

CAMBRIDGE STIMULATOR TREATMENT FOR AMBLYOPIA An evaluation of 80 consecutive cases treated by this method

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Abstract

Eighty consecutive patients with amblyopia ex anopsia were treated with the Cambridge Stimulator (Cam.). Each patient received an average of six, 15 minute treatment sessions at a frequency of 1-2 per week. Treatment was terminated after two consecutive treatments indicated no change in visual acuity. Sixty-nine patients were given minimal occlusion simultaneously with Cam. treatment. Eleven patients were given full-time conventional occlusion simultaneously with Cam. treatment. Of the first group, 47% achieved 6/12 or better visual acuity, although if the 14 eccentric fixators were excluded, 60% achieved 6/12 or better visual acuity. Of the second group, 91% improved to 6/12 or better vision. This means the patients treated with full-time occlusion and Cam. showed an improvement of visual acuity of nearly twice the extent of those patients treated with minimal occlusion and Cam. over the same period of time.

INTRODUCTION

In the treatment of amblyopia ex anopsia patching of the good eye is routinely acceptable for a period of 3-6 months in patients with less than 6/18 vision. There are several disadvantages with this form of treatment. One problem is the prolonged time factor and, consequent on this, the educational and psychological handicap placed on the child. This results in a 30% failure rate in tolerating the patch.¹ There is also a risk factor, in that patching the good eye disrupts all the binocular visual reflexes and so tends to cause ocular deviation.² The dissociative effect of a patch may increase a cosmetically acceptable strabismus to uncosmetic dimensions creating a need for cosmetic surgery. In many cases occlusion has to be reapplied, as amblyopia can recur until a child is eight to nine years of age. In certain cases, where all horizontal recti have already been operated and amblyopia recurs yet again, it is difficult to decide which is best for the patient — to improve the amblyopia at the risk of giving the patient an uncorrectable, uncosmetic squint with

medico-legal implications — or to leave him with an amblyopic eye for the duration of his life. Another problem with full-time conventional occlusion therapy is that in some cases, the good eye can become amblyopic suddenly, creating either a situation of bilateral amblyopia or amblyopia of the originally good eye. From the author's experience, Atropine occlusion is an effective therapy only if the patient's amblyopic eye has an acuity of 6/12 or better. The treatment of amblyopia has been considered to be unsatisfactory for all the previously mentioned reasons. Ingram, in a survey as recent as 1979, reported that in a series of over 200 patients with a three year follow-up, there was no measurable improvement in amblyopia despite treatment involving a large number of outpatient attendances.³

The first clinical results of Cam. treatment were reported by Campbell in 1978.⁴ Cam. treatment for amblyopia consists of rotating high-contrast square-wave gratings in front of the amblyopic eye while the child is performing some task requiring

visual concentration. Campbell's paper claimed that in a course of three 7 minute treatments, 73% of patients achieved 6/12 or better vision. While this method of treatment was considered to be a highly significant advance in the treatment of strabismic and aniso-metropic amblyopia there was concern as to possible dangers involved with its use. Because of the effectiveness of the treatment, it was thought that intractable diplopia could be induced with all its disastrous and possible medico-legal consequences. The Cam. method of treatment as an alternative to conventional occlusion attracted great interest as it reduced the patching of the good eye to terms of minutes rather than months and thus eliminated the educational and psychological handicap to the child. It also reduced the risk of dissociation of binocular reflexes and therefore eliminated the essential problems associated with conventional full-time occlusion therapy.

Materials and Methods

This series of 80 patients was drawn from one orthoptic private practice. Treatment was standardised and carried out by one person. Patients were assessed for treatment in the manner described by Banks *et al* in 1978⁵. All patients were fully assessed orthoptically and ophthalmologically and wore their glasses where relevant. Visual acuity was tested for near and distance with linear charts and Sheridan Gardiner single optotypes. Where the age of the child permitted, all four visual acuity tests were performed pre and post Cam. treatment sessions. As it is sometimes felt that amblyopia is due to subtle macular changes not detectable by ordinary ophthalmoscopy, two additional tests were undertaken to try to better assess macular function. These were the checking of fixation with a visuscope and the Arden contrast sensitivity test.⁶

