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IP International Journal of Ocular Oncology and Oculoplasty

Journal homepage: <https://ijooo.org/>

Original Research Article

The distribution of near point of convergence, near point of accommodation and their association with interpupillary distance in young adults- A cross sectional study

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ARTICLE INFO

Article history:

Received 10-06-2023

Accepted 04-07-2023

Available online 06-11-2023

Keywords:

Convergence

Accommodation

Interpupillary distance

ABSTRACT

Clinical Relevance: Vergence dysfunctions and accommodation anomalies are the main causes of asthenopic symptoms. These may be related to differences in the anthropometric measurements.

Background: The anthropometric measurements have a significance in understanding human physical and physiological variations. This study was carried out with the purpose of measuring the near point of convergence (NPC), near point of accommodation (NPA) and to determine their association with interpupillary distance (IPD) in a population of North-western India.

Materials and Methods: This was a cross sectional study carried out on young adults of 18-22 years age group. The NPC and NPA were measured with a Royal Air Force (RAF) scale. Distance IPD was measured with a ruler and autorefractometer. The results were analysed statistically to study the relation of the variables with each other.

Results: The average IPD of the study population was 62.18 mm, IICD was 29.65, NPC was 6.55 cm, NPA was 9.42 cm. The correlation between IPD and IICD was 0.15 (weak). The correlation between IPD and NPC was found to be 0.18, correlation between IPD and NPA OD was 0.35 and the correlation between IPD and NPA OS was 0.30, which all were statistically weak.

Conclusions: The anthropometric measurements of the study population were similar to those reported by other studies on the Indian population. The correlation between NPA and IPD and that between NPC and IPD was found to be weak.

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1. Introduction

The anthropometric measurements are important in understanding human physical and physiological variations. Vergence dysfunctions and accommodation anomalies are

the main causes of asthenopic symptoms such as occasional double vision, headaches, and blurred vision after prolonged near work.¹⁻³ Young adults experience such symptoms more often than others do because of their higher demand for near vision.¹ The high prevalence of accommodative and binocular dysfunctions, with estimates ranging between 13.5% and 42%, point to the importance of examining

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the binocular vision status during routine ophthalmic examinations.⁴⁻⁷ Measurement of NPC is commonly done by clinicians to evaluate binocular status. The near point of convergence (NPC) is a basic parameter of the visual system and represents the amplitude of convergence.⁸ The assessment of NPC is of clinical value in the diagnosis of convergence insufficiency (CI), which is one of the most common disorders of binocular vision. Most researchers consider NPC the most important diagnostic parameter in convergence insufficiency.⁹⁻¹¹ However, this variation could also arise because of the variable definitions and diagnostic criteria used by different researchers. Another common dysfunction that leads to asthenopic symptoms is Accommodation insufficiency (AI), a situation in which the accommodation amplitude (AA) is lower than expected for a person's age.^{12,13} Measurement of the near point of accommodation (NPA) provides an index for determining the AA were excluded from the study.¹⁴ Large variability in the AA may be due to inter-individual differences in ciliary muscle function or lens properties, optical factors other than physiological power, or psychological factors, such as variability in blur criterion among individuals (Woods, Colvin, Vera-Diaz, & Peli, 2010) or between different trials of the same individual. Other experimental errors also add to the variability.

The researchers did not find much literature which had shown if the value of IPD has any bearing on the NPC and NPA. This study was carried out with the aim of studying the relation of IPD with NPC and NPA.

2. Materials and Methods

This cross-sectional study was conducted in a medical college in India. The target population of the study was medical students and interns enrolled at the time of the study. The Ethics Committee of approved the study protocol, which adhered to the tenets of the Declaration of Helsinki. Informed consent was obtained from all participants. The students were assured that the data were anonymous and confidential. Subjects with visual acuity less than 6/9 in either eye, strabismus, history of intraocular surgery, ocular or systemic diseases affecting accommodation and binocular vision and use of ocular or systemic medications that can affect accommodation and binocular vision. All examinations were conducted in the department of Ophthalmology. All students underwent complete vision tests performed by an expert optometrist and slit-lamp ophthalmic examinations performed by an experienced ophthalmologist. Vision tests included the measurement of refraction and IPD with the autorefractometer, followed by uncorrected and corrected visual acuity measurement using a Snellen chart. The distance IPD was measured with a plastic ruler after asking the participant to look into the distance. The NPA and NPC were measured using the push-up method with the Royal

Air Force (RAF) Rule. The NPA was measured using the best correction in place. While the participants focused monocularly on the "E" one line above their near visual acuity threshold, the near Snellen E chart was gradually moved toward them until they reported that the letters were blurry, and they were no longer able to maintain a clear image. At this point of sustained blur, the distance between the target and the spectacle plane was measured in centimetres. The NPA was measured three times, and the average of these measurements was recorded. The AA was calculated monocularly for each eye. The next step was NPC measurement, which was performed with the best-corrected vision in place using the RAF Rule. A single line with a dot was used at 40 cm as the target. The target was gradually moved towards the participants until they were no longer able to maintain a single image and reported double vision, or the examiner noted ocular divergence. The distance from the target to the spectacle plane was recorded as the NPC. To increase measurement accuracy, NPC measurements were performed three times for each individual, and the average of the three measurements was recorded as the final NPC.

