MENINGEAL HÆMORRHAGE IN THE NEW-BORN

BY

G. B. FLEMING, B.A., M.D.,
and ELLEN D. MORTON, M.B., Ch.B.

(From the Infants Department, Royal Maternity Hospital, Glasgow.)

Intra-cranial hæmorrhage is an extremely common cause of neo-natal death ; indeed, a large proportion of infants who die from the effects of asphyxia show some form of meningeal hæmorrhage. In these cases capillary oozing from the meninges is almost invariably found. Gross hæmorrhage from the meninges is also an important cause. Holland and Lane-Claypon¹ found that 25 per cent. of still births and neo-natal deaths were due to intra-cranial hæmorrhage, while Cruickshank², in 800 consecutive post-mortem examinations on infants who had died within two weeks of birth, found gross intra-cranial hæmorrhage in 161 cases (20.1 per cent.). Tentorial tears, often involving the straight sinus or the vein of Galen, are the most common lesions found, but hæmorrhage may arise from injury to the falx cerebri or to vessels running into the longitudinal sinus, and there may be oozing from the choroid plexus into the ventricles. Hæmorrhage into the brain itself is probably rare, but Schwartz³ holds that petechial hæmorrhages into the brain substance, especially in premature infants, are of common occurrence.

It is much more difficult to estimate the incidence of meningeal hæmorrhage in infants who survive. It is probably more common than is generally supposed. In 500 infants without symptoms of intra-cranial hæmorrhage Sharpe, and later Sharpe and Maclaire⁴, found blood in the cerebro-spinal fluid in 49 cases. It is possible, however, that in some of their cases the blood may have been introduced in the course of the lumbar puncture.

The physical signs are often difficult to assess : for example, muscular rigidity to a greater or less degree is present in many healthy new-born infants ; feeble cry or inability to suck may result from other causes ; muscular paralyses, squint, respiratory disturbances, though of some diagnostic value are not necessarily associated with intra-cranial injury. Probably convulsions and intermittent attacks of cyanosis⁵ are signs of considerable diagnostic value. Examination of the fundi is not of great assistance : a large number of new-born infants who are apparently healthy have retinal hæmorrhages. None of these signs affords convincing evidence, and it seems probable that the most certain method of arriving at a diagnosis during life is by lumbar puncture and the examination of the cerebro-spinal fluid. Certain precautions, however, are necessary in the examination of the fluid before a definite diagnosis of intra-cranial hæmorrhage can be made. The theca terminalis of the new-born infant is of extremely small calibre and it is very common to injure vessels either in

the walls of the theca itself or in the vertebral canal, consequently the presence of blood in the cerebro-spinal fluid obtained by lumbar puncture is not definite evidence of intra-cranial hæmorrhage. If, however, the fluid be centrifugalized without undue delay and the supernatant fluid is found to have a yellow tint, there is justification for concluding that there has been intra-cranial bleeding. That blood introduced into the cerebro-spinal fluid during puncture does not tinge the fluid immediately can be shown by taking a clear fluid and placing in it a few drops of the patient's own blood; if this is allowed to stand for 24 hours and is then centrifugalized, the supernatant fluid will almost always be found to be quite colourless, and if it is centrifugalized within half an hour of being drawn off it is always colourless. It is probable, therefore, that a xantho-chromatic cerebro-spinal fluid is the most reliable indication of intra-cranial hæmorrhage in the new-born; but it must be borne in mind that the mere presence of blood in such a fluid is per se no evidence of this lesion; the pigmentation of the fluid after centrifugalization is the important factor in diagnosis.

It was thought that some points of diagnostic or prognostic value might be elicited by analysing some of the features, observed either in the birth or subsequent course, of a series of cases which had been proved by lumbar puncture or post-mortem examination to have had intra-cranial hæmorrhage at birth. The lumbar punctures were never done earlier than 12 hours after birth.

During the period May, 1927, to December, 1928, we have had under observation 103 infants with intra-cranial hæmorrhage. 50 of these died in hospital; 53 were discharged alive, but 7 of these are known to have died since, and it is probable that some of the others whom we were unable to trace are also dead. We have been able to examine 33 of these cases when they were not less than a year old, and we have had reports of three others all of whom are said to be well.

Analysis of series.

