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# Reprint of "Concerning Surgical Intervention for the Intracranial Hemorrhages of the New-born" by Harvey Cushing, M.D.

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**Abstract** This paper was first presented at a meeting in 1905 and gives an insight into the problems faced in early neurosurgical operations in newborns and the way they were approached by an adventurous surgeon.

**Keywords** Harvey Cushing · History · Intracerebral hemorrhage

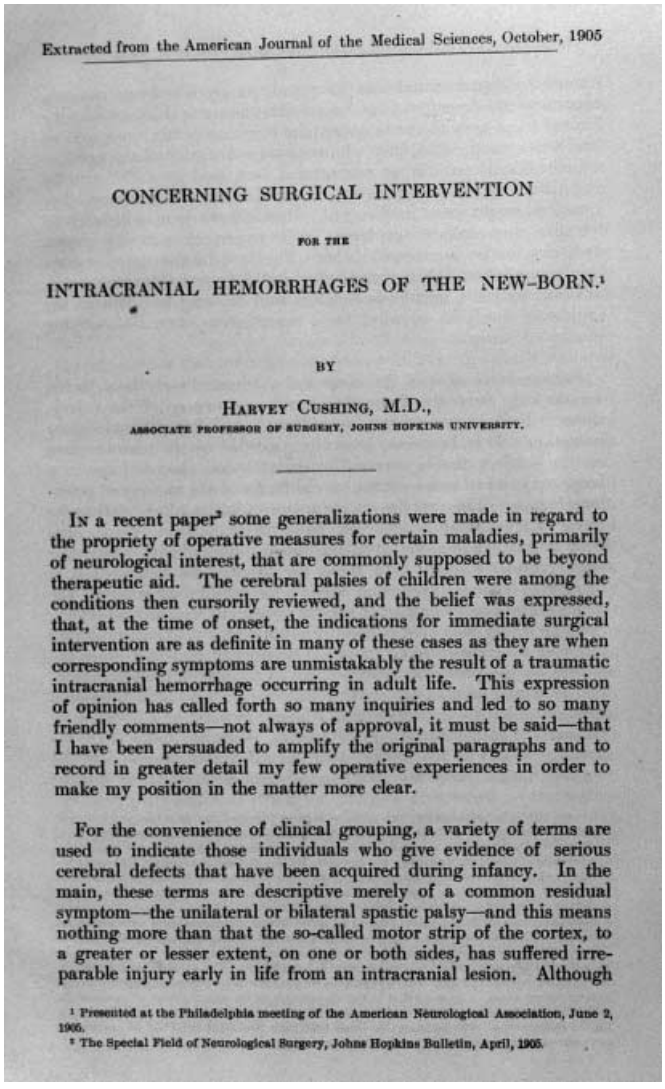
## Introductory remarks

Harvey Williams Cushing (1869–1939) was born in Cleveland, Ohio, USA and later educated at Harvard University and Yale. He did his surgical training at the Johns Hopkins University under William O. Halsted and left there to set up one of the major neurosurgical services in the USA. His output in terms of clinical work and literature was enormous throughout his life. While at Hopkins, and still in a very embryonic period of his neurosurgical career, he published this important paper on pediatric neurosurgery. It is now referred to by most medical historians as the first paper that deals with *successful* (italics mine) operative intervention for intracranial hemorrhage of the newborn. At the time this paper was published the average mortality in neurosurgical cases exceeded 80% in most services. A review of this paper reveals a thoughtful and meticulous approach to what then must have been extremely complex problems with survival rates that were close to zero. Review of this paper reveals his first patient died 8 hours after the surgery; however, his second patient did much better: "The child was a year old March 6th; it stands, takes a few steps, says a word or two, and is fine specimen of wholesome babyhood." Cushing concludes the paper with an interesting discussion on the risks involved in operating on newborns because of bleeding problems, but then goes onto to note that the level of risk appears to be no higher than that seen in the adult patient. Review of this paper reveals an adventurous surgeon doing landmark work in the very early part of this century.

## "Concerning Surgical Intervention for the Intracranial Hemorrhages of the New-born" by Harvey Cushing, M.D.

In a recent paper[1] some generalizations were made in regard to the propriety of operative measures for certain maladies, primarily of neurological interest, that are commonly supposed to be beyond therapeutic aid. The cerebral palsies of children were among the conditions then cursorily reviewed, and the belief was expressed,

[1] The Special Field of Neurological Surgery, John Hopkins Bulletin, April, 1905



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CONCERNING SURGICAL INTERVENTION

FOR THE

INTRACRANIAL HEMORRHAGES OF THE NEW-BORN.[1]

BY

HARVEY CUSHING, M.D.,

ASSOCIATE PROFESSOR OF SURGERY, JOHNS HOPKINS UNIVERSITY.

In a recent paper[2] some generalizations were made in regard to the propriety of operative measures for certain maladies, primarily of neurological interest, that are commonly supposed to be beyond therapeutic aid. The cerebral palsies of children were among the conditions then cursorily reviewed, and the belief was expressed, that, at the time of onset, the indications for immediate surgical intervention are as definite in many of these cases as they are when corresponding symptoms are unmistakably the result of a traumatic intracranial hemorrhage occurring in adult life. This expression of opinion has called forth so many inquiries and led to so many friendly comments—not always of approval, it must be said—that I have been persuaded to amplify the original paragraphs and to record in greater detail my few operative experiences in order to make my position in the matter more clear.

