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ANTHROPOMETRIC GROWTH PATTERNS IN THE NASAL ROOT AND INTERCANTHAL WIDTHS OF A NORTH AMERICAN CAUCASIAN POPULATION

ABSTRACT: To determine the age-related changes in the morphology of the space between the orbits, we measured the nasal root widths and the intercanthal widths of 1603 North American Caucasians, aged 1 to 18 years, and studied the relation of these measurements. At one year of age, the better developed width of the nasal root in both sexes occupies almost two thirds of the less developed intercanthal width. In the following years, because of greater increments in the orbital than in the nasal elements, the root width takes only slightly more than half of the interorbital distance. Knowledge of postnatal developments is important for the restoration of an optimal harmonious relationship between the nasal root and the orbits, one of the goals of reconstructive surgery.

KEY WORDS: Growth patterns — Nasal root — Intercanthal widths — North American Caucasians.

INTRODUCTION

The relationship of the nasal root width to the intercanthal width greatly influences the visual assessment of the orbits. During such an examination, our attention is focused more on the width of the space between the orbits than on the morphology of the nasal root. Although a moderately wide nasal root may create some aesthetic problems, a significantly wide root represents a major technical problem for the surgeon who is trying to restore a healthy relationship between the size of the root and the interorbital space. There are no morphological studies based on quantitative analysis of the root and orbital findings in the normal population in the anthropometric literature.

In this paper we report the growth-related changes in the nasal root width, the intercanthal width,

and the ratio of the two measurements in North American Caucasians between 1 and 17 years of age to provide normal values for use in surgical restoration of harmony in this region.

MATERIALS AND METHODS

We measured 1603 healthy North American Caucasians (800 males and 803 females) aged 1 to 18 years. Two surface measurements were taken (for those between 1 and 3 years, by Hreczko; for those from 4 to 18 years, by Farkas): the width of the nasal root is given by the projective distance between the maxillofrontal point right and left at the base of the root (mf – mf) or at the feet of the root elevation level with the palpebral fissures, which correspond to the bony landmarks located at the meeting point of the

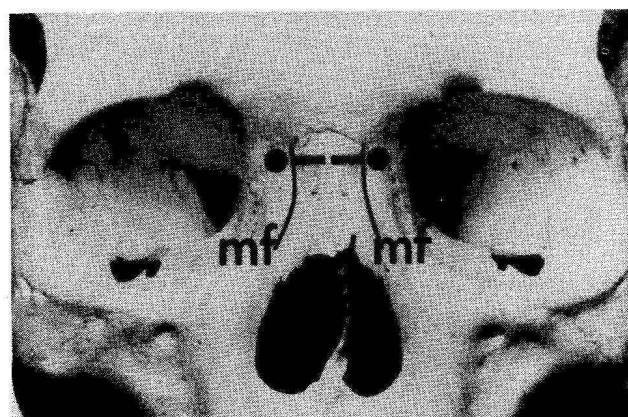
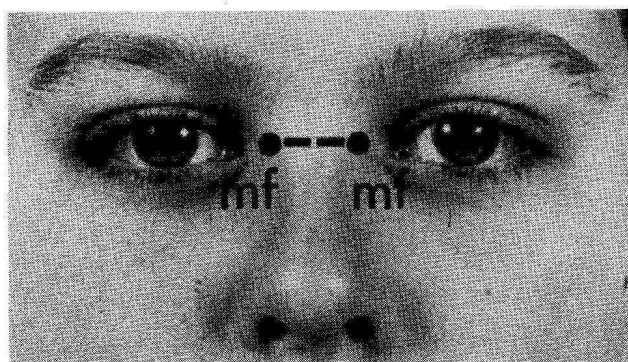


FIGURE 1. Nasal root width (mf-mf). The measurements were taken with a sliding caliper between the points where the right and left maxillofrontal and nasofrontal sutures cross (Farkas 1981). Upper half: Landmarks on the face. Lower half: Landmarks on the skeleton.

TABLE 1. Mean values of the intercanthal width, nasal root width, and the nasal root - intercanthal width index in North American Caucasian males.