Duration of labour.—Neither prolonged nor precipitate labour seemed to have any notable influence on the mortality. In Table 1 the cases have been divided into those in which the labour lasted for over 24 hours, between 24 and 6 hours, and those in which it lasted under 6 hours. It will be seen that the mortality from prolonged labour is lower than from precipitate labour, and that in the labours of normal duration it is higher than that of either the prolonged or the precipitate labours.

TABLE 1.
DURATION OF LABOUR.

Duration	Alive	Dead	Total
Over 24 hours	16	11	27
Between 24 and 6 hours	25	27	52
Under 6 hours	12	11	23
Totals	53	49	102*

*In one case of this series the duration of labour was not recorded.

Nature of labour.—The labour was abnormal in 51 cases (50 per cent.).

Of the 50 infants that died, 23 had abnormal deliveries (46 per cent.); instrumental in 17 and breech in 6. Of the 53 infants that survived, 28 had abnormal deliveries (53 per cent.): instrumental in 22, breech in 3, face in 1 and Cæsarean section in 2 cases. 28 of those that died were first children (56 per cent.), and 25 of those that survived were first children (48 per cent.). The incidence of abnormal delivery among these infants is almost double that occurring throughout the hospital; of 2603 women delivered in hospital during 1928 labour was abnormal in 712 cases (27 per cent.).

Influence of prematurity.—It is frequently difficult to decide whether a child is premature or not. The history of the pregnancy given by the mother is often unreliable, especially regarding the last menstrual period. On account of this we have taken the birth weight as our guide; infants under 2.5 kgm. were considered to be premature. Of the 103 cases 24 weighed less than 2.5 kgm. at birth (23 per cent.). Of these 18 died (75 per cent.), and only 6 survived, and one of these is mentally defective*. Excluding these premature infants the mortality among the mature infants was 40 per cent. The outlook therefore for the premature infant with intra-cranial hæmorrhage is bad.

Convulsions.—Convulsions were noted in 51 cases. 34 of these lived and 17 died. It is possible that convulsions occurred in other cases but were not noted. Moreover, some of those that died within a few hours of birth might have had convulsions if they had lived longer.

Intermittent attacks of cyanosis.—This sign was present fairly frequently, but it has not been possible to record its incidence numerically.

Retinal hæmorrhages.—The fundi of 81 of the infants in this series were examined and hæmorrhages were found in 38 cases (47 per cent.). It occurred in 17 of those that died and in 21 of those that lived. The incidence, however, is slightly greater in those that died, as the fundi of only 34 of these were examined as compared with 47 of the cases that lived. Many of the infants that died were either too ill to be examined, or died before examination could be made. If it had been possible to examine these, a large number would probably have shown hæmorrhages as they were the cases that had been most damaged during labour. We have found in making a routine examination of the fundi of all the infants admitted to the sick nursery, that retinal hæmorrhage frequently occurs in infants who show no signs of intra-cranial hæmorrhage, and the question arose whether an incidence of 47 per cent. was unduly high. It was found, however, that in 349 healthy infants there was retinal hæmorrhage in only 88 cases, an incidence of 25 per cent. Moreover, abnormal delivery did not seem to have any marked influence on the production of hæmorrhage, for of the 261 infants without retinal hæmorrhage the labour was abnormal in 48 per cent., and in the 88 with retinal hæmorrhage labour was abnormal in 50 per cent. An incidence of 25 per cent. is rather higher than that found by Montalcini⁶ (23 per cent.) and Sicherer⁷ (21 per cent.), but a possible explanation of this is that most of the infants who come under our care have for one reason or another, experienced rather a rough passage during birth.

*We have recently learned that this child died at the age of 2½ years.

Diagnosis.—It would appear that little is to be learned from these facts either of diagnostic or prognostic value. We have not been able to light on any sign or symptom, except a xantho-chromatic cerebro-spinal fluid, which is invariably present when there has been meningeal hæmorrhage. Though a difficult labour may arouse suspicion, many cases occur during easy labour. Prematurity is undoubtedly a predisposing cause, probably because of the weakness of the blood vessels in the immature infant. Retinal hæmorrhages are of too common occurrence in otherwise normal infants to be of value. Probably convulsions give us a positive sign of real value, but convulsions in the new-born are not always associated with intra-cranial injury; we have, on several occasions, found a colourless cerebro-spinal fluid in infants, who were having frequent convulsions. The signs presented by each case must be taken as a whole, and even then it is probable that many cases elude diagnosis.

