

Successful Occlusion Therapy for Amblyopia in 11- to 15-Year-Old Children

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Purpose: To investigate the effectiveness of full-time occlusion therapy in treating amblyopia in 11- to 15-year-old children and to determine its lasting results.

Patients and Methods: Fifty-five compliant children 11 to 15 years old who had amblyopia were treated with full-time (during all waking hours) occlusion of their good eye until no further improvement in the visual acuity of their amblyopic eye was observed on 3 consecutive monthly follow-up examinations. After this, part-time (4 hours per day) occlusion therapy was used randomly in 24 of 55 patients for 3 to 6 months for maintenance of the final visual acuity. Snellen visual acuity and its logMAR equivalent were recorded before treatment, at the cessation of full-time occlusion therapy, and on the most recent examination.

Results: All 55 of the patients had improved

visual acuity after treatment. The mean improvement was 0.46 logMAR unit (4.6 Snellen lines). Thirty-two of the patients had a mean follow-up of 17.6 months after the cessation of full-time and maintenance occlusion therapy. Twenty-nine (91%) of the 32 patients maintained improved visual acuity, whereas 3 (9%) exhibited a regression in visual acuity. Maintenance occlusion therapy did not have a significant stabilizing effect on the improved visual acuity.

Conclusion: Compliant, full-time occlusion effectively improves acuity in children 11 to 15 years old who have amblyopia due to strabismus, anisometropia, or both. Most older patients have lasting improvement with or without maintenance patching.

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INTRODUCTION

It is generally agreed that amblyopia must be treated at an early age to prevent permanent visual

loss, and that treatment is more prolonged and less effective in older children.¹⁻⁴ The response to amblyopia therapy is usually considered poor after the age of 8 years.⁵⁻⁷ However, good results of amblyopia treatment have been reported in even older children and adults.⁸⁻¹⁴ Mintz-Hittner and Fernandez¹² reported successful amblyopia therapy in children 7 to 10.3 years old. Oliver et al.¹³ also reported a marked improvement in visual acuity in children 8 to 11.5 years old who complied with occlusion treatment. Similarly, improved visual acuity with occlusion therapy was observed in all

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of the 16 children with amblyopia between 9 and 12 years old included in the study by Dayson.¹⁴ Some investigators have found that the efficacy of treatment for strabismic amblyopia decreased as a function of age and was null by the time the patient was 12 years old,⁵ whereas anisometric amblyopia could be successfully treated until at least the age of 12 years.¹⁵ It is not yet known whether the visual improvement in the amblyopic eyes of children who began treatment at the age of 8 years and older remains after occlusion is discontinued.

We report our experience treating selected amblyopia with full-time occlusion in 55 children 11 to 15 years old, and the lasting results of 32 of those observed for a mean of 17.6 months after discontinuation of full-time and maintenance occlusion therapy.

PATIENTS AND METHODS

This prospective, single-center study included 73 children 11 to 15 years old who had amblyopia and were willing to undergo conventional occlusion therapy strictly according to the schedule between January 1997 and September 2001. The patient source was mainly referrals from other ophthalmologists in Northern India. All of the parents consented to this study, and it was approved by the institution review board. Eighteen patients were later determined to be noncompliant during the treatment phase and were subsequently excluded from the study. The remaining 55 children (37 boys and 18 girls) were 11 years old (22 patients), 12 years old (13 patients), 13 years old (11 patients), and 14 to 15 years old (9 patients). Three of the patients who entered the study were between 15.0 and 15.9 years old. We excluded those with stimulus deprivation amblyopia, unilateral aphakia, and nystagmus. Five of 55 patients had prior amblyopia therapy and 25 already had spectacles.

