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## CAN INTRACRANIAL BIRTH INJURIES BE PREVENTED?\*

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In the face of certain facts now definitely established by careful clinical study of the new-born infant and by thorough anatomic investigations made on stillborn infants and those dying within a few days after birth, we may well ask ourselves the question, Can intracranial birth injuries be prevented?

Nystagmus can be observed in about 35 per cent of all babies born after perfectly normal labors, the incidence of this anomaly rising to almost 80 per cent in the first-born, and to 100 per cent in those with abnormal presentations.

Retinal hemorrhages are discovered within the first twenty-four hours of extra-uterine life in probably more than 12 per cent of infants.

Smaller and larger hemorrhages in the substance of the brain, outside of the fairly common pial and tentorial hemorrhages, are found at autopsy in about 65 per cent of all young infants.

Lacerations in various dural folds, with or without an accompanying hemorrhage, are revealed in about 50 per cent of such autopsies.

These are facts and figures which must convince us that anatomic and clinical evidences of some sort of traumatization of the central nervous system very often become noticeable immediately after birth.

In control studies made on the brains of certain new-born mammals with thick skull bones and no fontanels, in not one instance could any of these intracranial lesions be discovered. This furnishes convincing proof that the skull during labor acts as the all important protective factor for its contents.

The presence of sutures and fontanels in the cranium of new-born infants exposes brain and meninges to the possibility, if not likelihood, of a certain degree of traumatization during labor.

Since the aforementioned and some other anatomic and clinical proofs of a natal traumatization are encountered in a very large number of new-born and especially first-born babies, and since with relatively few exceptions they disappear promptly and permanently, it is my belief that we are justified in speaking, in analogy with a similar traumatic effect of labor on cervix or perineum, of a physiologic intracranial birth trauma.

A distinction in medical nomenclature between such a physiologic traumatization and the true pathologic

birth injury would greatly help in clearing up many of the existing difficulties in the complex problem of intracranial birth lesions, most of all in the question, now so much discussed, of the etiologic relation of such lesions to certain later deficiencies in physical or mental development of the child.

Within the range of physiologic natal traumatization should be placed all those anatomic observations and immediate clinical manifestations which in general express a sort of contusion or concussion of the brain. They disappear, as a rule, as already stated, within a very short time. As a matter of fact, they are discovered only by an examination which is more thorough than that customarily bestowed on the new-born infant by the attending obstetrician. Such minimal trauma is very unlikely to have later consequences. The severer injury, if not causing immediate death, becomes the source of a group of quite different symptoms that are more obvious and, with the ever increasing interest of the profession in this problem, now but rarely overlooked. These symptoms are caused by hemorrhage, and injury to nerve tissue, and if resorption and restitution are not complete later consequences might well be expected.

It seems superfluous today to discuss the direct relation of serious intracranial injury to deep indentations or fractures of cranial bones and thus its dependence on all brusque manipulations, on excessive force in the extraction of the aftercoming head or of the presenting head by means of forceps, especially if the latter are not properly applied. It will prove more profitable, in my opinion, to dwell rather on the question of how far our newer knowledge in regard to the origin of the inconsequential and almost physiologic traumatization of the infant's central nervous system in labor can be utilized in the prevention of the more severe injuries with their definitely pathologic consequences.

Molding and altered, uneven distribution of the blood within the cranium are the two phases of labor that exert the most noteworthy mechanical effect on the brain and meninges. The overlapping of adjoining skull bones in sutures and fontanels during molding yields two important effects: 1. Through distortion and partial compression of underlying venous sinuses the intracranial blood circulation is more or less markedly influenced. 2. Compression of the elastic skull in one direction in general causes the compensatory elongation of diameters in another direction. In this manner certain of the dural folds are subjected to a definite strain which seemingly often proves too severe for their integrity. This strain is most marked along the free edges of the tentorium.

The other factor which during labor affects the skull contents has been more recently revealed and now is commonly spoken of as the suction effect. As soon as the cervix becomes dilated, and particularly after the

\* More detailed information and bibliographic references will be found in the 1928 appendix to the author's monograph on Birth Injuries of the Child, New York, D. Appleton & Co.

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membranes have ruptured, the increased intracranial pressure during a uterine contraction is within the area of the dilated cervix, counteracted solely by the much lower outer atmospheric pressure. Thus through negative pressure a suction effect is exerted on the presenting part of the head, definitely expressed in the formation of the caput succedaneum but on more careful study as well evidenced in hyperemia or small hemorrhages in the bone, in the underlying meninges or even within the adjoining portions of the brain itself. Thus, the physiologic sources for common anatomic changes in the brain and meninges in the course of even a normal labor consist in intracranial stress and interference with intracranial blood circulation, the latter being the combined result of increased pressure from without and suction. Exaggeration of these factors necessarily must play an important part in the causation of the more severe injury.