For the convenience of clinical grouping, a variety of terms are used to indicate those individuals who give evidence of serious cerebral defects that have been acquired during infancy. In the main, these terms are descriptive merely of a common residual symptom—the unilateral or bilateral spastic palsy—and this means nothing more than that the so-called motor strip of the cortex, to a greater or lesser extent, on one or both sides, has suffered irreparable injury early in life from an intracranial lesion. Although

[1] Presented at the Philadelphia meeting of the American Neurological Association, June 2, 1905.

[2] The Special Field of Neurological Surgery, Johns Hopkins Bulletin, April, 1905.

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Inasmuch as most of the cases are not immediately fatal, being serious only from the distressing late consequences of the injury, there is little known of the morbid anatomy of the disease in its inception. It is, however, generally conceded by the many writers on the subject that a cerebral vascular lesion – hemorrhage in a large majority of cases – is the causal factor of the malady of prime importance. This applies to the cases of prenatal as well as to those of postnatal origin, but more particularly to those incident to parturition – the so-called "birth palsies," with which this paper primarily deals. In these the intracranial hemorrhage is usually of venous origin and follows the rupture of some of the delicate and poorly supported venous radicles of the cerebral cortex. Such an injury may be the direct result of undue traumatism during labor or may occur when too great strain has been put upon the vessels by the profound venous stasis of postpartum asphyxiation; just as in later months they may rupture under the passive congestion brought about by a

[2] It is, of course, presumable that there have been included in this large group of cases several diseases, which, from an etiological standpoint, are quite distinct, but which, being correspondingly destructive to cortical function, leave traces that in later years make them symptomatically indistinguishable. For example, should Strümpell's opinion that there is a cerebral infectious process – polioencephalitis akin to the more definite poliomyelitis – be finally established, a large group of cases, particularly those of the infantile hemiplegic type, could definitely be separated. Many have already accepted his views. On one occasion I performed a craniotomy on a child four years of age in an acute febrile attack, suffering with headache, vomiting, unilateral convulsions, and presenting a bilateral and rapidly forming stasis papilla. The trephination was conducted merely for the relief of tension, but with the hope at the same time that the symptoms might be due to a cortical hemorrhage. The exposed hemisphere was found tense, oedematous, and with a multitude of punctate hemorrhages scattered over the various convolutions. I presume that it was an instance of Strümpell's form of encephalitis, and on another occasion I should not hesitate to remove a small piece of the cortex for histological examination. The pathology of these conditions may more certainly be learned by early operative intervention than in any other way

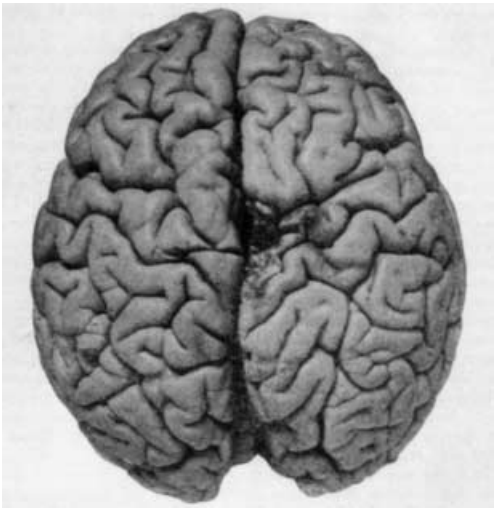

**Fig. 1** Photograph of the brain of an epileptic, in which the scar resulting from a birth hemorrhage is seen occupying the upper end of the right precentral gyrus (motor area of the left lower extremity). The entire convolution is smaller than the corresponding one on the left. Symmetrical incisions, due to removal of tissue for histological study

paroxysm of whooping-cough or a severe convulsion. Though Little's three papers, doubtless more than the writings of any of his predecessors, served to call attention to the malady, he had very few pathological data with which to support his contention, based largely upon clinical histories, that calamities of childbirth were responsible for a large proportion of the crippled and spastic children that had come under his care. This is the more apparent when one realizes how much importance has always been given by writers in all languages to the careful pathological reports which accompanied the papers of Dr. Sarah J. McNutt, published twenty-five years after Little's contributions called attention to the subject. Why such reports have been uncommon is not easy to explain, unless it is that autopsies of infants who have died seemingly from asphyxiation have rarely been conducted with this particular point in view. A few years ago, when interested in making some observations on the circulation of the cerebrospinal fluid, I was privileged by the obstetrical department to study, for the purposes of that investigation, quite a number of infants who had been stillborn or who had died during the early hours or days of life, and found, to my surprise, that a considerable percentage of them had died with an intracranial hemorrhage. This, too, has been the experience, I believe, of most pathologists, though records of such findings are astonishingly rare. Whether these cortical hemorrhages in the cases which I examined had been the cause of death could not, of course, always be told, though in some of them the effusion of blood was so great that little doubt was felt but that it must have played an important part in the asphyxiation which the clinical histories recorded. In one of the cases a large, thick clot was found overlying an entire hemisphere, and practically confined to one side, a condition which has been present in two of the cases on which I have since operated. In other instances the extravasations were smaller. One of them was in the cerebellar fossa, associated with a fissure in the occipital bone. In another case the chief distribution of the clot was over one of the occipital lobes.

