

Clinical characteristics of microtropia—is microtropia a fixed phenomenon?

Charlotte Anne Houston, Marie Cleary, Gordon N Dutton, Robert M McFadzean

Abstract

Background/claims—Microtropia is believed to be a static condition, in which accepted achievable levels of vision are those of 6/12–6/9 maximum, with the inability to achieve “normal” levels of stereopsis. The aim of this paper was to present the results of treatment of 30 consecutively presenting primary microtropes, and assess their outcomes using a more active treatment strategy than that conventionally used.

Methods—Visual acuity, stereoacuity, fixation, and the presence of a central suppression scotoma were assessed in all patients before, during, and after treatment, which comprised wearing maximum refractive correction, and an occlusion strategy aiming for equal visual acuity.

Results—Equal visual acuity of 6/5 Snellen was achieved in 43% of the 30 patients, while 87% achieved 6/9 Snellen or better visual acuity in the microtropic eye. Stereoacuity of better than 60" of arc was attained in 37%, and foveal fixation on visuscopy in 55%. The treatment outcome was not affected by the patient's age, initial visual acuity, or the amount of anisometropia. A change in the patient's diagnosis was noted in 50%, with nine patients recovering completely.

Conclusions—The results show that microtropia is not static. Equal 6/5 vision is attainable, as is high grade stereoacuity. The pattern of fixation may change during treatment and elimination of the microtropia is possible in some cases. There is a requirement for management protocols to be changed in order to treat this condition more effectively.

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Glasgow Eye
Infirmary, 3 Sandyford
Place, Glasgow
G3 7NB
C A Houston
M Cleary
R M McFadzean

Vision Science
Department, Glasgow
Caledonian University,
Glasgow G4 0BA
M Cleary

Tennent Institute of
Ophthalmology,
Western Infirmary,
38 Church Street,
Glasgow G11 6NT
G N Dutton

Correspondence to:
C A Houston, Orthoptic
Department, Glasgow Eye
Infirmary, 3 Sandyford Place,
Glasgow G3 7NB.

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the angle of anomaly were coincident, and therefore no movement was evident on the cover-uncover test. However, both sets of authors have now adopted the term “microtropia” to encompass both positive and negative cover-uncover test findings.^{8,9}

Microtropia is defined as a manifest deviation of less than 5° in which ARC (giving rise to abnormal binocular single vision (ABSV)), normal motor fusion, and reduced or absent stereoacuity are found. In addition, amblyopia, a foveal suppression scotoma, and unocular eccentric fixation are present and there is a close association with anisometropia. The term microtropia “with identity” is used by most authorities to describe patients with no manifest movement on cover test, the eccentric fixation point coinciding with the angle of ARC. Microtropia “without identity” describes patients in whom the manifest movement is demonstrated on the cover-uncover test.⁹ Microtropia may be primary, when there is no history of previous large angled strabismus, or secondary following surgical or optical correction of a larger strabismus or associated with other ocular pathology.

Treatment of microtropia centres on correction of any refractive error and conventional occlusion, particularly maintenance occlusion for amblyopia.^{10,11} Following occlusion it is generally accepted that levels of visual acuity of greater than 6/12 or 6/9 Snellen are rarely achieved, despite the lack of literature evidence to support this view. One previous report on the visual outcome following treatment of amblyopia in microtropia, recorded that 83% of 42 patients did not achieve 6/9 using a non-crowded picture chart or E test, and 25% of patients did not respond to treatment at all.¹² Others have found that the best achievable visual outcome is one line of difference in visual acuity levels between the amblyopic and non-amblyopic eyes.^{13,14}

ARC is primarily found in small stable angle esotropia. It may represent a cortical adaptation of the relation between retinal elements of one eye with respect to those of the other eye^{9,15,16} or alternatively an extension of the existing binocular cortical connections in the normal visual system.^{17,18} These concepts are generally believed to constitute the basis of BSV in microtropia, although NRC, maintained via an expansion of Panum's fusional area, has also been postulated.^{19,20} It is commonly stated that ARC in microtropia cannot²¹ and should not be disrupted owing to the risk of insuperable diplopia, which occurs as a result of a change in the oculocentric direction of retinal components of the

