'Does Size Matter?' - An Investigation of Anisometropia, Aniseikonia and Anisophoria

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ABSTRACT

Aim: To examine how acquired anisometropia commonly gives rise to symptoms of diplopia in patients and to differentiate the cause of these symptoms in terms of aniseikonia and anisophoria.

Method: Twenty-one patients with acquired anisometropia >1.00 D and astigmatism <1.00 D were examined. Symptoms of diplopia and cover test in primary position at 6 m and 1/3 m were recorded with the patient wearing spherical equivalent correction and then repeated through the reading position of the lenses, 12 mm below the optical centre. Stereopsis was assessed using the TNO test, and aniseikonia was measured using the Awaya New Aniseikonia Test.

Results: Twelve of 21 patients (57%) reported diplopia when viewing through the reading position, but only three (14%) when viewing through the optical centre. Cover test showed an induced vertical heterophoria in the reading position. Binocularity measured by TNO showed stereopsis to be markedly reduced when looking through the reading position of the spectacle lens. There was no obvious relationship between Awaya aniseikonia measurements and patients' symptoms.

Conclusion: Symptoms of diplopia in acquired anisometropia are more often due to optically induced anisophoria than to the aniseikonia. This finding is contrary to traditional teaching. Recognition of this and simple expedients in management resolve these symptoms for most patients.

Keywords: anisometropia, aniseikonia, anisophoria, prismatic effect

INTRODUCTION

Anisometropia is defined as a difference in refractive error between the two eyes. It is difficult to establish a symptomatic threshold due to significant tolerance variations between patients. It is commonly thought that the main cause of symptoms in patients with newly acquired anisometropia is the ocular image size difference or aniseikonia.[1] Early research in this area was greatly influenced by studies from the Dartmouth Eye Institute from 1920, where many researchers believed that the prism effect was not nearly as important as the differences in ocular image size.[2] Some studies suggest that aniseikonia begins to affect stereopsis at a subjective value of 3-5%.[3,4] This study investigates the degree of aniseikonia that has an impact on binocular function and whether there is any correlation between the amount of aniseikonia and the degree of anisometropia.

Anisophoria is the heterophoria induced by the prismatic effect of unequally ground lenses and it changes when looking from the primary position to other directions of gaze, for example, the reading position. Patients' symptoms can include ghosting, dizziness, feeling off-balance and diplopia. These symptoms increase as they look further away from the centre of the lens which is why many patients complain of double vision or other symptoms with reading. We believe that anisophoria is the main problem for newly acquired anisometropes. This agrees with the teaching of Hess (1903) who stressed the importance of considering the induced anisophoria. He felt that its treatment was just as important, if not more so, than aniseikonia in achieving patient satisfaction and ocular comfort.[2]

Patients who complain of symptoms of acquired anisometropia frequently have had cataract surgery or other types of refractive surgery. Their symptoms are characteristically vague and they have tried many different pairs of glasses and prismatic corrections. We aimed to establish the relative impact of aniseikonia and anisophoria on binocularity and explore which of the two is the major cause of diplopia.

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METHOD

A single examiner (KS) investigated 21 patients who had acquired anisometropia of >1.00 D and astigmatism <1.00 D. Patients were either pseudophakic in one eye or had LASIK surgery with monovision outcome. Best-corrected visual acuity was 6/12 or better in each eye for distance and at least N8 for near, with no significant ocular pathology and no history of strabismus or any current manifest ocular deviation or horizontal heterophoria greater than 15 prism dioptres for near or distance.

Spherical equivalent refractive correction was placed in custom-made frames (Ralph Clarke Optical, Castle Hill) using custom-made lenses to avoid the limitation of standard lens sizes and trial frames (Figure 1). Tests were first conducted in primary position through the optical centre of the lenses as marked by the optical dispenser. Alternate cover test and TNO (Clement Clarke International, Harlow, UK) were used to assess binocularity and stereopsis and the Awaya New Aniseikonia Test (NAT)[5] (Handaya Co, Tokyo, Japan) for image size difference. Patients were asked if they had any symptoms of diplopia. The tests were then repeated whilst the patient looked through the normal reading position. This was standardised with the use of the nose-piece lever, which moved the viewing zone to 12 mm below the optical centre.

