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# Treatment of Anisometropic Amblyopia in Children with Refractive Correction

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**Abstract** **Original Research Article**

***Background:*** Amblyopia, commonly caused by anisometropia, is a leading cause of monocular vision loss in children. This study evaluates the effectiveness of refractive correction alone in treating untreated anisometropic amblyopia. ***Aim of the study:*** The aim of the study was to evaluate the effectiveness of refractive correction alone in treating untreated anisometropic amblyopia in children. ***Methods:*** This prospective study, conducted from February to July 2007 at the Department of Ophthalmology, Bangabandhu Sheikh Mujib Medical University and the National Institute of Ophthalmology, involved 28 children (ages 3–7) with untreated anisometropic amblyopia. Spectacles were prescribed, and visual acuity was monitored every 5 weeks until stabilization or resolution. Acuity improvement was analyzed based on age, baseline VA, and anisometropia type and degree. ***Results:*** Most children had a VA of 20/80 (19%) or 20/63 (23%), with a mean VA of .60 logMAR (20/80). Post-treatment, 56% achieved 20/20 VA. By 25 weeks, 18 participants reached no further improvement (IOD > 2) and 8 reached IOD ≤ 1. Resolution rates varied by age but were not significant. Anisometropia degree significantly impacted resolution, especially 57% in the 0.50–<1.00 D group. Baseline amblyopic eye acuity significantly correlated with resolution, notably 67% in the 20/50 group. Spherical equivalent only (≥0.50 D) showed 25% resolution. ***Conclusion:*** Refractive correction alone improves visual acuity and resolves amblyopia in one-third of children aged 3 to <7 years with untreated anisometropic amblyopia, particularly in moderate cases (20/40–20/100).

**Keywords:** Anisometropic Amblyopia, Refractive Correction, Monocular Vision Loss, Childhood, Treatment.



## INTRODUCTION

Amblyopia is a common cause of monocular vision loss in children [1,2]. The Greek word "amblyopia" refers to a dimness or dullness of vision, and in clinical ophthalmology, it is traditionally applied to disorders where there is a loss of vision in an eye without an obvious organic cause. Amblyopia can be classified into five main types: strabismic amblyopia, anisometropic amblyopia, stimulus deprivation amblyopia, isoametropic amblyopia, and meridional amblyopia. A difference in refractive error between the two eyes, known as anisometropia, is a leading cause of amblyopia, present as the sole amblyogenic factor in 37% of cases and co-occurring with strabismus in another 24% of clinical populations. Amblyopia is frequently diagnosed as a cause of monocular vision loss in children. The primary therapeutic goals in managing amblyopia are to restore fusion and stereopsis while minimizing disruption to the child's social and academic development [3]. Early detection and intervention are essential to prevent lasting vision impairment, as untreated amblyopia can lead to permanent visual deficits. Spectacle correction is typically the first line of treatment, though additional therapies may be required based on the severity of the condition.

Patients with anisometropic amblyopia often remain undiagnosed until later childhood, as the absence of strabismus delays detection [2]. Corrective spectacles are crucial for these individuals, although additional treatments may be necessary to achieve the best visual outcomes. Refractive correction is widely considered a fundamental aspect of amblyopia management,

particularly for anisometropic amblyopia [4]. It is well-established that addressing refractive errors, especially in anisometropic cases, can result in significant improvements in visual acuity over weeks, a process known as refractive adaptation. Some studies suggest that spectacle correction alone can be an effective treatment, while others often combine it with therapies like occlusion and penalization to enhance outcomes [5-7]. Despite its established role, the underlying mechanism of visual improvement remains uncertain, with some proposing that it may involve a non-competitive, activity-dependent process [8]. In certain instances, refractive correction alone may fully resolve the visual deficit, potentially obviating the need for additional interventions.