Small angled squint with characteristics consistent with the term microtropia has been recognised for over 40 years.^{1–3} Parks and Eustis introduced the term monofixational phoria⁴ which they later revised to monofixation syndrome,⁵ to describe an absence of bifoveal fusion with maintenance of normal retinal correspondence (NRC) associated with an enlarged Panum's fusional area. Microtropia has been the subject of debate since Lang⁶ coined the term to describe a small angled strabismus with anomalous retinal correspondence (ARC), normal fusional amplitudes, and reduced stereopsis. Helveston and von Noorden⁷ initially reserved this term for cases in which the unocular angle of eccentric fixation and

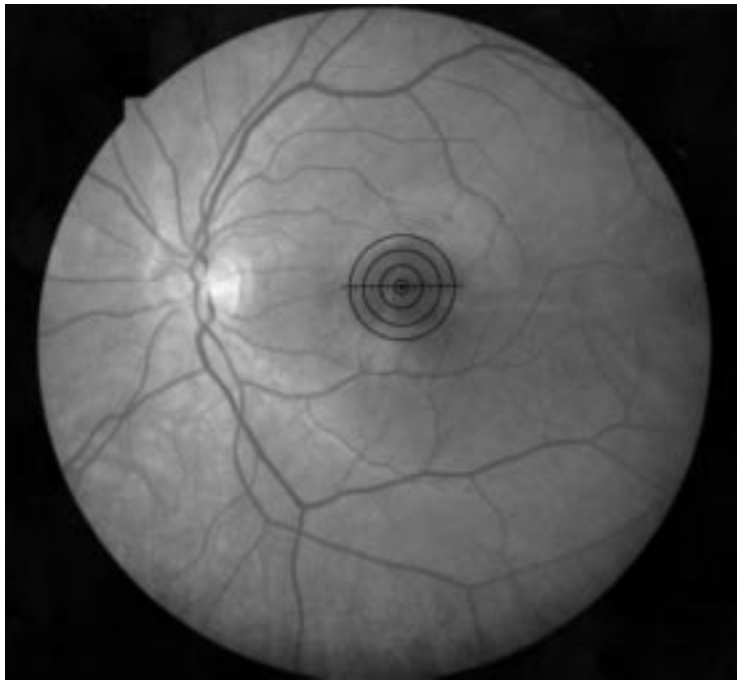


Figure 1 Appearance of the visuscopy fixation graticule superimposed on the fundus, of a patient with steady eccentric fixation 1° nasal to the fovea.

microtropic eye following antisuppression exercises.⁹ This approach is based on the theory that the facility for bifoveal fixation has not developed, owing to the onset of strabismus before 6 months of age, therefore overcoming suppression results in non-fusible diplopia. The suggestion has been made that once the neuroanatomical organisation, which allows NRC, has been disrupted it cannot be recovered even when normal binocular conditions are restored.^{15 22} The risk of insuperable diplopia, due to disruption of BSV by occlusion, is stated by some clinicians as a reason for not starting or only prescribing minimal occlusion.

The foveal scotoma found in microtropia is thought by some to be secondary to anisometropia,⁷ but others believe there is an innate inability or loss of a prior ability for bifoveal fusion.^{5 23 24} It has also been suggested that the scotoma may be an artefact of perimetric assessment.²⁵

Reduced stereopsis is an invariable finding in microtropia. In a previous series of 29 patients with primary microtropia, 54% had stereopsis of $400''$ of arc or less, while 42% demonstrated between 100 and $400''$ of arc using non-random dot tests. With random dot tests 100% of these patients demonstrated stereonegativity.¹⁵

Our study reports the response of an unselected group of primary microtropes to a clinical strategy of intensive occlusion therapy, with a re-evaluation of current concepts and accepted outcomes in microtropia.

Patients and methods

Thirty consecutively presenting primary microtropes who had completed a course of occlusion therapy were identified from the records of the orthoptic department at Glas-

gow Eye Infirmary during the period June 1993 to February 1996.

The initial visual acuity of each eye was determined using the linear Snellen test type in 23 patients, and the Sheridan-Gardiner single optotype test in seven patients. All final visual acuities were determined using the Snellen chart. Results were converted to a log scale for analysis.

