Neurosurgical Management of Intraventricular Haemorrhage in Preterm Infants

Pages with reference to book, From 195 To 200

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Abstract

A review of intraventricular haemorrhage (IVH) diagnosed in 103 preterm infants from 1983 to 1993 describes the presenting features and management of this condition. In this 10-year period, 37 infants with IVH developed post-haemorrhagic hydrocephalus (PHH), defined as ventriculomegaly, raised Intracranial pressure and Increasing head circumference. PHH was treated by external ventricular drainage and/or ventriculo- peritoneal shunting; but other drainage procedures like lumbar punctures and subcutaneous ventricular reservoir were used occasionally. Relative indications, merits and demerits of these various surgical options is discussed and results summarised. High incidence of neuro-developmental handicap and its correlation with the grade of haemorrhage and PHH is emphasized. External ventricular drainage (EVD) was found to be an effective and safe therapy for rapidly progressive PHH and increased intracranial pressure. Ultimate outcome depended mainly on the grade of haemorrhage, severity of PHH and promptness of its neurosurgical management (JPMA 43:195 , 1993).

Introduction

Intraventricular haemorrhage (LVH) or germinal matrix haemorrhage (GMH) is a major problem of preterm neonates[1] and with further progress in neonatology the number of viable preterm infants and hence the incidence of IV}{ and GMH will increase[2]. Over 40% of infants with birth weights less than 1500 gm sustain WH/GMH[3-5]. Of these infants, 20% to 50% will go on to develop transient or progressive hydrocephalus[6]. Two mechanisms have been described to explain the development of PHH. Obstruction of CSF pathways by clot and cellular debris may occur at Sylvian aqueduct or basal cisterns, causing an acute non-communicating Lydrocephalus[1,7]. More commonly, subarachnoid blood initiates a fibrosing arachnoiditis with obstruction of CSF flow[1,2,7,8]. PHH is associated with a high incidence of long-term neurological handicap[9-12]. We experienced a 40.5% incidence of such handicap. Early recognition and rapid control of PHH may lead to decreased morbidity.

Summary of Cases

Clinical Data

During this period of 10 years, the diagnosis of IVH/GMH was made on 103 preterm infants (41 females and 62 males). Ultrasound and computerized tomography (CT) scan confirmation of diagnosis was made in all the cases. Gestational age of these infants ranged from 25 to 35 weeks (mean 30.7 weeks); and their birth weights ranged from 500 to 1500 gm (mean 1055.8 gin). Of these 103 preterm infants with WH, 37 (35.9%) required surgical management for post-haemorrhagic hydrocephalus and were designated as the “surgical group”.

Grading

Using the CT criteria of Papile et al13 patients were classified into 4 grades; where a grade I

haemorrhage is subependymal, a grade II intraventricular, a grade III intraventricular with ventricular dilation and a grade W intraventricular with parenchymal extension. Haemorrhages diagnosed by ultrasound were also graded in a similar fashion. Thus 27 infants had GMH only, 19 had grade II haemorrhage, grade III was assigned to 33 and 24 infants sustained grade W WH. Five infants, initially classified as grade II IVH, developed delayed PHH.

Table I. Relationship of IVH grade and PHH.

IVH Grade	No. of cases	Cases developing PHH	
		No.	(%)
I	27	0	(0)
II	19	6*	(31.6)
III	33	17	(51.5)
IV	24	14	(58.3)
Total	103	37	(35.9)

*Delayed PHH

Table I gives a grade-wise break-up of our cases and the correlation between the WH grade and PHH.
Clinical presentation and associated conditions
The most frequent presenting feature was pallor, followed by seizures; but in more than half of our patients the haemorrhage was silent and diagnosis was made by ultrasonography (Table II).

Table II. Presenting feature of IVH (n=103)

*Signs and symptom	No. of patients	(%)
Pallor	44	(42.7)
Seizures	40	(38.8)
Bulging fontanelle	31	(30.1)
Apnoea	18	(17.5)
Hypotension	14	(13.6)
**None	56	(54.4)

*More than one sign or symptoms per infant
**Diagnosed by ultrasonography

The commonest conditions associated with WH were respiratory distress syndrome (EDS) seen in 82 of 103 infants (79.6%) and patent ductus arteriosus occurred in 41 cases (39.8%).

Radiological evaluation

All the 103 infants with WH had cranial ultrasonographic examination performed at 3 and 7 days of

age. In addition, all the 37 infants in the surgical group had pre- and post-operative CT scans of the brain to monitor ventricular size.