Age (yr)	No. of subjects	en-en		mf-mf		mf-mf × 100/en-en	
		mean (x̄)	SD	mean (x̄)	SD	mean (x̄)	SD
1	26*	27.3	2.0	16.8	1.6	61.6	6.2
2	31	26.5	2.0	16.3	1.4	61.7	6.1
3	30	27.2	1.9	16.2	1.4	59.5	4.7
4	30	30.3	1.9	17.2	1.3	56.8	3.9
5	30	30.8	2.1	18.0	1.4	58.5	4.2
6	50	30.6	2.3	16.3	2.6	53.3	7.1
7	50	30.2	2.5	16.3	2.5	54.0	8.8
8	51	31.2	2.2	17.2	2.1	55.4	6.7
9	51	31.7	2.4	18.2	2.5	57.5	6.6
10	50	31.2	2.0	17.2	2.2	55.1	7.1
11	50	32.6	2.3	18.1	2.5	55.7	8.1
12	52	32.0	2.1	17.4	2.0	54.6	6.3
13	50	32.8	2.8	18.9	2.0	57.6	4.6
14	49	33.1	2.6	18.8	2.0	57.0	5.7
15	50	33.7	2.3	19.1	2.1	56.7	6.7
16	50	33.4	3.2	18.8	2.4	56.5	5.6
17	49	33.9	2.6	18.1	2.2	53.5	6.2
18	52	32.9	2.7	16.2	2.2	49.3	5.6

* Note: In 1-year-old, the number of subjects for the mf-mf and index measurements was 25.

maxillofrontal and nasofrontal sutures (Farkas 1981) (Figure 1); the intercanthal width is measured between the inner commissures (endocanthion - endocanthion, en-en) (Figure 2). The soft endocanthion points are located laterally from the bony medial orbital landmarks (MO) in patients with orbital hypertelorism (Günther 1923, Virchow 1924, Freihöfer 1980, Farkas et al. 1989). To measure the width of the nasal root, then, the branches of a sliding caliper are pressed firmly to the bony landmarks. The relationship between the two measurements was

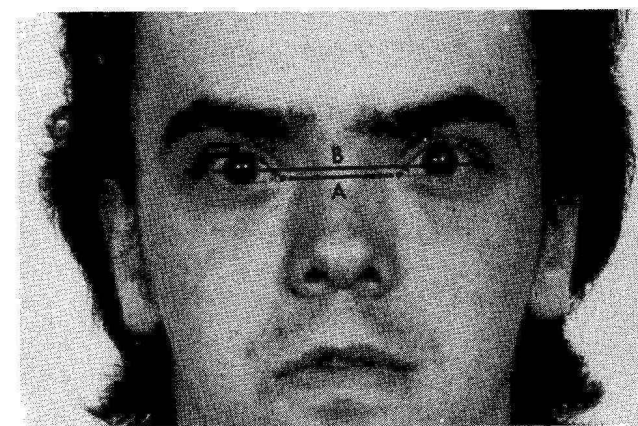


FIGURE 2. Full-face photograph of a patient. A: intercanthal width (endocanthion-endocanthion, en-en), B: biocular width (exocanthion-exocanthion, ex-ex).

TABLE 2. Mean values of the intercanthal width, nasal root width, and the nasal root - intercanthal width index in North American Caucasian females.

Age (yr)	No. of subjects	en-en		mf-mf		mf-mf × 100/en-en	
		mean (x̄)	SD	mean (x̄)	SD	mean (x̄)	SD
1	25	27.1	2.1	16.6	1.7	61.4	4.6
2	31	26.6	1.7	16.4	1.8	61.5	6.0
3	30	27.0	2.0	16.2	1.4	60.1	5.6
4	30	29.0	2.0	17.3	0.9	59.9	4.2
5	30	29.4	2.2	17.4	1.1	59.4	4.3
6	50	29.8	2.0	15.7	2.1	52.8	6.6
7	50	30.1	1.9	16.7	2.3	55.4	7.2
8	51	30.5	1.9	16.6	1.9	54.7	6.3
9	50*	31.1	2.2	17.3	2.4	55.9	6.7
10	49	31.2	2.6	17.2	2.4	55.1	6.6
11	51	31.6	2.2	16.9	2.1	53.6	5.8
12	53	31.6	2.6	16.8	1.8	53.5	5.6
13	49	32.2	2.3	17.3	2.3	53.9	5.3
14	51	32.4	2.1	17.6	2.3	54.5	7.0
15	51	32.7	2.3	18.7	2.2	57.1	6.1
16	51	31.8	2.0	16.9	2.5	53.2	7.3
17	51	32.5	2.1	17.1	2.4	52.5	6.1
18	51	31.6	2.4	15.4	2.1	48.8	5.7

* Note: In 9-year-old, the number of subjects for the mf-mf and index measurements was 49.

analysed with the help of the nasal root - intercanthal width index (Farkas and Munro 1987).