Diagnosis of a microtropia was determined by the following criteria: (1) Cover test revealing only a latent deviation or no deviation, in patients with microtropia with identity, or a small manifest deviation in microtropes without identity, measuring $<5^\circ$. (2) The Irvine 4 dioptre prism test¹ was employed to detect a central suppression scotoma in the microtropes with identity. (3) Bagolini glasses confirmed the presence of ARC. (4) The prism reflex test (usually 20^Δ base out) detected the presence of motor fusion or alternatively prisms were used to measure the fusion range. (5) The Frisby stereoacuity test was selected to measure the stereoacuity levels in the majority of patients, but if a negative or inconclusive response was found, then the Titmus fly or Lang II test was performed. (6) The uniocular fixation point was established in each eye using a visuscope with a central fixation graticule and a superimposed scale marked each 0.5° . The fixation pattern was documented with respect to steadiness, the area used, the tendency to drift towards or away from the fovea and the percentage of foveal fixation which occurred (F%). In addition, the fixation point used when asked to refixate, the zero retinomotor point (zrp) was identified. For example, slightly unsteady; 1° nasal; $1/2^\circ$ superior; flick to fovea; F10%; zrp-eccentric point. Figure 1 shows a fundus photograph with the scale superimposed in a patient with eccentric fixation.

At presentation, refraction was performed approximately 30 minutes after instillation of cyclopentolate hydrochloride 1%. Spectacle prescription for the full cycloplegic retinoscopy result was issued, with an allowance being made for the working distance only. This correction was worn for a period of 6–8 weeks before commencement of occlusion. Total to light occlusion was prescribed initially for a period of 4–8 hours each day with a greater number of hours prescribed in patients with poorer presenting visual acuities, with close work being encouraged during patching. Patients were reviewed 2–4 weeks after starting occlusion and thereafter every 4–6 weeks depending on the age and amount of occlusion. As the visual acuity improved occlusion was reduced to a minimum of 2 hours daily. In the case of no improvement over two visits or waning compliance, full time “Blenderm” (total to form) was substituted for conventional occlusion. When 6/5 or equal visual acuity was attained, or acuity was static for 2–3 months, occlusion was gradually reduced to 1 hour daily maintenance for 1–3 months (except in five cases in whom occlusion was stopped once 6/5 was achieved), before finally stopping. If visual acuity subsequently deteriorated, a

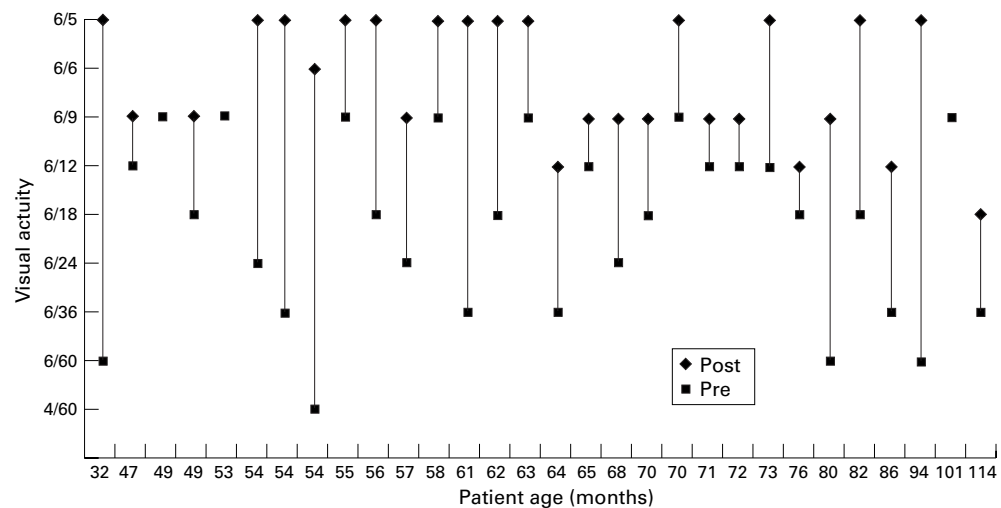


Figure 2 Visual acuity in the amblyopic eye both before and after treatment, corresponding to the patient's age.

period of occlusion was reinstated until optimal acuity was retained.

Patient compliance was assessed approximately by asking the parents and child how much occlusion was worn and by comparing it with how much had been prescribed at the previous visit. Both were then calculated into total hours prescribed and percentage worn.

The risk of insuperable diplopia was monitored by measuring fusional reserves. Additionally the Bagolini filter or Sbisà bar²⁶ was used to assess the stability of the ABSV in the older patients on full time occlusion.

Statistical analysis using linear regression was applied.

Results

The age range of the 30 patients was 32–114 months with a mean age of 66 months (5½ years old) and median of 63.5 months. The male:female ratio was 15:15. The microtropic eye was the right eye in 57% of patients and the left in 43%. Microtropia with identity was present in 30% of patients, and microtropia without identity in 70%. A positive family history of strabismus or hypermetropia was noted in the parents or siblings of 63% of patients.

