

Predictors of Unwanted Prismatic Effect Among Bespectacled Symptomatic Ammetropes (Refractive Error Less Than 4D) With Displaced Optical Centre

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Aim and objectives:- This study tries to estimate the relationship between alignment of spectacle, decentration, spherical equivalent and type of lens with induced prism in spectacles.

Design:- Descriptive cross sectional study.

Materials and Methods:- Symptomatic cooperative ammetropes, using spectacles and between the age of 10 and 70 years were included in this study. Induced prism in spectacles were calculated by the Prentice formula.

Abstract

Results:- The study group included 29 ammetropic patients having asthenopic symptoms while using spectacles. 65.52% (n=19) were females. The mean age of this group was 48.33 years, with a SD of ± 17.45 . This study showed a statistically significant positive correlation between spherical equivalent and induced prism and there is no significant correlation between decentration and induced prism.

Conclusion:- Spherical equivalent is considered as an important factor affecting the induced prism rather than decentration and alignment problem.

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Keywords: Induced prism, spherical equivalent, decentration

Introduction

Error in the measurement of pupillary distance, inaccurate fitting of spectacle lenses within the frame and mal-alignment due to faulty wear leads to decentration of optical centre of spectacle and subsequent unwanted prismatic effect. Unwanted prism in spectacles can produce discomfort and visual problems for wearer. This includes blur, headaches, nausea, and even double vision. Therefore, it is essential to verify that the lenses don't induce any prism.

Asthenopic symptoms are worsened among ammetropes especially among those with anisometropia due to the asymmetry in the visual performance of either eye. Prismatic effect depends on the amount of decentration and the severity of the refractive error. Decentration can be due to faulty fit or secondary to mal-alignment of glasses due to misuse. The role of spherical and cylindrical errors, type of lens used (convex or concave) and the alignment of glasses in inducing prismatic effect among spectacle corrected anisometropics with asthenopia is studied here.

Materials and Methods

A descriptive cross sectional study was conducted after getting approval from institutional ethics committee. The study period was six months. Subjects having spectacles corrected anisometropia with persistent asthenopic symptoms were included. For this study asthenopia was defined as headache with or without eye pain, watering and irritation on constant near work. All consecutive cases with one or more symptoms in either or both eyes during sustained near work with constant and regular (a minimum of 8 hours per day) use of spectacles for a period of atleast four months were selected. Spherical equivalent was calculated from the absolute retinoscopy reading. Spectacles with centered optical centre, history of headache

not related to constant near work, symptoms less than four months duration, irregular spectacle wearers, associated accommodation-convergence anomalies and latent squints were excluded. Age, gender, socioeconomic status and occupation of the patients were noted. The visual acuity, duration of spectacle wear and power of spectacles, alignment of spectacles, inter pupillary distance and decentration of optical centre in millimetres were recorded. Inter pupillary distance was measured with millimetre ruler. The optical centre of spectacle was found out by lensmeter. The prism induced was calculated by using Prentice formula $P = CF [C = \text{the distance of the image from optic axis in centimetres (decentration); } F = \text{the focal power of the lens}]$. The measure of horizontal and vertical prism were calculated separately. In spectacles having both horizontal and vertical prisms, the residual prism was calculated by the formula $Pr = \sqrt{PH^2 + PV^2}$ (Pr= Residual prism, PH=Horizontal prism, PV=Vertical prism). Statistical analysis was done with PSWP 18 version. Chi square test was used for univariate analysis. Paired t test was used to compare the means.

