

Change in Eye Position after Cranio-Facial Surgery*

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Introduction

The surgery of cranio-facial congenital orbital abnormalities can be done in the three dimensions: horizontal, in a medial direction, to correct orbital hypertelorism; sagittal, in an antero-posterior direction, to advance the orbit in craniofaciostenoses (Crouzon's and Apert's syndromes); vertical, in a superior and inferior direction, to correct the deformity of orbital dystopia.

The purpose of this paper is to discuss extra ocular muscle function in patients with hypertelorism, cranio-facial stenosis and orbital dystopia before and after monobloc orbital osteotomy.

Materials and Results

Twenty-nine patients have undergone major subtotal orbital translocation between 1976 and 1980 by Dr. P. Tessier. We excluded patients where evaluation of binocular extra-ocular muscle function was impossible. Ophthalmological and orthoptic evaluation were performed in the pre-operative and post-operative periods.

Analysis of the motor and sensory status of the extraocular muscle prism and cover testing, major amblyoscope measurements, retinal correspondence when possible, duction and version movements in all the positions and photographs.

The patients were divided into three groups.

Group I: Telorbitism

Twelve telorbitisms were examined before and after medial translocation of their orbits (Fig. 1, 2, 3).

Horizontal deviation was seen in all cases. Ten had an exotropia: five alternating exotropia, four exophoria-tropia (latent divergence that can be controlled by fusional mechanisms), one exotropia with amblyopia.

There was a trend toward esotropia in the post-operative period. Alternating exotropia was reduced in three of the five cases, but corrective strabismus surgery was necessary; in one case it was unchanged and in one case pre-operative exotropia was converted into esotropia. Exophoria-tropia was reduced in all four cases, exotropia with amblyopia was unchanged after surgery. Two patients had a pre-operative esotropia which was unchanged after surgery.

Summary

Twenty-nine patients have undergone major subtotal orbital translocation surgery between 1976 and 1980. Extra-ocular muscle function has been studied before and after orbital surgery.

Medial orbital translocation, like sagittal orbital translocation, produces a decrease of exotropia; sometimes there is no change which proves the importance of well-established binocular vision.

Orbital osteotomy in the three planes can produce a modification of the primary position of a vertical imbalance but it has no action on the vertical movements. The ophthalmologist can predict the post-operative result when he knows what type of ocular abnormality exists and what type of orbital surgery will be performed.

He can also discuss the timing of strabismus surgery.

Key-Words

Eye position – Cranio-facial surgery – Strabismus

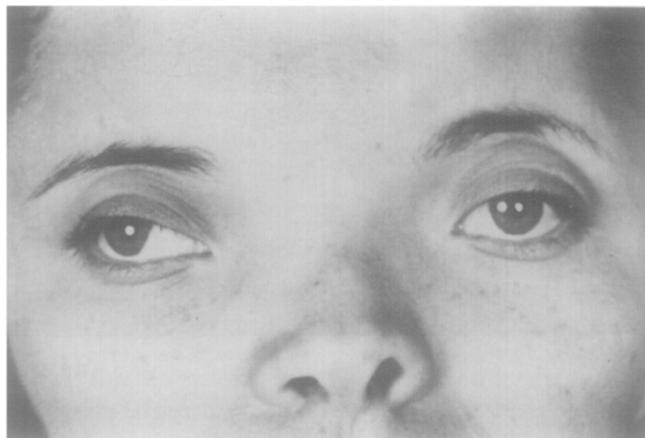


Fig. 1 a Telorbitism with right exotropia before orbital surgery



Fig. 1 b After medial orbital translocation, complete reduction of the telorbitism and exotropia. No eye surgery was performed.

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Fig. 2a Telorbitism with alternating exotropia before orbital surgery.



Fig. 2b After medial orbital translocation, exotropia was reduced. Eye surgery for ocular vertical deviation was performed on a second occasion.



Fig. 2c Final result after strabismus surgery.

Table 1 Medial orbital translocation in telorbitism and horizontal ocular deviation (12)

Pre-operative	Post-operative
Alternating exotropia (5)	Exotropia reduced (3) Exotropia unchanged (1) Esotropia (1)
Exophoria-tropia (4)	reduced (4)
Amblyopia exotropia (1)	Unchanged
Esotropia (2)	Unchanged (2)

Table 2 Medial orbital translocation in telorbitism and vertical ocular deviation (10)

Pre-operative	Post-operative
V syndrome	
Inferior oblique overaction	
Superior oblique weakness	Unchanged

Two cases were interesting: one patient had a pre-operative exotropia of 40 prism diopters, which remained unchanged after medial orbital translocation; another also had a pre-operative exotropia of 40 prism diopters which was converted after surgery into esotropia of 20 prism diopters (these two cases were alternating exotropia).