When one considers what an immense amount of traumatism the infant's head must necessarily be subjected to, particularly should the child be large and the firstborn of an elderly mother, it is little wonder that lesions of this kind occur. And this even without the additional strain that may be occasioned by the instrumental delivery which a narrow pelvis or inelastic soft tissues may ultimately necessitate. The infant's brain itself is doubtless fitted by nature to withstand, without injury or shock, a degree of moulding and manipulation which could not be borne by an adult, fully developed, and medullated brain. And furthermore in cases of traumatic oedema, or of actual hemorrhage, the distensibility of the partially membranous skull will accommodate effusions of such extent that were they to take place in the closed adult skull in proportionate degree, they would rapidly prove fatal. It has been my experience that of the adult cases with an equally extensive hemorrhage only those recover in which there is an associated great fragmentation of the cranial vault, and this, by allowing for some cranial expansion, releases the brain in a measure from the compression effects that otherwise would be produced. It is probably this distensibility of fontanelle and skull which lets many of these infants escape death, for, being at this time little more than spinal animals, they may live with their bulbospinal axis alone, even in case the cerebrum is thrown in large part out of function. The early days of life, however, when medullation is rapidly taking place, are, so far as cerebral development goes, possibly the most important of all, and it is natural to suppose that the pressure of a clot which may be long in absorbing, or which organizes slowly, will, through a local compression anaemia, prevent the normal development and lead to the cerebral abnormalities that we recognize as the late evidences of the lesion.

It is an impression gained from my own studies, and, I believe, one that has been advanced by others, that the vessels most likely to rupture are those which ascend over the cortex and enter the longitudinal sinus from the midcerebral region. These veins, which lie in the subarachnoid spaces, and for the most part are protected from pressure by following the sulci as they ascend toward the midline, leave this protection when near the vertex, and apparently with no support whatever cross the subdural space to enter the dura at the outer edge of the sinus. In the adult brain there are many adhesions between these cortical vessels and the adjacent dura, particularly where this underlies the lateral expansions of the

longitudinal sinus, for here the membrane is punctured in many places by the granulations of Pacchioni. In infants, however, as is also the case in the lower animals, there are no such adhesions, the unsupported vessels being the only connection between the leptomeninges of the hemispheres and the dural sheath underlying the sinus. This can easily be seen by removing the infant brain and calvarium in one piece and by allowing the former to sag away from its bony and membranous covering.

During parturition there is presumably always some overlapping of the parietal bones, owing to the lateral compression of the skull, a condition thought to be more marked with the after-coming head or in the precipitous expulsion of a premature child, whose cranium is less resistant to pressure. It is a condition, also, which must necessarily be accentuated by the lateral application of forceps.

Although the cranial moulding may take place to a considerable extent without putting any great strain on these lateral cerebral veins, any undue overlapping could readily tear one or more of them away from the sinus. This, I think, is the more common form of injury[3] and possibly accounts for the fact that the primary effusion and so the thicker portion of the clot is commonly median, and, in consequence, implicates primarily and most seriously the centres for the lower extremities. The rupture of the vessels may take place only on one side, and I am of the opinion that the extravasation is usually limited to one side of the falx, though, indeed, a bilateral lesion is common enough, as the many patients with diplegia would indicate. Intracranial bleeding may, of course, result from lesions other than the laceration of veins from overlapping. Fractures, particularly basal ones, may be followed by a serious hemorrhage, and in these instances, as Case III. illustrates, the extravasation may not find its way to any great extent on to the outer surface of the hemispheres, but may infiltrate and affect primarily the basal ganglia. It is possible that injuries of this sort, particularly when the thalamus is involved, may be the ones which lead to the extraordinary condition of double athetosis; for in these cases so far as my experience goes – I have seen but one of them at operation – the hemispheres are absolutely normal in appearance, and it is noteworthy, as well, that in them epilepsy is a rare sequence and intelligence fairly well preserved.

In the numerous and valuable monographs that deal with the cerebral palsies of children – and particularly is it true of the birth cases – there is a remarkable absence of any description of the early symptomatology of the lesion; its consequences alone are given in detail. This may possibly be due to the fact that there is a silent period, so to speak, in the malady, during which the child "improves," and after some months, when it becomes evident that normal cerebral development is not taking place, the patient has very commonly passed out of the obstetrician's hands. So that beyond the account of the abnormal labor there are few data from which we may construct the symptomatology of the early intracranial lesion.

Judging from the patients whom I have seen, however, the condition need not be difficult of diagnosis. Had there been in any of the cases, a serious doubt as to the actual nature of the lesion, it might have been decided by a lumbar puncture, for when there has been any effusion of blood into the subdural spaces, free corpuscles will soon after be found in the fluid of the lumbar meninges. This has proven of great value in determining the presence of subdural bleedings in adult cases, and in infants might serve to differentiate between the hemorrhagic and infectious cases were diagnostic difficulties present. The history of the labor is, of course, all-important; also the degree of postpartum asphyxiation. Among the objective signs should be placed first and foremost the condition of the fontanelle. The membrane is bulging and in some instances may be so tight as to show no pulsation. In two of the patients its bony outlines, in consequence of the tension, could not be palpated, and it has several times been learned from parents, whose hemiplegic children have been seen for the first time some years after birth, that the fontanelle could not be detected during the first days or weeks of life. Convulsions, of course, are frequent, and particularly if they do not appear until several days after birth they may be more or less unilateral in character. There may be also an undue reflex activity, the child starting or twitching in a convulsive way in response to any sensory stimulus. Ocular palsies or differences in the size of the pupils apparently are not uncommon, and in severe cases there may be symptoms referable to the medulla, as alterations from the normal in the cardiac or respiratory rhythms. In the early days evidences of paralysis are rare. There may be no difference observable in the muscular tone on the two sides of the body, even when the hemorrhage is confined to one hemisphere.

