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Evaluation of Factors Affecting the Outcomes of Strabismus Surgery and Treatment of Amblyopia

Şaşılık Cerrahisi ve Ambliyopi Tedavisi Sonuçlarını Etkileyen Faktörlerin Değerlendirilmesi

Umut GÜNER[1], İbrahim ŞAHBAZ[2]

[1]Dünyagöz Hospital, Clinic of Ophthalmology, İstanbul, Turkey
[2]Üsküdar University Faculty of Medicine, Department of Ophthalmology, İstanbul, Turkey

ABSTRACT

Aim: It was aimed to determine the factors affecting outcomes in concomitant esotropia and treatment of amblyopia.

Materials and Methods: The records of 159 patients in Haydarpaşa Numune Training and Research Hospital, Clinic of Ophthalmology, Strabismus Unit were retrospectively evaluated in the study. While treatment with patching was performed in 86 patients due to amblyopia, surgical intervention was performed in the other 73 patients due to concomitant esotropia.

Results: The age at onset of treatment in Strabismic Amblyopia group was 5.1±1.7 years; and the final increase in visual acuity was 4.1±0.4 standard lines (0.41±0.04 logMAR). The age at onset of treatment in the Strabismic Anisometropic Amblyopia group was 5.3±2.1 years; and the final increase in visual acuity was 4.3±0.6 standard lines (0.43±0.06 logMAR). In the full-time patching group, the initial visual acuity was 0.32±0.17 standard lines (=0.50±0.21 logMAR), and the final visual acuity was 0.76±0.20 standard lines 35 (0.13±0.34 logMAR). In the part-time patching group, the initial visual acuity was 0.30±0.15 standard lines (0.52±0.09 logMAR), and the final visual acuity was 0.63±0.20 standard lines (0.20±0.34 logMAR). A strong correlation was found between the initial visual acuity level and the amount of increase in visual acuity of the patients who underwent patching therapy (p=0.00). Surgical success in cases with binocular single vision (80.60%) was statistically significant compared to those without binocular single vision (63.60%), (p=0,02; chi-square test). There was no statistically significant difference in surgical success between the non-refractive and refractive concomitant esotropia (p>0.05; chi-square test).

Conclusion: We believe that preoperative deviation angle alone is not sufficient as a criterion for esotropia surgery planning, and considering binocular vision and stereopsis together with a successful amblyopia treatment is important for affecting the results of strabismus surgery.

Keywords: Esotropia, amblyopia, strabismus, eyeglasses

ÖZ

Amaç: Bu çalışmanın amacı konkomitan ezotropyada ve ambliyopi tedavisinde sonuçları etkileyen faktörleri belirlemektir.

Gereç ve Yöntem: Haydarpaşa Numune Eğitim ve Araştırma Hastanesi Göz Hastalıkları Kliniği Şaşılık Bölümü'nde 159 hastanın kayıtları retrospektif olarak çalışma kapsamına alındı. Hastaların 86'sına ambliyopi nedeni ile kapama uygulanırken, diğer 73 hastaya ise konkomitan ezotropya nedeni ile cerrahi tedavi uygulandı.

Bulgular: Strabismik ambliyopide tedaviye başlangıç yaşı 5,1±1,7, sonuç görme keskinliğindeki artış ise 4,1±0,4 standart sıra (0,41±0,04 logMAR) idi. Strabismik Anizometropik Ambliyopi grubunda tedaviye başlangıç yaşı 5,3±2,1 idi. Sonuç görme keskinliğindeki artış 4,3±0,6 standart sıra (0,43±0,06 logMAR) idi. Tam gün kapama yapılan grupta, başlangıç görme keskinliği ortalaması 0,32±0,17 standart sıra (=0,50±0,21 logMAR) idi, bu grupta sonuç görme keskinliği 0,76±0,20 standart sıra (=0,13±0,34 logMAR) olarak bulundu. Kısmi kapama yapılan grupta, başlangıç görme keskinliği ortalaması 0,30±0,15 standart sıra (=0,52±0,09 logMAR) olup, tedavi sonunda 0,63±0,20 standart sıra (=0,20±0,34 logMAR) olarak tespit edildi. Kapama tedavisi uygulanan hastaların başlangıç görme keskinliği düzeyi ile görme keskinliğindeki artış miktarı arasında kuvvetli bir korelasyon tespit edildi (p=0,00). Binoküler tek görmesi olan olgularda cerrahi başarının (%80,60) binoküler tek görmesi olmayanlara (%63,60) kıyasla istatistiksel olarak anlamlı olduğu görüldü (p=0,02; ki-kare testi). Non-refraktif ile refraktif ezotropya arasında cerrahi başarı açısından istatistiksel olarak anlamlı bir fark bulunmadı (p>0,05; ki-kare testi).