All patients underwent a detailed ophthalmologic examination that included measurement of visual acuity at distance using the Snellen chart, assessment of ocular alignment and fixation by the cover test, cycloplegic refraction using cyclopentolate 1% eye drops, subjective refraction, and ophthalmoscopy. The contralateral eye was occluded during acuity testing. The Snellen chart had crowded letters, and a child had to read more than

half of the letters correctly to pass a line. After we recorded his or her initial undilated acuity, the patient underwent a cycloplegic retinoscopy, followed by post-cycloplegic subjective refraction 3 days later. The best-corrected visual acuity was then recorded and designated the entry (pretreatment) acuity. Patients began wearing spectacles and occlusion treatment simultaneously without any period of spectacle wearing alone prior to occlusion. Spectacles were worn during the study and after cessation of the patching. The diagnosis of amblyopia was based on a difference of 2 or more lines between the best-corrected visual acuities of the 2 eyes on the Snellen chart. Anisometropia was defined as a difference of 1.50 D or more of either sphere or cylinder between the 2 eyes. Thirteen patients were myopic in the amblyopic eye and none was amblyopic in the good eye. The types of amblyopia included were strabismic (12 patients), anisometric (28 patients), and combined (ie, strabismic and anisometric; 15 patients).

All patients were treated with full-time (during all waking hours) occlusion of the good eye and were also encouraged to perform fine near visual activities such as reading fine print, threading beads, and tracing pictures. Compliance with occlusion was monitored by asking the patient at each visit during treatment whether he or she was using occlusion strictly according to the advised regimen. The patients were advised to seek help and cooperation from their parents and teachers for continuing educational activities. Full-time occlusion therapy was continued until there was no further improvement in the visual acuity of the amblyopic eye on 3 consecutive monthly follow-up examinations. We determined whether the acuity of the amblyopic eye of a patient improved by comparing it with his or her entry acuity. After the cessation of full-time occlusion, part-time (4 hours per day) occlusion along with near visual activities were used randomly in 24 patients for 3 to 6 months for maintenance of the final visual acuity, and no such maintenance therapy was used in 31 patients. Pretreatment and post-treatment best-corrected Snellen visual acuities and their logMAR equivalents were recorded with the good eye occluded by the same observer. All patients were asked whether they experienced diplopia after removing the occlusive patch during or after therapy.

Thirty-two of the 55 patients underwent follow-up for a minimum period of 12 months after the termination of occlusion therapy and were observed to determine the lasting results. Among these patients, 17 had not received maintenance occlusion therapy and were observed for a period of 12 to 52 months (mean, 20.6 months) after the cessation of full-time occlusion therapy. The remaining 15 patients received maintenance occlusion and were observed for a period of 12 to 20 months (mean, 14.1 months) after the cessation of maintenance occlusion therapy. Best-corrected Snellen visual acuity and its logMAR equivalent were recorded at the most recent examination by the same observer. Data were analyzed using the chi-square test, Student's paired and unpaired *t* tests, and analysis of variance.

RESULTS

All 55 of the patients showed an improvement in distance visual acuity after occlusion therapy. The amblyopic eyes had a mean logMAR visual acuity of 0.67 ± 0.26 (Snellen equivalent, 6/30) before treatment, and 0.21 ± 0.18 (Snellen equivalent, 6/10) after treatment; thus there was a mean improvement of 0.46 ± 0.24 logMAR unit (4.6 Snellen lines), which was statistically significant ($P < .0001$). Maximum improvement was 0.90 logMAR unit (9 Snellen lines) in 2 patients. The good eyes of these patients had a mean logMAR visual acuity of $0.03 \pm$

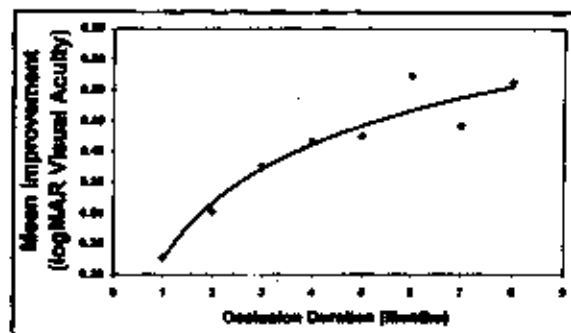


Figure. The mean improvement in visual acuity at different time intervals of occlusion.

