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Management of acquired esotropia

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Before discussing management it is important to consider aetiology since treatment is related to the cause of the strabismus.

The entire list of possible aetiologies of acquired esotropia is large but my comments will be limited to the following:

(1) Accommodative
(2) Associated with reduced uniocular function
(3) Secondary to exotropia surgery
(4) Divergence paralysis
(5) Sixth nerve palsy
(6) Cyclic esotropia.

Accommodative esotropia

The aetiology of accommodative esotropia is hypermetropia and a high ratio of accommodative convergence to accommodation (the AC/A ratio). In a study conducted by me many years ago, the patients with accommodative esotropia were divided into those with normal AC/A and high AC/A ratios. The average hypermetropia among the former was +4·75 D sph. in the least of the two farsighted eyes as determined by the spherical equivalent. Among the latter, the average hypermetropia was +2·25 D sph. The patients with a normal AC/A ratio have approximately the same prism and alternate cover measurements for both distance and near, whereas those with a high AC/A ratio have greater esotropia for near than distance.

The hereditary aspect of accommodative esotropia is well documented. The aetiology of both the hypermetropia and the high AC/A ratio shows the classic genetic pattern of dominant inheritance with a variable expressivity and penetrance.

The average age at onset of accommodative esotropia is 2½ years. I have personally documented congenital esotropia as early as 6 months and as late as 7 years.

Characteristically, the esotropia is intermittent at onset, but the tendency is for the frequency and duration of the esotropia to increase, and constant esotropia gradually replaces the intermittent pattern. After a variable period of constant esotropia, the added complication of a non-accommodative component becomes manifest by a residual esotropia persisting after all accommodation has been inactivated.

The ideal management of accommodative esotropia is one that permits the institution of anti-accommodative therapy while the esotropia is still intermittent. Since accommodative esotropia begins in childhood and the aetiological factors persist, long-range anti-accommodative therapy is required. Surgery cannot be successfully substituted for anti-accommodative therapy. The specific anti-accommodation therapies available are: plus lenses and miotics.

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PLUS LENSES

In children of 4 years old and younger, the whole cycloplegic refraction plus lenses are prescribed. In the older children, a minimal plus lens may be capable of maintaining straight eyes without having to enforce full cycloplegic plus-lens spectacles. If the child resists the plus-lens correction, topical atropine instilled daily for a few days overcomes the reluctance.

MIOTICS

The principal miotics used in the United States are 0·025 per cent. Isofluorophate (DFP) and 0·125 per cent. Phospholine Iodide (PI). Each is instilled daily and my preference is to instill the drops soon after the child awakens because the maximal benefit of the medication occurs during the first 8 hours after instillation.

Isoflurophate seems to cause more pupillary constriction and to reduce the high AC/A ratio to normal more consistently than PI, but it more often produces pupillary cysts than PI and is more difficult to maintain in a dispensible form. DFP is destroyed by water and must be dispensed in either an ointment or anhydrous oil. PI also has disadvantages in that it gradually deteriorates at room temperature and requires refrigeration.

DISADVANTAGES AND CONTRAINDICATIONS

Generally the miotics are useful for short-range therapy, much briefer than the total duration of therapy required for accommodative esotropia, and they are therefore not a good substitute for plus lens spectacles. However, they can help to determine the usefulness of disengaging the accommodation in equivocal patients and can be used for short periods if the patient is reluctant to accept spectacles. The physician must remember the dangers inherent in the use of these strong medications. PI in particular reduces the red blood cell and plasma choline-esterase levels, creating a dangerous situation if an additional choline-esterase inhibitor is injected at the time of surgery. In addition, systemic anticholinergic symptoms may result from the absorption of these drugs, causing excessive sweating, salivation, diarrhoea, and abdominal cramps. Also, eye problems may result from the instillation of miotics, but the only one I have personally observed is pupillary cyst. Although a cyst of this kind may enlarge so that the entire pupil is secluded, this can be prevented by instillation of 2·5 per cent. Neosynephrine two to three times a day.

