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Significance of Monocular Pupillary Distance in Prescribing Glasses

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Abstract: ***Purpose**: The aim of this study is to measure the monocular pupillary distance and interpupillary distance in patients with refractive errors to analyze its significance while prescribing spectacles. **Methods**: The research was conducted at a tertiary multispecialty hospital with patients seeking treatment for refractive errors at the ophthalmology outpatient department. Monocular Pupillary Distance and Inter Pupillary Distance were measured using a pupillometer and assessed in each patient. A total of 500 patients were included in the study, excluding those with ocular and neurological conditions unrelated to refractive errors. **Results**: Monocular pupillary diameter and interpupillary distance were assessed using a pupillometer in a study involving 500 patients. Among them, 250 were male and 250 were female, all of whom wore glasses. Among the males, 215 had identical Monocular Pupillary Distance (MPD) and Interpupillary Distance (IPD), while 35 exhibited differences. Among the females, 210 showed identical MPD and IPD, with 40 displaying variations. This represents approximately 15% of the total population under study. **Conclusion**: To conclude, both the parameters are crucial while prescribing glasses to avoid aberrations and asthenopia symptoms.***

Keywords: Interpupillary distance (IPD), Monocular pupillary distance (MPD), Pupillary distance, asthenopia, spectacles, lens centration

1. Introduction

Interpupillary distance is the distance between the center of the both pupils. The average interpupillary distance is 60 – 62mm, which corresponds to an intercanthal distance of approximately 30 - 31mm [1]. In telecanthus, there is an increased distance between the medial canthi of the eyes, while the interpupillary distance is normal. The interpupillary distance (IPD) is important for developmental anatomists and geneticists, and holds significance across various aspects of visual function. Clinically, IPD serves as a measure during surgery following facial trauma. Normative IPD values are valuable for diagnosing specific syndromes [1]. For instance, a small IPD is linked to ocular hypotelorism seen in conditions like mongolism, while a large IPD is associated with hypertelorism observed in conditions such as acrocephalosyndactly (Apert's syndrome), craniofacial dystosis (Crouzon's disease), median cleft face syndrome (frontonasal dysplasia), Klinefelter Syndrome, and fetal hydantoin syndrome. Hypertelorism can also lead to secondary effects like exotropia.

Monocular pupillary distance (PD) refers to the measurement between the centers of each pupil to the bridge of the nose, assessed separately for each eye [2]. Unlike the standard binocular PD, which measures the distance between the centers of both pupils, monocular PD considers the distance from each pupil individually to the midline of the face.

This measurement is particularly relevant in certain medical and optical contexts:

1) **Optical Corrections**: In optometry and eyewear fitting, knowing the monocular PD helps ensure the proper alignment of lenses with each eye. This is crucial for achieving optimal vision correction, especially in cases where there might be a significant difference in the distance between the eyes.
2) **Medical Applications**: Monocular PD measurements can also be important in medical assessments, particularly in cases where there are facial asymmetries, such as after facial trauma or in congenital conditions affecting facial structure. It aids in the accurate evaluation and treatment planning, ensuring symmetry and balance in facial reconstruction or cosmetic surgery.
3) **Research and Development**: For researchers and developers in fields like virtual reality (VR) and augmented reality (AR), understanding monocular PD helps in designing headsets and devices that provide a comfortable and immersive experience by aligning visual inputs with each eye's unique perspective.
4) **Ophthalmic Considerations**: Certain eye conditions or surgeries may require precise knowledge of the monocular PD for optimal outcomes. For example, in treatments involving intraocular lenses (IOLs) or in cases of strabismus (eye misalignment), accurate measurements ensure effective surgical planning and post - operative management.

Measuring monocular PD involves using specialized instruments or techniques that focus on each eye separately. It complements the standard binocular PD measurement, providing a more detailed understanding of the individual characteristics of each eye's position relative to the nose.

Overall, monocular pupillary distance is a critical parameter in both clinical practice and optical technology, ensuring accurate visual correction and optimal outcomes in various medical and technological applications related to eye health and vision.

2. Materials and Methods

The research was conducted at a tertiary multispecialty hospital among patients visiting the ophthalmology outpatient department for the correction of refractive errors. A total of

500 patients participated in this cross - sectional, randomized, population - based descriptive study, spanning six months. Patients with ocular and neurological conditions unrelated to refractive errors were excluded, while those requiring spectacle correction for refractive errors were included.

Each participant underwent a comprehensive assessment including visual acuity examination, color vision testing, intraocular pressure measurement, and the use of a pupillometer to measure Interpupillary Distance (IPD) and Monocular Pupillary Distance (MPD). Additionally, dilated refraction was performed after administering cycloplegic/mydriatic agents, followed by a thorough fundus examination.