Vertical deviation was seen in ten cases. The most typical and almost constant aspect was a V syndrome with hyperactivity of both inferior oblique muscles, weakness of both superior oblique muscles and exocyclotorsion.

There was no change in the vertical deviation after surgery (Fig. 4 a-d).

Group II: Faciostenoses

Eleven cranio-facial stenoses (nine Crouzon's diseases, two Apert's syndromes) were examined before and after sagittal expansion of the orbit.

Horizontal deviation was seen in ten cases. Eight Crouzon's disease cases had exotropia: five variable angle exotropia with equal visual acuity; two exophoria-tropia; one exotropia with organic amblyopia. After the surgical procedure, exotropia was always reduced with orthophoria in the primary position (Fig. 5 a-b).

Two Apert's syndrome cases had esotropia – which was unchanged after surgery.

Vertical deviation was seen in ten cases: bilateral and symmetrical in three cases, with weakness of both superior oblique muscles, hyperactivity of both inferior oblique muscles, exocyclotorsion and V syndrome; in seven cases the deviation was asymmetrical: the hypertropia in the primary position was combined with weakness of the superior oblique and hyperactivity of the inferior oblique, in three cases; with weakness of the superior oblique, hyperactivity of the inferior oblique and weakness of the contralateral superior rectus in four cases.

After surgery, vertical deviation sometimes diminished, but never disappeared entirely and we always found an overaction of the inferior oblique muscle in latero-version (Fig. 6 a-d).

Group III: Plagiocephaly

Six plagiocephalics were examined before and after vertical orbital displacement.

Horizontal deviation was seen in four cases. One patient



Fig. 3a Telorbitism with alternating exotropia before orbital surgery.



Fig. 3b After medial orbital translocation, exotropia was unchanged. Eye surgery was performed on a second occasion.



Fig. 4a

Fig. 4a–b Before surgery: overaction of the two inferior oblique muscles (double up shoot).



Fig. 4b

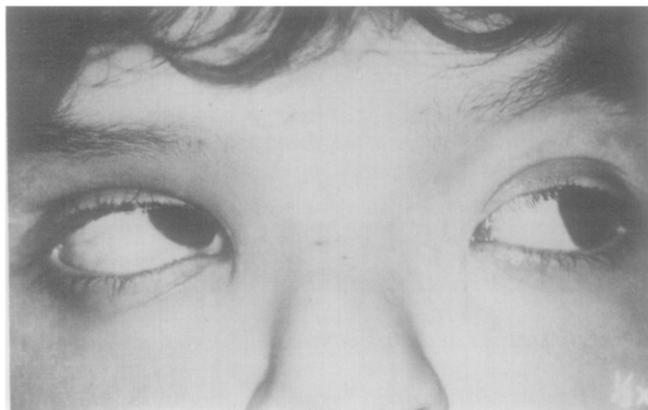


Fig. 4c

Fig. 4c–d After orbital surgery, overaction of the two inferior oblique muscles is unchanged.

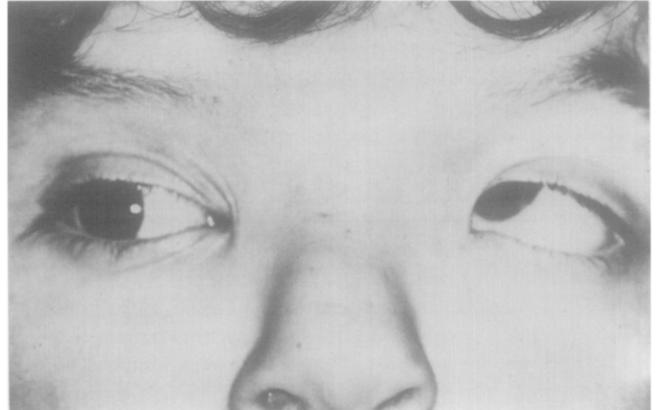


Fig. 4d

Fig. 4 Medial orbital translocation in telorbitism and vertical ocular deviation.

