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Original Article

# Characteristics of Anisometropic Patients with and without Strabismus

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## Abstract

**Objectives:** To evaluate the risk factors for strabismus in patients with anisometropia by comparing degree of anisometropia, depth of amblyopia, and binocular visual function in anisometropic patients with and without strabismus.

**Materials and Methods:** Sixty-five anisometropic patients older than 5 years with amblyopia in one eye who were followed in the Ankara University Faculty of Medicine, Department of Ophthalmology, Pediatric Ophthalmology and Strabismus Unit between May 2009 and April 2010 were included in this study. There were 27 cases of strabismus. The depth of amblyopia, degree of anisometropia, and binocular visual function were assessed in anisometropic cases with and without strabismus.

**Results:** The 65 patients with anisometropia were divided into two groups: 27 patients with strabismus (group 1) and 38 patients without (group 2). Depth of amblyopia was greater in patients with strabismus compared to those without (p=0.006). In patients with strabismus, there was no correlation between angle of deviation and depth of amblyopia (p=0.453). In anisometropic amblyopia patients without strabismus, there was a positive correlation between depth of anisometropia and depth of amblyopia (p=0.35, Pearson's correlation coefficient=0.343). Comparison in terms of anisometropia showed that patients with strabismus had significantly larger spherical difference between the two eyes than in patients without strabismus (p=0.000, Mann-Whitney U test). There was no significant difference in terms of cylindrical values (p=0.146, Mann-Whitney U test). There was no statistically significant difference in the presence of fusion between anisometropic patients with and without strabismus.

**Conclusion:** The risk of developing strabismus increased as degree of anisometropia increased in anisometropic cases. In addition, depth of amblyopia was greater in anisometropic patients with strabismus.

**Keywords:** Anisometropia, strabismus, amblyopia

## Introduction

Anisometropia is a difference in refractive power between the two eyes, and is one of the main causes of amblyopia. This inconsistency between the eyes leads to differences in the size and quality of the images that fall on the fovea. Amblyopia can develop as a result of chronic blurriness in an eye with considerable refractive error.[1] Unilateral refractive error of ≥1 diopter (D) for hypermetropia, ≥±2 D for astigmatism, and ≥3 D for myopia presents a risk for amblyopia. The risk of amblyopia increases with greater difference in refractive power between the two eyes.[2]

Anisometropic amblyopia may occur together with strabismus amblyopia, and it is difficult to determine whether the amblyopia is primary (due to anisometropia), secondary (due to strabismus), or a combination of both. Not every anisometropic patient has strabismus. The presence of strabismus in anisometropic patients and associated risk factors have yet to be fully explained. The aim of this study is to compare depth of amblyopia, degree of anisometropia, and binocular visual function in anisometropic patients with and without strabismus, and to determine risk factors for the development of strabismus in this patient group.

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## Materials and Methods

Sixty-five patients over 5 years of age who were diagnosed with anisometropia and unilateral amblyopia in the Ankara University Department of Ophthalmology, Pediatric Ophthalmology and Strabismus Unit between May 2009 and April 2010 (with 12 months of follow-up) were retrospectively included in the study. These 65 anisometropic patients were divided into two groups, those with strabismus (group 1, n=27) and those without (group 2, n=38). Of the 27 patients with strabismus, 13 had esotropia and 14 had exotropia. All patients' best corrected visual acuity (BCVA) and deviation test (near and far alternate prism cover test), Worth 4-dot test (near and far), Titmus stereo test, cycloplegic retinoscopy, and fundus examination results were recorded from their files. The study inclusion criterion for anisometropia was a ≥1 D difference in the spherical or cylindrical refractive error values of the two eyes. The absolute differences of spherical and cylindrical values were obtained separately when calculating degree of anisometropia. The criteria for amblyopia were BCVA of ≤0.8 or ≥2 rows of difference in visual acuity on the Snellen chart between the eyes. The logMAR visual acuity difference was used when calculating depth of amblyopia.

Patients with previous ocular surgery and those with any comorbid diseases were excluded from the study.

## Results

Of the 65 patients, 23 were female and 42 were male; the mean age was 12.5 years (5-34 years). Mean age was 13.1±3.75 years (7-23 years) in group 1 and 12.2±3.55 years (5-34 years) in group 2. There were no statistically significant differences between the groups in terms of age (Mann-Whitney U test, p=0.339) or sex (Pearson chi-square, p=0.814).

