few data on this issue, we analysed data concerning a large sample of babies (about 11000) born at the "Clinica Ostetrica L. Mangiagalli" in Milan between 1973 and 1979, and a subsample (some 1550 subjects), periodically examined up to the third birthday. The aim of this note is to evaluate the possible relationship of head circumference growth in the first three years of life to the size and age of closure of fontanelle.

Main results were as follows:

At birth the size of the anterior fontanelle is not related to the head circumference.

In the group followed up longitudinally, 24% of the boys and 14% of the girls showed a non palpable anterior fontanelle before the 9th month of life.

No association between the early closing of the anterior fontanelle and the increase of head circumference was shown.

No case was found with the anterior fontanelle closed at birth.

Key words: Anterior fontanelle; Post natal growth of head

Introduction

Over the first two years of life measurement of head circumference and the evaluation of the size of the anterior fontanelle is part of the routine practice during pediatric visits. The closure of fontanelle, estimated by using palpation, normally takes place between 9 and 20 months according to important pediatric and pediatric neurology textbooks (Nelson 1975, Menkes 1975, Barnett 1973).

In pediatric practice, however, it often happens that the anterior fontanelle closes before the above mentioned period. The aim of this note is to evaluate the possible relationship between head circumference growth during the first three years of life and the size of fontanelle and time of its closure.

Subjects and Methods

Subjects

The whole case-series, on which the evaluation of neonatal data was performed, consists of 11574 babies born (live and without detectable congenital anomalies) at the Clinica Ostetrica Ginecologica L. Mangiagalli in Milan between 1973 and 1979; the data were collected in the context of a multicentric research of Perinatal Preventive Medicine supported by CNR (National Research Council). The survey consisted of a cross-sectional part at birth, and of a longitudinal part, up to the third birthday (3, 6, 9, 12, 18, 24, 30, 36 months).

As regards postnatal growth of head, only a subset of 1554 babies (801 males and 753 females) was used; as a matter of fact, only 33% of subjects attended at least the first five visits or a complete follow up till the closure of anterior fontanelle.

With the aim of excluding possible effects of risk factors for postnatal growth, the following inclusion criteria were adopted: birth at term (≥ 37 weeks of gestation), appropriate weight for gestational age (between the 5th and 95th centile), absence of neonatal morbidity (as reported in *Table 1*). The presence of one of the conditions listed on the right of the *Table 1* is sufficient to classify an infant as "pathological".

Table 1. Types of neonatal morbidity

Neonatal morbidity due to	Symptom(s)
Neonatal asphyxia	Five minute Apgar score < 7
Respiratory diseases	Respiratory distress syndrome, Aspiration syndrome Pneumothorax
Central nervous system	Seizures, Apnoeic spells, Hypertonus, Hypotonus
Infections	Sepsis, Meningitis, Lung infections, Gastrointestinal tract infections, Skin and bone infections (positive blood and or spinal fluid culture, pathogenic organisms in stool culture)
Hyperbilirubinemia	Total serum bilirubin (maximum value): ≥ 8 mg% (if determined during the first day of life) ≥ 12 mg% (if determined later)
Hypoglycemia	Blood glucose (minimum value): < 30 mg% (if determined during the first 48 hours of life) < 40 mg% (if determined later)

Variables

Head circumference was measured with a tape measure at the largest occipito-frontal circumference. The transverse diameter of the anterior fontanelle (TDAF) at birth was estimated by palpation with an approximation of 0.5 cm and at the follow-up visits as TDAF > 1 cm, TDAF < 1 cm, closure of the fontanelle.

The Kolmogorov-Smirnov test was used to compare two frequency distributions. This tests the null hypothesis that the two populations are identical against a composite alternative concerning the first three moments of the distributions (Conover 1971).

Results

Sex and TDF at birth

Table 2 shows the distribution, for males and females, of the TDAF at birth of the whole set of 11574 subjects. It must be noted that the case-series does not contain babies with a closed fontanelle at birth (craniosynostosis). In fact the minimum value is 2 mm, recorded in 32 males and 26 females, and the modal value is 10 mm. No difference was

found between sexes in TDAF (Mean = 14.1 mm, SD = 6.6 mm and Mean = 14.6 mm, SD = 7.0 mm respectively for females and males).

