

To Investigate the Near Point of Convergence (NPC) in Hyperopic Children.

Sonia Phulke

Assistant Professor, Department of Ophthalmology, Dr. B R Ambedkar State Institute of Medical Sciences, Mohali

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Corresponding author: Dr. Sonia Phulke

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Abstract

Purpose: This study was aimed to investigate the Near point of Convergence (NPC) in hyperopic children.

Methods: The subjects comprised of school-going 76 children aged 5-14 years. The NPC was measured with the help of Royal Air Force (RAF) ruler. Refractive error is defined based on the spherical equivalent (SE) of cycloplegic refraction. The hyperopia is defined as SE equal to or greater than +2.00 D.

Results: The mean age of the participants was 10+2.517 years (range 5-14) and 42 (53%) of them were boys. The patients had shown varying amount of hyperopia (+0.75D- +12.0D). The mean NPC was 7.09+/-2.52cm (median 6 cm at 50th percentiles) and NPA was 6.004+1.9015cm. The mean NPC was significantly higher in females (7.48+2.72 cm P= 0.049). There was no significant relation of NPC with amount of hyperopia (P= 0.774).

Conclusion: We examined the relationship of NPC with the amount of hyperopia and after adjusting for age and sex, we did not find any significant relationship between NPC and the amount of hyperopia. Further studies including with larger sample size and comparison of NPC values with the different targets may help to determine the NPC distribution as per the amount of hyperopia in children.

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Introduction

Hyperopia is that form of refractive error in which parallel rays of light are brought to focus some distance behind the retina, when the eyes are at rest, the image formed here is therefore made up of circle of diffusion of considerable size and is consequently blurred.

Early detection of hyperopia may help to prevent the development of strabismus and amblyopia in young children. In older children, uncorrected hyperopia may affect learning ability.[1] In individuals of any

age, it can contribute to ocular discomfort and visual insufficiency.

The near point of convergence (NPC) test is an important test for the assessment of binocular function and done by clinicians as a routine test. [2]

It represents the convergence amplitude or in other words the nearest point in space where an individual can maintain binocular fusion. Many researchers consider NPC as the most important diagnostic parameter for convergence

insufficiency (CI).[3,4,5] According to Rouse et al. 93.8% of optometrists consider NPC as an important diagnostic index for the detection of CI.[6]

Despite the widespread clinical use of NPC and its diagnostic value, its normal value and its correlation with a refractive error have not been studied extensively.

In pre-existing studies, the primary aim was to record NPC value mostly in adults, in emmetropic or myopic children. [7,8,9] The definitive objective to correlate NPC with pediatric hyperopia was never considered. As based on the previous literature, NPA and NPC increase with age, male sex, and hyperopia.[7]

As the myopic kids are more symptomatic and can be diagnosed at an early age than hyperopic, various previous studies have significantly found the association between NPC and myopia, but the literature in view of hyperopic children is very less. [9,10,11]

In our review of the literature, we found few previously published studies addressing NPC values in hyperopic children. None of them were exclusively targeted for pediatric hyperopia and correlated with the amount of hyperopia. [12,13,14]

A variety of targets has been used for NPC measurements such as fingertip, pencil tip, or N5 letter presented in free space and RAF. [2,9,12,13,14] According to Scheiman and colleagues, although the clinical diagnosis can be made with either target, accommodative targets are the most accurate.[3] The sensitivity of NPC measurement using accommodative targets can be improved by repeating the test. In the present study, we aimed to determine the NPC value in hyperopic children by RAF rule and its correlation with the degree of hyperopia. In addition, the correlation of NPC value was also explored with different age groups, sex, and NPA.

To the best of our knowledge, it is the first study done to detect the NPC value and its correlation with degree of hyperopia in school going children.

Material and Method

Methods- This cross-sectional hospital-based, observational study was conducted at the Regional Institute of Ophthalmology, Bhopal, India. All patients attending the outpatient department were screened and all pediatric hyperopic children between the age group of 5-14 years were enrolled in the study from January 2007 to December 2007. Appropriate consent/assent was obtained from all the participants/parents and the conduct of the study complied with the Declaration of Helsinki.

