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ANOMALOUS MOVEMENTS, THEIR INTERFERENCE IN THE SURGICAL AND SENSORIAL TREATMENT OF CONVERGENT STRABISMUS

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The sensorial sequelae of comitant strabismus are suppression on certain areas of the visual field of the deviated eye, anomalous retinal correspondence and amblyopia if the strabismus is not alternating. There are also sequelae which are at least in part of a sensorio-motorial nature which have been known since Graefe and Javal and have been called by the various AA. with different names according to the interpretation they were giving to the phenomenon they were observing.

I am refering to the "repulsion des images" of Javal, the diplopia-phobia of Van der Hoeve, the "horror fusionis" described by von Graefe mainly supported by Hamburger and more recently the "reaction de fuite" of the French Authors. At least part of these clinical entities are probably expression of the same phenomenon which we frequently observe when we apply prisms to correct the angle of deviation in comitant convergent squint. The prismatic correction of the angle of strabismus frequently brings an increase of the angle of deviation which may more or less completely compensate the prismatic correction. We will call here the ocular disjunctive movements elicited by prisms in strabismic patients *anomalous movements.* Wich are the adequate sensorial stimulation to elicit this sensorio-motorial reaction, its probable significants, and how they may interfere with therapy and strabismus surgery, are the points I would like to emphasize here.

This sensorio-motorial aspect related to strabismus though known for a long time, has been recently brought to general attention by the introduction of prism therapy which is part of the armamentary at disposal for the so called treatment in "free space" or "in casual seeing" (Bagolini 1961).

What is in short a treatment in "free space"? It was observed that after surgical correction of the angle of convergent strabismus a previous anomalous correspondence would rapidly change if this sensorial anomaly is observed directly in "casual seeing" (with the aid of the striated glasses) and correspondence would normalize if the angle of strabismus can be completely eliminated. When however, correspondence is studied with instruments that add artefacts in relationship to the usual binocular stimulation (such as synopthophore, after images, etc.) in this case correspondence still appears to be anomalous while normal in casual seeing.

Provided no esotropia relapses, correspondence eventually normalizes at all tests (if the patient is young enough). Apparently this is because the retinal correspondence modifies under the continual stimulation of casual seeing and is under these circumstances that its variation can be first detected.

Prisms were then introduced in the effort to optically eliminate residual usually postsurgical angle of strabismus (Bagolini, 1961). Prismatic therapy has since become quite a common approach to the sensorial treatment in residual esotropias and a ponderous literature has fluorished on the subject particularly in continental Europe. Prisms are applied in various ways and I will not enter into detail here; the common aim is to avoid the persistence of residual small angle of esotropia because a new anomalous correspondence adapted to the residual esodeviation would unavoidably develop. A divergence optically induced by prisms, appears to facilitate normalization of correspondence.

It soon became evident however, that postoperative residual esodeviation when corrected by prisms frequently produces an increase in the angle of deviation that somewhat compensates the prismatic correction.

Prismatic correction induces therefore an increase of the angle of deviation that frequently renders useless the use of prism therapy. The adequate sensorial stimulation to elicit this disjunctive movement, called "anomalous movements" are therefore a displacement of the retinal images which may be induced by prisms. They have a common feature with *normal fusional movements* (n. f. m.) in that in both cases there is a variation in the muscle tonus when one of the retinal images is displaced; e.g. an increase in the tonus of the medial recti is produced by a lateral displacement as can be obtained by base out prisms.

They have also important differential features when compared with n. f. m. I will only mention the ones of interest for this discussion:

a) These anomalous movements (a.m.) are very slow if compared to normal fusional movements (n.f.m.) (see Fig. 1A). It may take several minutes, hours or even days for the final ocular deviation to be reached. Unlike n.f.m. they can never be observed by the naked eye because they are too slow.

They can only be detected because an increase in the angle of strabismus is observed at the cover test some time after the prisms have been applied.

b) A.m. are much less precise then n.f.m. In n.f.m. a base out prism is fully compensated by an angular movement of the given prismatic amount. Instead a.m. accomplish an angular dispacement which is frequently lower than the prismatic power of the base out prisms applied (see Fig. 1 B).

They probably represent a sort of fusional movements (Halldén 1952) of anomalous type (Bagolini, 1974).

Their probable aim is to bring equal retinal images roughly over areas of previously acquired anomalous retinal correspondence, just as normal fusional movements have the aim to bring equal retinal images over normal corresponding retinal areas.

The explanation of these movements using the concept of "horror fusionis", (according to Burian) is not presumably adaptable.

We may consider *horror fusionis* as a condition supporting ocular movements that tend to avoid superimposition of rather equal retinal images over corresponding points and particularly over the two maculae.

The ocular movements that I have observed and I have called anomalous movements do not fulfill the requisites implicit in the concept of *horror fusionis*. In fact, when the angle of strabismus is overcorrected by prisms, the image of the object of fixation shifts in the temporal retina of the deviated eye.

The reactive convergent movement that follows makes the retinal image in the deviated eye shift towards the macula and not away from it, as would be expected in *horror fusionis*.

From the other side, the concept of *diplopia-phobia,* recently reintroduced to explain these movements by Pratt Johnson do not equally seem to be tenable. In all the cases studied by me with prisms and in which the sensorial status has been carefully studied in casual seeing with the aid of the S.G. test and red filters, spontaneous diplopia when prisms were applied to correct the angle was an exceptional finding. I would, therefore, be quite reluctant to accept the point of view that patients increase their angle to avoid diplopia by again placing the image inside the scotomatous area.