Observations

The study group included 29 subjects with an age ranged from 10 to 70 years. The mean age of the group was 48.33 years with SD of ± 17.45 . All were constant users of spectacles for a minimum period of 4 months. 65.52% (n=19) were females. The distribution of cases based on the demographic profile, alignment of spectacles, and duration of wear is given in (Table 1). 55.2% (n=16) cases showed unilateral induced prism with their spectacles. 42.9% (n=18) of the cases had horizontal prism, 19% (n=8) had vertical prism and rest had oblique prism. 35.7% (n=15) had base in prism. 21.4% (n=9) showed an induced prism between 0.3 and 0.39 prism diopter. The mean value of induced prism with

Table 1: Distribution of cases based on demographic profile, alignment and duration of wear

Factor		N	%
Gender	Male	10	34.48
	Female	19	65.52
Age group (years)	10-30	6	20.7
	31-50	7	24.1
	51-70	16	55.2
Alignment	Aligned	6	20.7
	Not aligned	23	79.3
Duration of spectacles (years)	<2	14	48.3
	2-4	6	20.7
	5-7	6	20.7
	8-10	3	10.3

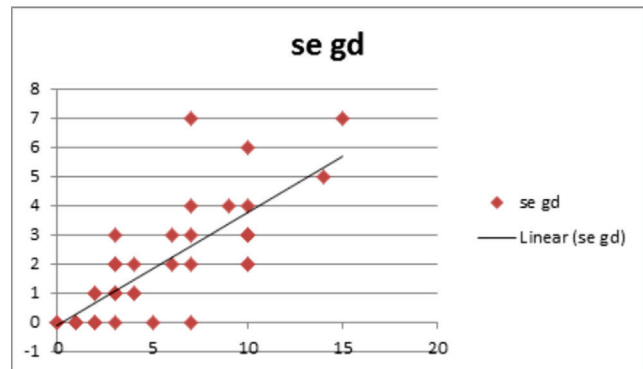
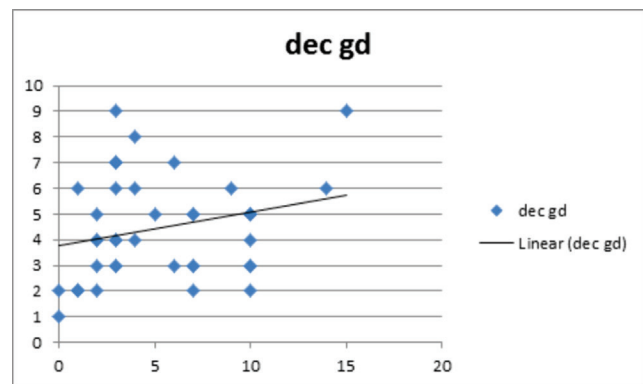
spectacles was 0.592 with a SD of ± 0.532 . The distribution of cases based on the type and value of induced prism are given in Table 2. 28.6% (n=12) had a spherical equivalent of $< 0.5D$. The mean value of spherical equivalent was 1.33 with SD of ± 0.998 . Majority showed decentration between 3.1-4.0 mm and 5.6-6.0 mm. The mean value of decentration was

Table 2: Distribution Of Cases Based On Type and Measurement Of Induced Prism

Prism	N	Mean	Std. Deviation
bu	6	.46	.40
bd	2	.18	.11
bi	15	.57	.33
bo	3	.43	.54
bu+bi	7	.54	.34
bu+bo	4	.49	.19
bd+bi	3	.90	.56
bd+bi	8-10	3	10.3
2	1.72	1.96	
Total	42	.59	.53

4.29 mm, with a SD of ± 1.88 .

It was observed that the induced prism did not increase proportionately with decentration, as shown in Figure 1. This was statistically significant (p value=0.038 by chi square test). As the spherical equivalent increased, the induced prism increased proportionately ($p=0.000$), as shown in Figure 2. 73.80% (n=31) had convex lenses. Patients with convex lenses had higher induced prism than those with concave lenses ($p=0.000$). There was no statistically significant relation between induced prism and type of lens i.e. whether it was sphere, cylinder, or spherocylinder, alignment of spectacles, duration of spectacle wear, and laterality of the prism.