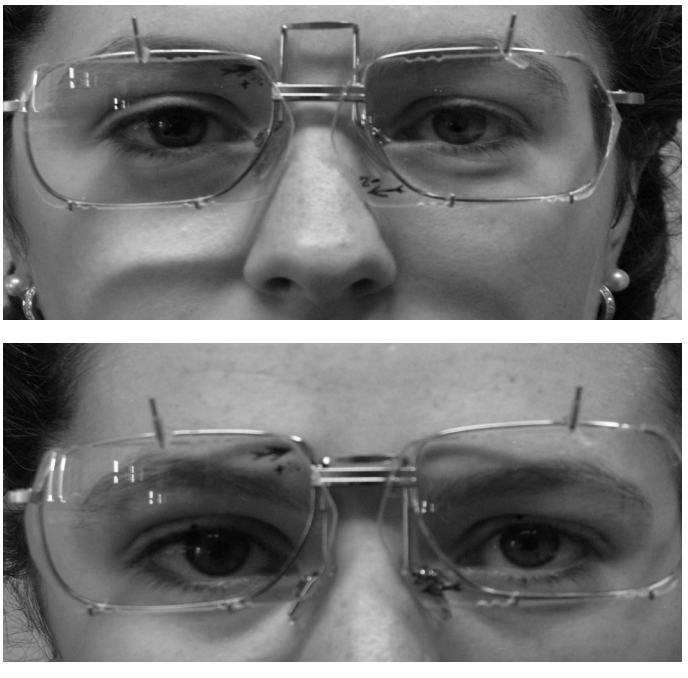

Figure 1. Custom frames made to allow custom lenses, including grooves to allow for horizontal adjustment of interpupillary distance and a centre lever on the nosepiece for standardised movement of the viewing zone 12 mm below the optical centre (Ralph Clarke Optical, Castle Hill, Sydney).

RESULTS

Three of the 21 (14%) patients complained of double vision through the optical centre and another nine had diplopia when looking through the reading position, giving a total of 12 patients (57%) who complained of double vision through the reading position (Figure 2). when looking through the reading position, giving a total of 12 patients (57%) who complained of double vision through the reading position (Figure 2).

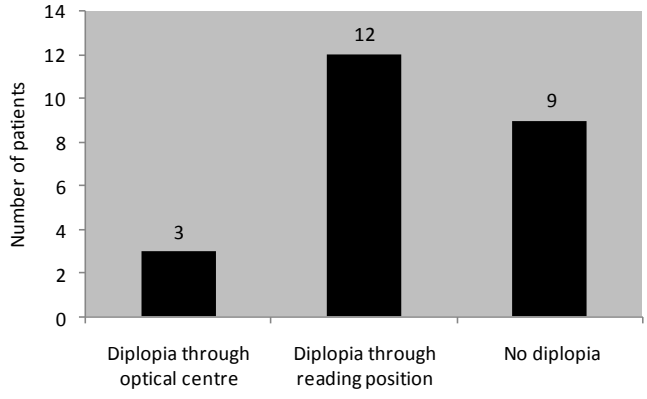

Figure 2. The number of patients with diplopia when viewing through the optical centre and through the reading position.

Results of the NAT showed no apparent relationship between the degree of anisometropia and subjective size difference (Figure 3), however no statistical analysis was performed. NAT results ranged from 0% to 18%. Some patients with large amounts of anisometropia reported no subjective image size difference and conversely a patient with only 1.50 D of anisometropia reported a 5% image size difference. Through the optical centre of the lens where there is no induced prism, only three patients were symptomatic (see circled points on graph in Figure 3).

