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Results of treatment in amblyopia associated with unilateral high myopia without strabismus

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SUMMARY Fifty-five patients with amblyopia in unilateral high myopia without strabismus were treated. Thirty-two (58%) had a visual improvement by two lines or more on the Snellen chart and 17 (31%) attained a final visual acuity of 6/12 or better. In patients with pretreatment corrected vision of 6/60 or better in the amblyopic eye treatment consisted of full-time occlusion of the good eye, in some cases supplemented by the after-image method of pleoptic exercises in the amblyopic eye. Overall improvement of vision in this group was 72·7%. Occlusion of the good eye combined with pleoptic exercises in the amblyopic eye had no advantage over simple occlusion of the good eye. In patients with pretreatment corrected vision worse than 6/60 in the amblyopic eye occlusion of the amblyopic eye was done and the after-image method of pleoptic exercises was instituted. Improvement of vision in this group was 36·3%. The study showed that it is worth the trouble to treat this disorder even after the age of 14 years and stresses the utility of pleoptic therapy in older patients with severe amblyopia.

Few reports show that patients with amblyopia in unilateral high myopia can be treated successfully.[1–4] However, many of the patients observed in those studies had associated strabismus, and it is difficult to determine whether the amblyopia was caused by the strabismus, the anisometropia, or both.[5,6] Moreover, the cases so far treated and reported belonged to the younger age group. In India many children with unilateral high myopia and amblyopia report at a more advanced age, as there are no proper health screening facilities in most of the schools.

Our purpose was to study the results obtained by treating these older patients and to compare the results with those obtained in the younger age group, and also to stress the value of pleoptic therapy in older children with unilateral high myopia and severe amblyopia.

Patients and methods

The patients were referred to the amblyopia clinic of Irwin Hospital and Guru Nanak Eye Centre by fellow ophthalmologists. None of them had any amblyopia therapy before reporting to us. We did a thorough general ophthalmological examination, including ophthalmoscopy. Vision was tested by means of Snellen chart. A complete orthoptic examination was done, including cover test, red glass test, Bagolini striated glass test, and bifoveal correspondence test of Cüppers. In many patients bifoveal fixation was also tested by having the patient superimpose Haidinger's brushes on a real object. Ocular fixation was studied by using projectoscope with the Linksz star graticule.

Only cases of unilateral high myopia with central fixation and without strabismus were included, and a full cycloplegic refraction was done in all of them. They were fully corrected with glasses. Contact lenses were given to patients with higher degree of myopia or who did not tolerate the prescribed glasses. The patients were asked to continue wearing them full-time until no further improvement in vision occurred.

In 55 patients the visual acuity did not improve to 6/12 or better even after full-time wearing of glasses for six weeks or more. They were divided into the following groups for the treatment of amblyopia: (1) Of the 33 patients with corrected visual acuity 6/60 or better 19 had only full-time occlusion of the good eye, and in 14 patients full-time occlusion of the good eye was supplemented with Cüppers' after-image method of pleoptic exercises in the amblyopic eye to see if the combined therapy was more helpful in increasing the

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percentage of success or expediting visual recovery. Cüppers' after-image method of pleoptic exercises by means of a projectoscope fitted with an autodisc has been described by Priestley *et al.*[2] Treatment with it was given one-half to one hour a day for five days a week. Patients in these two subgroups were matched for age, degree of myopia, and depth of amblyopia to ensure comparability of results. (2) Twenty-two patients with corrected vision worse than 6/60 had full-time occlusion of the amblyopic eye (as they did not tolerate the occlusion of the good eye which brought their schooling and outdoor activities to a complete halt) and Cüppers' after-image method of pleoptic exercises as described by Priestley *et al.*[2] When the vision in this group of patients improved sufficiently with this treatment, the occlusion was transferred to the good eye and pleoptic therapy was discontinued. We encouraged all the patients wearing the patch on the good eye to do home exercises involving fine visual tasks to provide enough stimulation to the fovea of the amblyopic eye. They were evaluated for progress once a week.

The cases were counted as failures when there was no improvement at all or only one line improvement after appropriate therapy for a period of four months. In successful cases, once the best possible visual acuity was obtained, full-time occlusion was replaced by part-time occlusion, the scheduling of which was planned for each individual patient. Orthoptic exercises were prescribed for all successful patients to improve binocular functions. Finally, we directed the patients to continue patching of the good eye one day a week, preferably on Sundays, for three hours as a precaution against return of amblyopia. The visual acuity and refraction were rechecked at six months' intervals. The period of follow-up was from four to six years.