**Figure 1: Correlation between spherical equivalent and induced prism****Figure 2: Correlation between decentration of optical centre and induced prism**

Discussion

The optical centre of a spectacle should coincide with the pupillary centre of the wearer. When these points do not coincide, it results in prismatic effect. A spectacle lens has prismatic effects when viewed through any point other than optical centre (off axis viewing). This is augmented by decentration of the optical centre. These effects can be wanted or unwanted. Unwanted prismatic effects result in eye strain. Displacement of optical centers of spectacle lenses cause induced prism which may worsen an existing heterophoria or even cause diplopia and asthenopia.¹ Decentration of spectacles can also reduce stereopsis.²

Each spherical lens behaves like a series of prisms. The direction of the prism base is relative to the optical axis. A plus lens acts as a bi prism base to base and a minus lens as

a bi prism apex to apex. The prismatic effect of a spherical lens is dependent on its power and the distance from the optical centre, assuming that the ophthalmic lenses are thin lenses. The prismatic effect at a specified point of the lens is calculated from Prentice's formula.³⁻⁵ Prentice's formula states that $D = CF$; D = deviation of image in prism diopters; C = the distance of the image from optic axis in centimeters; F = the focal power of the lens. The prismatic effect of a sphero-cylindrical lens is the sum of prismatic effect due to the sphere and prismatic effect due to the cylinder. A cylinder decentered along the axis will give no prismatic effect. A cylinder decentered perpendicular to the axis induces prismatic effect. While prism produce entire image shift of same amount towards the apex, spectacle lenses produce a linear increase in prismatic deviation away from the optical centre.⁵ Higher powered near-vision readymade spectacles such as +3.50 DS have prevalence of significant amounts of induced horizontal and vertical prism than low powers.⁶ Limit of tolerance of induced prism with spectacles is noted as < 0.5 prism diopter vertical, < 1.0 prism diopter horizontal.⁷ Small powers up to ± 1.50 DS rarely have sufficient lens decentration to cause discomfort.⁷ Many often the spectacle lenses are not dispensed as prescribed.⁸ Error in the spherical power or cylindrical axis is detected easily by the ophthalmologist. But the error due to decentration of the optical centre is often ignored by the practitioner. This is worsened by the mal alignment occurring to the lens and frames due to long term wear or misuse. The back vertex distance also has role in prismatic effect produced by decentration of spectacle.⁹ We observed that the prismatic effect was linearly related to the spherical equivalent and not to the degree of decentration. As according to Elliott DB et al⁶ majority in our study also showed a horizontal induced prism. The mean value of induced prism was within the tolerable extend. However they were significant enough to cause asthenopic symptoms in the subjects. Unless the ophthalmologist or the optician is aware of this, the symptoms will be ignored as the subject will tolerate the discomfort. By ensuring that the optical centre coincides with the pupillary centre and educating the wearer about the care and maintenance of the spectacle with regular and trimonthly follow ups for correction of spectacle alignment can easily correct this unwanted prism development. Often the subjects with improperly fitted glasses develop prism adaptation.¹⁰ This is achieved over a couple of weeks. Some subjects compensate for the prismatic effects of spectacle lenses for several days. This compensation is functionally useful for individuals who are using spectacles and contact lenses alternatively.¹¹ Small sample size, lack of sub grouping, BCVA not ensured to 6/6, lack of grading of subjective symptoms, and lack of consideration of prism adaptation were the major limitations of this study.

Conclusion

According to this study spherical equivalent has a statistically significant positive correlation with induced prism in a spectacle. Convex lenses has more induced prism than concave. Decentration, alignment problem, duration of wear, power of spectacle has no statistically significant correlation with induced prism. Thus by ensuring that the

optical centre of the spectacle coincides with the pupil and by proper maintenance of spectacles are very important to avoid asthenopic symptoms while using spectacles and to prevent the development of amblyopia in children while using spectacles for anisometropia. Dispensing errors have to be minimised among anisometrops with high refractive errors for ensuring good quality of vision.

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