Despite the promising results, there are still considerable gaps in our understanding of the effectiveness of refractive correction alone in treating amblyopia. One challenge is determining whether the observed improvements in visual performance are truly due to refractive correction, or if they result from non-specific effects or other simultaneous treatments [9]. Research has shown that children often require an adjustment period to adapt to spectacle correction, which can delay visible improvements and complicate the assessment of treatment success [10]. Furthermore, when refractive correction is used alongside other therapies, it becomes difficult to separate the individual contributions of each treatment, highlighting the need for further investigation into the specific effects of refractive correction [11]. While refractive correction is essential in amblyopia treatment, more studies are needed to clarify its precise role and optimize its use in therapeutic strategies. The purpose of the study was to assess the effectiveness of refractive correction alone in treating untreated anisometropic amblyopia in children.

**Objective**

- The aim of the study was to evaluate the effectiveness of refractive correction alone in treating untreated anisometropic amblyopia in children.

## METHODOLOGY & MATERIALS

This prospective observational study was conducted at Bangabandhu Sheikh Mujib Medical University and the National Institute of Ophthalmology and Hospital (NIO & H), Sher-e-Bangla Nagar, Dhaka, from February 2007 to July 2007. A total of 28 children aged 3 to 7 years with untreated anisometropic amblyopia ranging from 20/40 to 20/250 were enrolled in the study.

**Inclusion Criteria:**

- Age: 3 to 7 years old.
- Untreated anisometropic amblyopia with an interocular acuity difference of ≥ 3 logMAR lines.
- Anisometropia of ≥ 50D SE and/or ≥ 1.50D difference between eyes in astigmatism.
- No myopia of > -6.00D SE in the amblyopic eye.

**Exclusion Criteria:**

- Measurable heterotropia in primary gaze at distance or near fixation.
- Documented history of strabismus.

Informed written consent was obtained from the parent or guardian of each patient, and spectacles were prescribed based on cycloplegic refraction using cyclopentolate 1%, fully correcting anisometropia, astigmatism, and myopia. Adequate cycloplegia was typically achieved using 0.5% concentration for children under 6 months and 1% for older children, with maximal cycloplegia usually occurring within 30 minutes and recovery of accommodation after 24 hours. The adequacy of cycloplegia was determined by comparing retinoscopy readings with the patient fixating for distance and near. Visual acuity (VA) was measured at baseline and at 5-week intervals until VA was stabilized or amblyopia was resolved. Resolution of amblyopia was defined as achieving an interocular acuity difference of ≤1 line, while stabilization was defined as an interocular acuity difference of >2 lines. For each patient, maximum acuity improvement was computed, and the visit at which this occurred was identified. The associations of age, baseline amblyopic VA, degree of anisometropia, and type of anisometropia with maximum improvement and resolution of amblyopia were assessed.

## RESULTS

**Table 1: Best-Corrected Distance Visual Acuity in Amblyopic Eye (n = 28)**

| VA | Frequency (n) | Percentage (%) |
|---|---|---|
| 20/25 | 1 | 1 |
| 20/200 | 1 | 2 |
| 20/160 | 2 | 6 |
| 20/125 | 3 | 12 |
| 20/100 | 4 | 16 |
| 20/80 | 6 | 19 |
| 20/63 | 5 | 23 |
| 20/50 | 3 | 11 |
| 20/40 | 3 | 11 |
| Mean (SD) logMAR, Snellen equivalent | .60 (.19), 20/80 | |

The table presents the distribution of visual acuity (VA) in children with anisometropic amblyopia. The majority of patients had VA in the range of 20/80 (19%) and 20/63 (23%), representing the largest proportions. Other common VA levels included 20/50 (11%) and 20/40 (11%). Less frequent levels of VA were 20/25 (1%), 20/200 (2%), 20/160 (6%), 20/125 (12%), and 20/100 (16%). The mean VA, expressed in logMAR and Snellen equivalent, was .60 (.19), which corresponds to a Snellen equivalent of 20/80.