Patients with a high AC/A ratio may still cross the eyes for near fixation, but remain straight for distance while wearing their full cycloplegic plus lens spectacles. The near esotropia can be controlled with bifocal additional plus lens power which in young children automatically is a +2·50 addition. Older children may have a more accurate assessment of the minimal plus addition required to control the near esotropia. The top of the lower segment should be higher than ordinarily prescribed for adults, the best level being tangential with the lower pupillary border. Acceptance of the lower segment is manifest by the subconscious raising of the chin and depression of the eyes in order to see at near through the lower segments. If this is not apparent, then Atropine instilled topically for several days persuades the child to use the lower segments properly.

FOLLOW-UP

All children with accommodative esotropia must be repeatedly refracted with cycloplegia at intervals of 6 months to 1 year, anticipating that greater amounts of hypermetropia will be disclosed up to approximately 5 years of age. The plus lens spectacle power is increased according to the increased hypermetropia revealed on subsequent refraction.

Between 5 and 8 years of age, the hypermetropia generally reaches a plateau and remains unchanged; it begins its decline after 8 years of age and continues until maturity.

PROGNOSIS

The ophthalmologist should anticipate a certain percentage of deterioration of the previously controlled esotropia with plus lenses in patients with a high AC/A ratio. Deterioration is manifest by the plus lens no longer controlling the esotropia, the increase being revealed by prism and alternate-cover distant measurements. The relationship between the degree of high AC/A and deterioration rate despite maximal spectacle correction is shown in the Table. In a hundred patients studied by Manley and Parks (unpublished), forty were found to have a normal AC/A ratio since their prism dioptre difference between distance and near measurements was no more than 10 Δ. Sixty with prism dioptre differences in excess of 10 Δ were said to have a high AC/A ratio. An attempt was made to grade the severity of high AC/A into three groups:

(1) Nineteen had a difference ranging between 11 and 20 Δ.
(2) Twenty had a difference between 21 and 30 Δ.
(3) Twenty-one had a difference of 31 Δ or more.

Table *Relationship between degree of high AC/A and deterioration rate in accommodative esotropia despite maximal spectacle correction*

No of patients	*Δ difference between distance and near*	*Deterioration (per cent.)*
40	0–10	5
19	11–20	11
20	21–30	35
21	>30	43

* Unpublished study by D. R. Manley and M. M. Parks

The deterioration rate was directly related to the severity of the high AC/A ratio. There was a 5 per cent. deterioration rate among patients with a normal AC/A and an overall deterioration rate of 33 per cent. in those with a high AC/A ratio (11, 35, and 43 per cent. respectively in the three grades). The prognosis is therefore different between patients with normal and abnormal AC/A. The ophthalmologist can recognize that the chance that the patient with a normal AC/A will deteriorate and require surgery despite wearing glasses is very low, whereas the patient who requires bifocals, although initially controlled with glasses, will have a 33 per cent. chance of requiring surgery for an eventual superimposed non-accommodative esotropia. Most of the patients who required surgery, had deteriorated by 5 years of age and there was very little deterioration after 7 years of age.

Two causes of superimposed non-accommodative esotropia are seen in patients with accommodative esotropia:

(1) Inadequate anti-accommodation treatment due either to late institution of treatment or to less than total therapy, such as plus spectacle lenses being worn only part-time or the lenses giving only partial correction of the total hypermetropia.

(2) A patient with a high AC/A deteriorates despite adequate anti-accommodative therapy, and then requires surgery.

This should be performed after the accommodative esotropia component has been determined by wearing plus lens spectacles for 4 to 6 weeks or after having had a trial of miotics for several weeks. Also if amblyopia develops, which it generally does in acquired esotropia, the amblyopia must be eliminated by occlusion before surgery is undertaken. Since these patients had binocular vision before the onset of the esotropia they generally develop suppression or abnormal retinal correspondence very rapidly once the squint becomes constant. No specific therapy is directed towards these two sensory adaptations, since straightening the eyes by whatever method restores normal retinal correspondence. Patients with a high AC/A require more drastic surgery to achieve correction, whereas those with a normal AC/A ratio require only a normal operation.