0.08 on entry, and 0.03 ± 0.06 at the conclusion of full-time occlusion. Improvement was seen at mean intervals of 1.14 ± 0.35 , 1.38 ± 0.77 , 1.36 ± 0.67 , and 1.56 ± 0.73 months in patients 11, 12, 13, and 14 to 15 years old, respectively. Patients 14 to 15 years old showed a statistically significantly late improvement compared with those 11 years old ($P < .05$). The kinetics of vision improvement at different time intervals of occlusion is shown in the figure. The mean improvement in visual acuity increased with the duration of occlusion.

The effects of patient age and type of amblyopia on the mean improvement in logMAR visual acuity and the mean duration of occlusion therapy are presented in Table 1. Analysis of variance showed that patient age had no significant effect on the mean improvement in visual acuity ($F =$

Factor	No. of Patients	LogMAR Visual Activity				Mean Improvement	Duration of Occlusion Therapy (mo)	
		Pre-treatment		Post-Treatment			Range	Mean (\pm SD)
		Range	Mean (\pm SD)	Range	Mean (\pm SD)		Range	Mean (\pm SD)
Patient age, y								
11	22	0.30-1.00	0.66 (\pm 0.29)	0.00-0.60	0.23 (\pm 0.16)	0.45 (\pm 0.22)	3-12	5.77 (\pm 2.71)
12	13	0.48-1.50	0.77 (\pm 0.28)	0.00-0.60	0.25 (\pm 0.19)	0.52 (\pm 0.19)	3-11	6.31 (\pm 2.53)
13	11	0.48-1.00	0.68 (\pm 0.17)	0.00-0.48	0.19 (\pm 0.17)	0.49 (\pm 0.23)	3-9	5.27 (\pm 2.00)
14-15	9	0.30-1.00	0.58 (\pm 0.27)	0.00-0.60	0.19 (\pm 0.26)	0.39 (\pm 0.13)	3-11	5.22 (\pm 2.59)
Type of amblyopia								
Strabismic	12	0.30-1.50	0.64 (\pm 0.34)	0.00-0.60	0.26 (\pm 0.20)	0.39 (\pm 0.20)	3-11	5.83 (\pm 2.76)
Anisometric	28	0.30-1.00	0.68 (\pm 0.19)	0.00-0.60	0.18 (\pm 0.18)	0.51 (\pm 0.19)	3-12	5.93 (\pm 2.42)
Combined*	15	0.30-1.50	0.68 (\pm 0.32)	0.00-0.60	0.24 (\pm 0.17)	0.44 (\pm 0.21)	3-11	5.20 (\pm 2.48)

SD = standard deviation.
*Strabismic and anisometric.

TABLE 2
IMPROVEMENT IN LOGMAR VISUAL ACUITY AND DURATION OF OCCLUSION REQUIRED TO ACHIEVE STABLE IMPROVEMENT

Level of Amblyopia (LogMAR)	No. of Patients	Pre-Patch Visual Acuity		Post-Patch Visual Acuity		Improved Visual Acuity		Duration of Occlusion (mo)		Time to Stable Acuity (mo)	
		Range	Mean (\pm SD)	Range	Mean (\pm SD)	Range	Mean (\pm SD)	Range	Mean (\pm SD)	Range	Mean (\pm SD)
0.2 to 0.4	6	0.30-0.30	0.30 (\pm 0.00)	0.00-0.18	0.06 (\pm 0.09)	0.20-0.30	0.24 (\pm 0.09)	4-7	5.00 (\pm 0.89)	1-4	2.00 (\pm 0.89)
0.5 to 0.6	28	0.48-0.60	0.55 (\pm 0.06)	0.00-0.48	0.15 (\pm 0.14)	0.12-0.60	0.40 (\pm 0.13)	4-11	5.96 (\pm 20.9)	1-8	2.96 (\pm 2.09)
> 0.7	21	0.78-1.5	0.94 (\pm 0.21)	0.00-0.60	0.33 (\pm 0.19)	0.18-1.0	0.61 (\pm 0.21)	4-12	6.62 (\pm 2.35)	1-9	3.62 (\pm 2.35)
Good eye	55	0.00-0.30	0.03 (\pm 0.08)	0.00-0.18	0.03 (\pm 0.06)	0.00-0.18	0.01 (\pm 0.04)				