Mean BCVA in the patients' amblyopic eyes at time of diagnosis was 0.67±0.39 logMAR in group 1 and 0.37±0.30 logMAR in group 2. There was a significant difference between the two groups in the depth of amblyopia (p=0.006).

Among the patients with strabismus (group 1), 13 were diagnosed with esotropia and 14 with exotropia. The mean amount of deviation for distance was 12 PD (10-20 PD). No correlation was found between angle of deviation and depth of amblyopia in patients with strabismus (p=0.453, r=0.23; Pearson correlation analysis).

The degree of anisometropia according to spherical difference was between 1.5-4 D in 18 patients (66.6%) and over 4 D in 9 patients (33.3%) in group 1, and between 1.5-4 D in 23 patients (61%) and over 4 D in 15 patients (39%) in group 2. In terms of depth of anisometropia, the spherical difference between the two eyes was statistically greater in patients with strabismus compared to those without (Mann-Whitney U test, p=0.04), while there was no statistically significant difference between the groups in cylindrical difference (Mann-Whitney U test, p=0.146). There was a positive correlation between degree of anisometropia and depth of amblyopia in patients without strabismus (p=0.35, Pearson correlation coefficient=0.343). There was no statistically significant difference between the groups in terms of the ratio of patients with hypermetropia/myopia (Fisher's exact test) (Table 1).

In terms of binocularity, comparison of Worth 4-dot test and near and distant fusion test results showed that fusion was present in 15 (55.6%) patients with strabismus and 24 (63.2%) patients without strabismus, but the difference was statistically nonsignificant (chi-square test, p=0.538). When the values of the Titmus test for stereopsis were compared, there was no statistically significant difference between the two groups (group 1 median: 200 sec arc, group 2 median: 140 sec arc) (Mann-Whitney U test, p=0.295) (Table 2).

**Table 1. Properties of the refractive errors of the patient groups**

| Depth of anisometropia | Strabismus (+) | Strabismus (-) | All patients | p |
|---|---|---|---|---|
| Patient number (n) | 27 | 38 | 65 | - |
| Spherical difference (D) (absolute difference) | 2 | 1.2 | 1.6 | p=0.04 |
| Cylindrical difference (D) (absolute difference) | 0.38 | 0.5 | - | p=0.146 |
| Hypermetropia | 25 (92.6%) | 35 (92.1%) | 60 (92.3%) | - |
| Myopia | 2 (7.4%) | 3 (7.9%) | 5 (7.7%) | - |

D: Diopter

**Table 2. Fusion and stereopsis results of the patient groups**

| | Strabismus (+) | Strabismus (-) | All patients | p |
|---|---|---|---|---|
| Patient number (n) | 27 | 38 | 65 | - |
| Suppression/fusion | 12/15 | 14/24 | 26/39 | p=0.538 |
| Titmus, median (sec arc) | 200 (40-800) | 140 (40-800) | 200 (40-800) | p=0.295 |

## Discussion

Amblyopia is a term used to describe low vision caused by abnormal visual development in the critical period of childhood. The depth of amblyopia can range from missing a few letters on the 10/10 row of the Snellen chart, to the level of hand movements. While many factors can influence the pathogenesis of amblyopia, anisometropia and strabismus are two of the most common causes in the population, and these conditions can coexist in some patients.[3] Anisometropic amblyopia and strabismic amblyopia develop due to different neuronal mechanisms. In anisometropic amblyopia, visual development is impaired because unequal refractive power causes the image projected onto one or both of the retinas to be unclear. In strabismic amblyopia, the deviant eye cannot focus images on the fovea, resulting in suppression of visual stimuli from that eye.[4,5]

It has not been established whether amblyopia is a result of anisometropia or strabismus in patients with both conditions. A study conducted by Kiorpes and Wallman[6] on monkeys revealed a significant relationship between anisometropia and strabismus. Various other studies have shown that while strabismus is convergent in anisometropic patients, it usually occurs together with anisohypermetropia.[7,8,9,10,11] Philiphs[8] have claimed that esotropia arises in cases of hypermetropic anisometropia over 4 D and emphasized that anisometropia and esotropia can co-occur.

In terms of demographic characteristics, in one of the largest series in the literature, Woodruff et al.[12] compared 961 patients diagnosed with anisometropic amblyopia, strabismic amblyopia, and strabismic + anisometropic amblyopia and found the groups similar in terms of sex and age, similar to our study.