Treatment consisted of viewing an apparatus of which any one of a range of high contrast, sharp-edged gratings were rotated at one revolution per minute behind a transparent plate on which the child was encouraged to play drawing games to ensure his concentration. If two children of approximately the same age were seated in front of the same viewing apparatus with

the non-amblyopic eye occluded, co-operation and concentration tended to be better than giving individual treatment sessions. Contrast thresholds were assessed for the normal and the amblyopic eye both pre and post Cam. treatment using circular square-wave, test plates of varying contrasts. These plates contained high, medium and low spatial frequencies and were presented to the child, beginning at the highest contrast. The child was asked to identify the correct orientation. This procedure determined the grating size to be used for treatment and also assessed visual performance. A grating coarser than the finest one perceived by the child was placed on the turntable as a starting point and at intervals, relative to the total treatment time, this was progressively changed to a finer grating. The Arden grating contrast sensitivity plates were also used, where the age of the child permitted, to assess visual function.

The methods of treating the patient were similar to those reported previously but with two main modifications. In this series, each treatment session lasted for 15 minutes (rather than 7 minutes). All patients were encouraged to occlude their good eye either on a full-time basis or for a minimal, daily period of fifteen minutes at home, during which time they were required to perform some difficult visual task (for example, filling in the o's in the newspaper) in conjunction with their Cam. treatment. Patients in the previous reports were not given additional occlusion. The patients in this series were treated 1-2 times weekly, receiving an average of 6 treatment sessions. Treatment was ceased when visual acuity remained unchanged at two consecutive treatment sessions.

Results

Age of onset.

Of the 80 patients treated, 20 were anisometropic amblyopes and 60 were strabismic amblyopes. The mean age of this series was 7.8 years (Figure 1a). 40% of these patients were referred to their respective ophthalmologists by the School Medical Service and 5% were referred by the Lions Save-Sight Foundation amblyopia screenings. The mean age of onset was 4.4 years (Figure 1b) and the mean age of formal ophthalmological diagnosis was 4.7 years (Figure 1c).

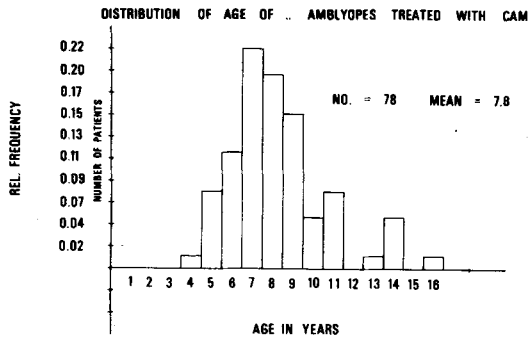


Figure 1a: Age distribution of 78 amblyopes treated with Cam. The mean age of treatment was 7.8 years. The two adults who were treated were excluded from this figure.

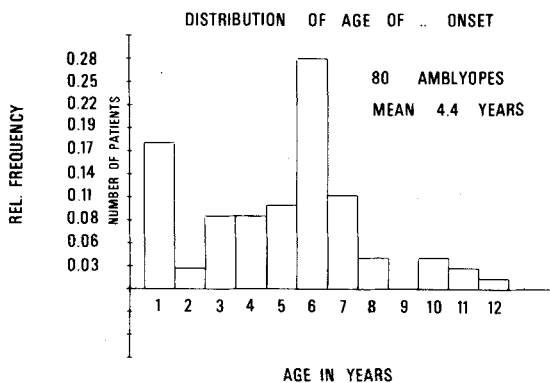


Figure 1b: Distribution of age of onset of 80 amblyopes treated with Cam. The mean age of onset was 4.4 years.

