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CT Measurement of the Normal Ventricular System in Premature Infants

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In order to develop quantitative criteria for normal lateral ventricular dimensions, 70 cerebral computed tomographic scans of premature infants were reviewed and 31 normal scans were selected as suitable for establishing cerebroventricular indices. In 15 normal premature infants of less than 32 weeks gestational age the mean bifrontal index was 0.28 ± 0.05, the mean bicaudate index 0.10 ± 0.02, and the mean bioccipital index 0.19 ± 0.05. In 16 normal premature infants of more than 32 weeks gestational age the mean bifrontal, bicaudate, and bioccipital indices were 0.26 ± 0.06, 0.11 ± 0.03, and 0.17 ± 0.04, respectively. No statistically significant differences were found in the values of the indices between the two groups, which demonstrates the uniformity of the ventricular size in normal premature infants.

Computed tomography (CT) is an accepted procedure in identifying a wide range of pathologic processes. The technique can be used in neonates to diagnose intracranial hemorrhage, encephalomalacia, brain malformations, and hydrocephalus. To establish the presence of hydrocephalus the size of the ventricular system, especially the lateral ventricles, must be known. Measurements of normal ventricular size in adults and children over 1 year have been widely reported [1–5], but only a few papers deal with ventricular dimensions in the first year of life [6, 7], particularly in full-term and premature infants [8]. The purpose of this study was to develop quantitative criteria for normal lateral ventricular size in premature infants.

Materials and Methods

Seventy cerebral CT scans performed in 70 premature infants were reviewed. Thirty-one scans were selected as suitable for the study. The scans selected were technically acceptable and exhibited no obvious pathology. The infants whose scans were selected demonstrated normal psychomotor development on follow-up and were considered representative of the normal ventricular system. For purposes of analysis, the scans were divided into two groups according to gestational age: (1) premature infants of less than 32 weeks gestational age (n = 15); (2) premature infants of more than 32 weeks gestational age (n = 16).

All CT scans were obtained with a Siemens Somatom scanner with a 256 × 256 matrix. The infants were not sedated. Axial tomographic cuts were made at an angle of 10° above the orbitomeatal line. The slices were 4 mm thick with 10 sec scan time.

The scans were projected and analyzed on the Evaluoskop screen (Siemens). The sections at the level of frontal and occipital horns were magnified ×2. From the magnified picture direct linear measurements were taken in three transverse planes. The measurements obtained were converted to dimensionless ratios and expressed as cerebroventricular indices, as follows (fig. 1):

1. The bifrontal index is the distance between the anterior corners of the frontal horns (A) relative to the width of the cerebral hemisphere at the same level (A_1).
2. The bicaudate index is the distance between the frontal horns at the level of the heads of the caudate nuclei (B) relative to the width of the cerebral hemisphere at the same level (B_1).
3. The bioccipital index is the sum of the maximum widths of the occipital horns ($C_1 + C_2$) relative to the width of the cerebral hemisphere at the same level (C_3).

Results

Table 1 presents the ranges, means, and standard deviations of the bifrontal, bicaudate, and bioccipital cerebroventricular indices according to the two gestational age groups. No statistically significant differences were found in the values of the respective indices between the group of normal premature infants of less than 32 weeks gestational age and the group of more than 32 weeks gestational age ($p > 0.05$).

Discussion

The absolute volume of the normal ventricular system in premature infants is small and the outlines of the ventricular cavities are not always clearly defined [9]. These facts diminish the accuracy of measurements and of the CT measurement technique. In 70 CT brain scans of premature infants, including scans of both normal and pathologic appearance, the frontal horns were very clearly visualized in 42.4% and clearly visualized in 36.3%. Thus, in 78.7% of scans the bifrontal and bicaudate dimensions were accessible to measurement, while in more than 20% of scans the bifrontal and bicaudate indices could not be determined. Occipital horns were accurately measured in 75.6% of scans. Poor definition of the ventricular outlines can stem from technical as well as anatomic difficulties (e.g., resolution of the scanner, cut thickness, partial volume effect, scanning time, and moving artifacts).

As no statistically significant differences were found in the values of the indices between the two gestational age groups in our study,

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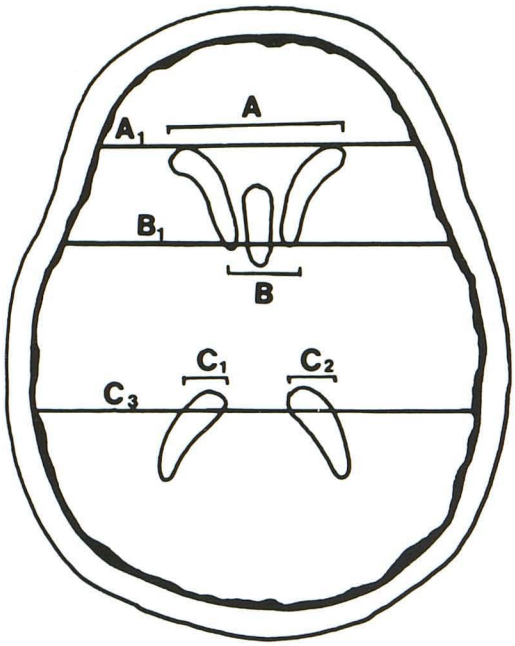

Fig. 1.—Schematic representation of cerebroventricular indices. Bifrontal index = A/A_1; bicaudate index = B/B_1; bioccipital index = $(C_1 + C_2)/C_3$.

TABLE 1: **Cerebroventricular Indices of Normal CT Scans in Premature Infants**

Index: Gestational Age (weeks)	Range	Mean	Standard Deviation
Bifrontal:			
< 32 (*n* = 15)	0.19–0.35	0.28	0.05
> 32 (*n* = 16)	0.19–0.36	0.26	0.06
Bicaudate:			
< 32 (*n* = 15)	0.07–0.15	0.10	0.02
> 32 (*n* = 16)	0.06–0.17	0.11	0.03
Bioccipital:			
< 32 (*n* = 11)	0.12–0.27	0.19	0.05
> 32 (*n* = 16)	0.12–0.28	0.17	0.04

all scans may be considered as belonging to a uniform group. Comparison of the mean bicaudate index in our series (0.11 ± 0.03) and the calculated mean bicaudate index for children in the first year of life (0.11 ± 0.06) [7] appears to indicate uniformity in ventricular size during the first year of life, regardless of gestational age. This supposition contradicts the results of a study [8] that reported significantly greater mean bicaudate indices in full-term infants as compared with premature infants of less than 32 weeks gestational age. The reported indices for full-term infants correspond to those seen in adults [2], a fact that makes the study suspect. Moreover, the mean bicaudate index in our group of premature infants of less than 32 weeks gestational age (0.10 ± 0.02) differs from the corresponding index in the group in question (0.13 ± 0.02). Errors in measurement and/or technical differences in scanning may be assumed.

The quantitative criteria developed for normal lateral ventricular dimensions are expressed as cerebroventricular ratios or indices in order to minimize the potential influence of individual anthropometric variations. Further study is indicated to confirm our results and to test the reliability of each of the indices. The development of similar indices in series of pathologic scans would also be useful.

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