

A 10-year Review of Intracranial Haemorrhage in Term Neonates

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Abstract

A retrospective chart review of 18 cases with imaging confirmed diagnosis of intracranial haemorrhages (ICH) delivered at term in Tuen Mun Hospital between January 1995 and December 2004 was done. The demographic data, perinatal events, clinical characteristics, treatment and long term outcome were reviewed. The commonest mode of delivery was vacuum extraction. The most prevalent perinatal event identified was fetal distress. In contrast with previous studies, coagulopathy was present in only one newborn. Ten infants (55.6%) presented with seizures, nine of them developed within the first 72 hours. For babies with intraparenchymal and/or extra-axial haemorrhages, they presented uniformly with seizure. For peri/intraventricular haemorrhages, the presentation was more varied. Only one infant required surgical intervention and during a mean follow-up period of fifty-five months in fourteen patients, ten children with an uncomplicated ICH demonstrated normal neurological outcome.

Key words

Full-term neonates; Intracranial haemorrhage

Introduction

Intracranial haemorrhage (ICH) is an uncommon event in full-term neonates. The clinical characteristics of ICH in full-term infants have been described in several case series or studies.¹⁻⁶ However, local data are yet lacking. With variation of disease pattern across the globe and changes in obstetrical and neonatal practice, clinical patterns, management and prognosis may change over time. In the recent decade, declining rates of instrumental (vacuum or forceps) delivery and rising rate of cesarean delivery are observed in oversea series^{7,8} and in our center. This may

result in decreasing incidence of birth trauma and birth asphyxia. The high frequency ventilation (HFV), inhaled nitric oxide (iNO) therapy and extracorporeal membranous oxygenation (ECMO) were used in the neonatal population since 1990s. Thus, previously non-salvage critically ill neonates may survive today under intensive care, at the cost of more iatrogenic complications. This case series will outline the demographic characteristics, common perinatal events, clinical characteristics, treatment and long-term outcome in a consecutive series of 18 full-term neonates with imaging confirmed ICH in the past decade.

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Patients and Methods

Patients Identification

Full-term newborns with imaging (ultrasonography, USG, computed tomography scan, CT scan, or magnetic resonance imaging, MRI) confirmed diagnosis of ICH delivered in Tuen Mun Hospital between January 1995 and December 2004 were identified and included in the study through a computerised search of the International

Classification of Diseases, 9th Revision (ICD-9) diagnostic codes. The records of the neonates with ICD code 767.0 (subdural haemorrhage, SDH and cerebral haemorrhage), 772.1 (intra-ventricular haemorrhage, IVH) and 772.2 (subarachnoid haemorrhage, SAH) and their mothers' records were reviewed using a standardised data collection form. Data collected include the demographic data, mode of delivery, common perinatal events, clinical presentation, imaging results, concomitant morbidity, interventions and long term outcome.

Indications for Imaging Studies

Beside cranial USG was the usual initial investigation to screen for ICH. Throughout the 10-year study period, imaging was considered in all infants with seizures, hypoxic ischaemic encephalopathy (HIE), birth asphyxia, unexplained rapid drop in haemoglobin level, significant thrombocytopenia with platelet count under 50,000/mm³, clinical bleeding tendency, hypovolemic shock at birth and clinical suspicion of hydrocephalus. For transient neonatal depression, non-specific complaints like vomiting or fever, the managing physician made the judgement on whether imaging should be indicated. For cases with intraparenchymal bleeding noted on initial cranial USG screening, CT scans would then be performed to delineate the extent of bleeding. Occasionally, CT scan was used as the initial investigation to screen for ICH. The usual scenario was neonatal seizure after traumatic birth process. Early MRI studies had been done for those with intraparenchymal haemorrhage, grade III/IV IVH or ventriculomegaly to look for underlying structural abnormalities. MRI studies had also been done within the first three months for those having stage II/III HIE⁹ for potential medicolegal problems and prognosis prediction.

Papille's Criteria

The results of the cranial USG were graded using the Papille's criteria.¹⁰ Grade I: isolated subependymal haemorrhage. Grade II: rupture into lateral ventricle without ventricular dilatation. Grade III: rupture into lateral ventricle with ventricular dilatation. Grade IV: intraventricular haemorrhage with parenchymal extension.

Developmental Follow-up

Developmental follow-up was conducted by paediatricians through clinic visits and by telephone interviews. Outcome was classified as normal if the child has no neurological signs and is coping well with the mainstream school education.