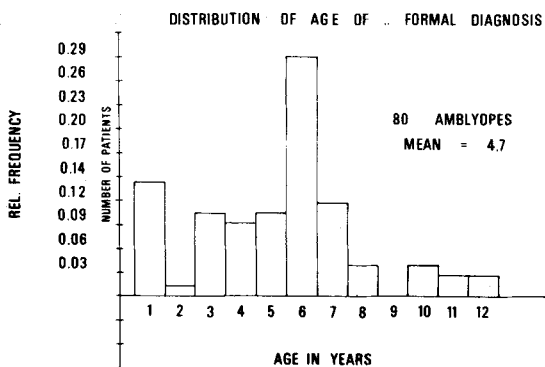


Figure 1c: Distribution of age of formal ophthalmological diagnosis of 80 amblyopes. The mean age of formal diagnosis was 4.7 years.

Family history.

41.25% of the overall number had a family history of squint. Of the strabismic cases 43.30% had a family history of squint, compared with only 35% of the anisometric cases.

Previous treatment

28% of the strabismic cases had already had squint surgery. Of the patients who had been previously occluded, the strabismic amblyopes averaged 7 months of previous occlusion, while the anisometric amblyopes averaged 3.5 months of previous occlusion.

Visual acuity improvement

In this survey of 80 patients, 60 patients were treated with Cam. and minimal occlusion. 47% achieved 6/12 or better vision. If the 14 patients with eccentric fixation were excluded from the latter average then 60% achieved 6/12 or better vision. Eleven patients were treated with Cam. and full-time occlusion and 91% achieved 6/12 or better vision.

The visual acuity results of Cam. treatment are demonstrated by scattergrams (Figures 2a, b, c & d) and table 1. Six metre single optotype visual acuity was used for the scattergrams as this was the only test able to be performed by every patient in the series.

Strabismic Amblyopes

Whether or not previous occlusion had been given made an unappreciable difference to the results of strabismic amblyopes treated with Cam. and, either minimal occlusion, or full-time conventional occlusion. Thirty-five strabismic amblyopes, previously occluded, were treated with Cam. and minimal occlusion and improved by a mean of 0.7 lines (Figure 2a, table 1). Nineteen strabismic amblyopes, who had not been previously occluded, were treated with Cam. and minimal occlusion and improved by a mean of 0.6 lines (Figure 2b, table 1). In six strabismic amblyopes, previously occluded, and treated with Cam. and fulltime conventional occlusion, the mean improvement was 2.3 lines (Figure 2c, table 1).

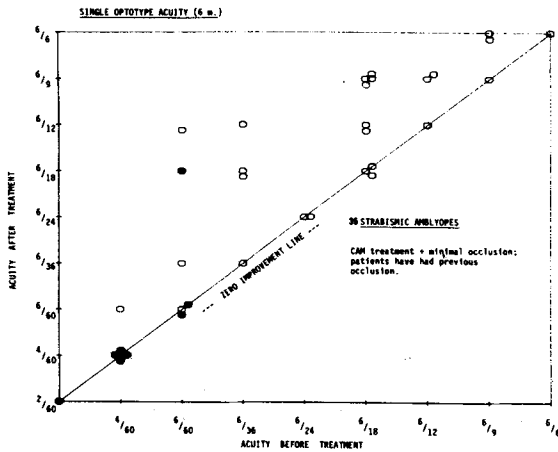


Figure 2a: Improvement of distance vision of 35 strabismic amblyopes who were previously occluded and were given Cam. treatment in conjunction with minimal occlusion. Filled symbols indicate patients with eccentric fixation.

Upward displacement represents acuity improvement from treatment and is with reference to acuity before treatment (sloping line/zero improvement line). Data falling on the sloping line represents no acuity change.

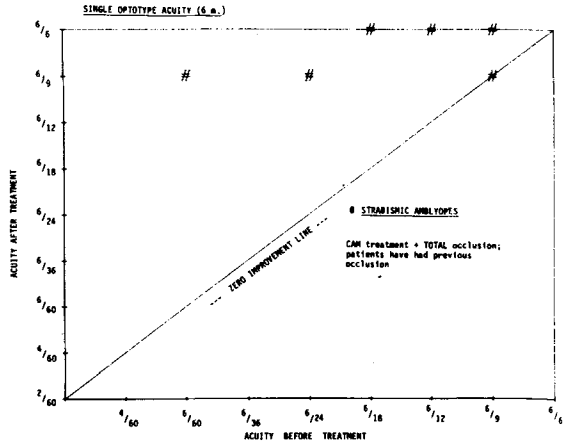


Figure 2c: Improvement of distance vision of 6 strabismic amblyopes who were previously occluded and were given Cam. treatment in conjunction with full-time occlusion. Upward displacement represents acuity improvement from treatment (sloping line/zero improvement line). Data falling on the sloping line represents no acuity change.