Pathological evidence.

Post-mortem examinations were made in 39 cases. Tentorial tears were the most common lesions, occurring in 16 cases. Gross hæmorrhage under the dura mater without obvious meningeal injury was found in 13 cases. Tears of the falx cerebri were present in 6 cases and intra-ventricular hæmorrhage in 6: one of these had also a tear of the falx and one a tentorial tear.

In 25 of the autopsies the intra-cranial damage was probably the direct cause of death, though other lesions were present in 4 of these cases. In the other 14 cases lesions outside the cranium were found which probably caused death: pneumonia or atelectasis in 7, asphyxia in 1, enteritis in 4 and sepsis in 2. Probably injury to the respiratory centre is an important factor in the causation of respiratory disease in the new-born, so it is likely that death in the pneumonia-atelectasis-asphyxia group was indirectly due to intra-cranial hæmorrhage; on the other hand the deaths from enteritis and sepsis were probably not related to the head injury. Thus, in all but 6 of these infants, it is probable that intra-cranial hæmorrhage was responsible for death. 18 of these cases were diagnosed before death by lumbar puncture; some of the 21 cases not diagnosed before death, died before lumbar puncture could be performed, but there were others in which the intra-cranial injury was not suspected. Probably meningeal hæmorrhage occurs much more commonly than is generally supposed.

In Table 2 the results of the post-mortem examinations are summarized.

Late results of intra-cranial hæmorrhage.

In the present series intra-cranial hæmorrhage proved fatal in over half the cases. Its influence on the subsequent development of the nervous system in such cases as survive is difficult to gauge. There is general agreement that a certain number of infants are permanently crippled either mentally or physically, but there is considerable difference of opinion regarding the nature of the disability produced. Some hold that intra-cranial hæmorrhage at birth is a common cause of Little's disease (McNutt⁸, Gowers⁹, Marfan¹⁰, Taylor¹¹, Munro and Eustis¹², Cameron and Osman¹³); Little¹⁴ thought that spastic rigidity in children was due to asphyxia and petechial hæmorrhages in the

TABLE 2.

SUMMARY OF PATHOLOGICAL RESULTS.

Intra-cranial lesion	Other lesions	Duration of life	Birth Weight	Cause of Death
			kgm.	
Tentorial tears	1. Hydrocephalus	7 days	3.5	Gastro-enteritis Pneumonia
	2.	1 day	4.3	
	3. Pericardial and pleural hæm.	6 hours	2.2	
	4.	2 days	3.7	
	5 Gastro-enteritis	20 "	3.4	
	6 Pneumonia	3 "	1.75	
	7 Hæm. round kidney ..	12 hours	4.0	Pneumonia Pneumonia
	8 Rupture v. of Galen ..	2 days	2.5	
	9	9 "	3.3	
	10 Pneumonia	8 "	2.3	
	11 Pneumonia	20 "	2.2	Atelectasis
	12	1 day	2.1	
	13 Atelectasis	12 hours	2.8	
	14 Epicardial and ventricular hæmorrhage	2 days	3.8	
	15	2 "	3.4	
	16	12 hours	2.8	
Tears of falx cerebri	1. Albuminuria	17 days	3.8	? Sepsis
	2.	4 "	2.6	Asphyxia
	3. Asphyxia	12 hours	?	
	4.	2 days	3.2	
	5. Fractured skull	2 "	3.8	
	6. Ventricular hæmorrhage ..	2 "	3.0	
Ventricular hæmorrhage	1. Sinus thrombosis	3 days	2.0	Pneumonia
	2.	3 "	2.35	
	3. Hydrocephalus	4 "	1.4	
	4. Thrombosis v. of Galen : pneumonia	6 "	3.1	
No gross meningeal tear.	1.	2 days	2.5	? Gastro-enteritis
	2.	1 day	3.0	
	3.	15 days	2.2	
	4.	5 "	2.3	
	5. Enteritis	15 "	4.8	Enteritis
	6. Thrombosis meningeal veins	15 "	2.0	Enteritis Pneumonia Pneumonia
	7. ? Enteritis	10 "	2.8	
	8. Atelectasis ; pneumonia ..	12 "	3.3	
	9. Pneumonia	14 "	3.3	
	10.	1 day	2.7	Sepsis
	11. Abscess of lung	26 days	2.2	
	12. Rupture v. of Galen. Cortical hæmorrhage	1 day	2.5	
	13. Thrombosis longitudinal sinus	7 days	2.65	