Methods of analysis

The mean values and standard deviations of the measurements and the index were determined for both sexes (Tables 1 and 2). We pooled the non-significantly differing findings for both sexes. Because of the marked drop of mean values in the width of the nasal root at 18 years of age for both sexes, the inevitable result of such a cross-sectional study, we used the larger mean values at 17 years. For consistency of analysis, we used the same age limit for the intercanthal width measurement and the nasal root - intercanthal width index.

The absolute total growth was calculated from the difference of the measurements between 1 and 17 years of age. The developmental level of the measurements is expressed as a percentage of the findings at 17 years. Growth increments in each category were calculated as a percentage of the mean value found in the previous age group (Savara and Singh 1968). We considered an increase of 6% or more a sign of rapid growth (Farkas 1981).

The time of full maturation was determined by the age at which the mean of the measurement plus two standard errors of the mean (SEM)

$$(SEM = \frac{\text{Standard deviation of the mean measurement}}{\sqrt{\text{Number of subjects}}})$$

is equal to the mean measurement value at 17 years of age minus two SEM (Blalock 1960).

Distance between the nasal root base and the endocanthion

The space between the palpebral fissure and the base of the nasal root is defined by the distance between the maxillofrontal and endocanthion landmarks, measured on the right and left from the nasal root. We calculated the size of this distance indirectly by subtracting the measurement of the nasal root width from that of the intercanthal width and dividing the result into two equal parts

$$(mf-en \text{ distance} = \frac{(en-en) - (mf-mf)}{2}).$$

RESULTS

Nasal root width

Developmental level. At 1 year of age, the mean width of the nasal root was 16.8 mm in males and 16.6 mm in females (mean, 16.7 mm). At 5 years of age the nasal root width reached 18 mm in males and 17.4 mm in females (mean, 17.7 mm).

Absolute total growth. Between 1 and 17 years, the mean of the absolute total growth was 1.3 mm in males and 0.5 mm in females.

Growth patterns between 1 and 17 years. Between 1 and 17 years, the width of the nasal root in males increased by a mean of 1.8 mm between 3 and 5 years and in females by 1.2 mm. A second growth spurt was observed in males between 7 and 9 years (mean, 1.9 mm) and in females between 6 and 7 years (mean, 1.0 mm). The third growth spurt occurred between 12 and 13 years in males (mean, 1.8 mm) and between 12 and 15 years in females (mean, 1.7 mm). Between 16 and 17 years, the mean values of the nasal root width decreased moderately in both sexes (Tables 1 and 2).

Maturation. In males, the nasal root width reached its adult size at 10 years of age (mean, 17.2 mm), 95.0 % of its full size; between 10 and 17 years, the root width increased by a mean of 0.9 mm. In females, the root obtained its adult size at 14 years of age (mean, 17.6 mm), 94.1 % of the largest width measurement at 15 years, after which age the width measurements decreased moderately.

Intercanthal width

Developmental level. At 1 year of age, the average intercanthal width was 27.3 mm in males and 26.9 mm in females (mean, 27.1 mm). The measurement between 1 and 17 years of age increased by 5.6 mm in males and 4.7 mm in females (mean, 5.2 mm). At 5 years of age, the intercanthal width reached a mean 30.8 mm in males and 29.4 mm in females (mean, 30.1 mm). It increased a further 2.1 mm in males and 2.2 mm in females to achieve the adult size at 17 years.

Absolute total growth. Between 1 and 17 years of age, the absolute total growth was 5.6 mm in males and 4.5 mm in females (mean, 5.2 mm).

Growth patterns between 1 and 17 years. A rapid growth spurt (mean, 9 %) was identified in the intercanthal width in both sexes between 3 and 4 years; the absolute increase (2.3 mm) represented 44.2 % of the mean absolute total growth increments (5.2 mm) between 1 and 17 years. A second, smaller growth peak was observed only in males between 10 and 11 years (26.9 % of the absolute total growth increment, 1.4 mm of 5.2 mm).

Maturation. The statistical maturation of the intercanthal width was reached at 8 years in females and at 11 years in males. The mean measurements, 33.2 mm in males and 31.1 mm in females, were only 0.3 mm (males) and 0.5 mm (females) smaller than the measurements at 17 years of age, 99.1 % and 96.5 % (mean, 97.8 %) of adult size, for males and females respectively.