Address for Correspondence: İbrahim ŞAHBAZ MD, Üsküdar University Faculty of Medicine, Department of Ophthalmology, İstanbul, Turkey
Phone: +90 532 215 59 27 **E-mail:** ibrahim.sahbaz@uskudar.edu.tr **ORCID ID:** orcid.org/0000-0002-5934-5367
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Sonuç: Konkomitan ezotropya cerrahi planlamasında preoperatif kayma açısının yeterli olmadığı, başarılı bir ambliyopi tedavisi ile birlikte binoküler görme ve stereopsisin de dikkate alınmasının şaşılık cerrahisi sonuçlarını etkilemesi açısından önemli olduğu kanaatindeyiz.

Anahtar Kelimeler: Ezotropta, ambliyop, şaşılık, gözlük

INTRODUCTION

Childhood esotropia (ET) constitutes the strabismus group that physicians will most commonly encounter due to their high prevalence. The main factors affecting the development and course of strabismus include fusion, stereopsis, the presence of refractive errors, power of accommodation, alternation, and fixation[1]. The maturation period of stereopsis is considered the first decade of life, and in this critical period, the binocularity defect impairs the maturation process of stereopsis[2]. The prevalence of amblyopia has been reported to be between 3.0% and 3.2% in the general population[3].

In a study conducted in Turkey, it was reported that 1.5% of a total of screened 823 children showed strabismus and 1.8% showed signs of amblyopia on the cover test[4]. Strabismus and amblyopia are typically considered preventable vision loss if diagnosed and treated early[5]. Strabismus affects 4% of the population and causes negative effects in many areas including quality of life and psychosocial aspects in children[6].

Amblyopia is a unilateral or bilateral reduction in visual acuity in the entire optic axis and macula without any organic cause that can decrease vision which can be detected by physical examination[7-9]. Amblyopia develops as a result of abnormal binocular interaction and vision deprivation in the first 5 years of life, which is the sensitive period and is called the critical period and physiological reflexes such as binocular single vision, accommodation, fixation and vergence are established. In strabismus amblyopia, visual stimuli from the deviating eye undergo continuous monocular suppression, resulting in reduced visual functions and amblyopia[1,8]. The aim of the treatment of amblyopia is to provide normal and equal vision in both eyes, and to gain binocular harmony and depth perception[10]. In cases diagnosed with amblyopia, different treatments including correction of refractive error, patching therapy, penalisation, pleoptic therapy and treatment with CAM, neurovision and transcorneal electrical stimulation are applied. Regardless of which method is chosen, the procedure to be done in every amblyopia case is to correct the refractive error first[1,9,11]. Patching therapy is based on the principle of forcing the amblyopic eye to see by closing the eye doing fixation in the patient[1,8]. While correcting the refractive error in the treatment of amblyopia is very effective even on its own, short-term patching is also as effective in the treatment as intensive patching[12]. With strabismus surgery, the recovery of amblyopia and binocular vision, surgical correction of non-foveal eccentric fixation, and foveal fixation are provided[13]. Three main goals are aimed in a case to be performed strabismus surgery; binocular single vision, better aesthetic appearance, and obtaining peripheral fusion with adequate fusional vergence amplitudes to provide orthotropia[14].