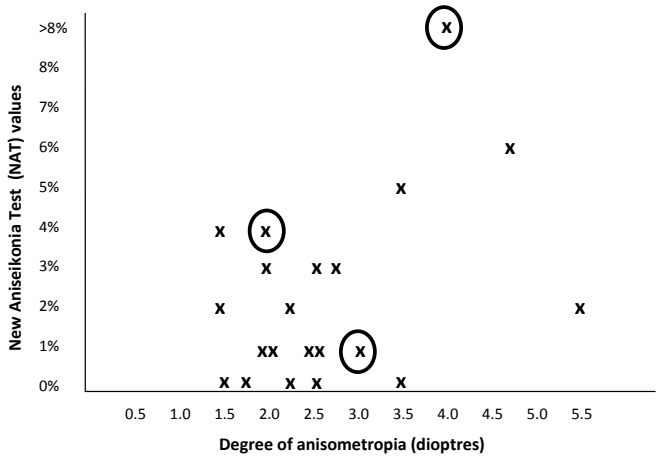

Figure 3. The relationship between the degree of anisometropia and amount of aniseikonia. The circled crosses indicate the three patients who were diplopic viewing through the optical centre of the lens.

The results shown in Table 1 compare the alternate cover test measurements at one-third of a metre through the optical centre of the lens with those through the reading position. In 18 cases (86%) a vertical heterophoria was detected through the reading position which was not present through the optical centre. All diplopic patients demonstrated an induced vertical heterophoria.

Table 1. Comparison of cover test measurements taken through the optical centre and the reading position with the target at 1/3 m

Alternate cover test measurements through optical lens centre	Alternate cover test measurements through reading position
Ortho	2Δ Exo 2Δ R/L
Ortho	2Δ Exo
Ortho*	2Δ L/R*
Ortho*	4Δ R/L*
Ortho	2Δ Eso 2Δ R/L
Ortho	4Δ L/R*
Ortho	2Δ R/L
Ortho	2Δ Exo 2Δ R/L*
Ortho	2Δ Exo 2Δ R/L
Ortho	2Δ R/L
Ortho	2Δ L/R*
2Δ Exo	2Δ Exo 2Δ R/L
2Δ Exo	4Δ Exo
2Δ Exo	3Δ Exo 4Δ L/R*
4Δ Exo	6Δ Exo 2Δ L/R*
4Δ Exo	6Δ Exo 4Δ R/L*
4Δ Exo	6Δ Exo
4Δ Exo	4Δ Exo 2Δ R/L*
8Δ Exo*	6Δ Exo 4Δ R/L*
12Δ Exo	12Δ Exo 5Δ R/L*
14Δ Exo	14Δ Exo 4Δ R/L

Ortho = orthophoria, Exo = exophoria, R/L = right hyperphoria, L/R = left hyperphoria, * = diplopic patients

TNO stereopsis scores were used as a measure of binocular function both through the optical centre and reading position of the lens. Results show that through the optical centre of the lens, 18 patients (86%) scored better than 480 seconds of arc (Figure 4). Through the reading position only eight patients scored better than 480 seconds of arc (38%) as shown in Figure 5. The patients who developed diplopia looking through the reading position were predominantly the same patients who reported a reduction in TNO stereopsis (indicated by circles on the graph in Figure 5).

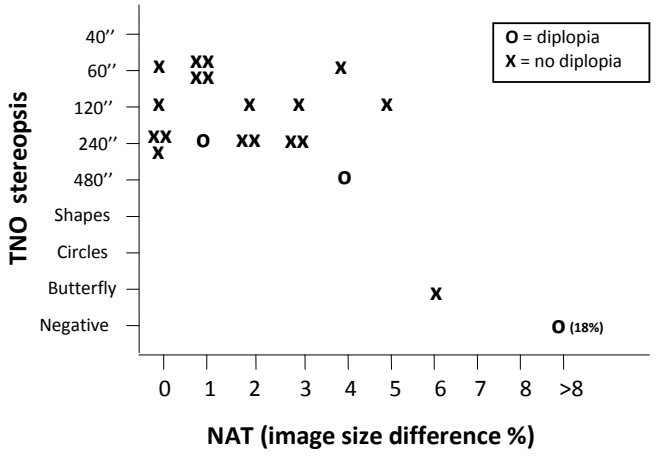

Figure 4. TNO results through the optical centre of the lens.