Review of Cases (Tables 1 & 2)

Demographic Characteristics

Eighteen full-term infants (13 male) with imaging confirmed ICH, including 11 infants with peri/intraventricular haemorrhage (PIVH), were included in the analysis. All were born in our center. Patients ranged in gestational age from 37+1 to 42+5 weeks. Birth weights ranged from 2290 to 4300 grams. Three of 18 patients weighed more than 4000 grams; the two patients who were small for their gestational age¹¹ weighed 2290 and 2700 grams, respectively.

Mode of Delivery

Seven patients were born by cesarean section (CS), seven by vacuum extraction (VE) and four by spontaneous vaginal delivery (SVD). Among the seven newborns delivered by CS, two (cases 8 & 10) were delivered electively for placenta previa in the absence of labour. For the other five, cesarean deliveries were performed after the period of labour process, one (case 2) was performed for fetal distress and failed VE. Another case (case 7) was performed for fetal distress and cephalopelvic disproportion. Two cases (cases 14 & 16) were performed for fetal distress alone and one (case 18) for compound presentation. All the seven VE done were for fetal distress.

As compared with infants born by SVD, those delivered by VE had significantly higher rates of imaging confirmed ICH. Imaging confirmed ICH occurred in 7 of every 6,077 infants delivered by VE, as compared with 11 of 53,444 not delivered by VE (odds ratio, 5.60; 95% confidence interval, 2.17 to 14.44).

As compared with infants born by SVD, those delivered by CS had higher, but statistically insignificant, rates of imaging confirmed ICH. Imaging confirmed ICH occurred in 7 of every 12,568 infants delivered by CS, as compared with 11 of 46,953 not delivered by CS (odds ratio, 2.38; 95% confidence interval, 0.92 to 6.13).

As compared with infants born by instrumental delivery (vacuum or forceps) and CS, those delivered by SVD had significantly lower rates of imaging confirmed ICH. Imaging confirmed ICH occurred in 4 of every 40,861 infants delivered by SVD, as compared with 14 of 18,660 delivered by instrumental or cesarean delivery (odds ratio 0.13; 95% confidence interval, 0.04 to 0.40).

Common Perinatal Events

As mentioned above, fetal distress was the main indication for emergency CS and VE. In fact, fetal distress

Table 1 Intraparenchymal and extra-axial haemorrhage in full-term neonates

No.	GA(wk)/ Sex	Birth weight (g)	Labour/ delivery ^a	AS (1,5 min)	Concomitant morbidity ^b	Clinical presentation	Imaging results ^c	Common perinatal events ^d	Treatment	Outcome (*defaulted)
1	41/F	4300	VE	1,3	Stage III HIE	Seizure, 3 hours	MRI: SDH in posterior cranial fossa, posterior interhemispheric fissure & along superior cerebral convexity	FD, DD, BA	Conservative	Epilepsy, spastic quadriplegia, blind & deaf. Died at 18 months
2	39/F	2680	EMCS	5,8	Transient tachypnoea of newborn	Seizure, 16 hours	CT: small left SDH	FD, DD	Conservative	Normal development, 5 years 10 months
3	37/M	2550	SVD	8,8	Osteogenesis imperfecta	Seizure, day 19	MRI: left parietal hematoma	Nil	Conservative	In special school, 4 years 4 months
4	40/M	4120	VE	2,5	Stage II HIE	Seizure, 16 minutes	MRI: subacute SDH in parietoccipital region & posterior interhemispheric fissure	FD, DD	Conservative	*Normal development, 2 months
5	40/M	3020	VE	9,10	Spontaneous pneumothorax on day 1	Seizure, day 3	CT: SDH along posterior falx on the right side	FD	Conservative	Normal development, 2 years 6 months
6	42/M	4040	VE	8,9	Group B <i>Streptococcus pneumoniae</i> & mild MAS	Seizure, day 2	MRI: right occipital-parietal intraparenchymal haematoma in different stage of bleeding, with loculated SAH and SDH	FD	Conservative	*Normal development, 1 month
7	40/M	3450	EMCS	3,8,9	Stage II HIE	Seizure, 40 hours	CT: acute SDH in bilateral fronto-parietal regions & SAH	FD, DD	Conservative	*Normal development, 6 months