Table 2. TDAF (mm) distribution at birth, by sex

TDAF at birth									
< 5	5	10	15	20	25	30	35	Missing	Total
<i>Females</i>									
60 1.08%	661 11.89%	2097 37.73%	655 11.78%	1550 27.89%	100 1.80%	233 4.19%	20 0.36%	182 3.27%	5558 100.0%
<i>Males</i>									
72 1.20%	683 11.35%	2069 34.39%	732 12.17%	1766 29.36%	128 2.13%	324 5.39%	35 0.58%	207 3.44%	6016 100.0%
<i>Total</i>									
132 100.0%	1344 100.0%	4166 100.0%	1387 100.0%	3316 100.0%	228 100.0%	557 100.0%	55 100.0%	389 100.0%	11574 100.0%

Gestational age and TDAF at birth

The mean diameter of the fontanelle at birth varies from 13 mm for babies born between 28 and 31 weeks of gestation, to 14.5 mm for babies born between 37 and 41 weeks (Table 3). Taking into consideration the method of measurement (palpation) the differences are not clinically relevant. The same results (not shown) were found in the subset of the 1554 selected babies.

Table 3. Means and standard deviations (SD) of TDAF (mm) at birth for gestational age (completed weeks)

Gestational age	N	TDAF at birth	
		Mean	SD
28 – 31	125	13.0	6.2
32 – 36	1276	13.7	6.3
37 – 42	9586	14.5	6.9
> 42	110	14.0	7.3
Total	11097	14.4	6.8

Head circumference and TDAF at birth

Figure 1 shows the frequency distributions of head circumference at birth in the three classes of babies grouped according to their TDAF (< 10 mm, 10–15 mm, ≥ 20 mm respectively: these distributions substantially overlap.

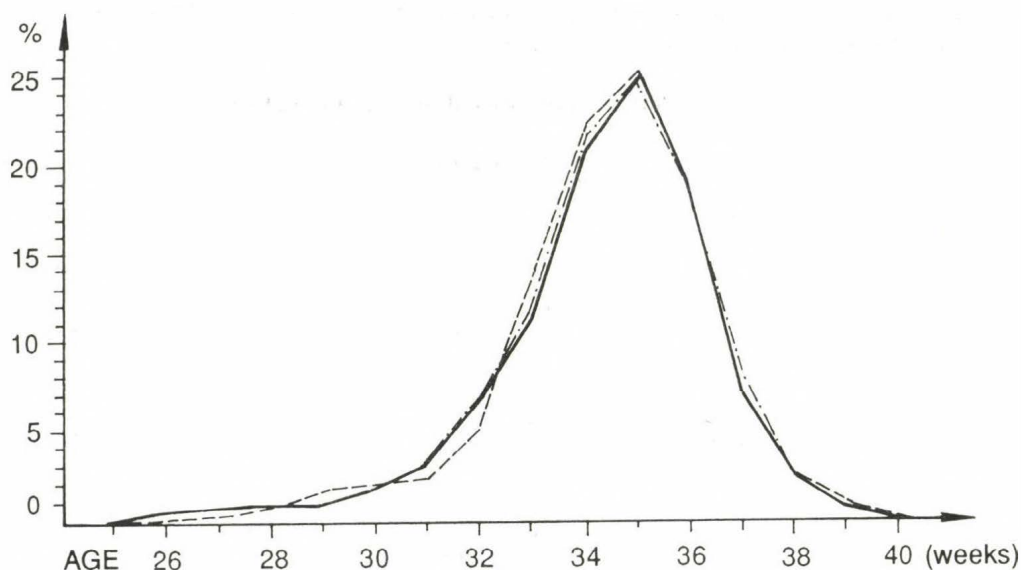


Fig. 1: Frequency distribution of head circumference at birth by TDFA at birth: < 10 mm (—); 10-15 mm (- - -) and \geq 20 mm (- . - .)