The evaluation of MPD and IPD was conducted in two steps: first, IPD was measured with both eyes open using the pupillometer and recorded; second, one eye was covered, and MPD was measured from the nasal bridge to the center of the pupil.

This study design ensured a comprehensive assessment of various ophthalmic parameters among a diverse patient population seeking refractive error correction.

Distance IPD = Subject fixating on examiner's **left** eye: $L_{temporal}$ → Subject fixating on examiner's **right** eye: R_{nasal}

Position the nose pads on the patient's nose and ensure the forehead bar is in place to center the instrument. Instruct the patient to hold the pupilometer similar to holding binoculars and focus on the illuminated circle. Adjust the distance wheel to infinity (∞) for measuring far Pupil Distance (PD), or set it to the appropriate near distances: 35cm (~14 inches), 40cm (~16 inches), or 45cm (~18 inches).

Always measure Monocular PDs for single vision and progressive lenses, and measure Binocular PDs for bifocals and trifocals. Record the measurements accurately, ensuring to verify them if necessary.

Use the occluder paddle to cover one eye if the patient struggles to focus both eyes on the target circle or if there is strabismus present. This technique can be particularly effective with children.

Data Analysis

The data was analyzed using a Chi - square test, where the null hypothesis assumed no association between Monocular Pupillary Distance (MPD) and Interpupillary Distance (IPD), while the alternative hypothesis proposed an association between MPD and IPD.

Table 1: Chi - square test for significance

Observered Frequency	Expected Frequency	(0 - E) ^2/E
215	212.5	0.0294
35	37.5	0.1667
210	212.5	0.0294
40	37.5	0.1667
500	500	0.39216
Calculated value P Value	0.3926	
Df	1	
Table value	0.531167837	

3. Results

The calculated value is below the critical table value (with a p - value of 0.531 > 0.05), leading to acceptance of the null hypothesis. This indicates that among the 500 patients in the sample, only 75 showed differing Interpupillary Distance (IPD) values between their eyes, a finding deemed not statistically significant.

However, there was a notable observation that IPD differences were more prevalent among females than males.

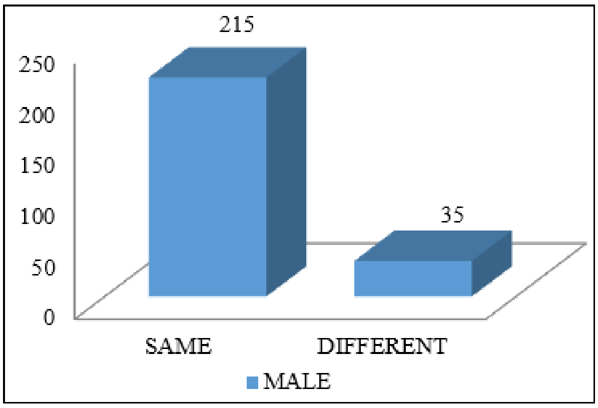

Chart 1: MPD and IPD observation on male respondent

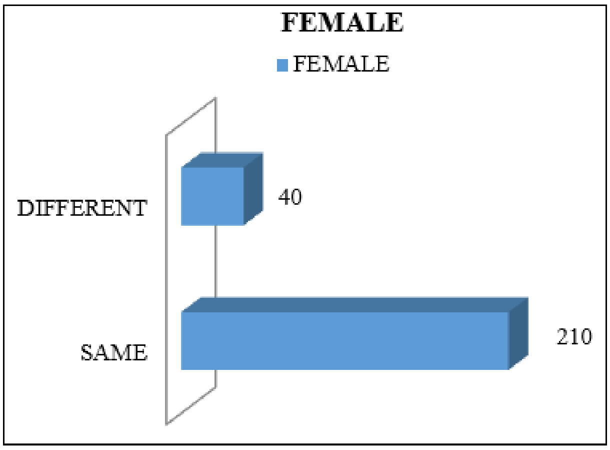

Chart 2: MPD and IPD observation on male respondent

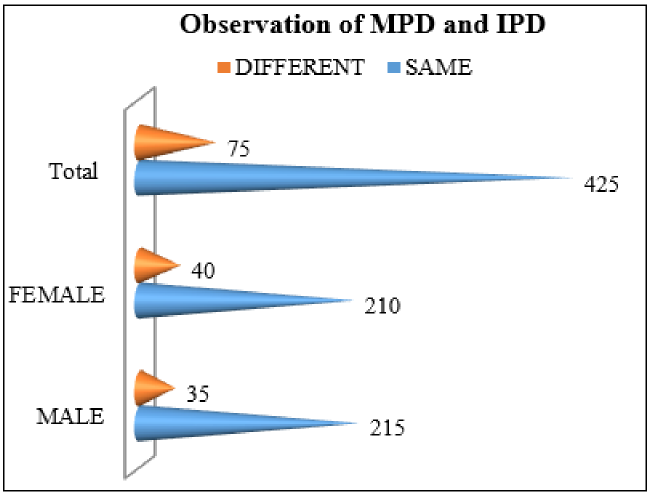

Chart 3: Comparative differences MPD and IPD, female has more difference than male.