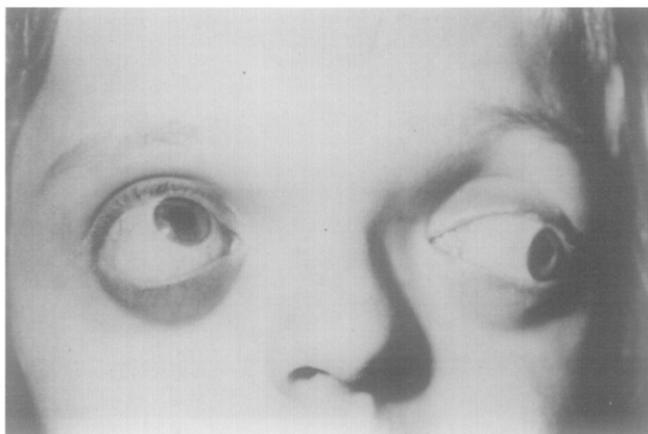


Fig. 5 a Before surgery: exotropia and right hypertropia.

Fig. 5 Sagittal expansion of the orbit in Crouzon's disease.



Fig. 5 b After surgery: exotropia and right hypertropia is reduced.

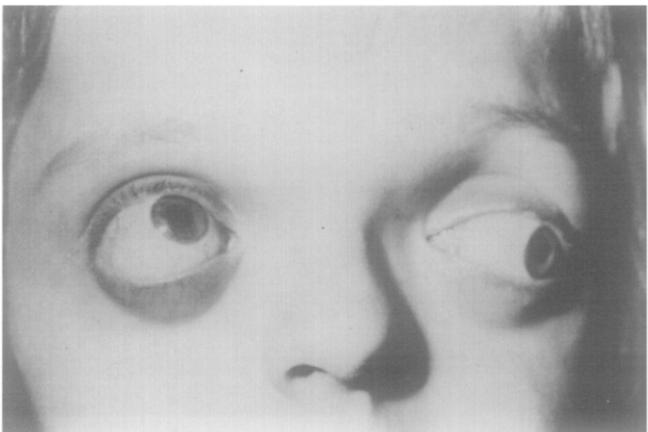


Fig. 6 a Crouzon's disease; before surgery right hypertropia with overaction of the inferior oblique muscle.



Fig. 6 b After surgery, the overaction of the right inferior oblique muscle is decreased.



Fig. 6 c Apert's syndrome: before surgery, overaction of the left inferior oblique muscle.

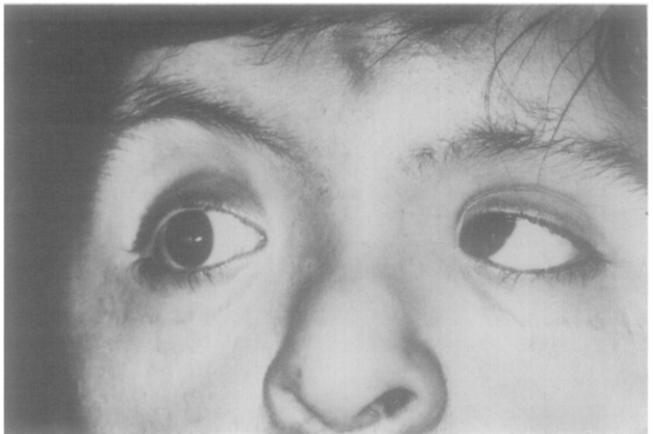


Fig. 6 d After surgery, the overaction of the inferior oblique muscle is decreased.

Fig. 6 Sagittal expansion of the orbit in C.F.S. and vertical ocular deviation

Table 3 Sagittal expansion of the orbit in C.F.S. and horizontal ocular deviation (11 cases)

Pre-operative	Post-operative
Exotropia with equal visual acuity (5)	Exotropia reduced (5)
Exophoria-tropia (2)	Orthophoria
Amblyopia exotropia (1)	Orthophoria
Esotropia (2)	Reduced
Apert's syndrome	Unchanged (2)

Table 4 Sagittal expansion of the orbit in C.F.S. and vertical ocular deviation (10 cases)

Pre-operative	Post-operative	
V syndrome – exocyclotorsion both inferior oblique overaction	Always present sometimes	Symmetrical C.F.S.
both superior oblique weakness (3)	diminished	
Hypertropia inferior oblique overaction (3)	Unchanged	Asymmetrical C.F.S.
superior oblique weakness		
Hypertropia inferior oblique overaction	Unchanged	Asymmetrical C.F.S.
superior oblique weakness (4)		sometimes ptosis
contralateral superior rectus weakness		

had an esotropia which was unchanged after surgery. Three patients had exotropia. In one case, it was unchanged, in two cases which had had vertical orbital change in addition to the medial orbital translocation (because they presented plagioccephaly combined with telorbitism), exotropia was converted into esotropia.