Figure 2 illustrates the presenting and final visual acuity levels for the 30 patients. Visual

acuties of 6/5 Snellen in both eyes were achieved in 13 patients, while in the remainder the visual acuity in the microtropic eye improved to 6/6 in one patient, 6/9 in nine, 6/12 in three, and 6/18 in one, and remained unchanged at 6/9 in three. In total, 87% of patients attained 6/9 or better in the treated amblyopic eye.

Figure 2 also relates the age of commencement of treatment to the final vision in the previously amblyopic eye. Patients attaining 6/5 had a median age of 5.1 years, range 2.7–7.9 years. Those attaining 6/9 had a median age of 5.5 years, range 4.1–8.4 years, and patients attaining 6/12 had a median age 6.3 years, range 5.3–7.2 years. There were three patients who were over 7 years of age at presentation of whom one improved from 6/60 to 6/5, one from 6/36 to 6/18, and one remained at 6/9.

Figure 3 details the results of the final “amblyopic” visual acuities compared with those of the better eye. Thirteen patients (43%) had residual amblyopia, nine patients were 6/5:6/9, one patient was 6/5:6/12, one patient 6/5:6/18, and two patients were 6/9:6/12 in the non-amblyopic and amblyopic eyes respectively employing the commonly used standard of classifying amblyopia as two or more Snellen lines difference or poorer than 6/9 Snellen.

Analysis of the original levels of amblyopia versus the levels of vision achieved showed that initially poor visual acuity did not predispose to a poor visual outcome. On the contrary the three patients who did not respond to treatment presented with an acuity of 6/9 in the amblyopic eye. In two of these patients, only single letter acuities could be obtained at presentation, but final Snellen acuities were obtained, possibly representing a marginal improvement.

Figure 4 shows the relation between the spherical equivalent refraction (SER) and the initial and final interocular visual acuity difference. Anisometropia which was defined as greater or equal to 1 D SER or >1 D cylinder was present in 17 patients (57%). The degree of anisometropia ranged from 1 D to a

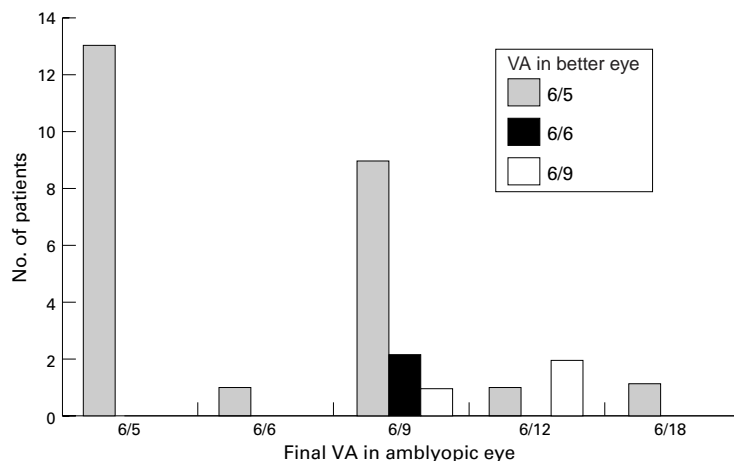


Figure 3 Final visual acuity outcome in both eyes (detailing residual amblyopia).

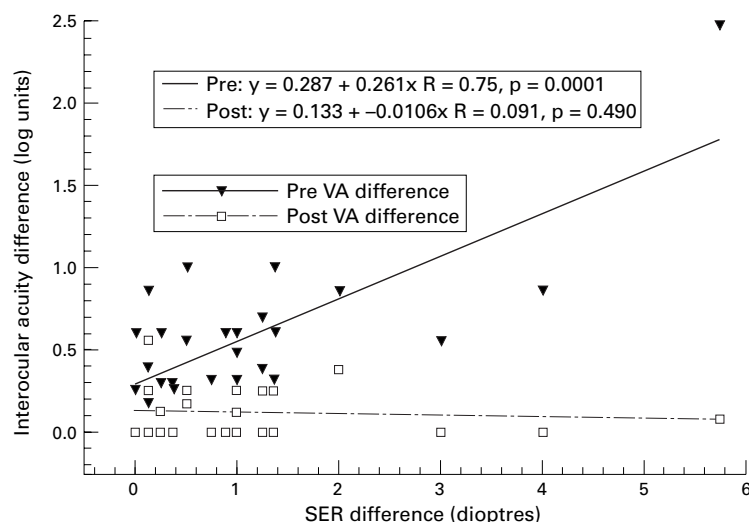


Figure 4 Visual acuity in the amblyopic eye before and after treatment, related to the degree of anisometropia (SER difference).