Thus far merely the initial lesion and the symptoms characterizing the onset of the disease have been briefly considered, and, though the critical stage of the malady, it is, to any but the obstetrician, its least familiar period. In its fully developed and terminal aspects the disease is better known – far too well known to neurologists, orthopedists, or attendants upon the asylums for feeble-minded children. A supposed restoration to health may gradually follow the first few precarious days of life, and not until some months have elapsed do the late manifes-

[3] In two of the cases that I have examined I have satisfied myself that such ruptures were present. A positive statement, however, cannot be given even for these cases, since the dissection and exposure, difficult enough under any circumstances, owing to the delicacy of the vessels, is the more so when they are obscured by extravasated blood. One of them was Case IV. of my series. Cases are on record in which the longitudinal sinus itself has been lacerated

tations of the disease begin to unfold and to bring to light the spastic palsies, or blindness, or deafness, or feeble-mindedness, or, in severe cases, even complete amentia.

There is one very serious sequel which frequently (two-thirds of the cases according to Gowers) accompanies the mildest grades of the disease, even when intelligence may have in nowise suffered. This is epilepsy; and the convulsions, often Jacksonian in character, are akin in all respects to those which follow the cortical changes resulting from cranial injuries with hemorrhage in adult life, and the late evidences of the lesion may have much the same gross appearance.[4]

It is this complication which brings many of these patients to the surgeon and gives him an opportunity of seeing at first hand and during life the extraordinary variety of the cerebral lesions that result from the original hemorrhage. In the adult, however, such a destructive cerebral lesion as may take place in infancy and still be compatible with life could hardly occur, and it is possible that the more firm and resistant character of the fully medullated brain may tend to check a venous extravasation which in the infant might have become huge and perhaps have been the forerunner of porencephaly.

The brain of one case, which I have had an opportunity of studying postmortem, is deserving of mention in some detail, as it shows a lesion, resulting from a birth hemorrhage, which is limited to the motor area of the lower extremity on one side. The patient was a colored girl, thirteen years of age, the firstborn, who had been delivered with instrumental aid. Convulsions had occurred soon after birth, and she had suffered from epilepsy from infancy. The attacks were typically Jacksonian in character and always began in the left leg, which was spastic and much smaller than the other in all of its measurements. The child seemed normally bright and intelligent. She died in the hospital of an intercurrent trouble while awaiting operation. An area of sclerotic atrophy, as shown in the accompanying photograph (Fig. 1), was found, limited to the motor area of the left leg. It is here that lesions would naturally be expected to occur as a result of a rupture of the veins entering the sinus. A similar lesion, if bilateral, would have led to the paraplegia so commonly seen, or to the diplegia of Little if the hemorrhage had been extensive enough to reach to the motor centres of the arms. The remarkable way in which the cortical lesion may be confined to the Rolandic convolutions on the two sides is well demonstrated by the careful study, made in 1885, by Dr. Welch, of Sarah J. McNutt's case.

It is the absolute hopelessness of any form of therapy in these late stages – other than tenotomies to relieve the spastic contractures, or the surgical attempts to check the epileptic seizures – that have led to the despairing words with which the best-known writers on the subject dismiss the therapeutic section of their papers. In his valuable monograph Freud gives his own and a distinguished American neurologist's opinion as follows: "Die Therapie der Infantilen Cerebrällahmung [*sic*] ist ein armseliges und trostloses Capitel sowohl an sich als im Vergleiche zu dem mächtigen klinischen Interesse, welches diese Affectionen erregen. Hier gilt, leider unwidersprochen, der Ausspruch von Allen Starr: 'Hemiplegia, sensory defects, and imbecility, occurring with or without epilepsy in children, are chronic diseases incurable by medical treatment.'"

It is hoped that in some instances, just as after serious cranial traumatism in the adult, the late results of the meningeal hemorrhage in these cases of so-called birth palsies may be warded off by an immediately conducted operation.

My four operative experiences are represented by the following cases:

*Case I.* – The patient, a male child three days old, was seen in consultation with Dr. Dabney on the afternoon of August 22, 1903. The child was the first of twins, born at full term of a primipara thirty-five years of age. Though a normal head presentation, the labor was slow and prolonged, and low forceps were finally applied. The delivery was easily accomplished without the exertion of force. The child was deeply asphyxiated and it was some time before it could be made to take a breath. Its twin brother, born a few moments later, was normal in every respect. The first child did very badly for the first two days. It could not suckle, and

[4] It may be said, too, in passing, that these cases of epilepsy associated with spastic palsies in children are almost as likely to be bettered by properly conducted craniotomies as are the post-traumatic epilepsies in the adult. During the past few years I have explored about thirty of these cases, and the abnormal conditions encountered defy description. I have seen a right-sided porencephalic cyst with spastic hemiplegia and contractures in a patient whose intelligence was practically normal; a microcephalic child with complete amentia, in whom both hemispheres were exposed, disclosing nothing that could deserve the name of a convolution. In some instances the dura and the cortex may be free, in others densely adherent, and at times there may be large, new-formed, venous sinuses over the lateral surfaces of the dura. In one such case a vertically placed sinus overlay the central area and was lined by Pacchionian granulations. There may be large areas of convolutional atrophy, and the situation of these areas is usually shown before the operation by configurative alterations in the shape of the skull. Twice I have seen in epileptics a flattening of this sort over one occipital lobe: they were cases of birth hemorrhage with homonymous hemianopsia. One of them was operated upon, disclosing a sclerosed and atrophied lobe with adhesions. There may, however, in these patients be no adhesions whatsoever between brain and dura, but merely some thickening of the pia-arachnoid, with an increase in the amount of fluid filling the sulci. In one patient seen with Dr. Osler and Dr. Thomas, of double athetosis associated with extremely painful cramps, both hemispheres were exposed at different sittings, and the cortex on each side was found to be perfectly normal in appearance, and to give clean-cut responses upon faradization of the precentral convolution. A large portion of this convolution was removed from one side, with a cessation of the cramps, but without affecting in any way the athetoid movements, and giving merely the usual temporary palsy of the extremity. Many other instances might be cited. In the whole series there have been no fatalities. The outer wall of the tense porencephalic cyst in two cases has been removed without appreciable symptoms. Dr. Starr, however, has recorded a sudden fatality following such a procedure

would only occasionally swallow the drops of milk which were put in its mouth. It had a peculiar dusky, cyanosed appearance. There had been several convulsive seizures.