GA (wk), gestational age (weeks); AS (1,5 min), Apgar scores at 1, 5 minutes

^a VE denotes vacuum extraction, EMCS emergency cesarean section, and SVD spontaneous vaginal delivery

^b HIE denotes hypoxic ischaemic encephalopathy, and MAS meconium aspiration syndrome

^c SDH denotes subdural haematoma, and SAH subarachnoid haemorrhage

^d FD denotes fetal distress, DD difficult delivery process and BA birth asphyxia

Table 2 Peri/intraventricular (PIVH) haemorrhage in full-term neonates

No.	GA(wk)/ Sex	Birth weight (g)	Labour/ delivery ^a	AS (1,5 min)	Concomitant morbidity ^b	Clinical presentation ^c	Imaging results	Common perinatal events ^d	Treatment	Outcome
8	37/F	2400	ELCS	7,9	Necrotising enterocolitis stage IV	<i>E. coli</i> bacteremia causing DIC, day 10	USG: left grade II	DIC	Conservative	Attend normal school with poor results, 10 years 6 months
9	42/F	3900	SVD	8,9	Soto syndrome, PDA+ASD causing CHF	Rapid increase in head circumference, 1 month	USG: old grade I	Nil	Conservative	Epilepsy, in special school, on hearing aids, 7 years 8 months
10	38/M	3300	ELCS, forceps applied	5,9	Pneumonia, negative cultures	Seizure, day 3	USG: left grade III	Nil	Conservative	Normal development, 7 years 4 months
11	40/M	2700	VE	7,8	Non specific birth asphyxia	Hypovolemic shock at birth	USG: right grade II	FD	Conservative	Normal development, 6 years 9 months
12	41/M	2960	VE	8,9	Neonatal jaundice	Repeated vomiting, day 4	USG: previous bilateral grade I	FD	Conservative	Normal development, 4 years 6 months
13	40/M	3150	SVD	3,5,6	Tuberous sclerosis Antenatal USG: ventriculomegaly	Transient neonatal depression at birth	USG, CT: IVH in both occipital horns & subdural haematoma	FD	Conservative	Mental retardation, impaired hearing & epilepsy, 3 years 9 months
14	41/M	3160	EMCS	5,7	Severe MAS and PPHN	Screen for complications of PPHN, day 9	USG: right grade I	FD	Conservative	Normal development, 2 years 7 months
15	40/M	3430	VE	2,3,4	Stage II HIE	Seizure, 1 hour	USG: right grade I, left grade II	FD	Conservative	Normal development, 2 years 6 months
16	41/M	3400	EMCS	9,10	Nil	Seizure, day 3	USG, CT, MRI: right grade II, left grade III	FD	Conservative	Normal development, 2 years 3 months
17	39/M	2290	SVD	8,9	Nil	Wide anterior fontanelle, day 5	USG: bilateral grade I	Nil	Conservative	Normal development, 2 years 3 months
18	37/F	3390	EMCS	8,9	Nil	Big head & repeated vomiting, day 13	USG, CT, MRI: acute IVH & obstructive hydrocephalus	Nil	Shunting for hydro- cephalus	Normal development, 19 months

GA (wk), gestational age (weeks); AS (1,5 min), Apgar score at 1, 5 minutes

^a ELCS denotes elective cesarean section, SVD spontaneous vaginal delivery, VE vacuum extraction, and EMCS emergency cesarean section

^b PDA denotes patent ductus arteriosus, ASD atrial septal defect, CHF congestive heart failure, MAS meconium aspiration syndrome, PPHN persistent hypertension of the newborn, and HIE hypoxic ischaemic encephalopathy

^c DIC denotes disseminated intravascular coagulation

^d FD denotes fetal distress

was the commonest perinatal events identified among our series. Fetal distress was present in 6 of the 7 neonates with intraparenchymal and extra-axial haemorrhage and in 6 of the 11 neonates with PIVH.

In four of the seven infants with intraparenchymal and extra-axial haemorrhage, the intracranial haemorrhages were associated with difficult delivery process. In cases 1 and 4, shoulder dystocia was present. In case 2, VE had been attempted but was unsuccessful as the fetus failed to descend. In case 7, the second stage was prolonged because of cephalopelvic disproportion and the delivery of the fetal head was difficult.