Long delay in the expulsion of the head after advanced dilatation of the cervix leads to marked and long continued hyperemization of certain parts of the brain with the concomitant exaggerated anemization of other parts. Sudden and excessive overlapping of adjoining cranial bones will endanger the underlying sinus, especially if it is engorged by asphyxiation or in an aftercoming head.

Extreme change in the configuration of the fetal head inevitably places certain dural folds under undue strain and may cause them to tear. It might be emphasized in this connection that the actual harm done by such a tear is determined solely by whether the tear incidentally involves any smaller or larger vessels. This brings us to the discussion of certain contributory or predisposing factors in the origin of intracranial injuries.

While pressure and suction in the main represent the primary mechanical forces, undeniably other conditions act as significant contributory elements in the development of the serious lesions. Unlike the firm skull bones of the normal full term child, those of the premature infant offer but little protection. In the premature infant both the dura and the vessel walls are of notorious fragility. It is well known that they often are severely lacerated merely by a forced or quick passage of the soft head through a not fully dilated cervix. Engorged veins or sinuses naturally will be ruptured more easily than empty ones. A delay in blood coagulation will permit a slight oozing from a small vessel to continue until finally it amounts to a very serious if not fatal hemorrhage. From these facts, several basic principles for a prophylaxis against serious injury to the central nervous system can be evolved.

Nothing should be done to hasten or shorten a labor which seemingly is progressing normally, and particularly not in a premature labor. The obstacle offered by a rigid perineum can be overcome by an episiotomy. If, in the course of a normal labor, intervention either by medication or by instrumentation seems desirable in the interest of the child, the probability of increased risk to the child through such intervention should be properly weighed. Beyond any doubt, the majority of all obstetric operations are undertaken presumably in the interest of the child. All these operations, however, imply a definite danger to the infant. Fatal dural lacerations have been recorded even in cesarean sections from extraction of the head through too small a uterine or abdominal incision.

The most common justification for extraction with forceps is the assumption or diagnosis of beginning

intra-uterine asphyxiation. As a matter of fact, with the exception of the relatively rare instances of placenta praevia, abruptio placentae, prolapsed cord, or profound toxemia, this diagnosis can hardly ever be made with any certainty. Even marked changes in the fetal heart rate or the passage of meconium are only of very limited value in this respect. Apparently most often the ominous retardation of the heart beat is the result of undue compression of the head. Forceps applied under such conditions will actually reduce the chances of the fetus if extraction causes a further or quicker compression of the head.

Tentorial tears are signs, not so much of excessive force as of the fact that this force has been exerted in a particularly unfavorable direction. Therefore, serious dural injuries might be looked for if an extraction is done at a time when the position of the head precludes entirely appropriate application of the forceps.

Irregularity and disquieting retardation of fetal heart sounds often yield promptly to the administration of chloroform or ether in small amounts, just sufficient to stop, temporarily, the uterine activity and thus to relieve the excessive compression of the head. The administration of anesthetics in this manner proves therefore doubly valuable in the prevention of serious intracranial injury; the heart action often improves promptly, while sufficient time may be gained to permit the application of the forceps later under improved conditions.

Undue haste in the extraction of the head, and especially of the aftercoming head in a breech labor, undoubtedly implies a risk to the fetus which in general is greater than the risk that hasty intervention intends to overcome.

These are only some general rules of prophylaxis evolved from basic facts. They must guide the obstetrician in dealing with the specific problems of the individual case. They must be taken into account by him if he wishes to safeguard the fetus when selecting the type of and the proper time for any obstetric intervention.

However, serious injuries responsible for immediate death or later disability are not inflicted solely during labor itself. In many instances severe harm results from improper management of the infant who is only physiologically or slightly traumatized.

It has been shown that out of every hundred newborn infants who are born dead or who die soon after birth, seemingly as the result of asphyxiation, between seventy and eighty actually succumb to intracranial lesions. Only one logical conclusion can be drawn from this fact: in the best interest of the seemingly asphyxiated baby, i. e., one who does not breathe properly, one should always consider it as probably having been intracranially traumatized. Therefore, only the very gentlest maneuvers must be employed in its resuscitation. Recommendation and possibly even the mere description of the notoriously dangerous method of swinging after the method of Schultze deserve to be eliminated from all textbooks of obstetrics. The common practice of suspending the presumably asphyxiated baby by its legs is reprehensible because this inverted position necessarily favors further escape of blood from ruptured and usually engorged vessels.

If anomalies of presentation or of labor require instrumental intervention or certain clinical symptoms make it particularly likely that the evident impairment of respiratory function has been caused by an intracranial hemorrhage, the immediate subcutaneous administration of about 20 cc. of the father's or mother's blood

will prove a valuable prophylactic measure against undue prolongation of a slight hemorrhage from a small vessel in the presence of reduced coagulability of the fetal blood.