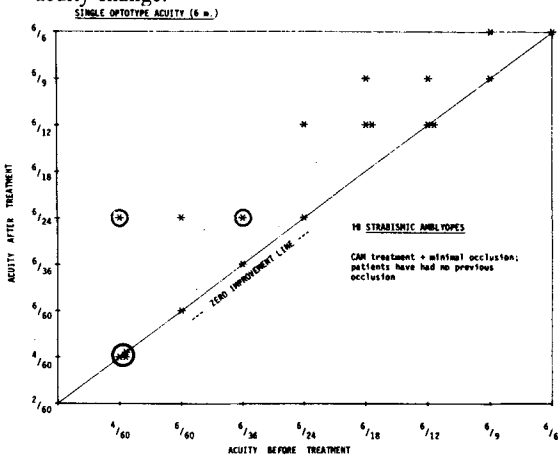


Figure 2b: Improvement of distance vision of 19 strabismic amblyopes who were not previously occluded and were given Cam. treatment in conjunction with minimal occlusion. Enclosed symbols indicate patients with eccentric fixation. Upward displacement represents improvement in acuity from treatment and is with reference to acuity before treatment (sloping line/zero improvement line). Data falling on the sloping line represents no acuity change.

Anisometropic amblyopes

Of the anisometropic amblyopes (Figure 2d, table 1), three who were previously occluded, and treated with Cam. and minimal occlusion, improved by a mean of 0.3 lines. Five anisometropic amblyopes, previously occluded,

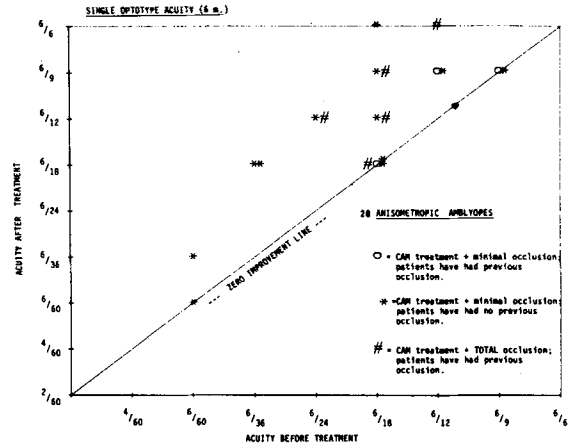


Figure 2d: Improvement of distance vision of 20 anisometropic amblyopes who were given Cam. treatment and either full-time or part-time occlusion (see symbol code). Upward displacement represents acuity improvement from treatment and is with reference to acuity before treatment (sloping line/zero improvement line). Data falling on the sloping line represents no acuity change.

who were treated with Cam. and full-time conventional occlusion improved by a mean of 1.4 lines. Another group of 12 anisometropic amblyopes, not previously occluded, and treated with Cam. and minimal occlusion improved by a mean of one line. Of these 12 patients, three were further occluded on a full-time basis after Cam. and minimal occlusion had been terminated and a mean of a further 1.5 lines of improvement was noted.

AVERAGE NO. OF LINES OF IMPROVEMENT IN VISUAL ACUITY,
POST CAM TREATMENT

PATIENTS TREATED WITH CAM AND MINIMAL OCCLUSION

	PREVIOUSLY OCCLUDED		NOT PREVIOUSLY OCCLUDED	
	LINEAR	SINGLE OPTOTYPE	LINEAR	SINGLE OPTOTYPE
19 STRABISMIC AMBLYOPES	NO SUBJECTS		6	6
12 ANISOMETROPIC AMBLYOPES	NO SUBJECTS		9	100
35 STRABISMIC AMBLYOPES	3	7	NO SUBJECTS	
3 ANISOMETROPIC AMBLYOPES	5	3	NO SUBJECTS	

