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MINUS OVERCORRECTION: CONSERVATIVE TREATMENT OF INTERMITTENT EXOTROPIA IN THE YOUNG CHILD— A COMPARATIVE STUDY*

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Abstract

Minus overcorrection is examined in the treatment of children, under 6 years of age, with intermittent exotropia of the divergence excess type. Minus lenses stimulate accommodative convergence which provides a stimulus to the fusional skills required to control a divergent deviation. A group of 22 children given minus overcorrection is compared with a second group of 12 children with whom minus overcorrection was not successful and later required surgery. Average strength prescribed was −2.50 D.S.

68% of Group 1 and 62% of the total (Group 1 and Group 2) were exophoric at all distances after 12 months with overcorrection. 27% of the total also had a reduction in deviation size of ≥ 15Δ at 6 metres. Group 1 had a significantly smaller near deviation and higher AC/A ratio than Group 2 ($p = 0.01$). It is concluded that minus overcorrection can enhance control of divergence in young children and may avoid unnecessary surgery.

Key words: *minus lenses, accommodative convergence/accommodation ratio, exophoria.*

INTRODUCTION

Satisfactory management of intermittent exotropia, X(T), in the young child under the age of six years, depends upon the prevention of suppression. Merely correcting the divergent deviation by surgery, in visual immaturity, may post-operatively lead to a recurrence of the divergent deviation or to a small angle esotropia because of the persistence of suppression.[1] Therefore nonsurgical methods of treating X(T) may be the preferred form of therapy in the young child, as this increases the time the child is bifoveal and prevents the development of suppression.

One method of nonsurgical therapy is over-correcting the refraction with minus lenses. Minus lenses stimulate accommodation hence accommodative convergence. This initiates the convergence response which is then completed by reflex fusional vergence, hence giving added stimulus to the fusional skills required to control a divergent deviation.[2]

Merrick[3] outlined the usefulness of weak minus lenses (less than −1.25 D.S.) in older symptomatic X(T) for relieving symptoms. She also reported a case of a young X(T) who after a trial of −3.00 D.S. became convergent at the near position, and concluded that minus lenses be approached with caution and are justified only as a temporary procedure in symptomatic X(T) until an operation is possible.

Jampolsky,[4] however, notes that 3 to 5 dioptres of accommodation stimulated is well tolerated by many children.

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In 1983[5] he reported that 72% of young children with X(T) had an improved ocular status while wearing minus lens overcorrection.

Burian[6] suggests that minus lenses are indicated temporarily in high AC/A types of X(T) but uses this form of treatment sparingly, being wary of accommodative asthenopia as the child grows older.

The literature indicates that there are differences in attitude towards minus lens overcorrection.

The purpose of this paper is to report the results of a study involving 34 children with X(T) whose initial treatment was by minus overcorrection, and to determine the variables which may influence the response to minus overcorrection.

METHOD

1. Subjects

A total of 34 subjects were first seen between 1978 and 1984. They were collected from the orthoptic records of a sponsored orthoptic practice in the Tamworth district, and in some cases the distance travelled by subjects was up to 400 km. Over 50% of the children travelled distances greater than 100 km to the clinic.

The following criteria for inclusion were used:

—acquired X(T) of divergence excess type—true or simulated

—no surgery prior to treatment with minus lenses

—less than 0.75 D.S. of anisometropia

—typical signs of divergence e.g. shutting one eye

—age or distance travelled prevented the subject from benefiting from orthoptic treatment alone.

The subjects were divided into two groups.

Group 1: consisted of 22 children (9 female, 13 male) who were given minus overcorrection as the only form of treatment.

Group 2: consisted of 12 children (4 female, 8 male) who were initially given minus lenses but later required surgery. Group 2 was included in the study to compare results with Group 1 and identify reasons for discontinuing minus overcorrection.

Age when minus overcorrection began in Group 1 ranged from 18 months to 6 years, median 3 years, and Group 2 ranged from 1 to 6 years, median four years.

2. Prescription of Minus Lenses

At the initial consultation all subjects had some form of orthoptic assessment ranging from screening tests to full assessment. Fundus and media examination and refraction were performed on all subjects. 85% had a cycloplegic refraction.

In all cases the working distance and −3.00 D.S. were subtracted from the refraction to ascertain the strength of minus lens to be prescribed; thus correcting astigmatism and small degrees of anisometropia. Initially the prescriptions ranged from a strength of −1.25 D.S. to −3.75 D.S. (averaging −2.50 D.S.).