Nasal root - intercanthal width index

Developmental level. At 1 year of age, the developmental level value of the nasal root - intercanthal

width index was 61.6 for males and 61.4 for females (mean for both sexes, 61.5). These values indicate a relatively wide nasal root within the space between the orbits that occupies almost two thirds of the intercanthal width.

Age-related changes between 1 and 17 years. The trend in index values decreased from 61.5 at 1 year to 53.0 at 17 years (means for both sexes) because of larger absolute total growth increments in the intercanthal width (6.1 mm) than those in the width of the nasal root (0.9 mm) (means for both sexes). The generally decreasing character of index values was not consistent. At 6 years of age, there was a marked drop in values for males, followed by moderate increases. A second decrease in the index values was observed between 10 and 12 years and a third one after 16 years. For females, a much more moderate fluctuation in the index values occurred between 6 and 17 years (Table 2).

Maturation. The relationship between the nasal root width and the intercanthal width reached its adulthood quality in 9-year-old boys (index, 57.5) and 15-year-old girls (index, 57.1).

Distance between the nasal root base and endocanthion

At 1 year of age, the nasal root side – palpebral fissure space was 5.3 mm for both sexes, which gradually increased to 7.1 mm at 6 years, 7.4 mm at 12 years, and 7.8 mm at 17 years of age (mean values for both sexes).

DISCUSSION

Our study shows that the width of the nasal root of 1-year-old children occupies most of the space between the orbits. Visually, the area is almost flat because of the relatively thick skin cover that masks the small elevation of the nasal root. With age, the sides of the root become better outlined because of the increased depth of the root. Simultaneously, because of the larger increments in the intercanthal width than in the nasal root width, the space between the base of the root slopes and the palpebral fissures increases. Thus, the distance between the endocanthions is not identical with the width of the nasal root.

In patients with facial anomalies, whose nasal root appears wide on visual examination, the only reliable method of measuring the nasal root width is anthropometric: the branches of the sliding caliper are pressed to the bases of the root-slopes.

The surface measurement of the nasal root width is larger than the measurement taken from the skeleton because of the various thicknesses of the skin cover. The intercanthal width is larger than the bony interorbital distance: in a group of hypertelorid patients, the intercanthal width was larger by a mean of 12.1 mm (Farkas et al. 1989).

The norms of the nasal root width and the intercanthal width, as well as the normal values of their ratio, offer valuable information for surgeons trying to help patients whose measurements deviate from their population norms or proportions. Only the control values for a population of the same age and ethnic group as the patient should be used (Günther 1933b, Cohen 1982, Farkas et al. 1989). The changes in these measurements, calculated from the nasal root – intercanthal width index, are essential to any surgical restoration of harmony in this area.

CONCLUSIONS

The surface measurements of the nasal root and intercanthal widths obtained from 1603 North American Caucasians between the ages of 1 and 17 years and the quality of the proportion between these measurements revealed the following:

1. For 1-year-old boys and girls, the mean nasal root width was 16.7 mm, representing 94.9 % of the mean value at 17 years of age.
2. The absolute total growth increment in the nasal root width between 1 and 17 years of age was negligible for both sexes (mean, 0.9 mm).
3. The mean intercanthal width at 1 year of age was 27.2 mm for both sexes, representing 81.9 % of the value at 17 years (mean, 33.2 mm).
4. The absolute total growth increment in the intercanthal width between the ages of 1 and 17 years was 6.6 mm in boys and 5.5 mm in girls (mean, 6.1 mm).
5. The nasal root-intercanthal width index decreased with age in both sexes, from 61.5 at 1 year of age to 53.0 mm at 17 years (means for both sexes).
6. The area between the root sides and each endocanthion landmark increased from 5.3 mm at 1 year of age to 7.8 mm at 17 years (means for both sexes).
7. The nasal root width reached its mature size in 10-year-old boys (17.2 mm) and in 14-year-old girls (17.6 mm).
8. The intercanthal width reached its adult size at 8 years of age in girls (30.5 mm) and at 11 years in boys (32.6 mm).
9. The statistical adult nasal root – intercanthal width index values for 9-year-old boys and for 15-year-old girls were 57.5 and 57.1 respectively.
10. Maturation time, which was defined statistically, helped to determine the age at which the measurement (index value) reached the level close to the adult value.

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