An answer to the question asked in the title of this paper: Can intracranial birth injuries be prevented? might briefly be formulated as follows: The physiologic traumatization of the brain and meninges in labor can be reduced to its possible minimum by absolute non-intervention during labor that is progressing normally, excepting in this respect an episiotomy and truly perineal forceps applied to a maximally compressed head. If in the interest of either the mother or the child intervention is considered necessary, haste almost invariably will increase the danger to the child. Serious harm will be obviated if the seemingly asphyxiated child is always considered as probably having been intracranially traumatized.

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### MECHANISM OF LABOR FROM THE NEUROLOGIC POINT OF VIEW\*

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Those of us who do not conduct labor see many children whose disabilities seem to be related to birth injury. In the nature of things, it is often hard to establish facts. One difficulty is a very real one and can be related to a varying sense of time in various groups of physicians. To the obstetrician nine calendar months is a long time to wait for a few hours of labor, which is terminated successfully when the baby breathes. Those of us who deal with children regard this period as the beginning of a series of increasingly complicated problems stretching over years. Many of our ideas are the fruit of more or less academic reflection rather than of direct experience.

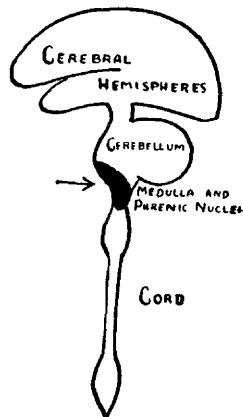


Fig. 1.—The "vital" area which controls respiration. The arrow points to the area within which injury is fatal.

A difference in point of view between obstetrician and pediatrician is perhaps inevitable. As a pediatrician, I believe that it is the duty of the obstetrician to consider whether it is not worth while to add to the ordinary conception of the mechanism of labor a description of the effect of the imposed forces on the central nervous system of the fetus and the membranes surrounding it. I believe that it is quite feasible to formulate a description of the effects of force on the central nervous system. Much of the evidence is indirect, and some of the steps in the argument are based on surmise rather than on observation; but the hypothesis seems to me worth setting up for inspection and attack.

First, it is quite clear and easily demonstrable that the various parts of the central nervous system are very different in character, in function and in development

at the end of pregnancy. It is equally clear that the cavity in which the brain and cord lie is subdivided so that excessive pressure, hemorrhage, and similar factors may injure one or more or all portions of the enclosed nervous system.

The anatomic and physiologic differences between various parts of the central nervous system are obvious

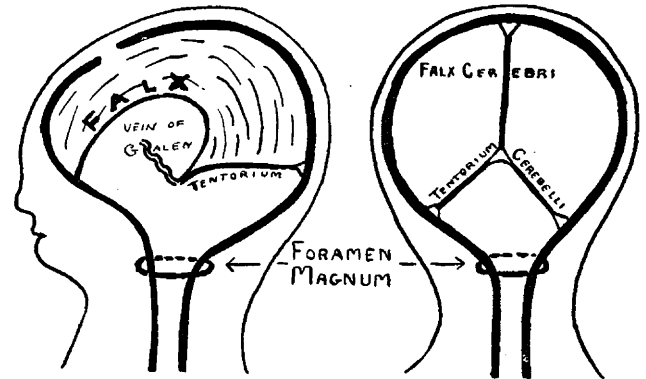


Fig. 2.—The dural septa.

enough. The vital respiratory and vasomotor apparatus lies in the medulla and the upper cord. These portions of the nervous system are fully developed at birth, and are the only parts that are needed at once.

The cerebral hemispheres are developmentally immature and are certainly not needed during or immediately after birth and there is, as far as I know, no good evidence that they are useful or active for some little time. The spinal cord, below the phrenic nuclei, can of course be destroyed without any immediate danger to life.

The question of whether a baby is living or dead at birth depends, then, on the integrity of a small block of tissue lying between the tentorium and the third or fourth thoracic vertebra and protected from direct injury by the relatively substantial muscles of the neck and by the relatively rigid base of the skull.

The arrangement of the walls and septa of the craniovertebral cavity is beautifully adapted to protect this vital area. The fetal skull is usually described as a collection of plates joined by sutures. When it is examined more critically, it is possible to draw a sharp distinction between the thin plates of the vertex and the far more massive and rigid bones of the base. To all intents and purposes the base, even at birth, is rigid, and the molding, such an important part of the mechanism of labor, occurs almost entirely above the base.

The dural septa are extremely important structures. Their relationship to the rigid base and the nonrigid vertex seems well worth emphasizing. The tentorium arises along the edges of the base and is to that extent fixed, but its fibers converge to join the falx, which acts as a ridge pole to support the roof of the subtentorial space. The falx, except at its extreme anterior part, arises from the flexible vault and sweeps back to its insertion into the tentorium. In general, it is demonstrable that distortion of the vertex does not greatly affect the rigidity of the tentorium.

The spinal part of the nervous system is enclosed in a flexible tube, which can be altered in length by compression or by extension. The dura is firmly anchored about the foramen above and to the sacrum below.

The consideration of the nervous system in its relation to its covering reveals several facts of interest. The cerebral hemispheres, which do not take any part in the initiation of independent life and are developmentally

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