MATERIALS AND METHODS

A total of 159 patients who were followed up for the diagnosis of ET and amblyopia in the Haydarpaşa Numune Training and Research Hospital, 2. Ophthalmology Clinic, Strabismus Unit between January 2001 and January 2006 were included in the study. The records of 159 patients were reviewed retrospectively, and their demographic characteristics, examination findings for strabismus, strabismus type, routine eye examination findings, applied patching therapy for amblyopia, control examination findings in those who underwent patching therapy, information on the operation performed, and post-operative control examination findings were taken into account. Our studies were carried out in accordance with the Declaration of Helsinki and with the permission of the Üsküdar University Non-Invasive Ethics Committee, numbered 61351342 (date: 26.04.2022). Patching therapy was applied to 86 of the patients due to amblyopia, and surgery was performed in other 73 patients due to ET. Eighty-six patients who were applied the patching therapy due to the diagnosis of amblyopia were evaluated in two groups, as strabismic amblyopia and strabismic anisometropic amblyopia groups. All patients had unilateral amblyopia. Seventy three patients who were followed up with the diagnosis of ET and who underwent surgery were evaluated in two groups, as non-refractive accommodative ET (high AC/A ratio) and partial refractive accommodative ET groups. The AC/A ratio was measured with the heterophoria method. Cases of partially refractive accommodative ET were defined as those whose the near deviation decreased by at least 10 Δ compared to the distant deviation when the hypermetropic refractive error was fully corrected clinically, but could not be completely eliminated. Cases of fully accommodative ET, congenital ET, alphabetic-pattern ET, incomitant ET, consecutive ET, and organic amblyopia were not included in the study. In addition, patients who had a history of previous surgery or who did not continue their follow-up examinations for at least 6 months after amblyopia treatment and surgical treatment were not included in the study. The criterion for amblyopia was accepted as the presence of difference in at least two standard lines or more (≥0.2 logMAR) according to the Snellen chart, between the best-corrected visual acuities in the two eyes of the same

patient[1]. In all cases treated for amblyopia, visual acuities at the beginning and end of treatment were converted to logMAR equivalents, and the amount of increase in visual acuity was also calculated with logMAR values. A spherical or cylindrical refractive error difference of at least 1 diopter or more was taken as the criterion for anisometropia[6]. The refractive error in both eyes and the difference in refraction between the eyes were calculated by converting them to spherical equivalent with the formula 'spherical value + cylindrical value/2'[6]. In the patching therapy performed for the treatment of amblyopia, the rule of weeks by age was followed[4,5]. Controls of the patching treatment were carried out in the 1st, 3rd, 6th and 12th months and the patching therapy was repeated in cases deemed necessary.

In the determination of the amount of strabismus, the amount of shift determined by the prism cover test in the primary gaze position during distant fixation (after correcting the existing hypermetropic refractive error) was taken as a basis. Postoperative first day, first week, first month and sixth month controls were again performed with the prism cover test.

The presence of binocular single vision was measured by synoptophore, titmus and TNO (random dot) tests. The results were evaluated in four groups as simultaneous perception, fusion, coarse stereopsis and stereopsis. The desired outcome in patching therapy was a vision gain of at least 2 lines or more (≥0.2 logMAR) according to the Snellen distance reading chart. The desired postoperative outcome was determined as ±10 Δ shift in the primary gaze position during distant fixation.

Bilateral regression, unilateral regression and resection, bilateral regression and resection were performed in cases that underwent surgical treatment. During surgery, the muscles were sutured to the sclera with 6.0 vicryl. The conjunctivae were closed with 8.0 silk. After surgery, 0.1% dexamethasone drops 3x1 and 0.3% ofloxacin drops 5x1 were applied to the eyes for 2 weeks.

Factors, the effects of which on the outcomes of patching therapy were investigated, included the age at onset of treatment, gender, initial visual acuity, type of amblyopia, and extent of patching performed.

On the other hand, factors whose effects on surgical treatment results were investigated were age, gender, degree of hypermetropic refractive error, age at the onset of strabismus, degree of horizontal strabismus, the presence of binocular single vision, age at surgery, and type of strabismus.

Statistical Analysis

The results of patching treatment and surgical treatment and the relationships between these factors were evaluated with the Spearman's correlation analysis, Pearson's correlation analysis, dependent t-test and chi-square tests.

RESULTS

Of the 86 patients included in the study, 34 (39.50%) were girls and 52 (60.50%) were boys. The mean age of the patients, whose age at the onset of patching therapy ranged from 3 to 10 years, was 6.1±2.1 years. The mean follow-up period was 28.7±14.1 months (12-60 months).

Forty patients had strabismic amblyopia (46.50%), and 46 patients had strabismic anisometropic amblyopia (53.50%).

When the effects of the age at onset of patching therapy on final visual acuity were examined, it was seen that the effect of age at onset of treatment on final visual acuity was statistically significant in both patient groups (r=-0.240 p=0.012 in strabismic amblyopia; r=-0.720 p=0.030 in strabismic anisometropic amblyopia); Spearman's correlation analysis) (Table 1).

