The position of the eyes is often thought to be determined by anatomical and mechanical factors. Several ophthalmologists, therefore, regard the surgical correction of strabismus as causal treatment, correcting the anatomical "malformations."

This paper presents evidence to support the hypothesis that the main factor in the position of the eyes is the tonus of the extrinsic ocular muscles. In most cases the muscle tonus corrects the frequent, minor, anatomical disorders of equilibrium in the binocular position of the eyes.

Surgical intervention seems justified only in the very rare case of gross anatomical abnormality. We should pay greater attention to conservative methods, which aim at the restoration of the tonus equilibrium of binocular motor coordination (Réthy and Gál, 1968). These methods influence the tonus of the extrinsic ocular muscles by the reflexes connected with the fixation, accommodative convergence, and fusion processes.

Introduction

Anatomical position is seen in deep narcosis and in death. It is determined only by the length and the position of the extrinsic eye muscles and their tendons, when the nervous control of the muscle-tonus ceases. We feel that the anatomical position of the eyes can be observed for a short period after birth in the neonate. The anatomical eye-position will soon be concealed by the tonic motor impulses to the external eye muscles in controlling fixation, accommodative convergence, and, later perhaps, fusion.

The conditioned reflexes of accommodative convergence can be quickly established, firmly stabilized, and maintained in this way for some time, even in the absence of appropriate stimuli. The stabilization process is responsible for the fact that this tonic reflex influence may be present during sleep. Once established, it is maintained for a longer period, as is also true in cases of sudden bilateral blindness. In spite of loss of recent stimuli for fixation and accommodation, the tone of the muscles remain unaltered for a period. The divergent anatomical eye-position reappears only after a lapse of time.

Neonates are rarely examined by ophthalmologists. Kettesy states that he has hardly ever heard of an eye specialist who has had the opportunity to examine a new-born with strabismus. Hamburger has rarely seen opthalmic paresis in the newborn, and he feels the reason for this is that the parents usually wait a long time before seeking the advice of a specialist.

Methods and Materials

We have studied the anatomical eye-position of the newborn in sleep, without narcosis. We presume that the eyes are still
in the anatomical eye-position, as the reflex motor influences of fixation, accommodation, and binocular functions respectively are not yet activated during the first days of life or, if activated, not yet firmly established.

The eyes of all neonates at the second Maternity Clinic of the Medical University of Budapest were examined during their first week of life, in the six months period, September 1, 1967 to March 1, 1968.

Of 601 patients seen, 526 were full-term, and 75 were premature babies. The eyes were examined using a flash light, giving a light-reflex on the corneal surface. The upper eyelid was raised, and the eye-ball deviation during sleep noted, according to the Hirschberg method. Due to a significant margin of error in using this method, it was considered as non-parallel only in those cases where the deviation was over ten degrees. The results were as shown in Table I.

More than half of the full-term babies had significant divergence (Fig. 1). Ten neonates, showing incoordinate eye movements during the test, were excluded from the study. Their anatomical eye-position remained undetermined.

Almost two-thirds of the premature babies showed divergence (Table II).

We have not seen any cases of fixed anatomical convergence. A convergent eye-position for short periods (up to a few seconds) was often seen. It alternated with divergence, yet was uncontrolled by binocular fixation.

The incidence of divergent anatomical eye-position was slightly higher in the premature group. The anatomical position was more often seen in those neonates who slept at the time of examination, than in those showing signs of visual activity. The full-term group tended to be more active in attempting to look at the light. In the latter group the earliest reflex, nervous influences of fixation and accommodation could already modify the eye-position away from the anatomical divergence. We feel justified in claiming that the per cent of true divergent anatomical eye-position could be even considerably greater than the 55% found in the full-term group.

Comments

The role of the Bell-phenomenon in the
high percentage of divergence cannot be completely excluded. The constancy of the divergent eye-position in the premature, and in the neonate sleeping child, seems to support our view that the divergence is the more passive, and the parallel position the more active, state in the tonus and position of the external ocular muscles. The opposite view, that the divergence is attributable to the more active tonus of the muscles against the passive parallel anatomical position, seems improbable. The examination of the basic eye-position in sleeping children, three to five years of age, could give an answer to this more theoretical side of this problem.

No efforts were made to diagnose strabismus in this series of neonates. It is impossible, according to Worth, to establish the diagnosis of strabismus in the first three to four weeks of life, due to incoordination of eye-movements. Strabismus is the manifestation of defective, abnormal motor coordination. In the newborn, both defective and correct coordination are absent.

The anatomical eye-position in the newborn has no correlation with refractive errors and fundus state. These are not dealt with in this paper. The abnormally developed eye-muscles, the often alleged abnormal relationship of the tendons in the orbit, or a paralysis of eye-muscles suffered before or at birth, may have influence on the anatomical or mechanical eye-position.

The high incidence of divergence in the newborn and also premature infant is not a new observation. According to Esente, this is the typical eye-position in the premature infant. The considerable divergence of the eyes of the newborn disappears at about the third week of age, as the waking periods of the baby become longer and more frequent. In the second month of life, most eyes are maintained in a parallel, or nearly parallel, position. Anatomical position is revealed only when the infant has been asleep for some time; and, on waking, one may observe the search for binocular position. During the subsequent months of life

![Simultaneous fixation](attachment:Simultaneous_fixation.png)

**Simultaneous fixation**

**lock**

![Anatomical divergent position](attachment:Anatomical_divergent_position.png)

**Anatomical divergent position**

**Fig. 2.** The main factors involved in the beginning of the development of binocular eye-position in a one month old baby: (a) divergent anatomical eye position; (b) accommodative-convergence commanding the eyes into position to be able to learn the (c) binocular fixation, which is taking over the control of convergence.

the binocular motor reflexes are developing, and, because of the gradual stabilizing of the tone of the external eye-muscles, the anatomical eye-position no longer reveals itself during sleep.