Surgical procedures

Various CSF drainage procedures used to treat PHH included lumbar puncture, ventricular puncture, external ventricular drainage, subcutaneous ventricular reservoir and VP shunt. Serial lumbar punctures were used in the earlier days of this study in 6 infants only. Direct ventricular puncture, via the outer angle of anterior fontanelle, was used as an emergency measure on 9 occasions to relieve acutely raised intracranial pressure (JCP) with apnoea or acute deterioration in the neurological condition and was found to be an effective life-saving measure in emergency situations. Apart from the previously mentioned ventricular and lumbar punctures, which were only used as emergency drainage procedures, the mainstay of definitive management of PHH consisted of judicious use of external ventricular drainage (EVD) and ventriculoperitoneal (VP) shunting. Subcutaneous ventricular reservoir, used in 5 of our cases, failed to provide permanent control of PHH. All the five reservoirs, including the one that got infected, were removed and replaced by VP shunts. Various modalities of definitive neurosurgical treatment used in our cases are summarized in Table III.

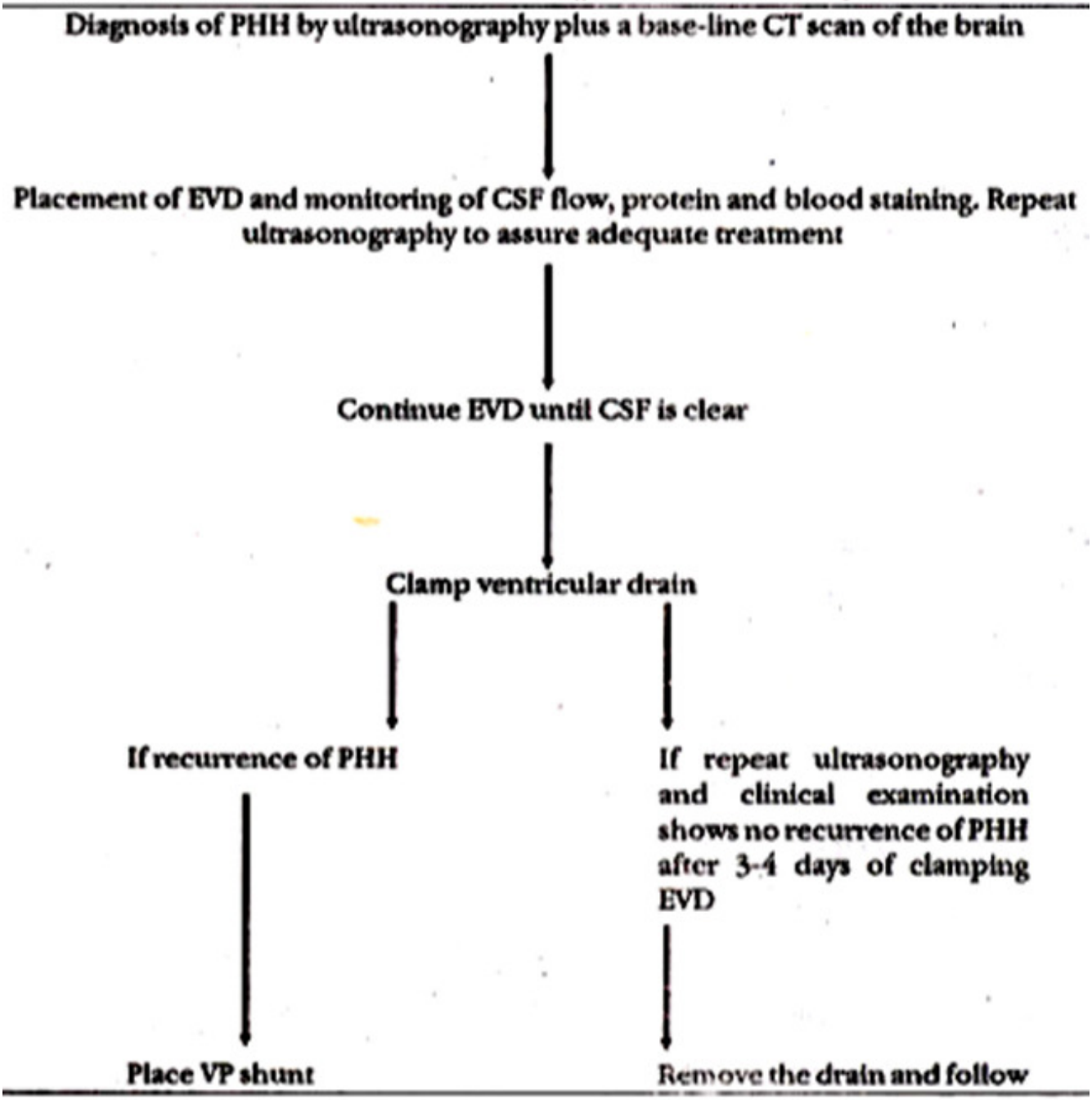
TAble III. Management of PHH: Summary of surgical procedures (n=37).