Subjects were then monitored by ophthalmologist and orthoptist for refractive changes as well as control of deviation one to three months later, then at periods of three, six and 12 months following. Any reduction in control was adjusted by increasing the minus power, and conversely, if well controlled, power was decreased, thus exercising negative relative fusion. Throughout the study the maximum power prescribed was −5.00 D.S.

A significant shift towards myopia did not occur in subjects with minus overcorrection. Three subjects became myopic, all of whom were less hypermetropic under the original refraction.

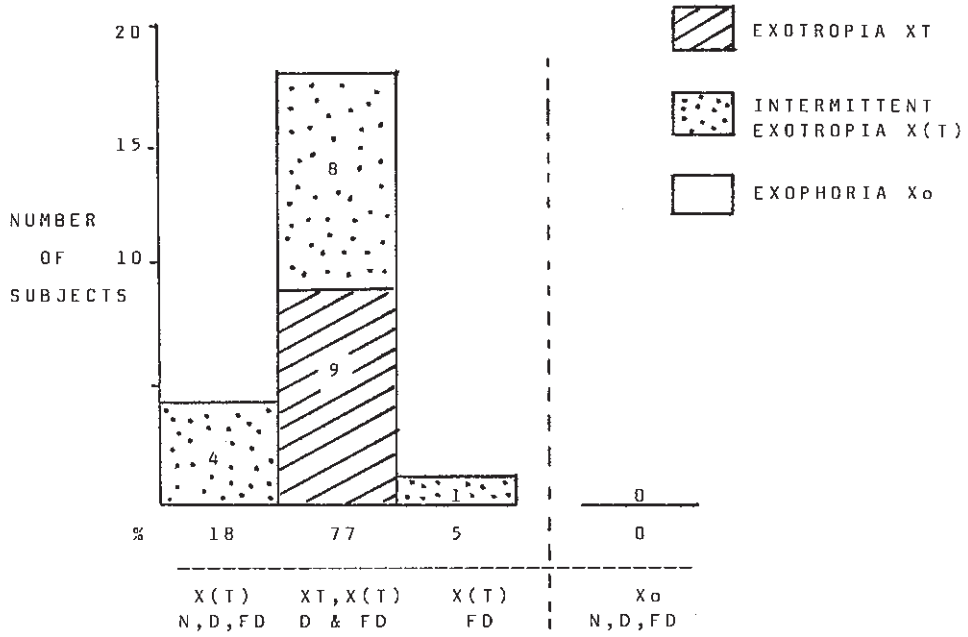
All subjects achieved vision of 6/9 or better with the minus overcorrection.

Orthoptic techniques consisting of part-time occlusion for amblyopia or elimination of suppression, pathological diplopia teaching and convergence exercises were used in conjunction with minus overcorrection to eliminate any further barriers to obtaining binocular single vision.

RESULTS

A functional cure was judged to have been achieved when an X(T) was converted to an exophoria at near, 6 metres and far distance. Degree of divergence was charted before

FIGURE 1 : GROUP 1 BEFORE MINUS OVERCORRECTION



treatment, at one to three months, six months and 12 months later with all subjects wearing initial prescription for 12 months.

(A) Group 1

Follow-up period for Group 1 ranged from five months to 67 months, with an average follow-up of 32 months.

Before treatment (Figure 1) no subject satisfied the criteria of a functional cure. 18% were becoming manifestly divergent at all distances and 77% at six metres and far distance.

After one to three months of wearing minus overcorrection full-time (Figure 2) there had already been a shift towards the functional cure; 32% actually achieving exophoria at all distances with minus overcorrection.

Six months after the commencement of therapy there has been a shift of the subjects who were intermittent at 6 metres and far distance in Figure 2, to being only intermittent in the far distance (Figure 3). Three subjects had not been followed up at this time, so percentages are of the known total of subjects.

After 12 months (Figure 4) 68% were functionally cured with minus lenses. The divergent deviation was latent at all distances indicating an improvement in fusional status whilst wearing a minus overcorrection.

Of the eight subjects with a follow-up period of greater than three years, six are now functionally cured with minus over-correction and a well controlled exophoria or X(T) without minus lenses (two moved out of the area). Of these, 4 have had minus lenses suspended altogether and control has been maintained 12 months later.

(B) Group 2

The follow-up period before surgery ranged from three to 59 months, with an average of two years before an operation.

Figure 5 shows that the pre-treatment degree of divergence in Group 2 is similar to that of Group 1.