Vertical deviation was seen in six cases. Four patients had an hypertropia on the same side as the plagioccephaly with asymmetrical overaction of both inferior oblique muscles and weakness of the superior oblique muscles in two cases, an overaction of the inferior oblique, weakness of the superior oblique and weakness of the contralateral superior rectus muscles in one case; an overaction of the inferior oblique and weakness of the superior oblique muscle in one case.

One patient had an hypertropia on the contralateral side to the plagioccephaly.

One patient had overaction of the inferior oblique muscle, weakness of the superior oblique muscle on the same side as the plagioccephaly without hypertropia in the primary position.

After orbital surgery, the vertical imbalance was unchanged (Fig. 7 a–e).

Discussion

Orthophoria depends on the presence of normal sensory and motor components. Malformation or malfunction of

Table 5 Vertical orbital change in plagioccephaly and horizontal ocular deviation (4 cases)

Pre-operative	Post-operative
Esotropia (1)	unchanged
Exotropia (3)	Unchanged (1)
	Esotropia (2)
	Vertical orbital change with medial orbital translocation

Table 6 Vertical orbital change in plagioccephaly and vertical ocular deviation (6 cases)

Pre-operative	Post-operative
(4) Hypertropia on the plagioccephaly side	Unchanged
(2) Asymmetrical overaction I. O. weakness S. O.	
(1) Overaction I. O. Weakness S. O.	
(1) Overaction I. O. Weakness S. O. Weakness contralateral S. R.	
(1) Hypertropia on the contralateral plagioccephaly side	Unchanged
(1) Overaction I. O. Weakness S. O. (on the plagioccephaly side) without hypertropia in I position	Unchanged

any of these interrelated components contributes to the development of strabismus. In craniofacial malformations the percentage with strabismus is very high. In the twenty nine patients examined, we found twenty-six horizontal deviations including exotropia (twenty-one cases) and esotropia (five cases) and twenty-six vertical deviations.

Abnormalities in the transverse plane

Horizontal deviation was found to be exotropia (twenty-one cases), sometimes esotropia (five cases).

Exotropia is a frequent association with telorbitism (Pruzansky et al., 1974; Diamond et al., 1980; Morax and Beaumont, 1981; Morax, 1982). The exo-deviation is thought to result from the abnormally increased interorbital distance, which changes the angle between the origin and the insertion of the rectus and oblique muscles on the globe.

Of the ten telorbitisms with exotropia followed up after surgery, there was a trend toward eso-deviation following medial translocation of the orbits in eight cases.

This post-operative change seems to be a mechanical factor. There is a change in the angle between the muscle planes and the centre of rotation of the globe after medial orbital translocation, in the same manner the angulations of the bony orbital walls in relation to the position of the globes change (Fig. 8 a–c). The four patients with pre-operative exophoria indicate that the mechanical factor of an increased interorbital distance does not necessarily result in



Fig. 7 a Before orbital surgery, right hypertropia (on the plagiocephaly side) without exotropia.

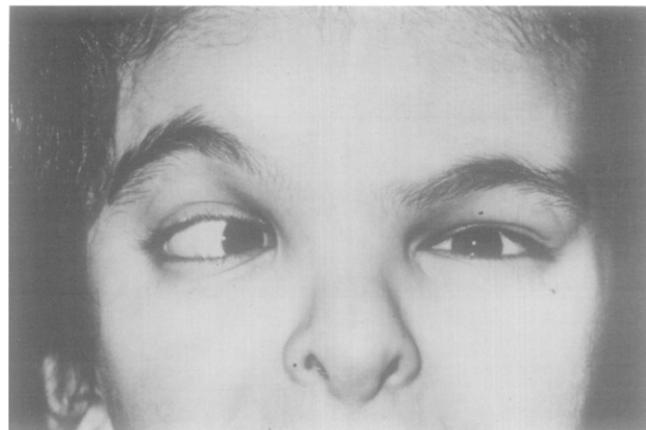


Fig. 7 b After orbital surgery: the hypertropia was reduced in the primary position, but an intermittent esotropia appeared.