PATIENTS TREATED WITH CAM AND FULL-TIME OCCLUSION

	PREVIOUSLY OCCLUDED		NOT PREVIOUSLY OCCLUDED	
	LINEAR	SINGLE OPTOTYPE	LINEAR	SINGLE OPTOTYPE
5 ANISOMETROPIC AMBLYOPES	1.00	1.4	NO SUBJECTS	
6 STRABISMIC AMBLYOPES	1.3	2.3	NO SUBJECTS	

TABLE 1: Shows average improvement of visual acuity expressed in lines, or parts of lines. Comparison should be made between patients treated with Cam. and minimal occlusion, and patients treated with Cam. and full-time occlusion in the "previously occluded" groups (for the sake of continuity). Patients treated with Cam. and full-time occlusion improved to at least twice the extent of patients treated with Cam. and minimal occlusion over the same time period.

Of the 80 patients treated, 38 showed no improvement of their single optotype distance acuity. Of the 14 eccentric fixators treated, three showed some improvement of their distance acuity, while two showed a pronounced improvement of their linear near vision.

Of the patients whose vision did improve to a degree warranting a three month follow-up, the visual acuity in 33% of cases treated was not maintained over a three month period.

No cases of intractable diplopia were produced.

Two adults, aged 40 and 44 years, were treated with Cam. and minimal occlusion. No improvement in visual acuity was achieved. The most impressive response was in the youngest child treated, aged three years. Her vision on repeated checking was initially 6/60 with eccentric fixation. The mother was given the machine to take home for one week as all previous attempts at occlusion had failed. The child's visual acuity improved to 6/18 and her fixation became central.

The Arden contrast sensitivity test.⁷

This test could be performed only on children over the age of six years with accuracy. Twenty-three patients were tested. The mean score for normal eyes was 64 ± 14 (Figure 3a). The mean score for amblyopic eyes was 93 ± 24 (Figure 3b). Note that the distribution of the amblyopic eyes is skewed to the high scores. Amblyopes tended to have high scores on high frequency plates.

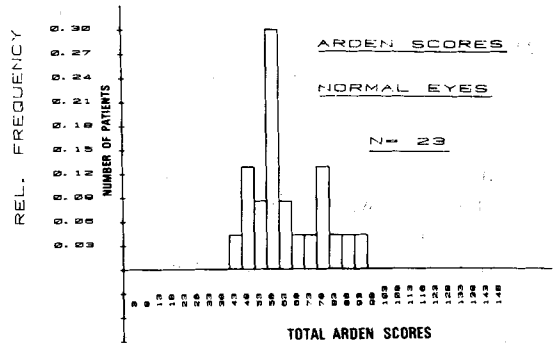


Figure 3a: Total score distribution for 23 normal eyes tested with the Arden Contrast Sensitivity Test. Note that the distribution is skewed to the lower scores.

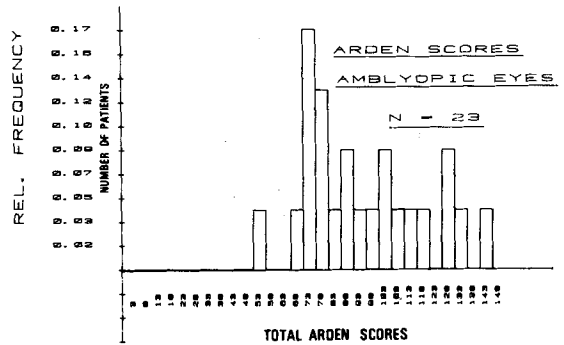


Figure 3b: Total score distribution for 23 amblyopic eyes tested with the Arden Contrast Sensitivity Test. Note that the distribution is skewed to the higher scores.

DISCUSSION

The mean age of onset in this series was 4.4 years. The mean age of formal ophthalmological diagnosis was 4.7 years (it took an average of slightly less than four months for a patient to see an ophthalmologist once the problem was

suspected). The fact that the School Medical Service was responsible for referring 40% of patients with amblyopia gave an indication of the efficiency of the School Medical Service and also indicated, in this series, that amblyopia is still being detected too late, as the parents obviously responded quickly to the advice that their child had an eye problem and sought professional help within a relatively short period of time. Given that 49 of the 80 patients in this series had previously been occluded and the mean age of the patients treated was 7.8 years, follow-up of treatment amblyopes is not currently tenacious enough.