maximum of 5.75 D SER. Initial corrected visual acuity levels in the amblyopic eyes were poorer in the patients with anisometropia (mean 0.167 log units (6/60–6/36)) than in those without (mean 0.333 log units (6/24)), $R=0.095$ $p=0.0001$. However, the final visual outcome was not related to the amount of anisometropia, $R=0.75$ $p=0.619$, in that the 15 patients with anisometropia attained equivalent mean degrees of improvement compared with the 15 patients without anisometropia (0.921 and 0.929 log units respectively—that is, both groups were between 6/6–6/9).

The amount of occlusion prescribed and patient compliance were assessed. The mean number of hours of occlusion worn and the compliance with treatment by those achieving 6/5 were 434 hours and 86%, those with 6/9 were 477 hours and 85%, and 6/12 were 523 hours and 84% respectively. Overall, the claimed compliance with treatment was good and not related to the initial visual acuity level.

Table 1 shows the stereoacuity levels before and after treatment. All patients manifested an improvement in their stereoacuties. Before treatment 13 patients had no demonstrable stereopsis, 16 patients had stereopsis poorer than 100" of arc, and one patient had 85" of arc, two were not tested. Following treatment, all patients demonstrated stereoacuity of some degree, with 11 patients developing a stereoacuity better than 60" of arc. In six patients it was noted that improvement in the stereoacuity levels preceded the improvement in visual acuity.

Twenty patients were sufficiently cooperative to allow visuscopy examination both before and after treatment. Initially a degree of eccentric fixation was detected in all patients. Following treatment the fixation point moved

Table 2 Change in fixation in 15 patients

Pretreatment	Post-treatment
Wandering	Foveal
Nasal 2°	Nasal 1°
Superior 2°, nasal 1°	Nasal 1°
Superior 2°, nasal 0.5°	Superior 0.5°
Nasal 1°, superior 0.5°	Foveal
Nasal 1°	Nasal 0.5°, sup 0.5°
Nasal 1°	Foveal
Nasal 0.5–1°	Nasal 0.5°
Nasal 0.5–1°	Foveal
Nasal 0.5°, inferior 0.5°	Foveal
Nasal 0.5°, inferior 0.5°	Foveal
Nasal 0.5°	Foveal
Nasal 0.5°	Foveal
Temporal 0.5°	Foveal
Temporal 0.5°	Foveal

closer to the fovea in 15 patients, 10 of whom developed foveal fixation (Table 2). The eccentric fixation point remained unchanged in five patients. Those patients most likely to develop foveal fixation presented with eccentric fixation of less than 1°. However, three patients with eccentric fixation of 1° or more, also went on to attain foveal fixation. Of the 10 patients who became uniocular foveal fixators, six no longer demonstrate a microtropia.

Following treatment the condition changed from the initial diagnosis in 15 patients. Of the nine patients with microtropia with identity before treatment, only one remained unchanged, two became microtropes without identity, two became esophoric, and four became exophoric. There was a less dramatic change in the 21 patients with microtropia without identity before treatment, in that 14 remained unchanged, three became microtropes with identity, and three became exophoric. In addition, one patient changed from being micro-esotropic without identity to being micro-exotropic without identity.

The time period during which best visual acuity was observed as being maintained in the patients attending review appointments ranged from 2 to 31 months (median 8 months, SD 6.89 months). The number of consecutive visits over which this occurred ranged from one to 10 visits (median three visits, SD 2.99 visits).

Discussion

The results of this study show that contrary to widespread belief visual acuity in microtropia can be improved beyond the 6/9 Snellen level commonly accepted, and 6/5 Snellen can frequently be achieved. Moreover, foveal suppression may be eliminated in some patients. Fixation may become foveal, and stereoacuity values consistent with bifoveal fixation can be attained. The microtropia itself may even resolve.