Binocular function begins to develop at the end of the first month of life. The parallel, or nearly parallel, eye-position is not due to quick anatomical changes in the orbital structure, but to the maturation and to the starting functions of central nervous system influences. The anatomical position of the eyes can remain unchanged. The parallel position enables the binocular functions to develop. We suppose the parallelism is the result of the first commencement of activity of accommodative and near convergence, connected with accommodation and the awakening of binocularity (Fig. 2).

Parallelism of the eyes, achieved during
the first month of life by a slight amount of convergence, may be due to the following factors:

(a) Accommodation: The first crude attempts may result in fleeting optical overcorrection. The rapid changes in convergence were associated with corresponding changes in the focus of the eye, detected by retinoscopy. We could observe changes in refraction up to 4.0 dioptries in babies of one month of age. There is a body of scientific opinion which accepts the theory that, in the first six to eight months of life, accommodation is inactive.

Ontogeny and histology show the development of the ciliary muscle in the newborn. It seems unreasonable to believe that this apt organ should remain inactive for a long time, and that, later on, it should start its activity abruptly, with full capacity and perfection and without any previous exercises and trials.

Retinoscopy at this age is clinically difficult. A great deal of patience needs to be shown by an experienced ophthalmologist and trained assistants. Sometimes, even in spite of good will, the examination is impossible at the first attempt. Eye specialists rarely perform this examination on children under one year of age. However, retinoscopy at an earlier age is not impossible, and, by applying it, anyone can observe the existence of accommodative convergence at the age of three to four weeks. Cycloplegia, using atropin, is necessary to test the refraction accurately, because of the great capacity of the accommodation at this age.

The other factor which may influence the eye-position is:

(b) Fixation: We could sometimes observe crude attempts of fixation for brief periods in one-week-old babies noticing the light. During the following weeks and months, these attempts were more frequent and more effective. Development of binocularity begins in the second month of life, with attempts at binocular fixation. At this moment the binocular fixation starts its important role of controlling the convergence reflex. Fusion begins only after fixation is fully developed, in the sixth month of life. This means it is able to rule more completely over the convergence reflex, unifying the sensomotor system of the eyes, and correcting its minor deviations.

The anatomical formation of the fovea, and consequently the fixation, is far from perfect in the first weeks of life. Andreeë (1965) has shown that eccentric fixation can be physiological in the first and second months of life, becoming perfectly central in the sixth month at the latest. At this time the conditioning of the accommodative-convergence reflex and accommodation can attain perfection, maintaining constant binocularity for far and near vision. If vision is defective due to refractive errors, the development of binocularity can be severely hampered. On the other hand, the accommodative - convergence reflex serving as the chief aid for the formation of a parallel eye position, can easily become the initiator of a convergent strabismus. This will happen, e.g., if vision in one or both eyes is defective due to astigmatism or anisometropia, and if fixation is impaired. Binocular vision cannot develop under such conditions. The affected eye may turn inward due to the failure of the fixation-lock to control the accommodative-convergence reflex.

Conclusions

The anatomical eye position has an inferior role to play, if the motor coordination commanding the reflex tonus of ocular mus-
cles is normal. Consequently, our efforts to cure strabismus should not be limited to the surgical correction of the anatomical eye position. Even in the most severe convergent squint, the anatomical eye position may not be related to the manifest squint. Every surgeon is aware of this fact, from observing the decrease of the angle of esotropia, and sometimes even a change to divergence, during general anesthesia, without any surgical correction of the muscle position. The anatomical eye position reveals itself, as the reflex tonus of the ocular muscles diminishes.

Surgery may indeed result in a lessening of the angle of esotropia, enhancing the original divergent anatomical eye position. The sometimes good new equilibrium, between unchanged muscular tonus and increased mechanical divergence, may be regarded more as a lucky coincidence than causal therapy. The dynamic convergence ability suffers often even in this lucky case. This may be evidenced by the result often seen after operation: exotropia for near, and esotropia for far, vision.

We feel that muscle tonus is the most important factor in determining the eye position.

We consider a logical and causal therapy for squint to be a concentration of our efforts on the alteration of the muscle tonus. Our conservative method of desaccommodation aims at changing the tonus of the eye muscles as soon as the squint starts. In cases of long-standing, stabilised, pathologic muscle-tonus, relaxation of the stabilized reflexes by various conservative measures seems to show the way of logical and causal therapy.

**Summary**

The anatomical eye position observed in 601 newborn children was 15°-35° divergent in more than 55% of the cases.

During the first three weeks of life the divergent eye position becomes less evident. The starting development of the binocular eye position is the result of the commencement of accommodative convergence activity and binocular fixation controlling the convergence activity.

The mechanical and anatomical conditions in the orbit are subordinate to the muscle tonus reflex influences, connected with the activity of the accommodation, fixation, and later of the fusion processes.

The early normalization of the muscle tonus in cases of esotropia seems the more efficient causal therapy. When dim vision is due to refractive errors, this should be able to influence those fixation, accommodation, and fusion errors, which hamper the normal development and proper conditioning of binocular (sensomotor) reflexes.

**References**


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