The symptoms were the more obvious, as we had the normal child for a control. The fontanelle was tense and without pulsation. The left eye was kept closed and the pupil on this side was dilated, being twice the diameter of that on the right side. Both reacted to light, the right more than the left. The winking reflex was present on both sides, but only when the lashes were touched. The supraorbital reflex was present, more active on the left. The child could move its arms and legs, and there seemed to be no spasticity nor difference in muscular tone on the two sides of the body. The convulsions had not been unilateral.

Contrasted with its twin, whose pulse was 110 and regular, this child's pulse was considerably slower, having an irregular action of about 92 beats per minute. The respiration, which had been rather irregular and shallow from the beginning, had on this last day assumed something of a Cheyne-Stokes type of rhythm, with periods of apnoea. The child was prepared for immediate operation.

Operation. August 22d, 6 P.M. After the head was shaved and prepared, a few drops of chloroform were administered and a horseshoe-shaped incision was made through the skin just within and concentric with the border of the left parietal bone. An osteoplastic flap was then raised, including almost the entire parietal bone. The bone was cut through with a stout pair of blunt, curved scissors, very close to its thin and serrated edge. On elevating the bone-flap a tense, dark, plum-colored dura was brought into view. When this membrane was opened and reflected, a clot about 1 cm. in thickness, apparently covering the entire hemisphere, was disclosed. This clot was lifted off in large pieces from the exposed area of the cortex with a blunt instrument, and a large amount of clotted blood which extended over the frontal and occipital regions was irrigated out from under the dura with warm saline solution. The wound was closed without drainage.

Despite its enfeebled condition, for it had taken practically no nourishment during its three days of life, the infant stood the operation remarkably well. A small subcutaneous infusion of salt solution was given, and two hours after the operation the child took some nourishment from a bottle by sucking the nipple for the first time since its birth. Though there seemed every prospect of a recovery, the infant suddenly died during the night, about eight hours after the operation.

No examination was allowed, and though it would have been interesting to have learned whether there was an extravasation over the opposite hemisphere, it seems quite likely, in the light of the last case in this series, and in view of the unilateral palsy of the third nerve, that an effusion, even were one present on the right side, was less extensive than the one which had been disclosed at the operation.

*Case II.* – The patient was first seen March 13, 1904. It was born of a primiparous parent a week previously, on the 6th of March. It had been a tedious breech presentation, with manual delivery. The head had been released with some difficulty. A condition of "pallid asphyxia" was present at birth, but in a few moments, after a hot and cold plunge, the child cried vigorously. There was no overlapping of the cranial bones or other obvious effects of traumatism. During the following night the child kept both of its eyes open most of the time, and for the next five days nothing unusual was noted, except this apparent wakefulness and some stupidity in nursing. The child was not fretful, its cry was strong, and it took nourishment from a bottle fairly well. It had begun to gain slightly in weight. On the fifth day there was a slight elevation in temperature (101.6°), for which there was no obvious cause. The pulse was somewhat slower than usual, registering between 80 and 100 beats per minute.

On the sixth day, Saturday, March 12th, at 9.15 A.M., convulsions first set in, the first spasm lasting perhaps two minutes. During the day there were five other convulsive seizures of varying type and of increasing severity. In the more severe seizures the most decided twitching occurred in the right arm and leg. Some of the convulsions were confined to the face and head, the arms and legs being quiet. In one of the attacks the eyes were crossed, with smacking of the jaws, and with the head thrown to the left, and some rigidity of the neck. The child would sleep after the convulsions, occasionally with its left eye tightly closed and the right partly open. At 11 P.M. there were several severe and repeated convulsions, with some opisthotonos and with a sharp cry at the termination of each.

On Sunday, March 13th, there were eleven convulsive attacks at varying intervals, several of which I observed, when late in the day the child was seen in consultation with Dr. E. F. Cushing and Dr. Crile, of Cleveland. Most of the seizures were bilateral in character, though some of them seemed to us more marked on the left side. There was a constant inequality of the pupils, the left being somewhat dilated, or the right contracted, except during an attack, when both of them were wide. The fontanelle was not as tense as in the previous case, and, though slightly bulging, its bony outline could be made out.

*Monday, March 14th*. *Up* to 9.30 A.M., an hour before the operation, there were seven convulsive seizures, more severe than on previous occasions, and associated with occasional cyanosis. They were for the most part left-sided, and were accompanied with a conjugate deviation of the eyes to the left. One of the spasms lasted five minutes. After the attacks a clear, non-frothy saliva with mucus would pour in considerable quantities from the child's mouth.

The operation, at which I was assisted by Dr. Lower, was performed at 10.30 A.M. Every effort was made to preserve the warmth of the patient and she was wrapped thickly in cotton. The head was shaved, and, as in the case above described, under chloroform anaesthesia, the parietal bone was turned down with its overlying soft parts, this time on the right side. The dura was found to be somewhat tense, and though not deeply plum-colored, as when it covers an extensive clot, it nevertheless showed the presence of an underlying extravasation. The membrane was opened, turned down, and the free blood and small separate clots which were scattered over the surface were irrigated away with warm salt solution. The wound was closed without drainage.