SD = standard deviation.

0.8171; $df = 3.51$; $P > .05$) or the mean duration of occlusion therapy ($F = 0.4704$; $df = 3.51$; $P > .05$). Improvement in visual acuity was seen at a mean interval of 1.32 ± 0.61 months in strabismic amblyopia, 1.40 ± 0.74 months in anisometropic amblyopia, and 1.17 ± 0.39 months in combined (strabismic and anisometropic) amblyopia, and these differences were not statistically significant ($P > .05$). Analysis of variance showed that the type of amblyopia had no significant effect on the mean improvement in visual acuity ($F = 1.5449$; $df = 2.52$; $P > .05$) or the mean duration of occlusion therapy ($F = 0.4299$; $df = 2.52$; $P > .05$).

The effect of the initial level of amblyopia on the degree of improvement and the duration of occlusion required to achieve stable improvement are presented in Table 2. There was a statistically highly significant inverse correlation between the level of amblyopia and the degree of improvement in visual acuity ($P < .000$). The severity of amblyopia had no significant effect on the duration of patching that was required to achieve stable improvement ($P > .05$).

None of our patients had significant localized skin reactions to the patch that warranted its discontinuation. Neither a transient nor permanent reduction in the acuity of the good eye was observed in any patient. No patient reported any injury due to fall or other hazards during the occlusion period, and none complained of diplopia after removing the occlusive patch. All patients were able to continue their routine and school activities with the help of their parents and teachers.

Thirty-two of 55 patients were observed for a period of 12 to 52 months (mean, 17.6 months) after the cessation of full-time and maintenance occlusion therapy. Table 3 presents the effect of maintenance occlusion therapy on improved visual acuity. Twenty-nine (91%) of the 32 patients maintained improved visual acuity, whereas 3 (9%) of them exhibited a regression in visual acuity by 0.1 logMAR unit (1 Snellen line [2 patients]) and 0.2 logMAR unit (2 Snellen lines [1 patient]). The regression in visual acuity occurred when maintenance occlusion was being used for 2 months (1 patient) and 7 months after the termination of maintenance occlusion therapy (1 patient). Neither patient received further amblyopia therapy, and both maintained the same visual acuity at the last follow-up examination. Another

patient had a regression in visual acuity on two occasions by 0.2 logMAR unit (2 Snellen lines) 1 and 3 months after the termination of maintenance occlusion therapy. The visual acuity improved to the previous level after she was again treated with full-time occlusion therapy on both occasions. There was no statistically significant effect of maintenance occlusion therapy on stabilization of the improved visual acuity ($P > .05$).

A comparison of resultant visual acuities in amblyopic eyes and good eyes between the patients with and without maintenance patching is provided in Table 4. There was no statistically significant difference in resultant visual acuities of amblyopic eyes between those with and without maintenance patching ($P > .05$). The resultant acuities of the good eyes also did not differ significantly between these two groups ($P > .05$).

