

Changes in the Interpupillary Distance (IPD) with Ages and Its Effect on the Near Convergence/Distance (NC/D) Ratio

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ABSTRACT

This study aims at determining the mean value of the ophthalmic anthropometrics parametar-IPD (Interpupillary distance) and the mean value of NC/D (Near convergence / distance) in 300 subjects aged 5 to 60 years. The influence of IPD on the NC/D ratio in the same subjects will also be investigated. The investigation showed that the mean value of IPD is 60.5 ± 2.4 cm, and the mean value of NC/D ratio is 4.95 ± 2.28 prD. Mean IPD of 5.1 cm in 5-year old children increases to 6.3 cm in adult over 20. In adulthood, IPD remains the same, i.e. 6.3 cm. Our study showed that the NC/D ratio is stable during lifetime. Since NC/D is stabile and IPD changes during lifetime, it is evident that factors other than IPD, such as convergence and accommodation, influence the stability of the NC/D ratio.

Key words: interpupillary distance, NC/D ratio

Introduction

In modern industrialized society near vision is more frequently used than far vision. Most of our activities today are performed at a distance less than six meters. In these circumstances, for binocular vision to remain clear and with stereopsis, the accommodation of the eyes must be adequately strained and the vision axes placed in a particular convergence.

Information about synkinesis between convergence and accommodation is obtained by determining the Convergence (C) : Accommodation (A) ratios¹⁻⁵. The ratio induces by accommodation is the Accommodative Convergence / Accommodation (AC/A) ratio. The ratio induced by accommodation and the feeling of nearness represents the Near Convergence /

Distance (NC/D) ratio and depends on Interpupillary distance (IPD)³. The ratio induced by proximal factors is the Proximal Convergence/Distance (PC/D) ratio.

The meaning of the term »normal C : A ratio« differs in various authors. The mean values of AC/A, PC/D and NC/D ratios are shown in Table 1³.

There is different evidence about mean value of the NC/D ratio. Francescheti² found that the mean value of the NC/D ratio is 4.7±1.7 prD, and Nishioka³ found that the mean value of the NC/D ratio in children equals 4.72±1.67 prD.

Opinions regarding its stability in lifetime also differ^{1,5}.

The effect of the ophthalmic anthropometric parametar of Interpupillary distance (IPD) on the NC/D ratio is not clear.

This paper investigates the mean value of IPD and NC/D and its stability during lifetime. An attempt is also made to evaluate the influence of IPD on the NC/D ratio.

Patients and Methods

300 healthy randomized subjects aged 5 to 60 years were tested for the assessment of IPD and NC/D ratio. 50 subjects were tested in each group.

Method of assessment

The far interpupillary distance was measured using a ruler calibrated in mm, after the Victorin method⁶. The subject wears own corrective glasses for ammetropia. Deviation of the visual axes at distance (Q1) was determined using the

TABLE 1
C/A RATIOS

Mean values of AC/A ratio	Mean values of PC/D ratio	Mean values of NC/D ratio
Morgan, (1944 year) –4.00 prD	1.2 prD	5.2 prD
Morgan, (1952 year) –3.60 prD	1.4 prD	5.0 prD
Ogle, Martenson (1957 year) –3.37 prD	1.5 prD	4.87 prD

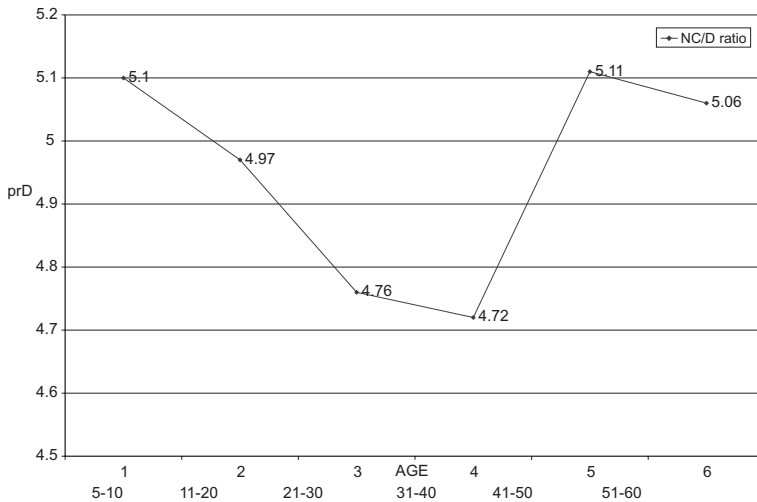


Fig. 1. NC/D ratio.