While case 1 demonstrated clinical features of stage III HIE, cases 4 and 7 demonstrated features of stage II HIE. Among these eighteen neonates with ICH, only one case fulfilled the diagnostic criteria of birth asphyxia as endorsed by ACOG.¹²

In this case series, ICH was associated with coagulopathy in one patient with disseminated intravascular coagulation (DIC) secondary to sepsis, case 8. Apart from that, all patients' platelet counts measured at or above 135,000/mm³ and all coagulation profiles performed were normal.

Five MRI studies had been done to look for underlying structural abnormalities (cases 3, 6, 13, 16 & 18). No structural abnormalities could be identified among all of them.

Clinical Presentation

Ten infants (55.6%) presented with seizures. All, except one, developed seizures within the first 72 hours follow birth. All seven babies with intraparenchymal and/or extra-axial haemorrhages presented with seizures. The single case with late onset seizure was a baby with osteogenesis imperfecta (case 3).

For patients with PIVH, the presenting symptoms were seizure in 3 infants. Other presentations included rapid head growth (case 9), wide anterior fontanelle (case 17), big head (case 18), hypovolemic shock (case 11), repeated vomiting (case 12) and transient neonatal depression (case 13). Two infants with PIVH were having no neurological symptoms but were picked up during USG brain screen while having DIC (case 8) and persistent pulmonary hypertension of the newborn (PPHN) (case 14).

Imaging Studies

Among the seven infants with intraparenchymal and extra-axial haemorrhage, ICH were initially identified by ultrasound, and confirmed by CT scans in three patients (cases 3, 5 & 6). In cases 2 and 7, CT scans were obtained

at presentation without prior USG. Intracranial haemorrhages escaped ultrasound detection but were picked up by MRI in cases 1 and 4. All peri/intraventricular haemorrhages were identified by USG.

Intervention and Long Term Outcome

One infant (case 18) required surgical shunting for obstructive hydrocephalus and one child (5.6%) died during the period under analysis.

Excluding the death case (case 1) and three other infants that defaulted (cases 4, 6 & 7), fourteen patients were available for follow-up. During a mean follow-up period of 55 months (range, 19-126 months), 10 of the 14 patients demonstrated normal neurological outcome. While the boy with osteogenesis imperfecta (case 3) attended special school, the girl that survived the necrotising enterocolitis and DIC (case 8) performed badly in ordinary school. Two patients with syndromal illness (cases 9 & 13) were in special school, had epilepsy and hearing impairment.

Discussion

ICH is an uncommon event in full-term neonates. In our locality, the clinical characteristics and the outcome of full-term neonates with ICH has never been reported. This case series is the first to report the demographic characteristics, mode of delivery, perinatal events, clinical presentations, cranial imaging results and outcome among this group of neonates in Hong Kong Special Administrative Region. The 18 cases of ICH were identified during a study period of 10 years during which a total of 59, 711 full-term infants were delivered in Tuen Mun Hospital.

Mode of Delivery

In our study, while vacuum extraction was found to be a risk factor for neonatal ICH, spontaneous vaginal delivery was found to be a protective factor. For VE, the associated ICH can be explained by the vertical traction on the skull and brain causing rupture of bridging veins in the subdural compartment.¹³ In addition, this vertical stress may produce subarachnoid haemorrhage via laceration of the venous sinuses and/or rupture of cortical veins as they enter the venous sinus and/or vein of Galen.¹³

Common Perinatal Events

1. Fetal Distress

As early as 1980s, the effect of fetal distress on the

neonatal CT brain findings had been reported in Japanese article.¹⁴ That study involved 11 cases of full term vertex delivery in which fetal heart rate (FHR) was recorded by fetal direct electrocardiogram during the second stage labour. All infants weighed 2500 grams or more. Two cases with prolonged bradycardia and no variability had intraventricular or intra-cerebral haemorrhage that resulted in severe central nervous system damage. One case with prolonged bradycardia and no variability resulted in severe neonatal brain oedema. Four cases with variable deceleration and increased variability resulted in mild neonatal brain oedema.

A recent Spanish study involved 17 newborn babies of over 35 weeks gestation who had a history of early neonatal intracranial haemorrhage showed that 58% had a history of acute fetal distress.¹⁵ In our study, 12 of the 18 (67%) neonates with ICH had a history of fetal distress.