The ophthalmologist should expect to achieve binocular fixation provided the esotropia was still intermittent when therapy was initiated. However, if constant esotropia evolved either before or after anti-accommodation therapy was begun and the patient was without the habitual use of binocular fixation for a few weeks, the possibility of its ever returning is almost hopeless, regardless of the intensity and form of the therapy offered. These patients remain with uniocular fixation, enjoying good peripheral fusion with normal fusional vergence amplitudes, gross stereoacuity, and asymptomatic, well-aligned eyes for the remainder of their life. Absence of binocular fixation, despite their eyes remaining straight, causes a high percentage of these patients to become amblyopic in the non-fixing eye. The visual acuity must be closely watched until 9 years of age and intermittent occlusion therapy must be given to maintain peak foveal vision in the non-fixing eye during this pliable period in visual development.

The need for anti-accommodation therapy may subside after 7 years of age provided the hypermetropia decreases and/or the high AC/A becomes normal. This offers a prognosis in some patients for partial or total removal of glasses and in others for discontinuance of the bifocals. However, in approximately 20 per cent. of patients the AC/A ratio does not improve sufficiently for the bifocals to be withdrawn, and they proceed into adulthood with this type of correction. Attempts to control this high AC/A ratio by surgery have been disappointing, since most of these patients ultimately develop post-operative distance exotropia.

Dissociation exercises can hasten the removal of the bifocals and glasses in some patients in this group.

Esotropia associated with reduced uniocular function

The management of esotropia associated with poor vision in one eye is cosmetic surgery. The accommodative component of the esotropia must be determined either by wearing plus spectacle correction for the refractive error or by using miotics for a few weeks, and only the non-accommodative component of the esotropic angle is corrected. Surgery can be deferred until 4 years of age unless the parents demand it sooner. The child should be spared this embarrassment by the time he is 4 years old because his personality may be affected if he is sensitive about his appearance. The surgeon should be content with approximately 15 Δ of residual esotropia after surgery because there is a tendency for esotropia to subside gradually with increasing age, with exotropia often eventually replacing esotropia.

Esotropia secondary to surgery for exotropia

After 1 month of persistent esotropia after exotropia surgery, base-out prism compensation for the esotropia angle should be provided. Anti-accommodation therapy with plus lens spectacles or miotics should also be offered. If amblyopia develops, occlusion should be used to control it. After 6 months of persistent esotropia that shows no tendency to reduce in angle, surgery should be performed to eliminate the problem. Unless the previously operated muscles reveal an obviously reduced power by duction studies, the secondary esotropia is managed as though it were a primary type. For example, if the lateral rectus muscles had first been recessed, the medial rectus muscles can now be recessed for the secondary esotropia.

Divergence paralysis

The divergence paralysis manifest by esotropia at distance with absence of esotropia at some near point of fixation and normal abduction of each eye, of rather sudden onset justifies a thorough examination for possible associated central nervous system disease. If nothing is disclosed, the patient should be carefully watched for several months to see if any central nervous system disease symptoms appear. Generally the divergence paralysis changes as the patient spontaneously improves, or a more concomitant esotropia pattern develops for both distance and near, or a sixth nerve palsy becomes associated with the original divergence paralysis. Surgery is seldom performed for a straight forward divergence paralysis.

Sixth nerve palsy

The patient with abrupt onset of sixth nerve palsy must be carefully observed to rule out associated central nervous system disease. The ophthalmologist should allow 6 months for spontaneous recovery to occur before considering surgery. In the meantime the patient may be offered occlusion for relief from diplopia, although some prefer not to wear a patch. Ideally, contracture of the direct antagonist may be reduced by forcing the patient to use the palsied eye, but this may present problems such as an uncomfortable head posture. Furthermore, it is questionable how thoroughly this does actually prevent contracture of the direct antagonist. If it becomes obvious that surgery is necessary, then ideally the direct antagonist should be recessed; the results of the Jensen procedure are most impressive.

Cyclic esotropia

The slow evolution of the pattern of cyclic esotropia usually becomes apparent in a gradual manner to both parent and physician. Once it is diagnosed, anti-accommodation therapy is required to rule out accommodative esotropia. The patient should be watched for several months to document the intermittent alternate-day pattern esotropia. Once the presence of this fascinating disorder has been established, recession of the medial rectus muscles is advocated with good prognosis for cure.

Discussion

LYLE When esotropia follows exotropia surgery why does Dr. Parks, as a rule, do bilateral recessions of the lateral rectus muscles? Does he ever do one eye at a time? If one eye is operated

upon there is less likelihood of producing an over-correction, because one can modify the extent of the operation on the second eye depending upon the result of the operation on the first eye.