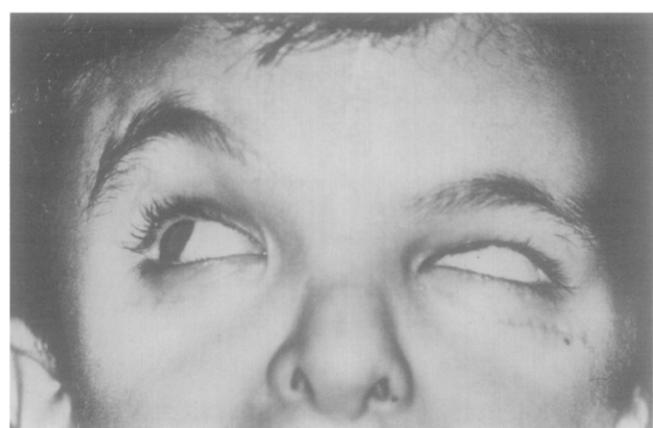
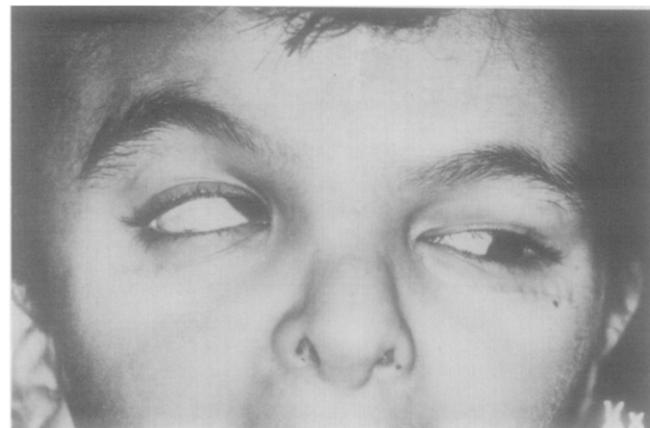


Fig. 7 c-d After orbital surgery: latero version shows a very marked double up-shoot with overaction of the inferior oblique muscle.

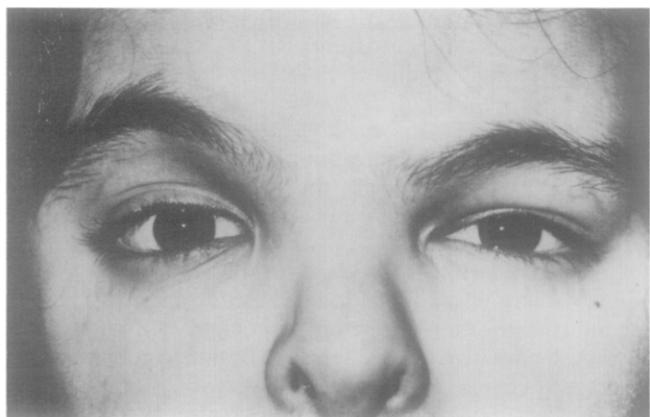


Fig. 7 e Final result in the primary position after strabismus surgery.

Fig. 7 Plagiocephaly with telorbitism.

an exotropia and the importance of well-established binocular vision.

The importance of the sensory factor is also demonstrated by one patient who had an amblyopia with exotropia and no change after surgery and another patient with the same alternating exotropia without binocular vision before and after orbital surgery.

The cranio-facial stenoses are also associated with exotropia; approximately 50% with exotropia in patients with midfacial hypoplasia, Pruzansky et al., 1974 and Choy et al., 1979.

In ten cases of cranio-facial stenosis, we found eight with exotropia which was always reduced after sagittal expansion of the orbit. It has been postulated that the great disturbances of size and position of the orbital structures in these patients could result in asymmetrical muscle origins and insertions in addition to mechanical restriction of ocular motility. As in telorbitism, after surgery the angulations of the bony orbital walls in relation to the position of the globes change. The pre-operative orbital divergence

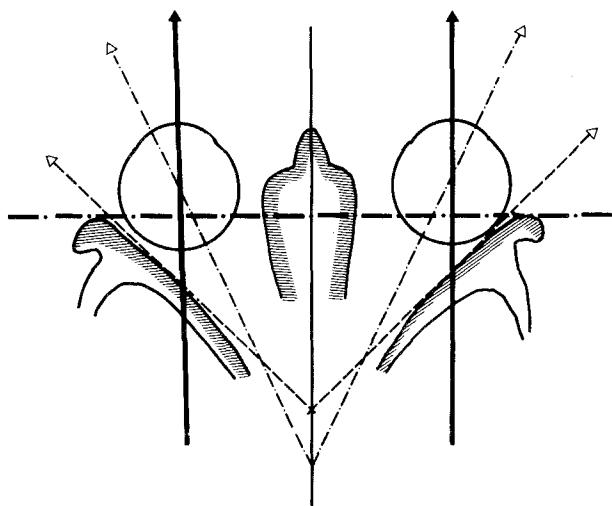


Fig. 8a Normal position of the globe in the orbit.