Fetal distress may be a manifestation of antenatal fetal ICH. A review on literature from 1966 to 1998 pertaining to antepartum fetal intracranial haemorrhage stated that the antenatal fetal ICH might occur spontaneously, or occur in association with various maternal or fetal conditions.¹⁶ Various types of antenatal fetal ICH that have been visualised sonographically include intraventricular, periventricular, subependymal, parenchymal, subdural, and intracerebellar events. Active haemorrhages may be associated with fetal distress manifested by fetal heart rate changes.

2. Birth Asphyxia and Coagulopathy

In our series, though HIE was an associated finding in 3 of the 7 neonates with intraparenchymal and extra-axial haemorrhage (Table 1), only one patient fulfilled the diagnostic criteria for birth asphyxia as endorsed by ACOG.¹² In contrary to the findings in previous studies³⁻⁵ of thrombocytopenia and coagulopathy being an important cause of ICH among full-term infants, coagulopathy was an associated risk factor in only 1 of our 18 neonates (5.6%).

Clinical Presentation

The commonest clinical presentation associated with ICH in our series was seizure and seizure was the presenting complaint in all our babies with intraparenchymal and extra-axial haemorrhage (Table 1). This finding is consistent with other reports of intraparenchymal haemorrhage in full-term neonates.^{4,17,18} In contrast with the early onset of seizures in babies with intraparenchymal and extra-axial haemorrhage, five peri/intraventricular haemorrhages (cases

8, 9, 14, 17 & 18) occurred at 5 or more days following birth, which confirmed previous reports that these haemorrhages occurred at a later age than usually seen in preterm infants.^{2,17,19} Moreover, the clinical spectrum of PIVH was more varied (Table 2). Apart from seizure, three patients presented with complaints of the size of the head or anterior fontanelle and three patients presented with non-specific symptoms. The remaining two PIVH cases were picked up incidentally.

Imaging Studies

Three SDH among our series escaped ultrasound detection (cases 1, 4 & 6). This finding is consistent with previous report that subarachnoid haemorrhage, mild coexistent intracerebral and subdural bleedings might escape ultrasound detection.²⁰ It was believed that the dilution of a small amount of subarachnoid blood in the cerebrospinal fluid might explain the negative ultrasound examinations.²⁰ In addition, small tears of brain parenchyma next to the falx and the associated small brain petechiae that appeared as high densities on CT were usually not demonstrated by ultrasound.²⁰

The detection of small SDH was not of major clinical significance as the aforementioned study,²⁰ using CT scan and a recent prospective study,²¹ using MRI, revealed that all babies with SDH required no intervention and all haematomas had completely resolved when rescanned at 4 weeks. Furthermore, a recent pilot study using MRI to evaluate ICH found small SDH of the falx cerebri or tentorium cerebelli in half of the normal term neonates with an uneventful vaginal deliveries.²²

Intervention and Long Term Outcome

In this series, no child with an uncomplicated ICH demonstrated developmental delay. For the four patients with neurodevelopmental sequelae, all of them have significant co-morbid condition. For the boy with osteogenesis imperfecta (case 3), the brain parenchymal insult and multiple long bones fracture would cause global delay. For the girl that survived the gut resection and fulminant sepsis (case 8), recurrent episodes of haemodynamic disturbance would lead to perturbations of cerebral blood flow. This will lead to hypoxic damage of the brain and may cause subtle cognitive and behaviour adversities. Soto syndrome (case 9) and tuberous sclerosis (case 13) on their own can be associated with neuro-developmental debilities. Thus, the neurodevelopmental delay in these four sufferers probably was related to their co-morbid condition rather

than the ICH.

Surgical decompression was required in only one child with elevation of intracranial pressure and obstructive hydrocephalus (case 18). That girl had the ventricular shunt inserted on day 15. During the subsequent follow up, repeated CT and MRI studies showed no recurrence of PIVH and when last seen at 19 months, her developmental milestones were age appropriate.

In summary, our finding of favourable clinical outcome in uncomplicated ICH is in line with previous studies.^{2,4,22}

Conclusion

Intracranial haemorrhage is an uncommon and underreported event in term neonates. In our series, vacuum extraction was the commonest mode of delivery and fetal distress was the most prevalent perinatal event identified. In contrast with previous studies, coagulopathy was present in only one newborn. Seizure was the commonest presentation and all babies with intraparenchymal and/or extra-axial haemorrhages presented with seizures. For patients with peri/intraventricular haemorrhages, the presentation was more varied and non-specific. Only one infant required surgical intervention and favourable outcome was seen in all children with uncomplicated ICH.

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