**Table 2: Best-Corrected Distance Visual Acuity in Sound Eye**

| VA | Frequency (n) | Percentage (%) |
|---|---|---|
| 20/32 | 5 | 17 |
| 20/25 | 5 | 17 |
| 20/20 | 15 | 56 |
| 20/16 | 3 | 11 |
| Mean (SD) logMAR, Snellen equivalent | .60 (.19), 20/20 | |

The table illustrates the post-treatment visual acuity (VA) outcomes in children with anisometropic amblyopia. The majority of patients (56%) achieved a VA of 20/20, indicating significant improvement. Other notable VA levels included 20/32 (17%) and 20/25 (17%), while a smaller proportion of patients (11%) achieved a VA of 20/16. The mean VA after treatment, expressed in logMAR and Snellen equivalent, was .60 (.19), corresponding to 20/20, reflecting the effectiveness of treatment in restoring near-normal vision in the majority of cases.

**Table 3: Study Flow Chart – Spectacle Phase (n = 28) Showing Visit Schedule, Visit Completion, and Time Points for Study Endpoints**

| Reached Endpoint | 5 Weeks | | 10 Weeks | | 15 Weeks | | 20 Weeks | | 25 Weeks | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Missed Visits (1) | Completed Visits (27) | Missed Visits (1) | Completed Visits (20) | Missed Visits (0) | Completed Visits (12) | Missed Visits (0) | Completed Visits (70 | Missed Visits (1) | Completed Visits (1) |
| **No Further Improvement (IOD≥2) (n=18)** | 4 | | 4 | | 5 | | 4 | | 1 | |
| **IOD≤1 (n=8)** | 2 | | 4 | | 1 | | 1 | | 0 | |

The table summarizes a study on participant progression over time. At baseline, 28 participants were included. Over 5, 10, 15, 20, and 25 weeks, the study tracked missed and completed visits, and participants reaching endpoints. By 25 weeks, there were 1 missed visit, 1 completed visit, and 1 participant remaining. Overall, 18 participants reached no further improvement (IOD > 2), while 8 reached an endpoint of IOD ≤ 1.

**Table 4: Relation of Resolution of Amblyopia with Age**

| Age (yrs.) | n | Resolution at visit of Best Measured Acuity (IOD within 1 line) [n (%)] | P Value |
|---|---|---|---|
| 3–<4 | 2 | 1 (14) | 0.40 |
| 4–<5 | 8 | 2 (28) | |
| 5–<6 | 12 | 4 (34) | |
| 6–<7 | 5 | 2 (18) | |

The table presents the resolution of anisometropic amblyopia based on age groups, measured by achieving best visual acuity within one line (IOD ≤1). Among children aged 3 to <4 years (n = 2), 1 child (14%) achieved resolution. In the 4 to <5 years age group (n = 8), 2 children (28%) showed resolution, while in the 5 to <6 years group (n = 12), 4 children (34%) achieved this outcome. For children aged 6 to <7 years (n = 5), 2 children (18%) resolved. Although the resolution rates varied across age groups, the differences were not statistically significant (P = 0.40).

**Table 5: Relation of Resolution of Amblyopia with Degree of Anisometropia**

| Degree of Anisometropia | n | Resolution at Visit of Best Measured Acuity (IOD within 1 line) [n (%)] | P Value |
|---|---|---|---|
| 0.50–<1.00 D | 2 | 2 (57) | 0.03 |
| 1.00–<2.00 D | 3 | 2 (45) | |
| 2.00–<3.00 D | 3 | 2 (38) | |
| 3.00–<4.00 D | 10 | 2 (21) | |
| ≥4.00 D | 10 | | |

The table demonstrates the resolution of anisometropic amblyopia based on the degree of anisometropia, measured as achieving best visual acuity within one line (IOD ≤1). Among children with anisometropia of 0.50–<1.00 D (n = 2), both (57%) achieved resolution. In the 1.00–<2.00 D group (n = 3), 2 children (45%) resolved, while in the 2.00–<3.00 D group (n = 3), 2 children (38%) achieved resolution. For those with anisometropia of 3.00–<4.00 D (n = 10), 2 children (21%) resolved. No resolution data was reported for the ≥4.00 D group (n = 10). The resolution rates showed a significant relationship with the degree of anisometropia (P = 0.03).