Visual acuity improvement

Patients treated with Cam. and minimal occlusion compared badly with strabismic amblyopes treated with Cam. and full-time occlusion.

Anisometric patients treated with Cam. and minimal occlusion compared badly with anisometric patients treated with Cam. and full-time occlusion. A group of 12 anisometric patients, not previously occluded, treated with Cam. and minimal occlusion showed a mean visual acuity improvement of one line. Although the improvement rate here is impressive it cannot be accredited to the Cam. or to the minimal occlusion applied as all the patients in this group had been prescribed their glasses less than one month prior to treatment. 50% had been prescribed their glasses less than two weeks prior to treatment. It was felt that the time lapse had been insufficient to allow for the spontaneous recovery of visual acuity which often occurs after glasses have been prescribed in anisometropes.

Eccentric fixators do not, on the whole, respond to this treatment. The improvement in near acuity could be attributed to the Cam. or to the fifteen minutes of minimal occlusion applied daily, at home, combined with concentrated close work.

Fears of the Cam. causing intractable diplopia have been dispelled in this series, and from our findings the vision is likely to drop back when the treatment is ceased, as is often the case after conventional occlusion.

Two adults, aged 40 and 44 years, were treated in this series and showed no improvement, while the most drastic improvement occurred in the

youngest child. Possibly the Cam. has a greater application for a younger age group but there are inherent problems associated with keeping the attention of younger children on the stimulus.

Arden contrast sensitivity test

This test is possibly a good assessment of visual function when combined with linear and single optotype visual acuity tests. Due to the overlap in scores between normal and amblyopic eyes, this test is not valid when used alone. Amblyopes tended not to see plates 6 & 7 and total scores were skewed to the high scores. However, this phenomena also occurs in other ocular diseases such as glaucoma.

The mean age of the patients in this series of 7.8 years was considered to be rather advanced in terms of instigating amblyopia treatment. It was felt that to use both forms of treatment (occlusion and Cam.) may improve the visual acuity more quickly than either used independently. The age distribution of the patients in this series (Figure 1a) does, however, compare well with that of the previous series.⁴ One third of all patients seen in Perth have to travel vast distances for their eye care as all ophthalmologists, with the exception of one, and orthoptists are based in the capital city. Treatment, or combinations of treatment, therefore have to be as concentrated as possible to reduce the patient's travelling expenses and domestic disruption. For these patients, in particular, a combination of Cam. and occlusion seemed preferable.

Catford (1967)⁷ reported 88% of patients achieving 6/12 or better visual acuity when treated with full-time occlusion where macular fixation was present. It has also been shown that minimal occlusion combined with concentrated close work improves visual acuity to 6/12 in 83% of cases over a thirteen week period (Campbell *et al.*, 1978).⁴ The patients, in this series of 80, received minimal occlusion combined with Cam. treatment for a period of only four to six weeks. However, at least some of the visual improvement must be attributed to occlusion in those patients treated with Cam. and minimal occlusion. In the group of patients treated with Cam. and full-time occlusion, the Cam. can only be responsible for a small

part of the final improvement. Tytla *et al.*⁸ have demonstrated in a series of 15 patients treated with Cam. and minimal occlusion that after four, weekly, 7 minute sessions patients responded equally to either a stimuli of stripes or a stimuli of a homogeneous grey disc. Both groups showed an improvement in acuity. However, Tytla *et al.* state "Whereas the rationale for the Cam. treatment is 'physiologically based', and this rationale is certainly appealing, our control results suggest that the presence of stripes plays little or no role in vision improvement and that it may be the 'minimal occlusion' which is the effective component of treatment." Our results from a series of 80 patients treated with Cam. agree with this statement. It seems that full-time occlusion, despite the difficulties, is still a much more effective way of treating amblyopia, at least while treatment of patients under the age of three years continues to be impractical with Cam.

Acknowledgements

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