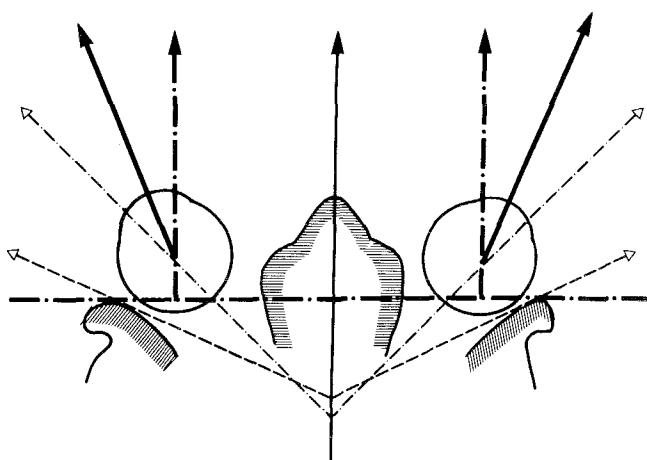


Fig. 8b Exotropia in orbital divergence (telorbitism) and retrusion of the orbital bone (C.F.S.).

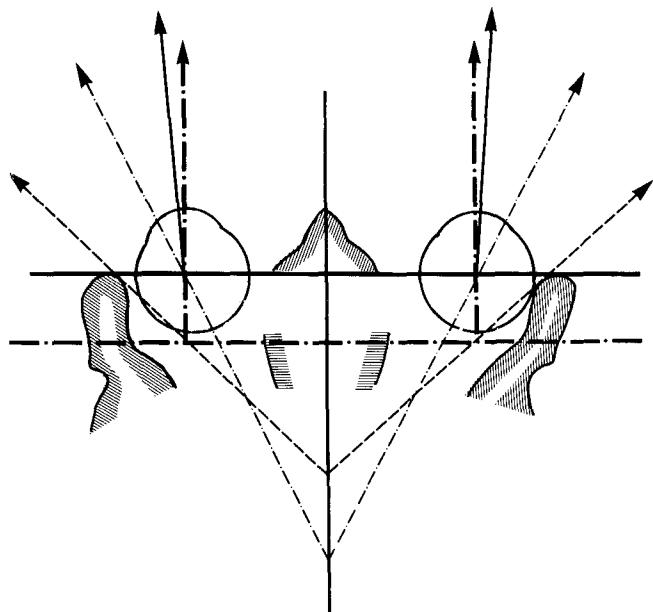


Fig. 8c Correction of the exotropia by advancement of the orbit (in C.F.S.).

decreases after sagittal expansion and reduces the ocular divergence. Sometimes there is a sensory factor (organic or functional amblyopia) which may lead to an ocular deviation.

In our cases, only one patient had amblyopia with exotropia which was reduced by orbital surgery, a finding that supports the importance of the orbital abnormalities as an aetiological factor in C.F.S.

Esotropia in telorbitism and C.F.S. is less frequent; of our four cases (two telorbitism, two Apert's syndrome) examined before surgery, there was no improvement in ocular motility after surgery. We found in all cases a pre-operative

weakness of one or both external recti which was unchanged afterwards.

It is easy to understand that medial translocation of the orbit or sagittal expansion can change the position of the eyes when duction and version eye movements are normal, but have no effect on oculomotor paralysis or pseudoparalysis with esotropia.

The cause of this external rectus pseudo paralys is not well known, but in two cases we found a macular pseudo ectopia with torsion of all the rectus muscles.

Vertical imbalance

These abnormalities are very frequent as we demonstrated on all the 26 cases. There is no change after orbital surgery in the three planes.

The V syndrome is the most classical, with hyperactivity of the inferior oblique and weakness of the superior oblique muscles.

It is observed in the primary position, or in latero version, or in upward gaze. Sometimes, superior oblique weakness is associated with superior rectus weakness.

To explain the absence of modification of oculomotor disturbance after orbital surgery, we must consider the aetiological factors (Morax, 1982).

The macular pseudo-ectopia with antimongoloid palpebral fissures we have seen in the Franceschetti syndrome, telorbitism, cranio-facial stenosis and plagioccephalies cannot be changed by an orbital osteotomy in the transverse, sagittal or vertical planes. Actually, the osteotomy displaces the "useful orbit" (that portion of the orbit which when displaced, will carry the globe with it) which therefore consists of the orbital walls situated behind the greatest diameter of the equator of the globe, but does not change the apex of the orbit, therefore there will be no modification of the position of the rectus muscles and they will stay oblique and thus possess the same action as before the orbital surgery. The rotation of the bones around an anteroposterior, vertical and horizontal axis cannot produce a rotation of the muscles. In order to achieve this rotation of the muscles, the surgery will have to include the inside and the outside of the orbit from the apex to the base (Fig. 9 a-d).