DISCUSSION

The response to amblyopia treatment mainly depends on the depth and type of amblyopia, the patient's age at initiation of therapy, and the patient's compliance. In a review of the results of amblyopia therapy by using the pooled data from 23 published studies, Flynn et al.¹⁶ reported that a patient's age at the initiation of therapy was the factor most clearly related to a successful outcome. Generally, the younger the patient is, the more rapid the improvement in visual acuity will be and the better the ultimate prognosis. However, the age beyond which treatment is not effective is still not known. Vereecken and Brabant⁸ observed improvement of vision in the amblyopic eye in adulthood after the loss of the good eye in 28.5% of their patients. Several investigators³⁻¹⁴ have reported the successful treatment of amblyopia with occlusion therapy in children 7 to 12 years old.

Undoubtedly, compliance plays an important role in the success of amblyopia treatment. Older children are less compliant with occlusion therapy than are younger children due to psychosocial implications and education disruption, and this might be responsible for the higher percentage of treatment failures reported in older children.³ Oliver and Nawratzki³ reported a mean improvement of 4 lines on the Snellen chart in compliant children older than 8 years. We also observed a

TABLE 3
EFFECT OF MAINTENANCE OCCLUSION THERAPY ON IMPROVED VISUAL ACUITY AT A MEAN 17.6 MONTHS OF FOLLOW-UP*

Maintenance Occlusion Therapy	No. of Patients	Improved Visual Acuity	
		Maintained	Regressed
Yes	15	12	3
No	17	17	0

*Follow-up of 32 patients after the cessation of full-time and maintenance occlusion therapy.

mean improvement of 4.6 Snellen lines in our patients. We included only the compliant children in our study and therefore achieved good results with occlusion therapy even in children 11 to 15 years old. It was merely a chance occurrence that we had more boys than girls in this study.

Our patients 14 to 15 years old exhibited late improvement in visual acuity compared with those 11 years old. However, there was no significant difference in the mean improvement in visual acuity or in the mean duration of occlusion therapy among patients of different age groups. The mean improvement in visual acuity increased with the duration of occlusion.

A low initial visual acuity is generally considered to be an unfavorable prognostic sign in amblyopia therapy. Older children with low initial visual acuity would be expected to have poor compliance, leading in turn to poor final results.³ However, our patients with poor initial visual acuity had statistically highly significant improvement compared with those with better initial visual acuity. We think it is possible that the patients with poor initial vision were more concerned about the visual loss and might have therefore performed occlusion treatment more seriously. Also, they probably would have performed more near visual activities in an attempt to improve vision compared with those who had better initial visual acuity. The level of amblyopia had no significant effect on the duration of occlusion required to achieve stable improvement in vision.

The treatment of amblyopia has been found to be successful in 78% of patients with strabismic amblyopia, in 67% of patients with anisometropic amblyopia, and in 59% of patients with both types of amblyopia.¹⁶ However, in a consecutive series of

TABLE 4
RESULTANT VISUAL ACUTIES IN THE AMBLYOPIC EYE AND THE GOOD EYE OF THE PATIENTS WITH AND WITHOUT MAINTENANCE PATCHING

Maintenance Patching	No. of Patients	Amblyopic Eye Acuity					
		On Entry		At the End of Full-Time Occlusion		At the End of Follow-Up	
		Range	Mean (\pm SD)	Range	Mean (\pm SD)	Range	Mean (\pm SD)
Yes	15	0.30-1.0	0.56 (\pm 0.16)	0.00-0.48	0.12 (\pm 0.15)	0.00-0.48	0.16 (\pm 0.17)
No	17	0.30-1.5	0.70 (\pm 0.32)	0.00-0.60	0.23 (\pm 0.19)	0.00-0.60	0.23 (\pm 0.19)

SD = standard deviation.

compliant patients, Mintz-Hittner and Fernandez¹² observed that visual acuity could be recovered uniformly for strabismic and anisometropic amblyopia; we had a similar observation. Epelbaum et al.³ found that the efficacy of treatment for strabismic amblyopia was null by the time the patient was 12 years old, whereas Hedgpeth and Sullivan¹⁵ found that anisometropic amblyopia could be successfully treated until at least the age of 12 years. We did not observe any such effect of age on visual improvement in strabismic and anisometropic amblyopia.