After 12 months (Figure 6), 33% were functionally cured but later required surgery for reasons to be discussed. When Group 1 and 2

FIGURE 2 : GROUP 1 ONE TO THREE MONTHS LATER

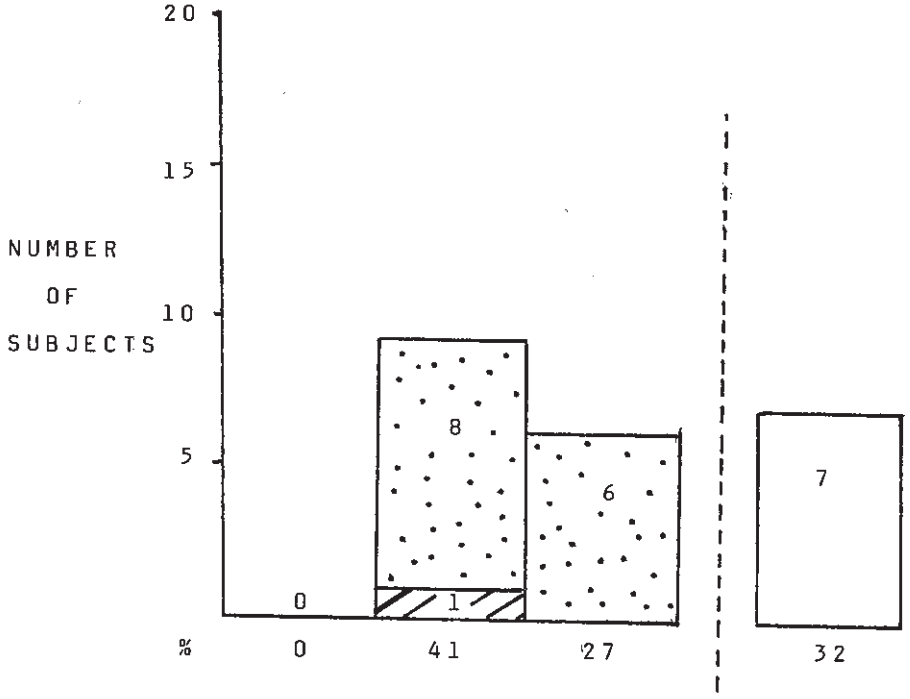


FIGURE 3 : GROUP 1 SIX MONTHS LATER