When we compared the two groups in our study in terms of depth of amblyopia, patients with strabismus had greater depth of amblyopia than patients without strabismus. Similarly, Tolun et al.[13] and Çalık et al.[14] reported that visual acuity was better in anisometropic amblyopia compared to strabismic amblyopia, while Öztürk et al.[15] observed similar degrees of visual acuity and amblyopia between the strabismic amblyopia group (44 patients) and the anisometropic amblyopia group (45 patients). However, in the studies comparing strabismic and anisometropic amblyopia, the degree of anisometropia in the patients with strabismus was not stated.

In the present study, there was no correlation between angle of deviation and depth of amblyopia in anisometropic patients with strabismus, but depth of amblyopia was positively correlated with degree of anisometropia in patients without strabismus. Helveston[16] reported that degree of anisometropia affects the depth of amblyopia in anisometropic patients with or without strabismus. Çalık et al.[14] observed a positive correlation between amounts of deviation and amblyopia in strabismic patients and a positive correlation between degree of amblyopia and depth of anisometropia in the anisometropia group. Studies by Weakly[2], Sen[17], Townshend et al.[18] and Sapkota[19] have also shown that that degree of anisometropia affects depth of amblyopia.

Various studies have yielded different results regarding the distribution of refractive errors in cases of exodeviations. While early studies suggested that the rate of high myopia was 70%,[20] more recent studies have determined that the distribution of refractive errors does not differ from that of the normal population.[21,22]

Burian[23] suggested that refraction is the key factor keeping convergence and divergence mechanisms in balance, whereas von Noorden[20] emphasized that patients with convergence insufficiency may not have exodeviation. Our findings of low myopia rate (7%) despite esotropia in 13 and exotropia in 14 of the strabismic patients supports the study by von Noorden[20] and underline the complex relationship between anisometropia and strabismus.

In our study, the mean amount of deviation for distance was 12 PD (10-20 PD). The lower mean deviation values observed in our study compared to those in other studies in the literature may be explained by the fact that patients with no previous ocular surgery were selected for our study.

While our findings of greater anisometropia in strabismic patients support the existence of a relationship between degree of anisometropia and strabismus, the trigger factor underlying this link remains unclear.

In addition to visual acuity, binocular visual functions such as fusion and stereopsis are also negatively affected in amblyopia.[24] Öztürk et al.[15] determined that patients with anisometropic amblyopia (n=44) had a higher rate of fusion and stereopsis compared to patients with strabismic amblyopia (n=45). However, the same study showed no significant difference in stereopsis when compared with patients with <10 PD deviation. Çalık et al.[14] determined that stereopsis was significantly more common among anisometropic patients than strabismic patients, and that fusion was significantly more common in cases of anisometropic amblyopia compared to cases of strabismic amblyopia. Chen et al.[25] reported that higher magnitude anisometropia was significantly associated with poorer contrast sensitivity, fusion, and stereopsis functions. When fusion and stereopsis were compared in terms of binocularity, no significant difference was found between the two groups in the present study. This may be attributed to the relatively small degrees of deviation in the group of patients with strabismus.

The limitations of our study are that it is a retrospective study and that the data were collected via medical record review. Strengths of our study were that the groups were well matched in terms of size and patient characteristics and we analyzed data from a long time period.

## Conclusion

Our study demonstrates that increasing degree of anisometropia is associated with higher risk of developing strabismus, and patients with concomitant anisometropia and strabismus exhibit deeper amblyopia. In particular, we believe patients with a large degree of anisometropia should be followed more carefully with respect to strabismus. Studies involving a

larger patient numbers and long-term prospective follow-ups are needed in order to improve our understanding of the relationship between strabismus and degree of anisometropia, and to explain the underlying trigger factor.

### Ethics

**Ethics Committee Approval:** Ankara University Faculty of Medicine Clinical Research Ethics Committee (154-4973).

**Informed Consent:** A retrospective study was planned.

**Peer-review:** Externally and internally peer-reviewed.

### Authorship Contributions

Surgical and Medical Practices: Huban Atilla, Reşat Duman, Emine Çatak, Concept: Reşat Duman, Design: Huban Atilla, Data Collection or Processing: Reşat Duman, Emine Çatak, Analysis or Interpretation: Huban Atilla, Reşat Duman, Literature Search: Reşat Duman, Emine Çatak, Writing: Reşat Duman.

**Conflict of Interest:** No conflict of interest was declared by the authors.

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