No.	Procedure	No. of cases
1	External ventricular drainage alone	6
2	External ventricular drainage followed by ventriculo-peritoneal shunt	20
3	Primary ventriculo-peritoneal shunt	6
4	Subcutaneous ventricular reservoir followed by ventriculo-peritoneal shunt	5
	Total	37

Operative techniques used for the placement of VP shunts and subcutaneous ventricular reservoirs were the same as described elsewhere[14]. Low-pressure Pudenz shunts were used in all the cases. We routinely place EVD in infants under local anaesthesia in the operating theatre. A small incision is made 2 cm anterior to the lateral angle of the anterior fontanelle. A radio-opaque silastic ventricular catheter with stylet is introduced through a burr hole and small dural incision and passed into the right lateral ventricle (Figure 3). Brownish-bloody CSF under pressure can be seen coming through the catheter when ventricle is entered. Free end of the ventricular catheter is tunnelled subcutaneously before being brought out through the scalp posterioriy and is anchored by a stitch at the exit site. The valve drain chamber of the EVD is set 3 cm below the forehead level to keep the ICP and intraventricular pressure normal. In&nts with EVD received prophylactic antibiotics, usually an antistaphylococcal drug (Vancomycin or Oxacillin), starting just before placement of drain and for the entire period of EVD. Six infants with rapidly progressive PHH had primary VP shunts because ventricular fluid was found to be relatively clear (only moderately xanthochromic and CSF protein less than 2 gm per litre). Excellent control of PHH was achieved and none of these primarily shunted neonates required a shunt revision. Twenty-six neonates with PHH and heavily blood stained ventricular fluid, were treated by EVD. ICP and ventricular size were controlled by adjusting the height of the drip-chamber of this system relative to the head of the infant. The volume, degree of blood staining, amount of protein, as well as microbiology of CSF thus drained, were monitored. Ventricular drainage was continued until the CSF was clear (protein less than 2 gin per litre, only mild xanthochromia and bacteriologically sterile). Drainage period ranged between 3 to 28 days. In 7

infants, CSF cleared and drainage reduced to less than 10 ml per day during the first week, alongwith clinical and ultrasound evidence of resolution of PHH. A further 2 days of clamping of the ventricular drain did not show recurrence of PHH. EVD was therefore, removed and these infants followed. Only one of these 7 infants developed progressive hydrocephalus many weeks later and required a VP shunt. The remaining 6 infants have remained free of any recurrence of PHFI and hence spared the problems of permanent shunting. Thus, a total of 31 infants, including the one who developed late ventriculomegaly and the 6 who had primary VP shunt, required permanent shunting. Neurosurgical management approach for PHH in preterm infants as used in our unit is summarized in Table IV.

Table IV. Neurosurgical management approach for PHH in preterm infants.



By following this scheme, an early reliable control of PHH and preservation of cerebral cortical mantle were achieved in all the cases. Two types of complications related to EVD were noticed. Dislodgement

and blockage of the ventricular catheter occurred in 3 cases and was easily treated by syringing and readjustment of the catheter. Sepsis and ventriculitis occurred in 2 cases and was successfully treated by parenteral and intraventricular antibiotics.

Results

Follow-up period ranged from 6 months to 6 years. Outcome is shown in Tables V and VI. Of the 37 neonates treated surgically for PHH, 10 (27%) died, while in 12 (32.4%) developmental and neurological outcomes were classified as normal. The remaining 15 (40.5%) survived with varying degrees of neuro-developmental handicap ranging from delayed developmental landmarks and mild limb spasticity to marked mental retardation and severe quadriparesis. Seven of these handicapped children remained bedridden and required prolonged institutionalized management, whereas the remaining 8 could be managed at home. Handicap rate was directly related to PHH and grade of haemorrhage (Tables V and VI).

Table V. Correlation between handicap and PHH.

	No. of infants	No. of handicapped	Handicap rate (%)
IVH without PHH	66	14	21.2
IVH with PHH	37	15	40.5

Table VI. Correlation between handicap and grade of IVH.