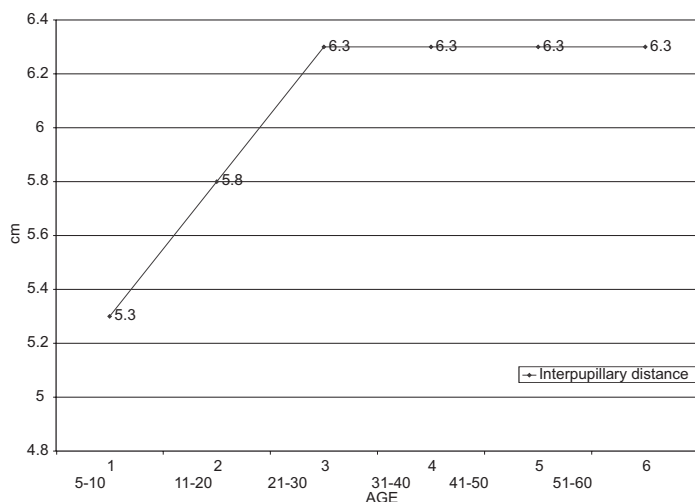


Fig. 2. Interpupillary distance.

Cover test and prisms: the subject focuses the smallest clearly visible symbols of optotypes at a distance of 6 meters.

Deviation of the visual axis at near distance (Q2) was determined next, where the subject focuses the smallest clearly visible letters of the Jagger chart at a distance of 33 cm. The ratio NC/D is calculated with the formula³:

$$\text{NC/D} = (\text{Q2} - \text{Q1})/3 + \text{IPD}$$

$(\text{Q2} - \text{Q1})/3$ can be read in Table 2⁷. IPD is then added.

Results

The mean value of IPD was $60.5 \text{ cm} \pm 2.4$ and mean value of the NC/D ratio was $4.95 \pm 2.28 \text{ prD}$ ($n=300$ subjects aged 5 to 60).

The mean value of the NC/D ratio for subjects aged 5 to 20 and 40 to 60 are a little higher than they are in subjects between 20 to 40, but this difference is not statistically significant on a level of 5% (Student t-test).

The mean value of IPD in subjects aged 5 to 10 was $5.1 \pm 1.5 \text{ cm}$. At subjects aged 11 to 20 it was wider for 0.7 cm i.e.

$5.8 \pm 2.5 \text{ cm}$. From the age of 20 to the age of 60 IPD remains constant: $6.3 \pm 2.3 \text{ cm}$.

Discussion and Conclusion

Our investigation showed that the mean value of the NC/D ratio for people aged 5 to 60 is $4.95 \pm 2.28 \text{ prD}$, which is very close to the mean value of the NC/D ratio found by Francesheti ($4.7 \pm 1.7 \text{ prD}$). There is a fair amount of conflicting data on the stability of the AC/A ratio during lifetime^{1,2,7-9}, but the stability of the NC/D ratio is mentioned by only one author¹. In our investigation, the NC/D ratio showed a small, statistically insignificant decrease between the age of 20 and 40 and a small increase in subjects aged 5 to 20 and 40 to 60, which is equally statistically insignificant. These findings clearly demonstrated the stability of the NC/D ratio during lifetime.

The mean value of IPD was $60.5 \pm 2.4 \text{ cm}$ and it showed a significant increase from 5.1 cm in 5-year olds to 6.3 cm in adults over 20. In adulthood IPD remains the same, i.e. 6.3 cm. It is evident that the absolute value of IPD increases with age, at least until the third decade of life.