There are no statistically significant differences in TDFA for different head circumference: the average values of the TDFA vary from 14.3 mm (head circumference at birth: 33 cm) to 14.8 mm (head circumference at birth: 37 cm) (Table 4).

Table 4. Means and standard deviations (SD) of TDFA (mm) at birth for different head circumference at birth (cm)

Head circumference at birth	N	TDFA at birth	
		Mean	SD
\leq 32	1489	14.3	6.6
33	1295	14.3	7.0
34	2383	14.3	6.7
35	2763	14.4	6.9
36	2040	14.3	6.9
37	854	14.8	6.8
\geq 38	361	14.7	6.6
Total	11185	14.4	6.8

Premature closure of the fontanelle and TDFA at birth

Approximately 50% (range interquartile) of the 1554 babies showed closed fontanelle within 10 and 17 months of life. A total of 300 babies 196 males (24.5%) and 104 females (13.7%), showed their fontanelle closed up to 9 months (premature closure).

In Table 5 the TDAF distribution at birth (3 classes) of the babies with premature closure of the fontanelle is compared with the corresponding one of the remaining babies (control group). The chi-square test for linear trend ($\chi^2 = 55.6$, d. f. = 1) is highly significant, showing that the frequency of premature closure tends to increase as the TDAF at birth tends to decrease (see Table 5).

Table 5. TDAF (mm) at birth for group with premature closure of the fontanelle and control group

Group	TDAF at birth			Total
	< 10	10-15	≥ 20	
Premature closure	88 (13.10)	137 (16.14)	35 (8.77)	260
Control group	195 (68.90)	712 (83.86)	364 (91.23)	1271
Total	283	849	399	1531

χ^2 (linear trend) = 55.6 d. f. = 1 (p < 0.001)
 χ^2 (departure) = 3.78 d. f. = 2 (p = 0.05)

Premature closure of the fontanelle and growth head circumference at birth

Figure 2 shows the frequency distribution of head circumference at birth of the premature fontanelle closure group and of the control group. No statistically significant difference emerges.

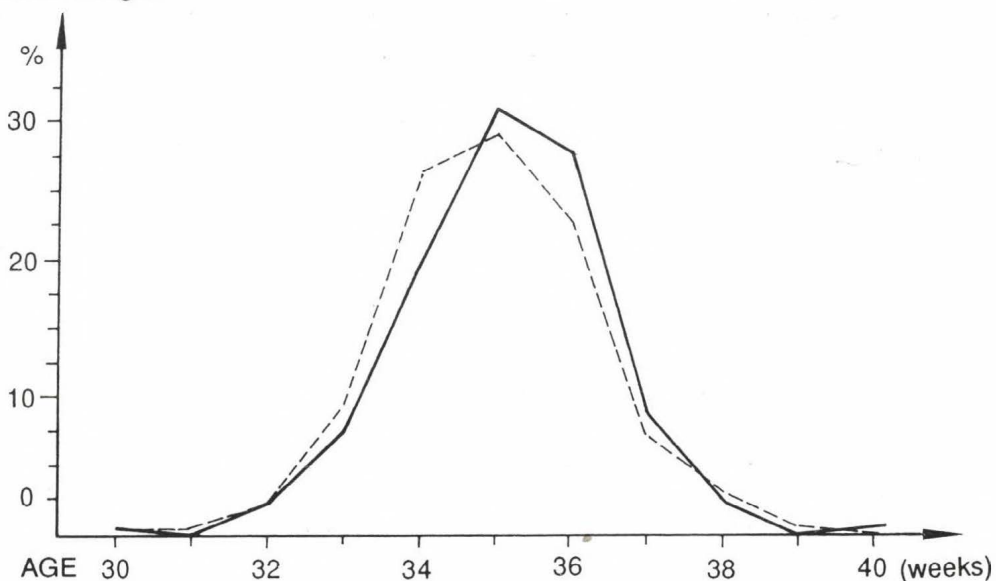


Fig. 2: Frequency distribution of head circumference at birth in premature fontanelle closure group (—) and control group (- - -)