PARKS I do not see excessive over-corrections from doing bilateral recessions of the lateral rectus muscles and I now never indulge in single eye surgery for this condition.

LYLE What size recessions do you do?

PARKS Between 5 and 7 mm. If there is still a residual exotropia I would add resections of the medial rectus muscles to this. I get very little result from unilateral recessions. For the last 20 years I have advocated early surgery for exotropia on the assumption that it may prevent the adaptation of suppression in the temporal retina. The over-correction rate in this series of patients over a period of 18 years was 5 per cent. The under-correction rate has been 27 per cent. Thus a satisfactory result has been obtained in 68 per cent.

LYLE My second question is why Dr Parks now uses the Jensen procedure for lateral rectus paralysis. I wonder whether he has experience of the other method which I use, that is detaching the superior and inferior rectus from their insertions and bringing them round to be inserted above and below the lateral rectus respectively.

PARKS The medial rectus recession should be done as a separate initial procedure from the transposition of the vertical muscles. Previously I have performed the Hummelsheim operation, a procedure similar to that which Mr. Lyle advocates. I now prefer not to do the Hummelsheim operation because it involves disinserting three rectus muscles: the medial, the superior, and the inferior. This could embarrass the circulation of the anterior segment, giving anterior segment necrosis. The Jensen procedure avoids this risk. I do not think that the results are any better or any worse than those provided by the procedure outlined by Mr. Lyle.

VON NOORDEN I agree that the Jensen procedure is less likely to produce anterior segment necrosis, but this is a very rare phenomena and seems to occur only in adults. Once seen it is something which you would rather not have further experience of.

DUNLAP I do not want the meeting to be left with the impression that the Jensen procedure is necessarily the most satisfactory. I have not seen invariably successful results with this procedure, and I have found the Hummelsheim-type operations to be just as poor, particularly if preceded by a medial rectus recession, either at the same or a different operation. I feel that the medial rectus recession should be done first, and the Hummelsheim-type or the Jensen procedure second, but I feel that none of these procedures has produced very good results.

FELLS Concerning the treatment of accommodative esotropia by a full hypermetropic correction. There seems to be considerable misunderstanding on both sides of the Atlantic by what is meant by "full hypermetropic correction". To take this specific example, the retinoscopy reading at 1 metre is plus 4 Δ, what is the full hypermetropic correction?

PARKS I should deduct the working distance and order a plus 2·50 for this patient.

FELLS Generally the practice in Great Britain is to deduct one dioptre for the working distance and a further dioptre for the atropine cycloplegia. This is a mysterious figure which I do not understand, and for which there is no adequate explanation in the literature.

Claude Worth, in his original description, only took off 0·50 from the retinoscopy reading, making no allowance for the working distance. What I understand by the full hypermetropic correction is the retinoscopy reading with allowance for the working distance only.

Do you consider that different cycloplegics required a different reduction? For example does atropine require more reduction than cyclopentolate?

PARKS There should be no difference between the two. My usual cycloplegic is cyclopentolate, cyclogyl 2 per cent. One drop is instilled and the patient examined 40 minutes later. This works

very well in eyes with lightly pigmented irides. In eyes with heavily pigmented irides, I use atropine 1 per cent. for 2 days before examination and cyclogyl 2 per cent. 40 minutes before examination.

ABRAHAMS I take off more than the working distance, because unless somewhat more than the working distance is removed the patient may see extremely poorly. Children with accommodative esotropia who are given a very full correction will not even wear their glasses. Similarly many myopes will not accept a full correction.

MEIN We have had very considerable accommodative difficulties over a long period of time with people in bifocals, and we have found it almost impossible to wean them from the bifocals.

PARKS About 20 per cent. of the patients treated with bifocals never improve and required continuous wear into adulthood. About 80 per cent. improve so far that the bifocals can be removed although it may be many years before this result is achieved. The patient rarely shows complete recovery from the high AC/A ratio, even though he may require less strength in the lower segment of the bifocal, and many eventually need no lower segment as he uses fusional divergence to control the near esophoria. When the aetiology of the high AC/A was first discussed many years ago between Dr. Costenbader and myself it was apparent that we each had different ideas. Dr. Costenbader initially considered that the high AC/A was a manifestation of premature presbyopia. As a result of this theory the amplitude of accommodation has been recorded on every patient for the past 25 years. I have never found any suggestion of premature presbyopia in these patients, nor has the amplitude of accommodation been found to diminish with prolonged wearing of bifocals.