TABLE 2
CONVERGENCE / ACCOMMODATION RATIO TABLE

		Dsph									
		1	2	3	4	5	6	7	8	9	10
prDsph	1	1	0.5	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1
	2	2	1	0.7	0.5	0.4	0.3	0.3	0.2	0.2	0.2
	4	4	2	1.3	1	0.8	0.7	0.6	0.5	0.4	0.4
	6	6	3	2	1.5	1.2	1	0.8	0.7	0.6	0.6
	8	8	4	2.6	2	1.6	1.3	1.1	1	0.9	0.8
	10	10	5	3.3	2.5	2	1.6	1.4	1.2	1.1	1
	12	12	6	4	3	2.4	2	1.7	1.5	1.3	1.2
	14	14	7	4.6	3.5	2.8	2.3	2	1.7	1.5	1.4
	16	16	8	5.3	4	3.2	2.6	2.3	2	1.8	1.6
	18	18	9	6	4.5	3.6	3	2.6	2.5	2	1.8
	20	20	10	6.6	5	4	3.3	2.8	2.5	2.2	2
	22	22	11	7.3	5.5	4.4	3.6	3.1	2.7	2.4	2.2
	24	24	12	8	6	4.8	4	3.4	3	2.6	2.4
	26	26	13	8.6	6.5	5.2	4.3	3.7	3.2	2.8	2.6
	28	28	14	9.3	7	5.6	4.6	4	3.5	3.1	2.8
	30	30	15	10	7.5	6	5	4.3	3.7	3.3	3
	32	32	16	10.6	8	6.4	5.3	4.6	4	3.5	3.2
	34	34	17	11.3	8.5	6.8	5.6	4.8	4.2	3.7	3.4
	36	36	18	12	9	7.2	6	5.1	4.5	4	3.6
	38	38	19	12.6	9.5	7.6	6.3	5.4	4.7	4.2	3.8
40	40	20	13.3	10	8	6.6	5.7	5	4.4	4	

Dsph = dioptic sphere; prDsph = prism dioptic

These results corroborate the conclusion of Pointer's earlier investigation⁶. IPD of our children were narrower than those in Chinese children in Taiwan¹⁰ and wider than those observed in the Indian population¹¹. A knowledge of the normal value of these parameters in race, ethnic group or specific population can help in studying cranio-facial syndromes, developmental anatomy, surgical management of trauma and in restorative facial surgery. It is

useful also for commercial (frame and lens design) and clinical (design of binocular optical instruments) manufacture.

The NC/D ratio depends on IPD, accommodation and convergence. Since IDP changes during lifetime, while NC/D ratio remains stable, it can be considered that IDP influences by accommodation or convergence, rather than the stability of the NC/D ratio.

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PROMJENE INTERPUPILARNE DISTANCE TIJEKOM ŽIVOTA I NJEZIN UTJECAJ NA OMJER IZMEĐU BLIŽE KONVERGENCIJE I DISTANCE (NC/D)

S A Ž E T A K

Namjera ove studije je odrediti srednje vrijednosti oftalmičkog antropometrijskog parametra –IPD (interpupilarne distance) i srednju vrijednost NC/D (konvergencija na blizinu/daljinu) omjera u 300 osoba starosti od 5 do 60 godina. Također se istražio utjecaj IPD na NC/D omjer u istih osoba. Istraživanje je pokazalo da je srednja vrijednost IPD $60,5 \pm 2,4$ cm, a srednja vrijednost NC/D omjera $4,95 \pm 2,28$ prD. Srednja vrijednost IPD od 5,1 cm kod djece stare 5 godina povećava se na 6,3 cm u dvadesetoj godini. Kod odraslih IPD ostaje isti i iznosi 6,3 cm. Naša studija je pokazala da je NC/D stabilan tijekom života. Budući da je NC/D stabilan, a IPD se tijekom života mijenja, očigledno je da na stabilnost NC/D ne utječe IPD već drugi faktori kao konvergencija i akomodacija.