In order to investigate whether the premature closure of the fontanelle has an effect in reducing growth of the child's head, average and standard deviation of head circumference at birth, at one, two and three years of life were computed for males and females separately (*Table 6*). The means of head circumference of the control group (age of closure ≥ 9 months) are constantly higher than those of the premature closure group: the maximum difference observed (0.65 cm) does not appear to be of clinical interest. Thus, it seems that head circumference (from 3 months to three years) is not affected by the age of closure of anterior fontanelle.

Table 6. Means and standard deviations (SD) of head circumference (cm) at birth and at one, two and three years of life for premature fontanelle closure group and control group

Head circumference	Females		Males	
	Premature fontanelle closure group	Control Group	Premature fontanelle closure group	Control group
<i>Birth</i>				
N	85	656	168	609
Mean	34.44	34.70	35.44	35.20
SD	1.31	1.25	1.19	1.34
<i>1 year</i>				
N	72	659	154	612
Mean	45.15	45.55	46.55	46.64
SD	1.41	1.21	1.14	1.30
<i>2 years</i>				
N	42	471	109	452
Mean	47.36	48.01	48.74	49.08
SD	1.48	1.23	1.29	1.34
<i>3 years</i>				
N	36	416	97	411
Mean	48.83	49.21	50.00	50.14
SD	1.40	1.62	1.48	1.32

It must be noted that in some 2% only of the infants the closure of the anterior fontanelle is earlier than 6 months of age and that no baby of this 2% showed any significant change in the pattern of growth of head circumference (*Table 7*). Even for the 4 infants with closure of the anterior fontanelle at 3 (1 female and 1 male) and 4 months (2 males) head circumference continued to increase from birth to 3 years following their growth centile (see *Fig. 3* as an example). Further the average head circumference of subjects with closure of fontanelle at 5 months does not deviate from the standard reference values (Milani et al, 1988).

Table 7. Head circumference (cm) from birth to three years for babies with closure of fontanelle before 6 months of life

Month of closure of anterior fontanelle	Head circumference								
	birth	3	6	months			18	24	30
<i>Females</i>									
3	35	39	42	43	44	45	46	47	47
5	33	37	40	41	43	44	44	—	—
5	33	38	43	44	46	—	49	49	—
5	34	40	44	45	47	—	—	—	—
5	35	39	42	43	45	—	—	—	—
5	33	40	42	—	—	—	—	—	—
5	34	39	42	44	46	47	48	49	49
5	34	40	42	—	—	—	—	—	—
5	35	40	44	—	—	—	—	—	—
<i>Males</i>									
3	36	43	46	48	48	50	50	—	51
4	35	41	42	—	—	—	—	—	48
4	34	41	—	—	—	—	—	—	51
5	36	41	42	—	—	—	—	—	—
5	40	42	44	47	48	50	50	50	51
5	37	40	43	—	—	—	—	—	—
5	36	40	44	45	47	49	—	—	—
5	35	40	43	—	—	—	—	—	49
5	38	42	44	47	—	—	—	—	52
5	35	40	43	—	—	—	—	—	50
5	38	42	47	—	49	50	50	50	51
5	36	41	44	—	—	—	—	—	—
5	36	40	44	46	48	—	—	—	50
5	34	39	42	44	45	46	47	48	48
5	—	39	42	44	46	—	—	—	—
5	36	39	43	45	46	48	49	49	—
5	36	41	44	46	47	49	50	50	50
5	36	40	42	45	46	47	48	49	49