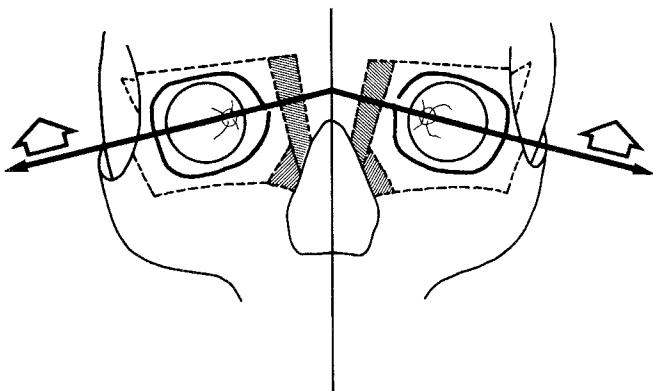


Fig. 9a Telorbitism with antimongoloid palpebral fissure and macular pseudo ectopia.

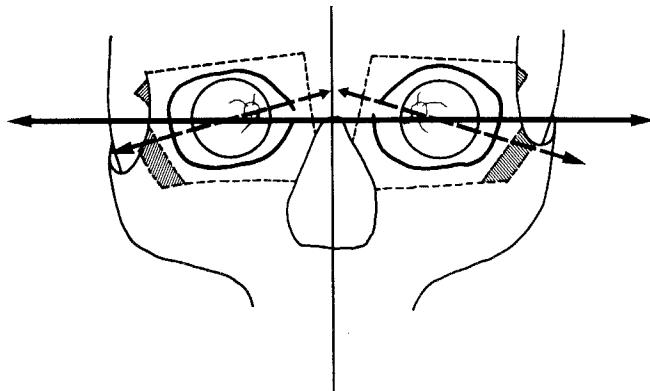


Fig. 9b After orbital translocation, the orbital extorsion is reduced. The ocular extorsion is unchanged and the rectus muscles are found at the same place as before.

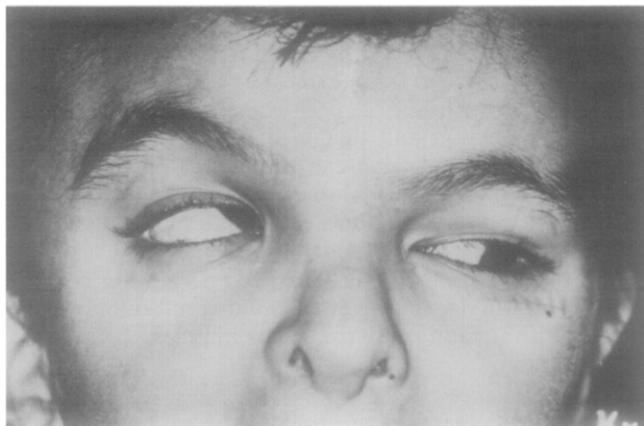


Fig. 9c Telorbitism with plagioccephaly. After orbital surgery there is again an overaction of the right inferior oblique muscle.

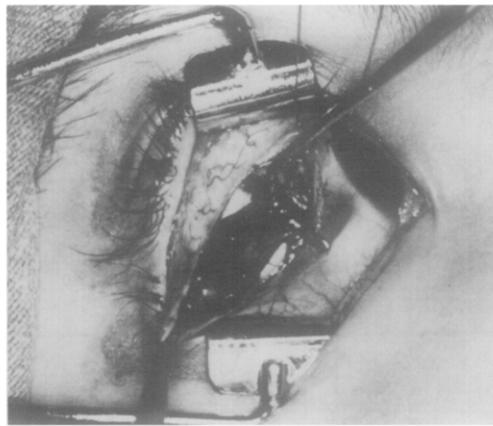


Fig. 9d Same patient. Position of the right lateral rectus muscle. Macular pseudo-ectopia syndrome.

The absence of the muscle as we have seen in Apert's syndrome, cannot be modified by orbital surgery. This explains why we have never observed a modification of weakness of the superior rectus muscle in one Apert's syndrome and in three cranio-facial stenosis cases.