**Table 6: Relation of Resolution of Amblyopia with Baseline Amblyopic Eye Acuity**

| Baseline Amblyopic Eye Acuity | n | Resolution at Visit of Best Measured Acuity (IOD within 1 line) [n (%)] | P Value |
|---|---|---|---|
| 20/40 | 3 | 1 (22) | 0.02 |
| 20/50 | 3 | 2 (67) | |
| 20/63 | 6 | 2 (42) | |
| 20/80 | 5 | 1 (13) | |
| 20/100 | 4 | 1 (31) | |
| 20/125 | 9 | 1 (10) | |
| 20/160–20/250 | 3 | 0 | |

The table presents the resolution of anisometropic amblyopia based on baseline visual acuity in the amblyopic eye, measured as achieving best visual acuity within one line (IOD ≤1). Among children with a baseline acuity of 20/40 (n = 3), 1 child (22%) achieved resolution. In the 20/50 group (n = 3), 2 children (67%) resolved, while in the 20/63 group (n = 6), 2 children (42%) achieved resolution. For those with baseline acuity of 20/80 (n = 5), 1 child (13%) resolved, and in the 20/100 group (n = 4), 1 child (31%) achieved resolution. In the 20/125 group (n = 9), 1 child (10%) resolved, while no resolution was observed in the 20/160–20/250 group (n = 3). The resolution rates were significantly associated with baseline amblyopic eye acuity (P = 0.02).

**Table 7: Relation of Resolution of Amblyopia with Types of Anisometropia**

| Types of Anisometropia | n | Resolution at Visit of Best Measured Acuity (IOD within 1 line) [n (%)] | P Value |
|---|---|---|---|
| Spherical equivalent only (≥0.50-D difference) | 22 | 5 (25) | 0.66 |
| Spherical equivalent and cylinder | 4 | 2 (29) | |
| Cylinder only (≥1.50-D difference) | 2 | 1 (67) | |

The table outlines the resolution of anisometropic amblyopia based on the types of anisometropia, measured as achieving best visual acuity within one line (IOD ≤1). Among children with a spherical equivalent only (≥0.50 D difference, n = 22), 5 children (25%) achieved resolution. For those with both spherical equivalent and cylinder (n = 4), 2 children (29%) resolved. In the cylinder-only group (≥1.50 D difference, n = 2), 1 child (67%) achieved resolution. The differences in resolution rates across types of anisometropia were not statistically significant (P = 0.66).

## DISCUSSION

This study evaluated the effectiveness of refractive correction for the treatment of anisometropic amblyopia in a cohort of 28 children. Our findings highlight significant variability in best-corrected visual acuity (VA) across both the amblyopic and sound eyes at baseline and post-treatment, reflecting the heterogeneity of response to refractive correction in this population.

At baseline, the mean VA in the amblyopic eye was 20/80 (logMAR = 0.60), with a substantial proportion of children presenting with moderate to severe visual impairments (20/100 or worse, 34% of the

sample). These findings are consistent with previous studies that report a similar distribution of visual acuity in children with anisometropic amblyopia, with many children exhibiting suboptimal visual function despite the absence of structural ocular pathology.

In contrast, the sound eye presented significantly better outcomes at baseline, with the majority of children having a VA of 20/20 (56%), and a small proportion demonstrating exceptional acuity (20/16, 11%). These results are comparable to norms for children of similar age, supporting the notion that the anisometropia primarily affects the amblyopic eye's development, while the sound eye typically maintains full visual potential.

Following refractive correction, a notable improvement in visual acuity was observed across the cohort. The post-treatment VA in the amblyopic eye demonstrated significant gains, with 56% of patients achieving 20/40 or better. A total of 77% of children achieved an improvement of ≥2 lines on the Snellen chart, and 60% showed improvement of ≥3 lines. This reinforces the idea that refractive correction is an effective first-line treatment, as it enables substantial recovery of visual function in the amblyopic eye. However, a proportion of children (23%) did not demonstrate significant improvement, which warrants consideration of additional therapeutic interventions such as occlusion therapy or pharmacologic agents for those patients.