The child slept for two hours after the operation, awoke, cried vigorously, and took its nourishment eagerly. The convalescence was without incident. The wound healed by primary union, the slight pyrexia, which had been present for some days, subsided, and at no time following the operation was there a suggestion of any further convulsive seizures.

On March 28,1905, the attendant writes me: "The child was a year old March 6th; it stands, takes a few steps, says a word or two, and is a fine specimen of wholesome babyhood."

*Case III.* – The patient, with the following history, was seen for the first time October 11, 1904, in consultation with Dr. J. Whitridge Williams. A large baby, a girl, was born October 3d, after a difficult labor lasting forty-eight hours, which was finally terminated by a low forceps operation. At birth the child was profoundly asphyxiated, and only after vigorous efforts was spontaneous respiration established. There was a small abrasion, evidently made by the instruments, over the frontal region. This little wound bled considerably, healed up partially, and later on began to bleed again, so that it was thought the child might possibly be haemophilic. On the day following birth the right eyelids began to swell somewhat, and there was considerable oedema in the surrounding tissues. On the third day there was an extreme protrusion of the eyeball (Fig. 2), which appeared in the course of a few hours. For several days after birth the child nursed fairly well at the breast,

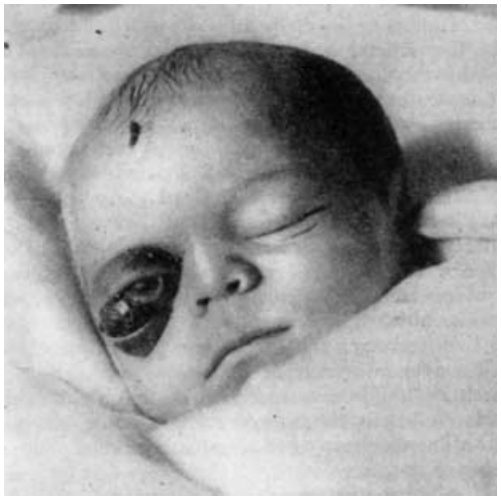

**Fig. 2** CASE III. – Photograph of the nine-day-old comatose infant, taken the morning of operation. Extreme degree of ocular proptosis, due to cavernous sinus thrombosis

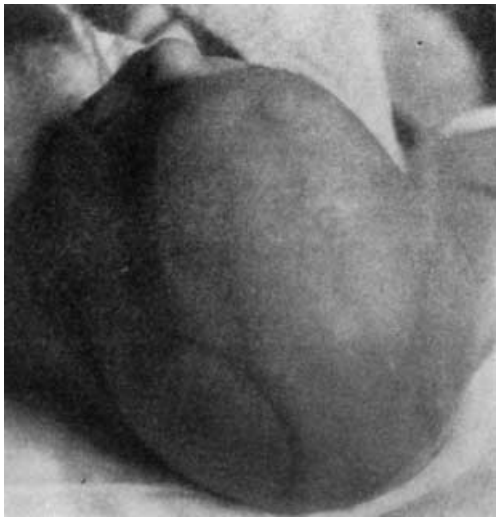

**Fig. 3** CASE III. – View of cranial vault, to show scars of the bilateral operation

but later on it refused or was unable to suckle, and nursing on October 8th had to be discontinued. The child became dull and stupid and would not swallow even the nourishment put in its mouth. Its respirations were very irregular. On the morning of October 10th they became markedly Cheyne-Stokes in character, and in the afternoon there was great restlessness and convulsive movements of the arms and legs. Twitching, particularly of the right hand, was noted, and some rigidity of the legs was first observed on this date. The nurse had noted that the child's pulse often registered below 100 beats per minute. The fontanelle was exceedingly tense.

When first seen by the writer it hardly seemed possible that the child could survive, and indeed its life had been for a day or two despaired of. The most startling feature was the extraordinary protrusion of the right eyeball with corneal opacity and hemorrhagic oedema of the lids and conjunctiva. The fontanelle was bulging and so tense that its bony margins could not be made out; there was no pulsation. The radial pulse was very irregular in rhythm and quality. The respiration was irregular, with long periods of apnoea.

There seemed little question as to the presence of an intracranial hemorrhage, though considerable doubt existed as to its exact situation. The history of a sudden non-pulsating protrusion of the eyeball, with great oedema of the lids and conjunctiva – a condition rarely if ever met with except after cavernous sinus thrombosis – made it seem most probable that a basal fracture had occurred with resultant laceration of this vessel, which had not thrombosed and produced the proptosis until the third day.

It seemed to us both that a craniotomy offered the only hope of recovery. The child was transferred to Dr. Williams' department at the hospital, where an operation was performed early on the following day, October 12, 1904.

As in the previous cases, an osteoplastic flap, including most of the parietal bone, was elevated. This was first done upon the right side. The dura was found to be extraordinarily tense, and, in the endeavor to reflect this membrane by an incision concentric with the osteoplastic flap, some cortical injuries were unavoidably made, owing to the great cerebral tension, which caused the brain immediately to bulge through the small primary opening. This protrusion was so extreme, and the soft, jelly-like infant's brain so easily lacerated, that it was impossible to elevate the temporal lobe sufficiently to discover whether or not a clot was present at the base as a result of the presumed lesion in the cavernous sinus. The operator had to be satisfied with nothing more than washing off from the cortex of the numerous old blood clots which were present on the exposed surface, as well as those which could be liberated from below by such slight dislocations of the hemisphere as was possible without occasioning further cortical lacerations. With the removal of these clots and the escape of cerebrospinal fluid, the bulging, though still considerable, diminished to such an extent that the dura could be brought together again by sutures. Being fearful, however, lest the tension was sufficient to break down these sutures and lead to a hernia cerebri, or, worse, to a fungus, the desperate nature of the case seemed to justify a similar exposure of the other hemisphere. Consequently, a parietal flap was turned down in like fashion on the left side, and a similar procedure carried out, with the washing away from the surface of numerous blood clots and the escape of cerebrospinal fluid. This sufficed to diminish the tension to such an extent that the fontanelle became depressed, and the brain no longer tended to protrude through the dural openings. These were carefully approximated by sutures, the bone-flaps were replaced, and the scalp wounds were closed without drainage.