Table 1 *Relation of degree of myopia to age at presentation*

Age in years	*Dioptres of myopia in spherical equivalents*			*Total no. of patients*
	5–10	*11–15*	*16–21*	
7–14	18 (50·0%)	11 (30·5%)	7 (19·5%)	36 (100·0%)
15–22	9 (47·4%)	6 (31·6%)	4 (21·0%)	19 (100·0%)
Total no. of patients	27 (49·0%)	17 (31·0%)	11 (20·0%)	55 (100·0%)

For statistical analysis of the results non-parametric distribution-free tests such as Wilcoxon's rank sum test and Jonckheere's test[7] were sometimes preferred to the conventional tests of significance to avoid misleading conclusions due to possible deviations of the data from normality.

Results

CLINICAL DATA

The age of the patients ranged from 7 to 22 years (mean 12·8 years). Thirty-six (65·4%) were aged 7 to 14 years and 19 (34·6%) were 15 to 22 years. Twenty-five (45·4%) were boys and 30 (54·6%) were girls. The right eye had high myopia in 35 (63·6%) patients. The amblyopic eye had a mean myopia of 11·4 dioptres in spherical equivalents (range, −5 to −21 dioptres in spherical equivalents). A refractive error ranging between −3·50 dioptres and +2·00 dioptres in spherical equivalents was present in the fellow eye. In all the patients a difference of more than −5 dioptres existed between the spherical equivalents of the two eyes. Vision before treatment was 6/60 or better in 33 (60%) patients and worse than 6/60 in 22 patients (40%).

The degrees of myopia as related to the age at presentation are given in Table 1. We found no statistically significant association between the two (χ^2= 0·04 for 2 DF, $p>0·95$). There was, however, a statistically significant relationship (χ^2=37·60 for 3 DF, $p<0·001$) between the age at presentation and the depth of amblyopia (Table 2); the higher the age the greater was the depth of amblyopia. We also analysed the correlation of the degree of myopia with the depth of amblyopia and found that, though there was a suggestion of higher degrees of myopia being associated with severe degrees of amblyopia (Table 3), it failed to attain statistical significance (χ^2=5·23 for 2 DF, $0·05<p<0·10$).

RESPONSE TO TREATMENT

We regarded the amblyopia therapy as successful when there was a visual improvement of at least two lines on the Snellen chart. Thirty-two of 55 (58%) patients met this criterion, and 17 of 55 (31%) attained a final visual acuity of 6/12 or better. We have given the number of patients improved separately in

Table 2 *Relation of corrected pretreatment visual acuity to age at presentation*

Age in years	*Pretreatment visual acuity*					*Total no. of patients*
	<6/60	*6/60*	*6/36*	*6/24*	*6/18*	
7–14	12 (33·3%)	8 (22·2%)	6 (16·7%)	8 (22·2%)	2 (5·6%)	36 (100·0%)
15–22	10 (52·7%)	4 (21·0%)	3 (15·8%)	2 (10·5%)	0 (0·0%)	19 (100·0%)
Total no. of patients	22 (40·0%)	12 (21·8%)	9 (16·4%)	10 (18·1%)	2 (3·6%)	55 (100·0%)

Table 3 *Relation of corrected pretreatment visual acuity to degree of myopia*

Dioptres of myopia in spherical equivalents	*Pretreatment visual acuity*				*Total no. of patients*
	<6/60	*6/60*	*6/36*	*6/24–6/18*	
5–10	7 (26·0%)	6 (22·2%)	5 (18·5%)	9 (33·3%)	27 (100·0%)
11–15	8 (47·1%)	3 (17·6%)	4 (23·5%)	2 (11·8%)	17 (100·0%)
16–21	7 (63·6%)	3 (27·3%)	0 (0·0%)	1 (9·1%)	11 (100·0%)
Total no. of patients	22 (40·0%)	12 (21·8%)	9 (16·4%)	12 (21·8%)	55 (100·0%)

Table 4 *Results of treatment related to degree of myopia and corrected pretreatment visual acuity*