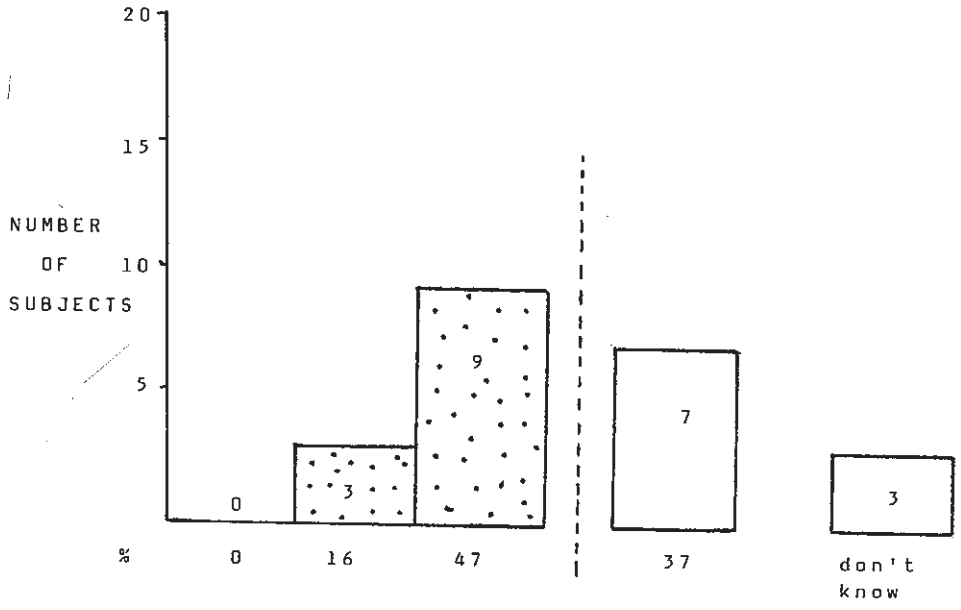


FIGURE 4 : GROUP 1 TWELVE MONTHS AFTER COMMENCEMENT OF MINUS OVERCORRECTION

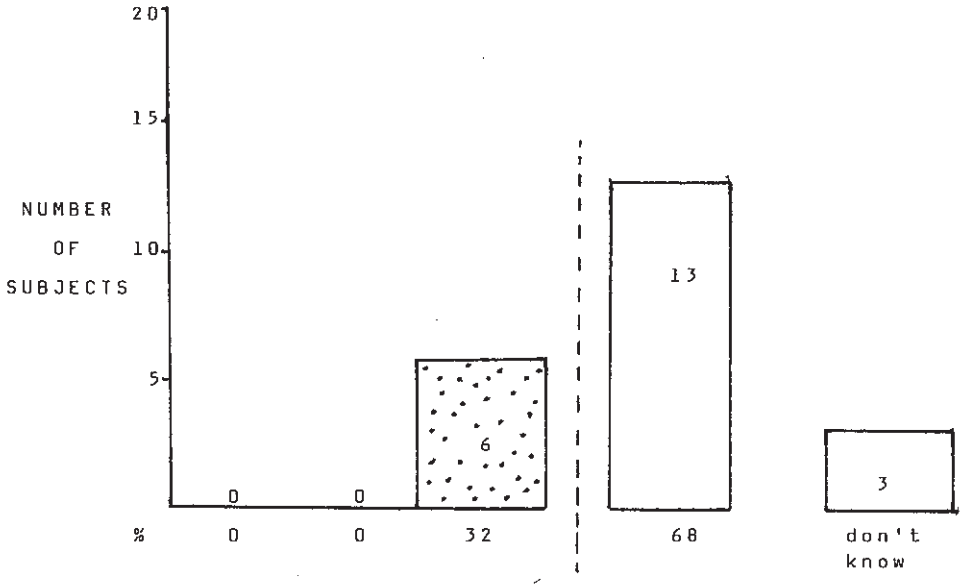


FIGURE 5 : GROUP 2 BEFORE MINUS OVERCORRECTION

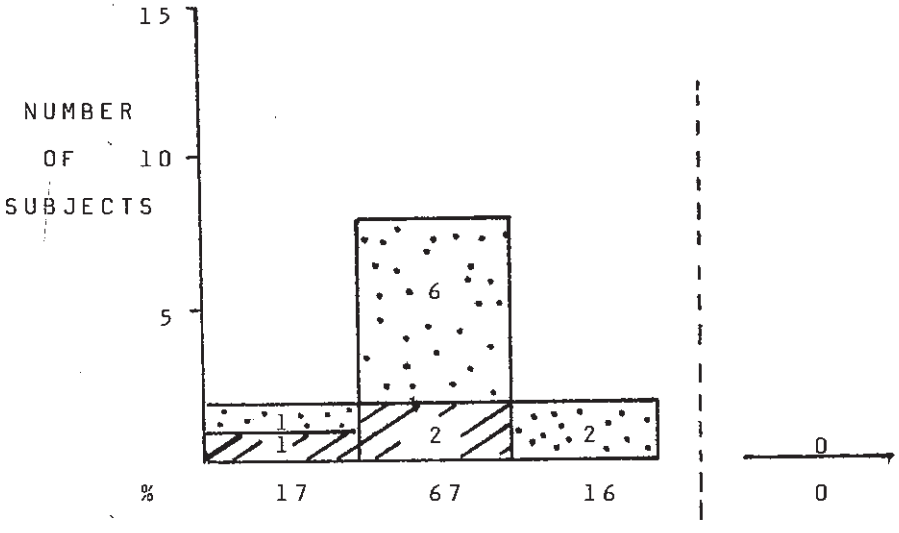
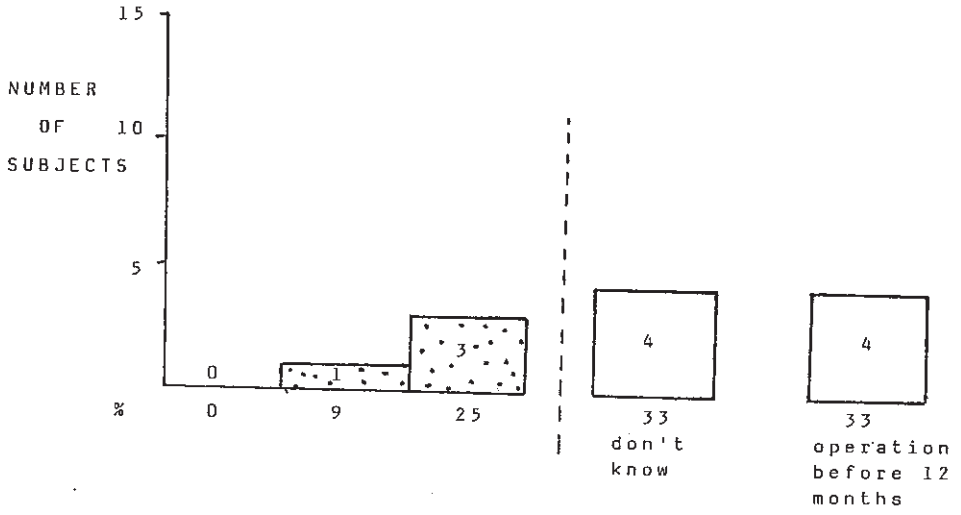