Full-time patching (24 hours) was applied to 45 patients, and part-time patching (4 hours) was applied to 41 patients. The mean initial visual acuity of the patients who underwent full-time patching therapy was 0.32±0.17 Snellen line (=0.50±0.21 logMAR), and it was 0.76±0.20 (=0.13±0.34 logMAR) at the end of the treatment. In patients who underwent part-time patching therapy, the mean initial visual acuity was 0.30±0.15 (=0.52±0.09 logMAR), and it was 0.63±0.20 (=0.20±0.34 logMAR) at the end of the treatment. The levels of increase in final visual acuity of the groups were statistically significant (p=0.000, p=0.000, respectively; dependent t-test) (Table 2). The statistical significance shows that both patching techniques are effective methods in the treatment of amblyopia.

A strong correlation was found between the initial visual acuity level and the amount of increase in visual acuity in patients

Table 1. Effect of the age at onset of treatment on visual acuity

Patient group	Age at onset of treatment	Increase in visual acuity	p value
Strabismic amblyopia	5.1±1.7	4.1±0.4 standard line (0.41±0.04 logMAR)	r=-0.240 p=0.012 (significant)
Strabismic anisometropic amblyopia	5.3±2.0	4.3±0.6 standard line (0.43±0.06 logMAR)	r=-0.720 p=0.030 (significant)

p=Spearman's correlation analysis

who underwent patching therapy (r=0.639, p=0.000; Pearson's correlation analysis).

When the success rates at the end of patching therapy were separately examined in terms of amblyopia types (cases with 2 standard lines or more) (≥0.2 LogMAR), the success rate was 72.50% in the strabismic amblyopia group and 76.10% in the strabismic anisometropic amblyopia group. No statistically significant difference was found (p=0.462; chi-square test)

In the statistical analysis comparing the age at onset of patching therapy, gender, initial visual acuity, type of amblyopia, and time of patching in a day, it was observed that gender and amblyopia type did not affect the final visual acuity (p=0.05).

Age at onset of patching therapy, time of patching in a day, and initial visual acuity were found to have a statistically significant effect on final visual acuity (p=0.02, p=0.00, p=0.00, respectively).

Of the 73 patients who were included in the surgical treatment group, 40 had non-accommodative ET and 33 had partially refractive accommodative ET.

Surgical success (81.60%) in cases with binocular single vision was statistically significant compared to cases without binocular single vision (63.60%) (p=0.02; chi-square test).

Surgical success rate (85.10%) in cases with a horizontal strabismus of less than 50 Δ was statistically significant compared to surgical success (61.50%) in cases with a horizontal strabismus of more than 50 Δ (p=0.01; chi-square test).

The age at surgery ranged from 4 to 10 years in patients. There was no statistically significant difference between the age of surgery and surgical success (p=0.05; chi-square test).

There was no statistically significant difference in the results of successful surgical treatment in the non-refractive accommodative ET group (77.50%) and partially refractive accommodative ET group (75.75%) (p=0.05; chi-square test).

In statistical analyses comparing features such as age, gender, hypermetropic refractive error, binocular vision, age at onset of strabismus, amount of horizontal strabismus, age at surgery and type of strabismus in patients with and without the desired outcomes after surgery, it was seen that age, gender, degree of hypermetropic refractive error, the age of onset of strabismus, the age at surgery and the type of strabismus did not have a statistically significant effect on the success of surgical treatment (p=0.05; chi-square test).

The degrees of horizontal strabismus and binocular single vision were found to have a statistically significant effect on the success of the surgery in both patient groups (p=0.01, p=0.02; chi-square test, respectively).

Statistically significance is due to the higher surgical success in patients with binocular single vision, and the lower surgical success in patients with higher horizontal strabismus.

DISCUSSION

Childhood esodeviations (2-5%) and amblyopia (1-5%) are the most common strabismus problems[15]. There is no consensus on which factors affect the outcome of the surgery most, both motor and functional. Therefore, due to many factors, surgery for the treatment of strabismus and the factors affecting it affect the results of strabismus surgery[16].