4. Discussion

This study was conducted to understand the significance of monocular pupillary distance measurement in all patients alongside measuring interpupillary distance whilst prescribing spectacles. Centration in spectacles is a key factor to avoid asthenopic symptoms [4], [5]. To ensure the glasses effectively correct vision problems, it's crucial that both the lenses and frame are properly positioned on the nose. The optician assesses specific centering measurements to accurately cut the lenses, ensuring they fit correctly within the frame. This process, referred to as lens centering, varies depending on each individual's face shape and the chosen frame. Factors such as eye and head movements, posture, and eye position all contribute significantly to this alignment.

In most Ophthalmology outpatient facilities interpupillary distance is measured whilst prescribing glasses but MPD is not.

Our research involved 500 patients, evenly split between males and females. We discovered that in a notably small portion of the population, the distance between the centers of the pupils (IPD) differed from the monocular pupillary distance (MPD). Normally, the sum of both MPDs should equal the IPD, which is evenly divided between the eyes. However, deviations in MPD suggest possible asymmetry in eye alignment or nasal bridge positioning, which can affect how glasses are fitted, leading to issues like lens centration problems and symptoms such as astigmatism or eye strain.

Interestingly, despite the overall rarity of this finding, we observed that these discrepancies in MPD were more prevalent among females than males. Specifically, among the 250 females in our study, 40 exhibited variations in MPD for both eyes, whereas among the 250 males, 35 showed similar variations. This suggests that such variations may be more frequent among females compared to males

Asthenopia, which refers to eye strain or discomfort, can occur when the interpupillary distance (IPD) is incorrect. This distance is crucial because it affects how well the eyes align with the optical centers of the lenses in glasses. When the IPD is not properly adjusted, it can lead to symptoms such as eye fatigue, headaches, or difficulty focusing. Adjusting the IPD correctly ensures that the lenses provide optimal vision correction and comfort, reducing the likelihood of asthenopia.

The interpupillary distance (IPD) and monocular pupillary distance (MPD) are critical measurements in the accurate prescription and fitting of eyeglasses, influencing both visual comfort and effectiveness.

The IPD, which is the distance between the centers of the pupils of the two eyes, plays a fundamental role in ensuring that the optical centers of the lenses align perfectly with the wearer's eyes. When glasses are fitted with an incorrect IPD, it can lead to visual discomfort such as eye strain, headaches, or difficulty focusing. [6] Therefore, precise measurement and adjustment of the IPD are essential for optimal vision correction and overall comfort.

Similarly, the monocular pupillary distance (MPD) refers to the distance from the center of each pupil to the bridge of the nose. This measurement is particularly important for ensuring that the lenses are correctly centered over each eye [7, 8]. An incorrect MPD can result in visual distortions, particularly in higher prescription lenses, affecting visual acuity and comfort.

Prescribing glasses involves not only determining the correct lens power but also accurately measuring and adjusting both the IPD, MPD and even the pupillary size [9]. Optometrists and opticians use specialized tools and techniques to obtain these measurements. For instance, pupillometers are commonly used to measure the IPD accurately, while other devices help determine the MPD [10].

Furthermore, variations in facial structure, such as differences in facial width or the position of the eyes relative to the nose, underscore the need for individualized measurements. Personal factors like head posture and eye movements also influence these measurements, emphasizing the importance of a thorough examination and fitting process.

5. Conclusion

In conclusion, while the optical power of lenses is crucial in correcting vision, the interpupillary distance and monocular pupillary distance are equally vital for ensuring that glasses provide optimal visual clarity, comfort, and alignment. Precision in these measurements not only enhances the effectiveness of vision correction but also contributes significantly to the wearer's overall visual well - being and satisfaction with their eyewear.

Declaration of Patient Consent
The authors certify that they have obtained all appropriate patient consent forms. In the form the patients have given his/her/their consent for his/her/their names. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity.

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Conflicts of Interest: There are no conflicts of interest.

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