FIGURE 6 : GROUP 2 TWELVE MONTHS LATER



were compared before treatment and after 12 months there was no significant difference. (Before treatment Chi square = 1.42, after treatment Chi square = 2.53).

Reasons for discontinuing minus overcorrection were identified and divided into 2 groups:

1. Ocular
   - —strength of minus lenses increased but poor control remained, or control deteriorated despite increases in strength 3 subjects
   - —large angle: $>35^{\Delta}$ at 6 metres 3 subjects
   - —poor motor fusion 1 subject

2. Social
   - —parents wanted surgery 2 subjects
   - —behaviour problems and minus lenses not tolerated 3 subjects

(C) Group 1 and 2: Functional cure within 12 months

Combining the two groups, a total of 21 subjects (62%) became exophoric at all distances within 12 months of minus overcorrection, regardless of whether surgery was required later on.

This group was then examined to determine the frequency of quantitative reductions in deviation size. A reduction of $\geq 15^{\Delta}$ of divergence at 6 metres was considered significant. 27% of the total number of subjects not only became exophoric but also had a $\geq 15^{\Delta}$ in reduction of deviation. But 35% of the total, who were functionally cured did not have this reduction in angle size, thus indicating that achievement of exophoria could be obtained without significant reductions in deviation size (Table 1).

(D) An interesting exception

There was only one case of a child becoming convergent following minus overcorrection. C.S. was 18 months old when therapy was commenced for a 30^{Δ} X(T) at 6 metres and far distance. He became an intermittent left convergent squint after six months with minus overcorrection so a bifocal of +3.00 D.S. was

TABLE 1
Functionally Cured: Reduction in Deviation Size

	Number of Subjects	
	Group 1	Group 2
Exophoria and Angle decreased $\geq 15^{\Delta}$ at 6 m	6 (max 30^{Δ})	3 (max 22^{Δ})
Exophoria and Angle not reduced	8 (min 4^{Δ})	4 (min 0^{Δ})

TABLE 2
AC/A Ratio

	Percentage	
	Group 1	Group 2
Low AC/A ≤ 3	0	0
Normal AC/A $3 < \times \leq 6$	0	58
High AC/A >6	100	42

given at near, but was not worn correctly. After glasses were discontinued he returned to the original X(T) and surgery was performed.

Variables which may have influenced response to minus overcorrection were then compared between groups.

(1) Age:
The mean age at commencement of therapy for Group 1 was 3 years 9 months, and for Group 2, 4 years 1 month. The 't' test shows no statistical difference between groups.

(2) Pre-Treatment Size of Deviation:
The pre-treatment deviation size, in prism dioptres, at near, 6 metres and far distance was compared between the two groups. 95% of Group 1 and 50% of Group 2 had a near deviation of $\leq 24^{\Delta}$. Using Chi squared analysis, Group 1 had a significantly smaller near deviation than Group 2. (Chi = 7.37, p = 0.01) Deviation at 6 metres was $>30^{\Delta}$ in 19% of Group 1 and 33% of Group 2. When deviation at far distance was compared, 33% of Group 1 and 41% of Group 2 measured $>30^{\Delta}$. Although a greater number of children in Group 2 had large deviations, this was not statistically significant.