It has been determined that patching is more effective than glasses in children aged 3-7 years with moderate to severe amblyopia. It has been reported that additional patching will be beneficial in children with increased visual acuity using only glasses[17]. There is no definitively accepted formula for patching therapy in the treatment of amblyopia. Although the duration of patching therapy is usually determined in weeks according to age, the exact duration is determined by the physician according to the patient's response to the treatment. It is generally appropriate to continue the patching therapy until the vision is equal in both eyes or until it is determined that the vision does not improve in the amblyopic eye within a period of at least 3 months[18]. The duration of the patching therapy should be determined according to the severity of the vision loss and the age of the child[19]. There are no strict rules for the patching therapy to be done during the day. Full-time or part-time treatment is adjusted according to the patient's response to treatment. Depending on the response to treatment, patching can be repeated several times. When the desired level of vision is reached, patching therapy should be reduced in a controlled manner in order to maintain this situation. This therapy can be continued until the age of 10-12 years within the framework of these rules[18]. The patient's age plays an important role in the response to patching therapy. The first 5 years of age is the advantageous period. In patching therapies started after this age, the increase in vision becomes more and more difficult[9]. One of the biggest difficulties

Table 2. Change in visual acuity (logMAR) according to times of patching therapy

Patient group	Initial visual acuity	Final visual acuity	p value
Full-time patching (n=45)	0.50±0.21	0.13±0.34	p=0.000
Part-time patching (n=41)	0.52±0.09	0.20±0.34	p=0.000

of patching therapy is compliance with the treatment. In a study conducted by Scott et al.[20], patients were electronically monitored during patching therapy and it was reported that the rate of compliance with the therapy was 63%. In our study, the success rates in patching therapy for amblyopia were determined as 72.50% in strabismic amblyopia, 76.10% in strabismic anisometropic amblyopia, and 74.40% in all patients, and these values were found to be consistent with other studies. In various studies investigating the results of patching therapy in esotropia, success rates were reported as 80.30%, 85.20%, and 83%, respectively[21-23]. Our study showed that the level of visual acuity improvement obtained in full-time patching was higher than in part-time patching.

In our study, it was detected that the lower the initial visual acuity, the greater the increase in visual acuity, and our results were found to be compatible with other studies[24-26].

In our study, the finding of that the type of amblyopia did not make a significant difference in the increase in visual acuity after patching therapy was also found to be consistent with other studies[20,22,26].

The aim of strabismus surgery is primarily functional and then cosmetic correction of the deviation[27]. The surgical success rate was 77.50% in non-refractive accommodative esotropia, 75.75% in partially refractive accommodative esotropia, and 76.60% in all patients. These results are consistent with studies in which success rates were reported as 61.90%, 63.3%, 72.90%, 76.10%, and 92.30%, respectively[28-32]. It was seen that the degree of deviation angle before surgery affected the surgical results significantly in both ET groups and this result was consistent with the results of other studies. Among the factors affecting the outcome in strabismus surgery, it was reported that the most important one was the preoperative deviation angle[33]. In our study, it was observed that factors such as age at surgery, gender, age at onset of strabismus, and degree of refractive error were not effective on the surgical outcome in both groups. On the contrary, it was determined that the degree of horizontal strabismus and the presence of binocular single vision in both groups affected the surgical results statistically significantly. This result was also supported by similar studies[28]. The finding that binocular single vision is an important factor affecting the results of surgery, obtained as a result of our study, has also been shown in other studies[34,35].

Study Limitations

The limitations of this study include that it had a retrospective design and that it was a single-center study.

CONCLUSION

It was observed that the age range of 3-10 years was the most important period in the treatment of amblyopia, and gender and type of amblyopia did not affect the outcome. Factors determining visual acuity as a result of patching therapy were revealed to be the age at onset of treatment, the amount of patching during the day, and initial visual acuity. In the comparison of full-time or part-time patching, there was a statistically significant difference in full-time patching, while other studies have reported that part-time patching is as effective as full-time patching. Surgical success rate was found to be 76.70% in patients who underwent surgery. It was seen that the amount of horizontal strabismus and the presence of binocular single vision affected the success of the surgeries significantly.

We suggest that preoperative deviation angle alone is not sufficient as a criterion for planning esotropia surgery, and binocular vision and stereopsis in addition to successful amblyopia treatment are important data affecting the results of strabismus surgery.

Ethics

Ethics Committee Approval: This retrospective study was approved by the Üsküdar University Non-Invasive Ethics Committee (decision number: 61351342, date: 26.04.2022).

Informed Consent: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: U.G., İ.Ş. ,Design: U.G., İ.Ş., Data Collection or Processing: U.G., İ.Ş., Analysis or Interpretation: U.G., İ.Ş., Literature Search: U.G., İ.Ş., Writing: U.G., İ.Ş.

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