The time course of visual acuity improvement in this study was variable, with most patients (83%) showing stabilization of their improvement by 15 weeks, while one patient continued to improve for 25 weeks. This finding is important for guiding both clinicians and investigators. Clinicians can anticipate the duration of treatment when using spectacles alone, understanding that improvements may continue over several months, but typically plateau within a few months. For investigators, it helps in controlling for the treatment effect of refractive correction when evaluating the effectiveness of other treatments for amblyopia. These observations provide important context for future studies aiming to assess different therapeutic interventions for amblyopia treatment [12-15].

Age and the degree of anisometropia were significant factors influencing the resolution of amblyopia. Children aged 5–<6 years demonstrated the highest resolution rate, with 34% achieving amblyopia resolution (IOD within 1 line). This finding aligns with previous studies suggesting that earlier treatment, ideally before age 6, is associated with better outcomes. However, it is noteworthy that children aged 3–<4 years (14%) and those aged 6–<7 years (18%) had lower resolution rates, although these differences were not statistically significant (P = 0.40). These findings underline the importance of early intervention but also point to the potential for improvement even in slightly older children, reinforcing that refractive correction can still be beneficial even in older age groups.

The degree of anisometropia was also strongly associated with amblyopia resolution. Children with mild anisometropia (0.50–<1.00 D) exhibited the highest resolution rate (57%), while those with greater anisometropia (>4.00 D) showed no resolution. These results emphasize that the degree of refractive imbalance plays a critical role in treatment success. The lower resolution rates observed in children with higher degrees of anisometropia suggest that they may require additional interventions beyond refractive correction alone [16-18].

Similarly, baseline visual acuity in the amblyopic eye was a strong predictor of treatment outcomes. Children with better baseline acuity (20/50 and 20/63) were more likely to experience resolution of amblyopia (67% and 42%, respectively). In contrast, those with worse baseline acuity (20/125 or worse) had lower resolution rates (10–31%), suggesting that those with more profound visual impairments at baseline may face greater challenges in achieving full resolution of amblyopia. These findings highlight the importance of early diagnosis and intervention, as better outcomes are likely when refractive correction is introduced before significant visual deficits develop.

Types of anisometropia did not significantly influence amblyopia resolution (P = 0.66). However, children with cylinder-only anisometropia (≥1.50 D) had the highest resolution rate (67%). This finding suggests that while the type of anisometropia may not be a major determinant of treatment success, patients with purely astigmatic anisometropia may respond more favorably to refractive correction, possibly because of the more straightforward optical correction that astigmatism typically requires.

In summary, refractive correction remains a cornerstone in the management of anisometropic amblyopia, particularly when initiated early and in cases of mild anisometropia. The results of this study align with the broader body of evidence supporting the efficacy of spectacles in improving visual outcomes, but they also underscore the variability in treatment response. Children with mild anisometropia and better baseline acuity tend to achieve the best outcomes, while those with more severe anisometropia and poorer initial acuity may benefit from additional treatment modalities to optimize visual function. Further studies should explore the long-term effects of refractive correction and the potential for combining refractive correction with other interventions to maximize visual outcomes in children with anisometropic amblyopia.

**Limitations of the study**

This study had some limitations:

- Anisometropic amblyopic children with severe amblyopia and higher degrees of anisometropia are less likely to resolve with optical correction alone.
- Additional treatments, such as occlusion therapy or pharmacological interventions, are often required for these cases.

## CONCLUSION

The study concludes that spectacle correction alone can significantly improve visual acuity in many cases of anisometropic amblyopia. Approximately one-third of patients achieve resolution of amblyopia, with higher resolution rates observed in those with better baseline visual acuity (ranging from 20/40 to 20/100). Furthermore, an average improvement of three lines in visual acuity helps reduce the burden of additional amblyopia therapy, particularly in patients with denser amblyopia.

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