brain substance. Others maintain that it is never due to injury at birth, but is caused by maldevelopment of the brain during or after foetal life (Freud¹⁵, Collier¹⁶, Ford¹⁷). The question has been discussed at length by Ford. He admits that mental deficiency, hydrocephalus and asymmetrical spastic paralyses may occur, but is strongly of opinion that Little's disease is not the result of intra-cranial injury at birth. He says that he has been unable to find a single report of a case of true cerebral diplegia in which the occurrence of intra-cranial hæmorrhage at birth was established. The present conflict of opinion may be due to confusion in nomenclature; what one may call spastic diplegia, another may call double hemiplegia; but there can be no doubt that the hemiplegias and spastic hydrocephalics are not cases of Little's disease, though Little himself in his classical paper includes in his series of cases several examples of hemiplegia and monoplegia which are almost certainly due to birth trauma.

In some respects the question is only of academic interest. From the patient's point of view it is of little consequence whether he has a double hemiplegia or a true spastic diplegia. To the obstetrician, on the other hand, the question is of the first importance. There is no doubt that intra-cranial hæmorrhage is responsible for a large proportion of neo-natal deaths and also for a considerable number of cases of spastic infantile paralysis and mental deficiency, and if we are to add to these the true cases of Little's disease, it becomes doubly important for the obstetrician to devise means to mitigate the stresses and strains to which the infant is subjected during birth.

In the present series 53 infants were dismissed from hospital alive: 6 of these are known to have died and we have been able to examine 33 when they were not less than one year old. The great majority of these appeared to be quite normal both mentally and physically, but 5 were definitely suffering from the effects of the birth injury.

Summaries of cases showing permanent defects.

The following are brief summaries of the five cases which were found to show defects more than a year after the birth injury.

1. **McI.** First child, mother eclamptic, forceps delivery, duration of labour 24 hours. Cried readily, feeble and very cyanosed. Weight, 2·7 kgrm. Had a convulsion during examination. Lumbar puncture, fluid deeply blood-stained, supernatant fluid yellow. For first two days very rigid and had frequent attacks of cyanosis; after this did well.

At age of 8 months mother reported that the child was doing well. At the age of 20 months the mother sought advice because she was not satisfied with the child's condition. At that time the child was probably mentally defective, neither talking nor walking. Twitching and stiffness of the left arm. Scoliosis. Head circumference 44 cm.

2. **SH.** Fourth child, spontaneous delivery, duration of labour 11 hours. Birth weight 3·6 kgrm. Breathed at once, cried incessantly. Generalized rigidity noted when six days old, right arm especially rigid. Lumbar puncture, 3 c.cm. blood-stained fluid withdrawn, supernatant fluid yellow. Rigidity passed off and child improved rapidly.

When seen at age of 2 months appeared normal but when seen again at the age of one year, child looked mentally defective and the mother thought the child backward, not talking nor attempting to walk. No rigidity. Head circumference 46 cm.

3. **SM.** Second child, spontaneous delivery, duration of labour 4 hours. Pale and feeble at birth. Weight 3·4 kgrm. Retinal hæmorrhages in both fundi. Child seemed to do fairly well but when 9 days old fontanelle noted to be tense. Lumbar puncture failed. When 11 days

old fontanelle still bulging. Squint and nystagmus noted. Head circumference 39.5 cm. (normal 32 to 35 cm.). Ventricular puncture yielded 100 c.cm. reddish brown fluid which on centrifugalizing remained deeply pigmented. At the age of 3 months hydrocephalus had increased and was proved to be of the obstructive type.

At the age of 2 years huge hydrocephalus, head circumference 62 cm. Probably blind, optic discs pale, nystagmus. Spastic condition of left arm, legs not definitely spastic but knee jerks very active. Plantar reflexes, ? flexor. Not sitting up, not talking. Mentally defective.