The children of Indian origin, of both sex and who were found to be cooperative and give consent for the study were included. The children, who were not cooperative, not willing for the test, have amblyopia, strabismus, nystagmus or vertical phorias, and prior history of any ocular surgery were excluded from the study.

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The purpose and procedures for the study were clearly explained to children and their parents. Trial testing was performed for all complex tests such as the measurement of NPA and NPC on RAF rule. To minimize examiner bias, all tests were performed by well-trained single optometrists who were not aware of the refractive status of the child.

Examination- All children underwent a comprehensive ophthalmic examination starting with visual acuity measurement and refraction. Visual acuity was measured

using the Snellen's chart at a distance of 6 meters. For all children, non-cycloplegic refraction was done by retinoscopy using the streak retinoscope.

The retinoscopy was then performed under cycloplegia with 1% cyclopentolate eye drops. One drop of cyclopentolate was instilled after every five minutes three times and retinoscopy was performed almost one hour later. Then post mydriatic test (PMT) performed after three days and maximum convex lenses with which the patient has maximum visual acuity were prescribed. For NPC and NPA, measurement was done with the help of RAF (Royal Air Force) rule after the post mydriatic test and after optimal refractive correction. A vertical line target over the RAF rule moved slowly toward the child. The break point was recorded as NPA for analysis when the child reports blurring of the line and as NPC (break point) when diplopia or at a point where the eye diverges. The NPA was determined first for each eye separately and then binocularly. The NPA is measured in

centimeters marked on one side of the instrument bar. The side of the bar marked in dioptres indicates the amplitude of accommodation in dioptres. The third side of the bar shows the age corresponding to the accommodation.

Refractive error is defined based on the spherical equivalent (SE) of cycloplegic refraction. The hyperopia is defined as SE equal to or greater than +2.00 D.

The hyperopia was further subdivided into mild (+2.0D), moderate (+2.25D-+4.0D) and, severe groups (>4.0D).

Results

In this study 3655 patients were screened for pediatric hyperopia. (Figure 1) Of these, 76 children were found to be fulfilling the inclusion criteria for the study. The mean age of the participants was 10 ± 2.517 years (range 5-14) and 42 (53%) of them were boys. The patients had shown varying amount of hyperopia (+0.75D- +12.0D) and presented with different presenting complaints and symptoms (Table 1 and 2)

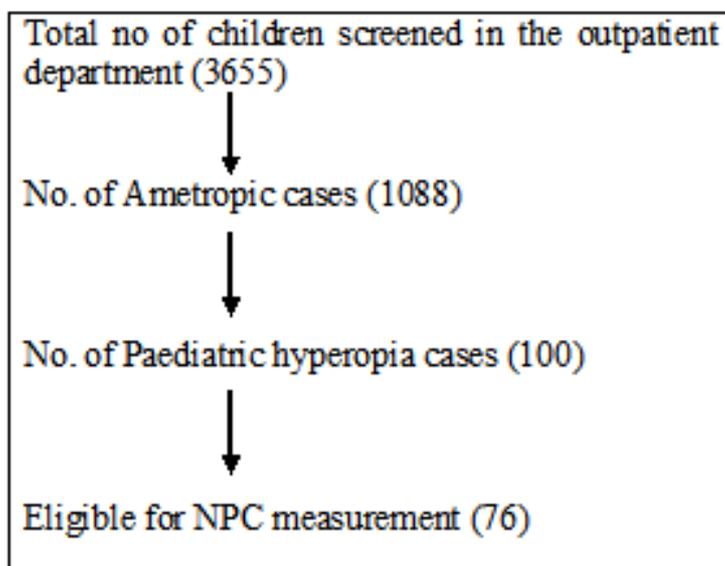


Table 1: Amount of Hyperopia

Sr. No	Amount of Hyperopia in Diopter	Eyes	%
1.	<+2.0D	142	71.0
2.	+2.25D- +4.0D	42	21.0
3	>4.0D	16	8.0

Table 2: Presenting complains/symptoms in Hyperopic children

Symptoms	No. of cases
Ocular	
- Heaviness of eyes	07
- Pain in eyes	20
- Recurrent Redness	25
- Frequent blinking/Watering	45
- Deviation of eyes	06
Visual	
- Defective distant vision	30
- Defective Near Vision	16
- Defective distant and near vision	05
Referred (from other department)	
- Headache	51
- Unspecified	14

The mean NPC was 7.09 ± 2.52 cm (median 6 cm at 50th percentiles) and NPA was 6.004 ± 1.9015 cm. The mean NPC was significantly higher in females (7.48 ± 2.72 cm $P=0.049$), but not found to be statistically significant.