There is a possibility of inducing diplopia by treating amblyopia in children older than 5 years.¹⁷ However, in a series of children older than 5 years, Oliver and Nawratzki³ found that none of the children complained of double vision at any time during or after occlusion therapy; we had a similar observation. The absence of diplopia in our patients could be due to suppression in the amblyopic eye because of long-standing amblyopia. It may also be attributable to treatment only by occlusion of the good eye because diplopia is a known complication of pleoptic treatment at this age, as mentioned by Oliver and Nawratzki.³ We think that diplopia after occlusion therapy in older children is not a common occurrence and the fear of inducing diplopia should not discourage the clinician from treating amblyopia in these children. All patients tolerated patching well and were able to continue their routine as well as school activities with the help of their parents and teachers.

Amblyopia is known to recur in nearly 50% of younger patients after the cessation of traditional patching treatment.¹⁸⁻²¹ This tendency for recurrence persists until children have reached 8 to 10 years of age because of the persistence of inhibitory effects from the fixating eye. Therefore, to stabilize

the visual acuity and prevent recurrence of amblyopia, it has been suggested that maintenance (several hours per day) occlusion therapy should be continued until children have reached 8 to 10 years of age.^{22,23} In a study on the long-term results of successfully treated amblyopia in children 2 to 11.5 years old, Levartovsky et al.²¹ reported that the age at which treatment for amblyopia was started did not significantly affect the final visual outcome after the cessation of treatment, provided that the visual acuity was monitored until the patient was at least 9 years old.

Thirty-two of our patients underwent an average follow-up of 17.6 months after the cessation of full-time and maintenance occlusion therapy. Ninety-one percent of them exhibited the same visual acuity as at termination of treatment, whereas in 9% there was deterioration by 1 to 2 Snellen lines. We did not find any statistically significant beneficial effect of maintenance occlusion therapy on stabilization of the improved visual acuity. However, the 2 recurrences of amblyopia on cessation of maintenance occlusion therapy and the subsequent improvement of visual acuity to the previous level after reinstitution of full-time occlusion therapy in 1 patient do indicate that some patients may require maintenance occlusion therapy for stabilizing the improved visual acuity. We therefore suggest that not all patients 11 to 15 years old need maintenance occlusion after the termination of full-time occlusion therapy. The visual acuity should be monitored and maintenance occlusion should be used if there is a recurrence of amblyopia.

This study has some limitations. It was composed of compliant children from a single center and the outcome examinations were not performed by masked observers.

TABLE 4 (cont'd)
RESULTANT VISUAL ACUTIES IN THE AMBLYOPIC EYE AND THE GOOD EYE OF THE PATIENTS WITH AND WITHOUT MAINTENANCE PATCHING

On Entry		Good Eye Acuity At the End of Full-Time Occlusion		At the End of Follow-Up	
Range	Mean (\pm SD)	Range	Mean (\pm SD)	Range	Mean (\pm SD)
0.00-0.18	0.04 (\pm 0.07)	0.00-0.18	0.02 (\pm 0.06)	0.00-0.18	0.01 (\pm 0.05)
0.00-0.18	0.03 (\pm 0.07)	0.00-0.18	0.02 (\pm 0.06)	0.00-0.18	0.02 (\pm 0.06)

The observations from our study indicate that full-time occlusion therapy can be successful in treating amblyopia in compliant children 11 to 15 years old. The improvement in visual acuity persists at least 18 months regardless of whether the patients had maintenance, part-time occlusion therapy. We therefore suggest that adolescents with strabismic and anisometropic amblyopia should be encouraged to comply with full-time occlusion therapy. A multicenter study of intensive occlusion therapy should also be considered for older patients with all types of amblyopia including stimulus deprivation.

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