Anomalous movements may acquire various degrees of strength. The use of progressively stronger prisms may offer a simple clinical indication of the strength acquired by a.m.: cases of residual postoperative or primary small esotropia where overconvergence cannot be prevented, even by strong prismatic over-correction, indicate deeply rooted a.m.; cases that do not overconverge or that with an appropriate overcorrection even may diverge (see case C and D of Fig. 1) have not developed, or have only weak a.m. and offer the best possibility for sensorial and sensorio-motorial treatment; we may then hope to completely eliminate the postoperative residual ocular deviation with the aid of appropriate prism therapy if the residual angle is too small for a surgical approach.

The use of progressively stronger prisms is therefore a useful test to know the strength acquired by these sensorio-motorial sequela of strabismus and give indication on the probability we have to treat successfully anomalous correspondence. Fig. 2 shows a case of rather strongly radicated a.m. The a.m. could compensate a correction of 20 D but could not cope with an overcorrection of 40 D to which the patient reacted by diverging. This was because the parts of muscle tonus of the medial recti related to the displacement of the retinal images ceased completely when the angular displacement of the two retinal images exceeded certain limits.

It should be realized that if a residual esodeviation remains, a new anomalous correspondence, readapted to the new residual angle, will invariably develop, as previously said, and the attainment of normal binocular vision impaired.

Anomalous movements are, therefore, a handicap in restoration of normal binocular vision because they tend to restore an esodeviation postoperatively. Two therapeutical approaches have been proposed in an attempt to remove this anomalous sensorio-motorial obstacle. One is based on the observation that anomalous fusional movements may often take a long

time to develop. In other words, when we place base-out prisms over the eyes of an esotropic patient, the angle of deviation may take from a few minutes to several hours to increase. The second approach proposed, is based on the observation that it is often possible to find a prism strong enough to prevent the patient from converging and even to induce the patient to diverge (see figure I case D).

The former approach was proposed by Bagolini (see 1966-1969) under the name of "prism temporisation". The lowest possible prismatic overcorrection of the residual postsurgical esodeviation is given by means of clip-on prisms. The time needed for the patient to overconverge as well as the time taken to relax convergency when the dominant eye is afterwards patched must be calculated; then, binocular vision through clip-on prisms is allowed several times a day for a period not exceeding the amount previously found. Then the dominant eye is kept patched. If the time it takes the patient to overconverge is very short, the power of the prisms is increased so as to find a convenient period of at least half an hour in which binocular visions can be allowed. If the period of time necessary is still too short, a "prism temporizer" is used; this is an apparatus which allows binocular vision for a period of time from a few seconds to some minutes. The patient sits in front of the apparatus containing the prismatic overcorrection and is invited to watch a television program while binocular vision is intermittently allowed. The tendency to overconverge is frequently hampered by these exercises. Prisms are then lowered in an attempt to stimulate strictly corresponding retinal points.

The second approach followed by various A.A. has been clearly outlined mainly by Adelstein and Cüppers (1968) and greatly facilited by the introduction of Fresnel prisms. The aim is to find an amount of prisms strong enough not to be overcome by anomalous movements and possibly to make the patient diverge as in the case D of Fig. 1. Both systems can be combined to discourage anomalous movements. The eye of the patient then, after elimination of a.m. (which sometimes cannot be eliminated and at best requires various weeks) can be placed in a position as parallel as possible, while strictly avoiding the relapse of small residual esodeviations.

The fact that a.m. can be discouraged and eliminated by appropriate therapy is, in my opinion, a demonstration that they are a sequela of strabismus and not one of the possible causes of it.

Finally, it is important to realize how a.m.; may interfere with surgery.

When a case of esotropia is operated upon, an undercorrection may be obtained either because an insufficient amount of surgery was planned or because strong a.m. increase the tonus of the medial recti presumably in an attempt to restore the preoperative sensorio-motorial situation. This behaviour of post-operative angles of esodeviation was already observed by Tittarelli and Bracaglia (1960).

If we interrupt the system and the amount of surgery is such that a.m. can no longer be active, we may end up with an overcorrection. We more or less obtain the effect of the case D in Figure 1; where rather weak a.m. were not able to compensate for a strong prism, and the angle of strabismus decreased. In these cases an important factor raising the tonus of the medial recti is eliminated, and a positive angle of strabismus may tend to turn negative postoperatively.

A.m. are an unpredictable element in surgery. Different patients with approximately the same amount of deviation react in different ways to the same amount of surgery. It is also well known that the same amount of surgery (e.g. an equal amount of medial rectus recession) produces a greater degree of correction when the angle of esotropia is larger than when it is small. The unreliability of a mathematical approach to the correction of the angle of squint is largely due to the strength acquired by a.m. which are possibly less stronger in a large angle of deviation.

So far as we can now understand, it is not easy to determine preoperatively what is the strength of a.m. prisms. To have a sufficiently exact opinion of their strength we have to correct by prisms the angle of strabismus and see whether or not the angle increases. If the angle increases (as usually is the case in long stading strabismus) we should increase the power of the prisms till a breaking point is reached and the patient does not converge anymore, but begins to diverge. If this breaking point can be reached only by a great amount of prismatic overcorrection, we would expect a more or less greater tendency to relapse of the angle of deviation. Unfortunately the amount of prisms diopters necessary to study this phenomenon preoperatively is high and such as to create a great distorsion and a difference between the two retinal images. This difference has a dissociating effect and weakens both anomalous retinal correspondence and the strength of the a.m. that we want to investigate. We do not have therefore at the present moment a sufficiently reliable test to know the interference of the a.m. with the surgical act.

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