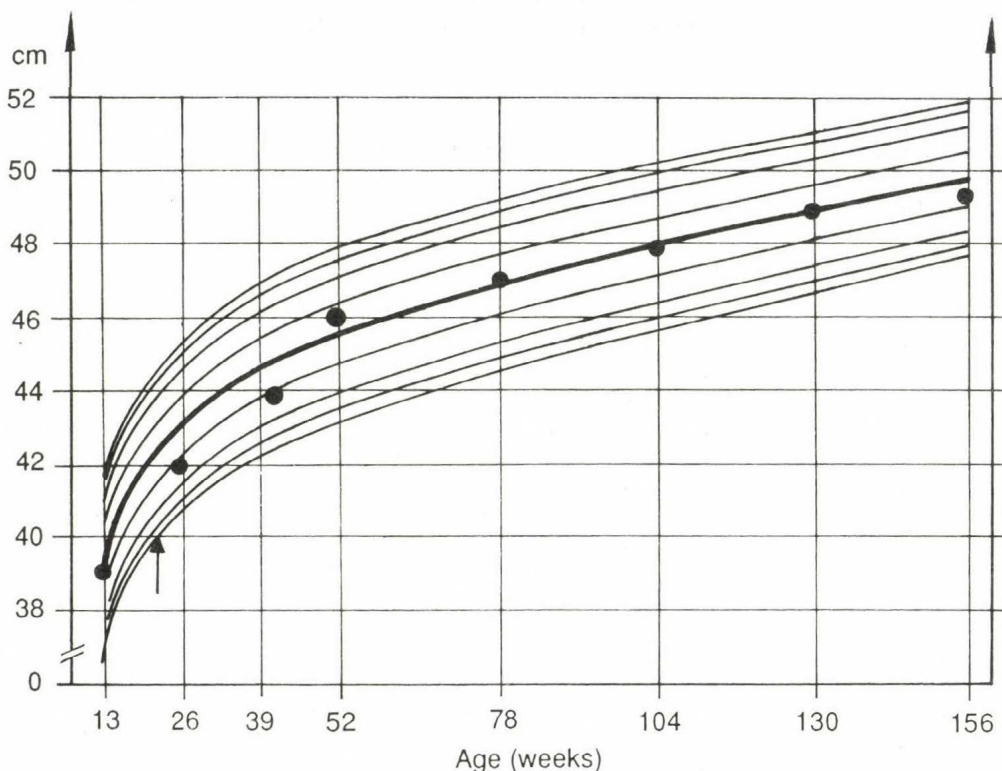


Fig. 3: Growth profile (circles) of girl No. 44342, plotted on Italian growth standards 0-3 years (3rd, 5th, 10th, 25th, 50th, 75th, 90th, 95th and 97 th centile). The arrow indicates the time of closure of anterior fontanelle

Discussion

The closure of fontanelle is part of the normal process of skeletal maturation, and it is a fundamental observation in the global evaluation of a child's growth. The premature closure of the anterior fontanelle must always be considered in relation to the growth of head circumference and a careful examination of the baby is needed in order to exclude pathological situations such as craniosynostosis (closure of the fontanelle present at birth), or decrease in brain development with consequent primary (present at birth) or secondary microcephaly. The present study does not include any case of fontanelle already closed at birth (Matson 1969), nor subjects with primary or secondary microcephaly.

Infections, traumas, metabolic diseases and anoxic status during the last months of pregnancy, the perinatal period and early infancy may induce brain damage with reduced postnatal head growth and premature closure of fontanelles (Menkes 1975).

Rare cases of closure of anterior fontanelle prior to 6 months of life with normal mental development have been described elsewhere (Barnett 1973). In this study, the 27

subjects with closure of the anterior fontanelle prior 3–6 months did not show significant changes in the pattern of head circumference growth.

This study confirms that the closure of the anterior fontanelle prior to 3–9 months of age, in the absence of peri- and postnatal problems does not appear, by itself, to determine variations in the growth of head circumference. The fibrose union of suture lines, which generally persists until 12 years of age, is likely to permit the normal growth of head circumference. The premature closure of the anterior fontanelle, even without other pathological data, requires, in any case, strict longitudinal observations.

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Mailing address: Dr Ivan Cortinovis
Istituto di Statistica Medica e Biometria
Università di Milano
Via Venezian 1
20133 Milano
Italy