LANG I should like to give a warning against the prolonged use of bifocals. I have seen an esotropic patient wearing them until the age of 24, and he then had to wear trifocals, since he had no more accommodation.

PARKS There is a rare group of young patients who have abnormally low accommodation amplitudes and a normal AC/A who benefit from bifocals but these are not the patients we are currently discussing. Also, certain patients with accommodative esotropia suppress their accommodative effort when their amplitude of accommodation is tested to prevent overconvergence so that they will not experience diplopia. Therefore some are properly aligned but are under-accommodated for any particular point in space. However, testing their amplitude of accommodation properly by encouraging them to accommodate will reveal that it is normal

VON NOORDEN Burian (1956) has discussed how and when to use bifocals. It is very important to determine the power of the lower segment of the bifocal; there is nothing magic about plus 3 spheres! The power should be carefully titrated. The minimal amount of plus lenses which convert a patient from a tropia to a phoria should be prescribed. The ideal candidate is one who is orthophoric at distance but has an esotropia for near. Such a patient has a high AC/A ratio, and may be converted from an esotropia to an esophoria with a bifocal lens.

CALDEIRA I have been using bifocals for a long time. How does Dr. Parks deduce the addition for the patient?

PARKS I use a binocular test provided the child is sufficiently mature to identify the small symbols, and I prescribe the minimal near 'add' that converts an esotropia to an esophoria. The maximal 'add' used is +2·50 and this may gradually be decreased to +2·00, and later to +1·50, and so on until it can be removed altogether.

WYBAR I have had cases in which the accommodation has apparently failed at a young age, in which no neurological cause could be found, but in whom treatment with orthoptics had improved both the convergence and the accommodation. There are also certain emotional problems with some of these patients.

HUBER No change can be obtained in the high AC/A ratio with age. I have had experience of

using a full correction plus the Mintacol, and this seems to improve the AC/A ratio whereas bifocals do not.

PARKS I hope I have given the impression that I almost always prescribe the total hypermetropic refraction in the upper part of the bifocals.

WHITWELL I have always performed bilateral medial rectus recessions and consider this operation infinitely preferable to full or overcorrection of the accommodative esotropia, and certainly better than using bifocals.

PARKS I should be interested to see the facts supporting the thesis that this is, in fact, a better procedure. I have watched a surgical project, designed to test this thesis, but after approximately twelve cases had been operated upon it was abandoned, because postoperatively, the high AC/A ratio persisted, manifested by some patients remaining esotropic for near, whereas others who were straight postoperatively for near were now exotropic for distance. So the high AC/A problem did not seem to be solved by surgery. Accommodative esotropia requires therapy that disengages the accommodation, and surgery does not qualify as this type of therapy.

BAGOLINI Apart from the young patients who are well-recognized as being straight for distance and esotropic for near, there is a group of older patients who, although they are perfectly straight for near, overconverge when looking at a distance object. Does Dr. Parks think that these two types of patients are connected?

PARKS One possible explanation for this phenomenon is an esotropia which is combined with a low AC/A ratio. Some examiners prognosticate that a persistent esotropia for near will remain despite bifocals if they observe after having placed plus 3 lenses in front of the hypermetropic correction that the patient is still esotropic. However, this assumption is not necessarily valid, for, if the patient is given the opportunity to wear the bifocal correction, he may return to the examiner at the end of the month with straight eyes at near. Merely placing +3 lenses in front of the patient's distant spectacle correction does not assure that the habit of near accommodation will immediately be surrendered. However, the esotropia occasionally persists even after a month's wear of the bifocals and this may be explained by any number of reasons: perhaps the patient is not positioning his head so that he looks through the lower segment, or the lower segment was not placed high enough in the glasses by the optician, or there is a V pattern and the downgaze involved in looking through the lower segment nullifies any gain on overcoming the near esotropia by disengaging the accommodation.