Dioptres of myopia in spherical equivalents	*Pretreatment visual acuity*					*Total no. of patients*
	<6/60	*6/60*	*6/36*	*6/24*	*6/18*	
Patients aged 7 to 14 years						
5–10	2(1)/4*	3(1)/4	2(2)/3	4(4)/5	2(2)/2	13(10)/18
11–15	2(0)/4	1(0)/2	2(1)/3	2(2)/2	0(0)/0	7(3)/11
16–21	1(0)/4	1(0)/2	0(0)/0	1(1)/1	0(0)/0	3(1)/7
Patients aged 15 to 22 years						
5–10	2(0)/3	1(0)/2	2(2)/2	1(1)/2	0(0)/0	6(3)/9
11–15	1(0)/4	1(0)/1	0(0)/1	0(0)/0	0(0)/0	2(0)/6
16–21	0(0)/3	1(0)/1	0(0)/0	0(0)/0	0(0)/0	1(0)/4
Total no. of patients	8(1)/22	8(1)/12	6(5)/9	8(8)/10	2(2)/2	32(17)/55

*Numerator gives the total number of patients improved. Numerator in parentheses gives the number of patients improving to 6/12 or better. Denominator gives the total number of patients in each subgroup.

relation to age groups 7 to 14 years and 15 to 22 years (Table 4). It was observed that patients aged 7 to 14 years improved their vision more often (63·8%, 23 of 36) than those aged 15 to 22 years (47·3%, 9 of 19). However, the difference in the improvement rate between the two groups was not statistically significant ($\chi^2=1{\cdot}40$ for 1 DF, $p>0{\cdot}20$).

The average number of lines of improvement in different age groups in patients with pretreatment visual acuity 6/60 or better by two methods of treatment are given in Table 5. Wilcoxon's rank sum test showed that there was no significant difference in the results obtained by simple occlusion of the good eye and occlusion of the good eye supplemented with pleoptic exercises in the amblyopic eye either in the age group 7 to 14 years ($p=0{\cdot}51$) or in the age group 15 to 22 years ($p=0{\cdot}30$). The mean period of treatment for visual recovery in the patients with simple occlusion of the good eye was seven months and that in the patients with occlusion of the good eye combined with pleoptic exercises in the amblyopic eye was six months. A single tailed Wilcoxon's rank sum test showed that there was no significant difference either in the age group 7 to 14 years ($p=0{\cdot}09$) or in the age group 15 to 22 years ($p>0{\cdot}90$) in the time taken for visual recovery by the two methods of treatment.

Table 5 *Average visual improvement in lines on Snellen chart in different subgroups of patients*

	Average visual improvement in lines with therapy	
	Age in years	
	7–14	*15–22*
Pretreatment vision		
6/60 or better (33 patients):		
occlusion of good eye (19 patients)	1·8	1·8
occlusion of good eye and pleoptic therapy in amblyopic eye (14 patients)	2·1	2·2
Worse than 6/60 (22 patients)		
occlusion of amblyopic eye and pleoptic therapy	1·4	0·9
Dioptres of myopia in spherical equivalents		
5–10	1·9	2·1
11–15	2·0	1·0
16–21	1·0	0·8

We recorded visual improvement in 36·3% (8 of 22) patients with corrected vision worse than 6/60. The average number of lines of improvement in different age groups in this category of patients are given in Table 5. Here also there was no significant difference ($p=0{\cdot}67$) in the improvement rate between the two age groups 7 to 14 years and 15 to 22 years. The mean period of treatment for visual recovery in these patients was nine months (range 6 to 14 months). We have also given the results of treatment related to degree of myopia in Table 5. It was found that in the younger age group the rate of improvement was not influenced by the degree of myopia ($p=0{\cdot}12$), whereas

Table 6 *Results of treatment in relation to degree of astigmatism*

Dioptres of astigmatism	*Lines of improvement*					*Total no. of patients*
	0–1	*2*	*3*	*4*	*5*	
0	9	5	3	2	1	20
1	1	2	3	1	0	7
2	6	4	4	3	0	17
3	4	1	1	0	0	6
4	2	0	2	1	0	5
Total no. of patients	22	12	13	7	1	55

in the older age group the rate of improvement was significantly higher in those with lesser degrees of myopia ($p=0.048$).

We analysed the correlation of the degree of astigmatism with the rate of improvement (Table 6) and found no association (Jonckheere's test giving $p=0.90$). Stereopsis as tested with the Titmus fly and the Worth 4-dot test before and after therapy is given in Table 7. It may be noted that a considerable number of patients had some form of binocular vision before therapy, and the percentage improved considerably after therapy.