(3) Accommodative Convergence/Accommodation Ratio:
The accommodative convergence/accommodation ratio (AC/A ratio) was calculated to determine if response to minus overcorrection was better in subjects with a high AC/A ratio. The heterophoria method of calculation was used:

$$\text{AC/A ratio} = \frac{\frac{\text{IPD}}{\text{NFD}} + n^{\Delta} - o^{\Delta}}{D}$$

where: IPD —cms—taken from the table of averages of IPD measurements[7]
NFD—near fixation distance, 0.33 metres
n —deviation at near, in prism dioptres
o —deviation at 6 metres, in prism dioptres
D —dioptres of accommodation used in changing fixation from distance to near

An AC/A ratio of ≤ 3 was considered as low, 3 to 6 normal and >6 high. Since this study involved X(T) of the divergence excess type it was expected that most subjects would have a high AC/A ratio. Table 2 shows that in Group 1 all of the children had a high AC/A ratio, ranging from 7 to 12. In Group 2 only 42% had a high AC/A ratio. The 't' test shows that Group 1 had a significantly higher AC/A ratio ($t = 2.91$, $p = 0.01$). Of the subjects in Group 2 who had ocular reasons for discontinuing minus overcorrection, five out of seven had a normal AC/A ratio.

(4) Vertical Element:
Presence of vertical deviation was compared between the two groups. 62% of Group 1 and 52% of Group 2 had a vertical component to their deviation. Chi squared analysis, comparing the presence or absence of vertical deviation showed no difference between the two groups. Therefore, a vertical component to the deviation does not appear to prevent achievement of a functional cure.

DISCUSSION

Age of onset of X(T) is frequently within the first years of life.[5,8] Treatment at this time is restricted to patching regimes, as surgery too early increases the occurrence of esotropia and consequent reduced stereopsis. Minus over-

correction has a role in bridging this gap in management techniques.

In this study 21 children, i.e. 62% of the total, who had a poorly controlled X(T) at one or more distances, converted to an exophoria after 12 months of wearing minus lenses. This is slightly less than the 72% with a functional cure recorded by Jampolsky.[5] However, Jampolsky notes that his sample had a selection bias, because half of the children already had myopia or myopic astigmatism, and may have had better compliance with therapy.

In the past, minus lenses have been avoided because of the fear of inducing an esotropia.[3] Jampolsky[5] noted the development of a transient esophoria at the near position immediately after the initiation of minus overcorrection. This esophoria usually readjusts within a few weeks back to the original orthophoria or exophoria, suggesting plasticity of the AC/A ratio. It appears that the child will only occasionally be unable to make this adjustment and decompensate to an esotropia. Only one subject in this series, and two out of 35 in Jampolsky's study became esotropic and they all reverted back to exophoria once the minus lenses were removed. The evidence suggests that fear of inducing intractible esotropia is not justified.

It is beneficial to determine the conditions which maximize the effectiveness of minus overcorrection. Achievement of control is a gradual process and it is suggested that at least 12 months is necessary before fusional skills are sufficiently improved to convert an X(T) to an exophoria. For the majority of children a refractive overcorrection of -3.00 D.S. and up to a strength of -5.00 D.S. is well tolerated and a visual acuity of 6/9 or better achieved. As expected, subjects with a high AC/A ratio, hence small near deviations ($\leq 24^{\Delta}$), proved to benefit most from minus overcorrection, presumably because a greater convergence response is produced for each dioptre of accommodation stimulated. However, a reduction in deviation size is not necessarily required to obtain a functional cure.

Initially the aim of minus overcorrection was as a temporary method of increasing bifoveality in X(T) until the child was old enough to benefit from orthoptic techniques, or permit measurements that are accurate enough for precise surgery. However, from this study it appears that minus lenses may be used in the long term. Where control is improved sufficiently and a functional cure achieved, the strength can be reduced and minus lenses ultimately suspended without the need for surgery. A greater follow-up is necessary to determine the long-term effect of minus overcorrection on divergence. The fact that some subjects have had minus lenses suspended, with exophoria maintained, is encouraging.

CONCLUSION

Minus lenses do appear to enhance the fusional skills required to control divergence in young children. In this study 62% of the total were converted to an exophoria at all distances with minus overcorrection. Minus 3.00 D.S. of overcorrection is well tolerated. Attainment of exophoria is more likely to occur in subjects with a high AC/A ratio and a near deviation of $\leq 24^{\Delta}$. In the short term minus lenses offer a conservative approach to the treatment of X(T) in young children until surgery and conventional orthoptic exercises can be instituted. It is especially useful in cases where the child needs glasses to correct anisometropia and astigmatism, or if the child lives some distance from the clinic and consequently visits are infrequent. In the long term, it is possible that minus overcorrection can improve control of divergence sufficiently to then be ultimately suspended with exophoria maintained and surgery avoided.

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