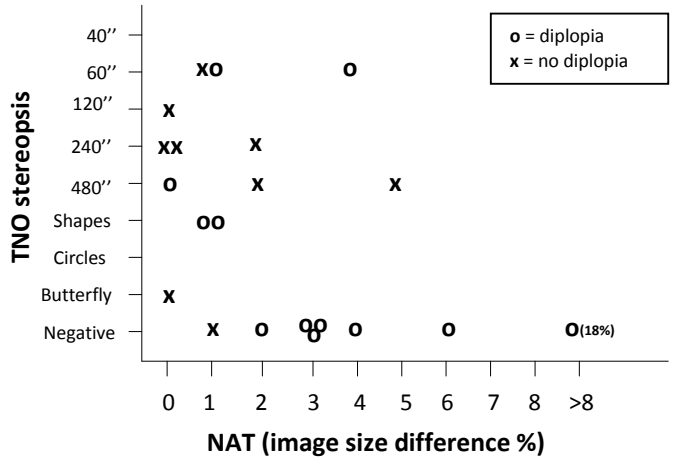

Figure 5. TNO results through the reading position.

DISCUSSION

The results in this group of patients indicate that diplopia, when it occurs, is more often caused by anisophoria or anisotropia secondary to induced prism than to aniseikonia. Prior to extrapolating this finding to other anisometropic patients it is important to consider some aspects of the study.

The range of anisometropic error in the patients studied extends only to 5.50 dioptres and all cases were newly acquired. Studying patients with larger errors, childhood onset, or those with longer periods of adaption may well give different results but the cohort selected represents a not uncommon clinical scenario and thus is of interest.

The use of the custom-made frames to physically move the lenses, thereby utilising the reading position without having the patients move their eyes, is clearly different to normal reading behaviour. The advantage is a standardisation of

optical change, difficult to achieve using normal glasses, and may not be directly comparable to the situation when the visual axes are rotated downwards in the normal course of reading. Utilising this device does however limit the change to a single variable which perhaps strengthens the conclusion.

Patients' descriptions of their symptoms are frequently vague including dizziness, ghosting, eyestrain and blurred vision as well as double vision. Reporting only double vision may underestimate the frequency of symptoms in this group but provides a clearer decision for the patients in their reporting. An accepted normal value for vertical fusion range is 2-4 prism dioptres[6] and it seems likely that as the induced vertical heterophoria reaches these levels it will manifest as a heterotropia resulting in double vision, albeit intermittently. This scenario fits with the intermittent and often vague nature of these patients' symptoms.

Stereopsis and the alternate cover test provided the measurement of binocular function in the study. Both of these measurements demonstrate deterioration in the reading position and closely follow the increased frequency of subjective diplopia. The only optical change is the prism-induced anisophoria and it seems reasonable to attribute the increase in symptoms to this change. Whilst not the primary aim of the study, it appears from the results that there is no clear link between the magnitude of anisometropia and the subjective appreciation of aniseikonia, however no statistical analysis was undertaken. It might be expected that the three patients who experienced diplopia when tested through the optical centre of the lenses were those with the larger NAT scores, however two of these three patients had only mild subjective image size differences of 1% and 3%. Literature reports vary on this issue with levels of up to 7% tolerated by some,[4,7,8] whilst levels as low as 1% were symptomatic in others.[4]

Recognition of the contribution of anisophoria in the patients' symptoms suggests treatment options other than 'size' or aniseikonic lenses. Simply prescribing separate reading glasses rather than bifocal or multifocal glasses will assist the patient to utilise the optical centre of the lenses and minimise diplopia. Contact lens correction or surgery to minimise anisometropia are also useful treatment options.

CONCLUSION

The results of this study suggest that in this patient group 'size does not matter much' and it is the anisophoria that more often disrupts binocular function leading to patient complaints of diplopia. They do not support the notion that the image size difference is the main cause of problems in patients with acquired anisometropia.

Even if patients do specify diplopia as their concern, simply performing a cover test in the primary position does not reveal the problem. Recognition of the likely cause, careful attention to the patient history, cover testing and tests of binocular function in gaze positions other than primary will assist in arriving at the correct diagnosis.

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