The child, contrary to our expectations, and almost against our desires, immediately began to improve. By the following day nourishment was well taken from a bottle and she soon began progressively to put on weight. Both wounds healed by primary union (Figs. 3 and 4). It became evident after a few weeks that the cavernous sinus was once more becoming re-channeled. Ultimately, the circulation from the eyeball became re-established, and the exophthalmos gradually disappeared (Fig. 5). It has, however, probably left the eye completely blind.

It is, of course, difficult to tell, before a few years have elapsed, what will be the mental status of the unfortunate child whose life seems to have been saved in this way. At the present time, however, it seems to be developing normally, and is a natural and healthy-appearing baby, with no evidences of motor disability.

*CASE IV.* – The patient, a second child, was born on the evening of Tuesday, February 14, 1905, after a brief and rather precipitous labor. It was first seen three days later in consultation with Dr. Iglehart, who, though not present at the labor, saw the child soon after birth, and at that time believed it normal in every respect. On the following day, however, his attention was called by the nurse to a swelling which had appeared over the left parietal region. This was somewhat tense and fluctuant, and presented the appearance

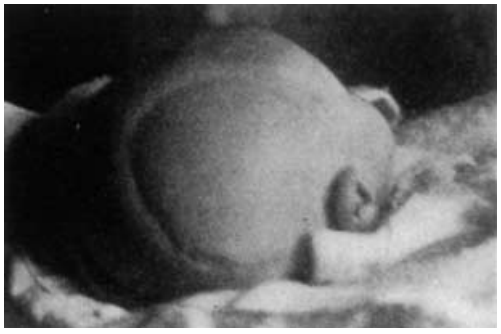

**Fig. 4** CASE III. – Lateral view, to show size and position of one of the symmetrically placed osteoplastic flaps

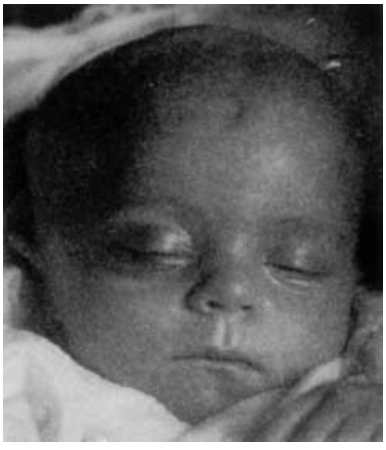

**Fig. 5** CASE III. – Photograph, taken during sleep, of patient two months after operation, to show complete retrocession of exophthalmos. Contrast with Fig. 2

of a cephalhaematoma. This swelling during the day, February 15th, and on the following day, increased rapidly in size, until by the evening of the third day it had become as large as a hen's egg. Beyond this, nothing was thought to be wrong with the child until Friday, February 17th. On this day it was first noticed that the left pupil was larger than the right, and that the pulse had become slow. The nurse also noted that the child had become stupid in taking its nourishment. Fearing that the symptoms indicated an intracranial hemorrhage, Dr. Iglehart made every effort to secure an early consultation; there was an unfortunate but unavoidable delay of some hours, and during the interval the child had become very much worse.

When first seen the large, tense swelling on the left side of the head, its base corresponding exactly in size, position, and shape to the left parietal bone, gave the child a very remarkable appearance. The swelling projected from the surface of the head fully 5 cm. It was pulsating. Pressure upon it did not seem to affect the infant in any way. The left pupil was dilated and the left eyelids kept closed. The eyeballs were somewhat prominent, though there could be said to be no definite exophthalmos. The eye-grounds were not examined. The superficial veins radiating from the angles of the eyes, and particularly those running over the scalp, were so much dilated as to be visible at a distance. There were numerous small, punctate hemorrhages in the skin over the neck and chest. The child's right side was possibly more rigid than the left, but this could not be positively stated. There had been one severe general convulsion about four in the afternoon. The child had taken practically no nourishment for twelve hours.

As rapidly as possible preparations were made for the operation. While the head was being shaved the infant had a second general convulsive seizure, accompanied by several sharp cries. Its general condition was very unfavorable.

Operation, *February 17, 1905, at 10 P.M.* The head was carefully shaved and prepared, every effort being made meanwhile to sustain the infant's bodily warmth and strength. Chloroform was used as the anaesthetic, a few drops only being required. A needle was first inserted into the cephalhaematoma and dark fluid blood flowed out of it. An incision was then made about its base, concentric with the left parietal bone. An amount of clotted and dark fluid blood which must have measured two or three ounces was evacuated. This clot lay between the epicranium and the denuded shell of the parietal bone. There was no indication of any connection between it and the intracranial contents. After the evacuation of this clot and exposure of the parietal bone, the latter was turned back almost in its entirety as in the preceding cases. As was expected, a tense, plum-colored dura, exactly similar to that seen in Case I., was brought into view. The dura was opened and a large clot about a centimetre in thickness, which seemed to cover the entire hemisphere, was disclosed. Much of this clot escaped as soon as the opening was made, and other large pieces of it were lifted off from the surface with a blunt instrument and removed.