The oblique muscle sagittalization represents a loss of parallelism between the two antagonist oblique muscles. This theory Gobin (1968) could explain a lot of vertical abnormalities in plagioccephalics. In order to correct this abnormality, the orbital surgery must advance the trochlea and the insertion of the superior oblique muscle so that the two obliques muscles become parallel, but this is quite impossible to achieve.

To detect any changes in the insertions of the superior oblique muscle, Ortiz Monasterio et al. (1976) placed small metallic markers during surgery in the periosteum and in the bone at the same point in the medial and lateral orbital walls.

After revision, minimal or no changes could be detected in the position of the markers attached to the periosteum. The markers in the bony walls were clearly advanced.

It was evident from these observations that no significant modification occurred in the insertion of the superior oblique. We examined six plagioccephalics before and after orbital surgery. The hyperactivity of the inferior oblique muscle in all cases was unchanged after vertical and sagittal expansion.

The contact between muscle and sclera.

Ortiz Monasterio et al. (1976) give an explanation concerning the contact between muscle and sclera; in exorbitism with a short orbital floor, the eye is located in a more anterior and inferior position, in extensive contact with the inferior oblique and recti. After orbito-facial advancement, the globe is not supported by the inferior muscles, the contact between muscle and sclera was decreased and the hyperactivity is corrected as in the ten observations of Ortiz Monasterio et al. (1976). In our experience this theory is an insufficient explanation for some V syndromes unchanged after surgery, however, we have observed in cases of cranio-facial stenosis a decrease in the hyperactivity of the inferior

obliques muscles and the V syndrome after orbito-facial advancement.

Conclusions

The clinical study of congenital cranio-facial malformations demonstrates the frequency of oculomotor disturbances. Often, there is a correlation between an orbital syndrome and an oculomotor abnormality.

This orbital syndrome is never characteristic of a single affection, but sometimes of several aetiological factors.

These oculomotor disturbances seem to be related to the structural abnormalities of the orbit, very often they are modified by a sensory factor and extensive alteration of binocular vision. The existence of paralytic factors and absence of muscles could also occur.

The monobloc orbital osteotomy in the three planes displaces "the useful orbit" and preserves the apex.

So, after medial orbital translocation in telorbitisms and, sagittal orbital translocation in cranio-facial stenosis, there is a reduction of the orbital divergence which leads to reduction of the exotropia, as was often seen in our cases. Orbital surgery has very little effect on the vertical imbalance. Except for a certain decrease of V syndromes after sagittal orbital translocation, this surgery has no effect on the pseudo-ectopia macular syndrome with ocular extorsion and weakness of the superior oblique and hyperactivity of the inferior oblique muscles in plagioccephalics.

Again orbital surgery has no action on the ocular muscle weakness which can be explained by palsies or absence of muscles.

Orbital surgery can also produce an oculomotor disturbance which did not exist before: for example, some authors insist on the increased incidence of the V pattern following corrective orbital hypertelorism surgery, after disinsertion of the trochlea of the superior oblique tendon.

The ophthalmologist can predict the post-operative result when he knows what type of ocular abnormalities exist and what type of orbital surgery will be performed.

Medial orbital translocation, like sagittal orbital translocation produces a decrease in exotropia, or increase in pre-operative esotropia if ocular movements in duction and version are normal; sometimes there is no change which proves the importance of well-established binocular vision, or because there is a motor abnormality in duction.

The orbital osteotomy in the three planes can produce a modification of the primary position of a vertical imbalance but has no action on the vertical movements, particularly the V-syndrome and up-shoot in latero-version.

The timing of strabismus surgery

Like Choy et al. (1979) we recommend that no corrective surgery for strabismus should be undertaken until at least 6 months after major orbital translocation procedures. At this time, the strabismus is stabilized. This attitude could be modified: it mostly depends on the age at which the patient

was examined and then when the orbital translocation was performed.

If the malformation is discovered very early and operated on in the first few years, (between 3 and 5 years for some authors), the strabismus will be treated first and operated on later.

If the malformation is operated on later, after the eruption of the permanent dentition, or for another reason, the strabismus surgery should be performed primarily for functional reasons.

Like Diamond et al. (1980) we think that early correction of congenital deviations, is more likely to result in the attainment of binocular vision.

However, we know that after cranio-facial reconstruction the possibility of decompensation of strabismus is possible specially when binocular vision is absent and revision of strabismus surgery is frequent.

If the malformation is seen and operated on in adult life, strabismus surgery will be done after the orbital surgery because the operation is then done only for cosmetic reasons.

Acknowledgement

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