4. S. First child, forceps delivery, duration of labour 27 hours. Weight at birth, 4.1 kgrm. Breathed readily. Stiffness of left arm. Lumbar puncture, 6 c.cm. xanthochromatic fluid withdrawn. For five days after birth numerous attacks of twitching especially of the left side. After this rigidity became less and twitchings ceased.

When seen at the age of 14 months, appeared mentally defective, violent attacks of screaming, not trying to walk, can hardly sit up, does not grasp objects. Stiffness and athetoid movements of both arms and rigidity of right leg. Head circumference 45 cm.

5. B. Mother multiparous, contracted pelvis, spontaneous delivery, duration of labour 11½ hours. Birth weight 2 kgrm. Feeble at birth, stiff left side, numerous convulsions. Retinal hæmorrhages both eyes. Lumbar puncture, 5 c.cm. yellow cerebro-spinal fluid withdrawn. For first two weeks child extremely ill. Comatose and very rigid, then gradually began to improve. At 20 months old obviously mentally defective not walking or talking. No definite rigidity. Head circumference 41.5 cm. A further report of the child when 2 years old obtained from Dr. Martin of Stobhill Hospital states that the child is a microcephalic idiot with rigid limbs and optic atrophy. The child died in Ruchill Hospital at the age of 2½ years. At the autopsy (the report of which we owe Dr. Anderson of Ruchill Hospital) empyema and bronchopneumonia were found; there was external hydrocephalus, the cerebral convolutions were small and flattened and there was considerable softening of the upper cerebral grey matter.

Discussion.

Certain features worthy of note emerge from a study of these five cases. The labour was abnormal in three of the cases.

One infant was premature.

Three were above normal weight.

Two were first children.

Three had convulsions.

Two had retinal hæmorrhages.

There was spasticity of one or more limbs in four cases.

One infant was hydrocephalic.

All were mentally defective.

One of the patients (No. 5) was probably a true case of cerebral diplegia. The child was premature and developed spastic limbs, optic atrophy and microcephalus; post mortem external hydrocephalus was found with softening and atrophy of cerebral grey matter.

From these data it does not seem possible to find any common factor in the birth to account for the intra-cranial injury. One was a very large full term infant, one was very small and premature. In two the delivery was by forceps, in the other three it was spontaneous. Moreover the physical signs observed after birth did not differ in any respect from many other infants who have subsequently shown neither mental nor physical defects. Some of those, indeed, who have made a complete recovery seemed to have had far worse injury at birth than any of the five cases under discussion. The following case illustrates this:—

Twin; high forceps delivery. Weight at birth 2.48 kgrm. Facial paralysis right side. Hæmorrhages left fundus. Twitching of the limbs commenced six days after birth. Lumbar

puncture revealed xanthochromatic spinal fluid. Twitchings and convulsions continued till the child was two months old then ceased. When seen at the age of 14 months the child was noted to be very bright and intelligent, walking and beginning to talk. No rigidity. Facial paralysis well. Head circumference 45 cm.

In this case we have a premature infant who was delivered by forceps and had facial paralysis, retinal hæmorrhages and convulsions, yet at the age of 14 months appeared to be a perfectly normal child.

Probably the apparent severity of the injury received at birth is of little help in the prognosis. There are, of course, cases in which the head is so severely damaged that there can be no hope of recovery and death occurs in a few hours or days, but once the infant gets over the immediate effect of the trauma it is impossible to foretell its ultimate fate. It is possible that the sequelæ are dependant more on the site of the hæmorrhage than its extent. Thus hæmorrhage into the ventricles with blocking of the iter or foramina of Majendie will probably cause hydrocephalus which in a large number of cases leads to mental deficiency and paralysis; hæmorrhage in the region of the medulla though only of small extent may prove rapidly fatal, while there may be complete recovery from extensive hæmorrhage over the cerebral cortex.

Summary.

103 cases of intra-cranial hæmorrhage occurring at birth are discussed.

A xantho-chromatic cerebro-spinal fluid found by lumbar puncture is the most certain proof of meningeal hæmorrhage in the new-born.

In the cases under review the immediate mortality was 48 per cent. The mortality in the premature infants was 75 per cent.

Labour was abnormal in half the cases.

Tentorial tears were the most common post-mortem finding.

In 33 cases seen when over a year old 5 were found to have mental or physical defects.

Many of the infants showing severe injury to the head at birth made perfect recoveries and showed no sequelæ.

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