Despite the lack of published evidence to confirm the view that microtropes will not readily achieve visual acuity levels better than 6/9 Snellen, this concept underlies current teaching and practice. Full time occlusion has been recommended for microtropia¹⁵ and our experience indicates that the use of full time Blended occlusion when visual acuity levels reached 6/9 Snellen in the amblyopic eye is a major factor in improving the visual outcome. It is common practice to reduce the amount of

Table 1 Stereoacuity levels, before and after treatment

	Stereoacuity (seconds of arc)					
	<60"	60–120"	>120–240"	<240"	None	No test
Pretreatment	0	3 (10%)	4 (13.3%)	8 (26.7%)	13 (43.3%)	2 (6.6%)
Post-treatment	11 (36.6%)	10 (33.3%)	5 (16.6%)	4 (13.3%)	0	0

occlusion worn as the amblyopia improves. Thus, many patients undergo only 1–2 hours of occlusion daily when they achieve 6/9 Snellen visual acuity in the amblyopic eye. However, our results appear to indicate that full time Blenderm occlusion at this stage is beneficial.

The effects of the patient's age, degree of anisometropia, and initial visual acuity level on the final visual outcome were assessed. The age at commencement of treatment was slightly greater in patients achieving poorer visual acuities, but even patients over 7 years of age at presentation attained substantial improvement in their visual function. Although it has formerly been reported that patients with higher degrees of anisometropia and eccentric fixation have denser amblyopia and a poor prognosis,²⁷ the degree of anisometropia did not have a significant bearing on the final visual outcome in this series. Patients with anisometropia were as likely to attain 6/5 visual acuity as those with no anisometropia. Compliance with occlusion was not influenced by the patients' initial visual acuity and patients with poor initial visual acuities responded as well to occlusion as those with better initial levels. One previous study has reported a similar relation between the age of the patient and initial visual acuity with the final visual outcome.¹²

The marked improvement of stereoacuity to a level of better than 60" of arc in one third of patients was unexpected. To achieve levels of stereopsis of better than 60" of arc, bifoveal fixation must be present^{5 28 29} and 11 patients achieved this level. Nine of these patients were deemed to be "cured" of their microtropia, while the other two patients were noted on cover test to have a latent deviation with an occasional manifest movement. Presumably these two patients were bifoveal at times, although not exclusively so. One previous study³⁰ found that microtropes with identity achieved better stereoacuity levels. In this series seven of the 11 patients attaining better than 60" of arc were originally microtropes with identity.

The eccentric retinal point used for fixation moved towards the fovea in 15 of the 20 patients assessed by visuscopy, 10 of whom developed foveal fixation. It is our understanding that this finding has not previously been documented in the literature on microtropia, although one paper alludes to an impression that fixation pattern was not greatly influenced by therapy.¹²

Management of the suppression scotoma and ARC has been heavily influenced by the potential risks of insuperable diplopia and poor results.⁹ Previous reports have identified insuperable diplopia arising as a consequence of occlusion therapy, but we could find no literature related specifically to this complication in microtropia, which is recognised as having normal or near normal fusional amplitudes. Nevertheless, we warned patients and their parents of the risk of diplopia and requested that this symptom be reported immediately, should it develop during therapy, no patient reported any diplopia. We did not aim to elimi-

nate the suppression scotoma but found that as vision improved the scotoma resolved spontaneously in some patients with concurrent movement of fixation closer to the fovea. Fusional amplitudes were carefully monitored throughout treatment and did not reduce. Provided appropriate precautions are taken to monitor the risk of diplopia (for example, measurement of fusional amplitudes and use of the Sbisa bar to assess the depth and stability of retinal correspondence²⁶), then in our view anxiety concerning the risk of insuperable diplopia should not supersede the requirement to fully develop each patient's potential for maximal visual acuity and high grade stereopsis.

Microtropia is commonly regarded as a static incurable condition, with statements like "microtropia cannot be cured" being found in the literature.³¹ However, a few patients have been described in whom microtropia has been "cured"⁹ or in whom "spontaneous" recovery has taken place.³² Our findings indicate that there is a potential for flexibility of the retinal correspondence within this condition, particularly in those nine patients who fully recovered. The mechanisms involved in those nine patients will be considered in a following paper.

Conclusions

Conventional attitudes to the clinical treatment of microtropia warrant re-evaluation. This study demonstrates that microtropia is a dynamic rather than a static condition, in which it is possible to obtain a substantial improvement in visual acuity and binocular function using an appropriate occlusion regime. Amblyopia is the main treatable factor and the aim of treatment should be equal visual acuities and not "6/9". In this series partial "total to light" occlusion was enhanced with subsequent full time "total to form" occlusion in patients showing an arrested visual improvement or waning compliance. During monitoring, assessment of stereoacuity and the fixation pattern are important, as improvement in these variables may precede an improvement in visual acuity or indicate those eyes with a better visual potential.

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