There was no significant relation of NPC with amount of hyperopia ($P=0.774$).

Table 3: The NPC and NPA in centimeter

	Number of participants	NPC break in cm (mean \pm SD)	NPA in cm (mean \pm SD)
Gender			
1. Male	34	6.63 ± 2.211	5.37 ± 0.89
2. Female	42	7.48 ± 2.75	6.53 ± 2.32
Age group (years)			
1. 5-9	27	6.92 ± 2.421	5.759 ± 1.41
2. 10-14	49	7.26 ± 2.648	6.255 ± 2.2927

Discussion:

In general, the prevalence of refractive errors varies considerably according to the region, ethnicity, and age, which major factors are known to influence the prevalence of ocular characteristics including hyperopia. The reported prevalence of hyperopia in our study is comparable with that of previously published reports by Oveneri-Ogbomo et al in 2010.[15] The findings from the current study is coinciding with Naidoo et al., who applied cycloplegia for hyperopia

assessment.[16] However, our results (2.73%) are in contrast with Kumah et al., who reported 0.3% of hyperopia in school age children between 12-15 years of age group without cycloplegia.[17]

In the current study, the mean NPC was significantly higher in females (7.48 ± 2.75 cm, $p=0.049$). The previously published reports by Chen et al[18] in 2000 and in 2016 by Ostadimoghaddam et al[19] had shown that the male group of their studies had higher NPC, though the

difference between male and female NPC was not statistically significant.

In the indexed study, the mean NPC values was 7.09 ± 2.52 cm and had shown increase in NPC values with age, however, Larson et al. and Yekta et al. observed lower NPC values in children (younger ages).[20,21]

The difference in NPC values in different region could be influenced by genetic and environmental factors as well as by the measurement techniques. [22]

Previously published studies have also shown that NPC recedes with aging (Table 4).[23] This can be due to accommodation reduction with age, which results in reduced accommodation convergence and consequently, a remote NPC.

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Table 4: NPC values in different age group reported in various studies

Author	Sample size	Age (years)	Mean NPC (in cm)
Abraham et al [14]	50	1-18	7.17
Larsson et al [20]	270	10	6.2
Yekta et al[12]	3701	4-6	5.10
Hussaindeen et al [13]	920	7-17	3 (accommodative) 7 (nonaccommodative)
Chen et al[18]	485	2-17	1.9
Hyperopia cases			
Aryawan 2021[7]	5	7-12	6
Present study	76	5-14	7.09

Investigating the relationship between the NPC and the amount of hyperopia, the current study did not show any significant correlation. Though, the previously published reports showed that the hyperopia group had higher NPC break as compared to myopic or astigmatism group the results were not adjusted for the amount or degree of hyperopia.[7]

Hashemi et al in 2018 and 2019 reported that refractive errors significantly affected NPC.[24,25] Based on the multiple linear regression, Hashemi et al found that the hypermetropic group had a higher NPC value compared to myopic and emmetropic groups even after controlling the age and sex. Ostadimoghaddam H et al in 2017 also reported a higher mean NPC in hyperopic subjects as compared to individuals with myopia, but the difference was not significant after controlling the effect of age and sex. [26]

Theoretically, individuals with hyperopia have lower accommodation amplitude even though they have stronger muscle tone for accommodation, resulting in decreased accommodation convergence, which results in higher NPC value.[25]

This was the first retrospective study of NPC measurement targeted exclusively in hyperopic children in India. We examined the relationship of NPC with the amount of hyperopia and after adjusting for age and sex, we did not find any significant relationship between NPC and the amount of hyperopia.

Limitations- The choice of target is an influential factor in NPC measurement. Further studies including with larger sample size and comparison of NPC values with the different targets may help to determine the NPC distribution as per the amount of hyperopia in children.

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