3. Results

Five hundred participants were included in the study of which 230 were male and 270 were female. The mean age of the study participants was 21.2 (+ 1.4) years. Table 1 shows the distribution of responses.

On statistical analysis, following were the observations.

The correlation between IPD and IICD was 0.15 (weak).

The correlation between IPD and NPC was 0.18 (weak).

The correlation between IPD and NPA OD was 0.35 (weak).

The correlation between IPD and NPA OS was 0.30 (weak).

The correlation between IPD and NPA B/L was 0.18 (weak).

4. Discussion

It is essential to know standard values of anthropometry in different specialties such as oculoplasty and Orbital Surgery, optometry and genetics.¹⁵

In the present study, the IPD range for the females was 56-67 mm and that for the males was 58-65 mm. The IICD for both females and males ranged between 24-38 mm. The measurements are similar to those reported by an earlier Indian study wherein the IICD, IPD and OICD ranges for males were 20-36 mm, 46-70 mm and 76-105 mm, and for females 20-36 mm, 46-75 mm and 71-105 mm, respectively. The normal values of these parameters were lower than those observed for other races.¹⁶ Another study done by Vasanthakumar P et al. showed the mean values of IPD, ICD and OCD to be 66.72 mm, 34.27 and 95.55 mm.¹⁷ The results of our study are also similar to those reported by a

Table 1: Showing distribution of the anthropometric measurements

Gender	IPD mm	IICD mm	NPC cm	NPA OD cm	NPA OS cm	NPA BL cm
F	61	31.22	6.14	9.81	9.81	9.35
M	63.3	27.72	7.04	10.72	10.93	9.52
Total	62.18	29.65	6.55	10.24	10.31	9.42

study conducted in Pakistan which reported the mean IPD to be 61.8 mm and mean IICD of 30.9 mm.¹⁸

The present study population had a range of NPC for females ranging between 5-10 cm and that for the males between 5 to 11 cm. Which is similar to those reported by other Indian studies.¹⁷ The range is lower than that reported by a study from Iran which reported a range of 5-15.24 cm for expected NPC values¹⁹ A study from the USA has reported much lower values of NPC.²⁰

Different NPC values have been reported in different studies. These different results can be attributed to several factors, including the type of target used in the NPC measurement, differences in the characteristics of the studied populations, and variations in the source and method of measurement. Siderov et al²¹ measured the NPC in 20–85 years old subjects using several types of targets and found that the NPC results were influenced by the target type only in younger individuals but not in presbyopic individuals. A study concluded that the NPC is related to accommodation. They argued that because in NPC measurement, the absolute convergence is being evaluated, which is the combination of tonic, accommodative, proximal, and reflexive convergences. Therefore, stimulating accommodation increases the total amount of absolute convergence by increasing accommodative convergence, and ultimately, the measured NPC is underestimated; however, this does not occur with non-accommodative targets.¹⁹ Regarding the measurement method, it has been suggested that targets that are mounted on a rule provide a higher estimated NPC than targets that are moved manually and freely.²²

In the present study, the NPC was more in the males but the intergender difference was not statistically significant. Studies on the relationship between sex and the NPC suggested a more distant NPC in men²³ even though the inter-sex difference in the NPC in both studies was ≤ 0.1 cm, which was clinically insignificant. However, in another study, the mean NPC in men was 0.37 cm further than that in women.¹⁹

IPD has been reported to differ among races. Mean IPD has been quoted in the stereoscopic literature as being anything from 58 mm to 70 mm.²⁴ The 'international standard' for IPD is 63.5 mm. The mean IPD measurements of our study population was 61 mm for females and 63.63 for the males which is higher than that reported by earlier Indian studies.^{25,26} The difference may be because of the different ethnic group studied and a different range of age groups included in the studies. Across researched ethnic

backgrounds, the male IPD is on the average 2 to 3 mm wider than the female IPD.²⁷ In our study population also similar difference was observed.

The researchers did not find any literature on relation of IPD with NPC and NPA though some studies have documented that NPC is mostly under the influence of four components of the total convergence response, namely, fusional convergence, accommodative convergence, proximal convergence and the accommodative-convergence/ accommodation (AC/A) ratio,²⁸ as well as interpupillary distance (IPD).²⁹ As per earlier studies, the ratio induced by accommodation and the feeling of nearness represents the Near Convergence / Distance (NC/D) ratio and depends on Interpupillary distance (IPD).³⁰ However, in the present study the correlation between NPA and IPD and that between NPC and IPD was found to be weak.

5. Conclusions

The anthropometric measurements of the study population were similar to those reported by other studies on the Indian population. The correlation between NPA and IPD and that between NPC and IPD was found to be weak.

6. Limitation of the study

Since the sample size was not very large and the participants belonged to one region, the results may not be generalizable.

7. Source of Funding

None.

8. Conflict of Interest

There is no conflict of interest

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Cite this article: Bandhu SD, Pawar SA, Garg S, Yukta, Rahman MHU. The distribution of near point of convergence, near point of accommodation and their association with interpupillary distance in young adults- A cross sectional study. *IP Int J Ocul Oncol Oculoplasty* 2023;9(3):122-125.