Possibly I should have been satisfied with the relief which this partial operation would have afforded. It doubtless would have been wise to have postponed further interference to another and later occasion, but the child's condition seemed to justify an effort to more thoroughly remove the clotted blood which was within easy access over the anterior and posterior poles of the hemisphere. While irrigating away some of the blood, the child suddenly stopped breathing. Under artificial respiration the heart beat continued for some minutes, but all efforts to restore spontaneous breathing were unavailing.

Postmortem Examination, *February 18th.* A careful dissection made it quite evident that the cephalhaematoma had no direct connection whatsoever with the subdural hemorrhage: It seems quite likely that its formation was due to the fact that during the precipitous labor there was a slight injury and slipping of the epicranium from the parietal bone; this did not lead to an extracranial haematoma until the intracranial hemorrhage reached a size sufficient to produce great venous engorgement, and this in turn caused bleeding from the torn venules of the epicranium, which under other circumstances would not have had an intravascular tension sufficient to lead to so extensive an extravasation. The outlines of this extracranial hemorrhage were found to be limited by the attachment of the epicranium at the margin of the parietal bone. There was no extracranial extravasation over the frontal or occipital bones. On removing the calvarium it was found that the hemorrhage was limited to the left side of the cranial cavity, and was almost entirely supratentorial. The cerebrospinal fluid over the right hemisphere and in the spinal canal was somewhat bloody, but there were no clots. The accompanying photograph (Fig. 6), taken with the brain still *in situ* but after removal of the calvarium, shows the widespread distribution of the clot. At one place only, the convolutions are exposed; namely, where the clot had been partially removed at the time of the operation. On clearing away the remainder of the clotted blood, which surrounded the hemisphere like a mould, thickest in the central regions, the cortex was found to be macroscopically uninjured. One of the larger cerebral veins was found torn away from the dura at its point of entry into this membrane near the longitudinal sinus.

It seems needless to add anything to the story which these cases tell. There are, however, certain points which

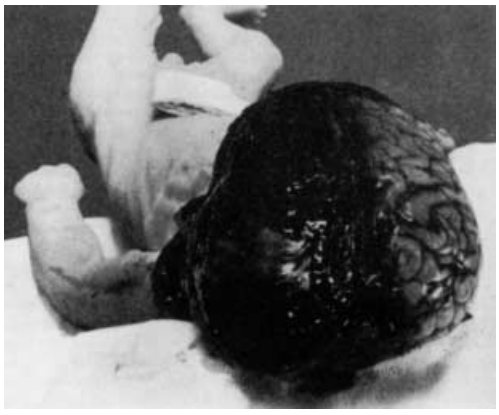

**Fig. 6** CASE IV. – Postmortem appearance of brain after removal of calvarium. Note the extravasation over the entire left hemisphere, the convolutions of which are visible in the parietal region alone, where a portion of the clot was removed at the operation. Right hemisphere totally free from extravasation

may deserve mention before closing this paper. One of them is that a new-born child, with proper regard for haemostasis and careful avoidance of exposure, will stand a cranial operation well. This is contrary, however, to the statements in our text-books; but when one considers what an amount of traumatism every child must have to endure while making its entrance into the world, it would seem reasonable to expect that a careful operation, provided there is no loss of blood, would be no more serious. An operation could hardly have been undertaken under less favorable conditions than those presented by the third one of these patients. Yet the child was in better condition a few hours after the double craniotomy than before the operation. Further experience alone will determine the best method of treating the patients with extensive hemorrhages such as the first and last of these cases presented. The operation in each instance should have been done at least a day earlier, and, as the results show, I should have refrained from attempting too much at one sitting.

An argument, advanced against the possibility of carrying out these operations on the new-born, is that the blood of these infants has such a slow coagulation time that a fatal hemorrhage from the incision would result. This is no more true for cranial operations in the new-born than for those in other parts of the body, and my experience leads me to think that coagulation is as rapid as in the adult, though I have made but few accurately timed tests. It is worthy of remark in this connection that the effused blood in all of these cases has been found clotted.

It will have been noted that in two of the patients symptoms definitely pointing to intracranial trouble did not appear or were not recognized until several days after birth. A more careful study of symptomatology – and this will surely follow upon the knowledge that something immediate can be done to relieve these cases and possibly to ward off the consequences of the hemorrhage – will perhaps enable us to recognize these conditions earlier.

In three of the cases – those with primary cortical hemorrhages – the effusion was confined to one side. The birth palsies, however, are more commonly supposed to be bilateral, and many of the writers on the subject regard the spastic diplegias or paraplegias as the typical cases of Little's disease, whereas a spastic hemiplegia is supposed to be more commonly of infectious origin. Extensive as it was, however, the effusion in Cases I. and IV. was unilateral, and had these patients survived, unoperated, a spastic hemiplegia probably would have resulted. In Case II., on the other hand, symptoms, appearing on the fifth day after birth with fever and unilateral convulsions, might easily have been ascribed to some infectious process; yet a hemorrhage was found and they immediately abated after the operation.

If it can be demonstrated that a craniotomy on the new-born child, when conducted with due precaution and delicacy of manipulation, is comparatively free from danger – and Cases II. and III. show how well such operations may be tolerated – I believe the immediate risk of death and the sorry late consequences of meningeal birth hemorrhages may be avoided in many cases by surgical interference. It is reasonable also to suppose that these explorations will at the same time lead us to a better understanding of the varying pathological features of this group of diseases in their early stages.