Discussion

In this series high myopia was found in the right eye in most (63·6%) of the patients. This agrees with the finding of Rosenthal and Von Noorden[3] and Cambiaggi[8] but is at variance with that of Priestley *et al.*,[2] who found a preponderance of high myopia in the left eye. Rosenthal and Von Noorden[3] found that the severity of amblyopia corresponded to the amount of myopia, and in patients with myopia 15 dioptres or more the corrected vision was always less than 6/60 (20/200). However, we failed to find any such correlation and observed that all the categories of myopia had both poor and relatively good levels of corrected visual acuity.

Treatment of amblyopia in unilateral high myopia used to be neglected owing to the belief that the chances of visual recovery in these patients were remote. Bangerter[1] was the first to stimulate interest in the subject by treating 16 patients with pleoptic therapy and reporting a 25% success (visual acuity 6/12 or better). Jonkers,[9] however, stated that any therapy in such cases would fail. Priestley *et al.*[2] treated 21 patients with pleoptics and obtained a visual gain of 6/12 (20/40) or better in 15% cases. Rosenthal and Von Noorden[3] treated 29 patients with simple occlusion of the good eye and achieved success in 76% of them and an improvement of 6/12 (20/40) or better in 24% cases. Pollard and Manley[4] treated 40 patients also with the simple occlusion of the good eye and obtained success in 75% cases, with visual acuity improving to 6/12 (20/40) or better in 55% cases. However, none of the previous workers considered patients with amblyopia in unilateral high myopia over the age of 14 years for treatment. Pollard and Manley[4] observed that, while younger patients responded better to therapy, improvement might be seen up to 14 years of age on rare occasions. Results obtained in the present study show that 50% of the patients reporting even after the age of 14 years are expected to improve with treatment if they are properly motivated. Moreover, it is interesting that some of our patients above 14 years of age showed much greater improvement than some of the children below 14 years did.

Occlusion of the good eye was supplemented with pleoptic exercises in the amblyopic eye in some patients with pretreatment corrected vision 6/60 or better to see if the combined therapy enhanced the percentage of success and/or shortened the period of visual recovery. However, the study shows that the combined therapy has no advantage over simple occlusion of the good eye.

Rosenthal and Von Noorden[3] and Pollard and Manley[4] showed that simple occlusion of the good eye was as effective as occlusion of the amblyopic eye and pleoptic therapy practised earlier by Bangerter[1] and Priestley *et al.*[2] As a result a feeling gained ground that these patients need not be subjected to the rigours of pleoptic therapy. However, in older children with severe amblyopia (vision worse than 6/60) who do not tolerate the occlusion of the good eye, occlusion of the amblyopic eye and pleoptic therapy is the treatment of choice.

Prognosis as to visual recovery was found to be related to the degree of myopia only in the older age

Table 7 *State of binocular function*

Age in years	*No. of patients*	*Stereopsis (Titmus fly)*		*Peripheral fusion (Worth 4-dot test)*	
		Before therapy	*After therapy*	*Before therapy*	*After therapy*
7–14	36 (100·0%)	8 (22·2%)	18 (50·0%)	12 (33·3%)	25 (70·0%)
15–22	19 (100·0%)	3 (16·0%)	7 (37·0%)	6 (31·6%)	13 (68·4%)
Total no. of patients	55 (100·0%)	11 (20·0%)	25 (45·5%)	18 (33·0%)	38 (70·0%)

group of 15 to 22 years, where the greater the degree of myopia the worse was the prognosis. However, Rosenthal and Von Noorden[3] found the prognosis to be worse in young patients in whom the myopia was greater than 15 dioptres.

It is desirable to monitor these patients closely for signs of regression. The improvement in visual acuity dropped off in three out of 40 patients of Pollard and Manley[4] and in approximately one-half the cases of Rosenthal and Von Noorden[3] after the occlusion was discontinued. Although in such an eventuality occlusion of the good eye rapidly re-establishes the previously gained good vision, one should not take chances. The patient should be advised to continue occlusion of the good eye once a week for a few hours, which he can easily do at home on Sundays without curtailing any social or outdoor activities. It may be mentioned that with this regimen none of our patients showed any sign of regression within the follow-up period of four to six years.

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