Grade of IVH	Total No. of infants	No. of survivors	No. of handicapped	Handicap rate (% of survivors)
*I	27	26	2	7.7
*II	19	16	4	25.0
*III	33	28	11	39.2
*IV	24	12	12	100
Total	103	82	29	28.1

*Died: grade I = 1, grade II = 3, grade III = 5, grade IV = 12

Thus 11 of 28 survivors with grade III IVH experienced mild to moderate neurological deficits and developmental delay; whereas all the 12 survivors with IVH grade What a poor neurological outcome. Seven had quadriparesis and severe retardation and 5 had diplegia and severe developmental delay.

Illustrative Case Reports

Case 1: F.I.

On 16th March, 1988, a 1500 gin preterm (gestational age 30 weeks) infant was delivered by caesarean section. Neonate's head circumference at birth was 30cm. Cranial ultrasonography was carried out soOn after admission to neonatal intensive care unit (NICU) and showed grade W WH (Figure 1).

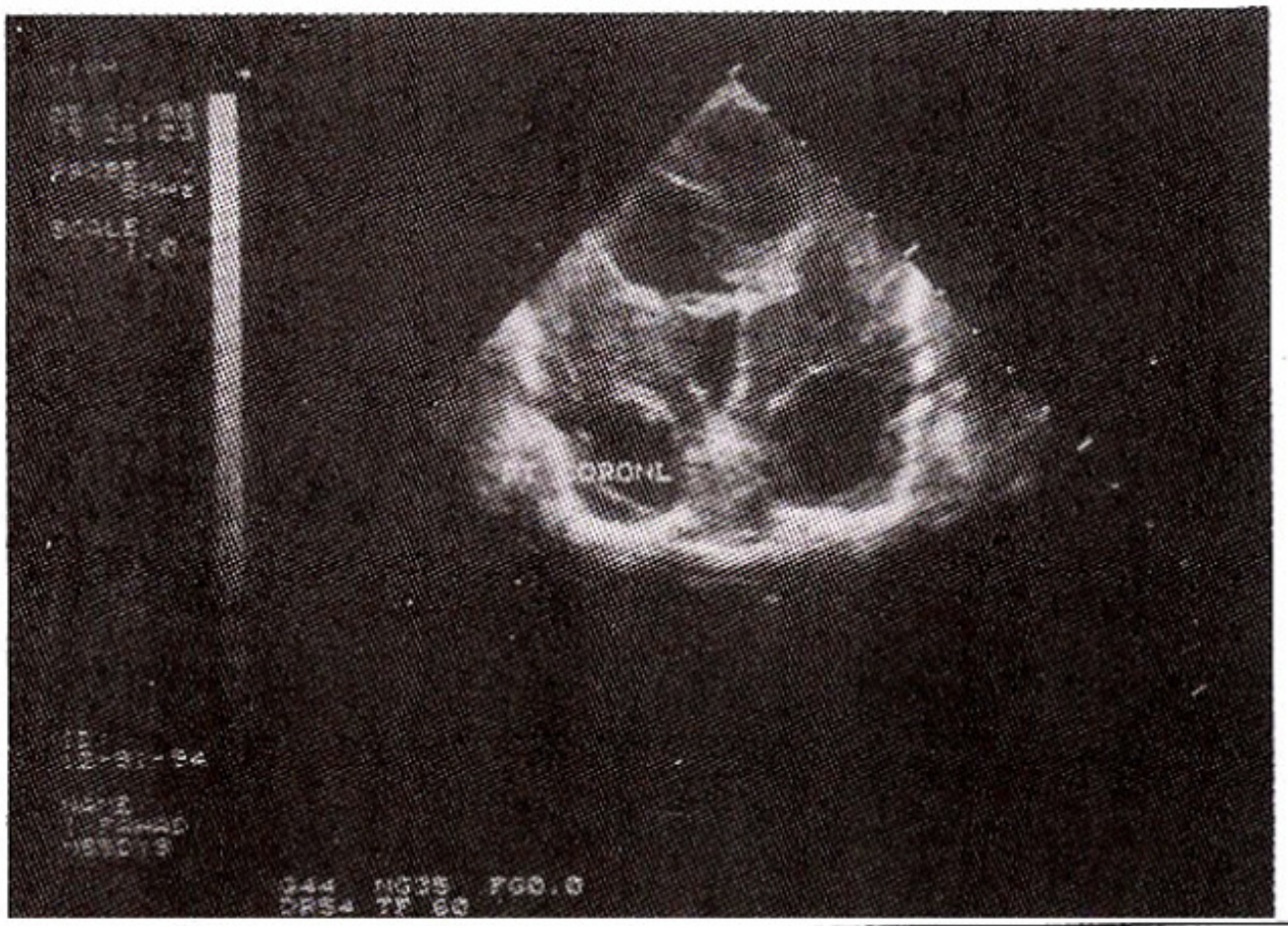


Figure 1. Cranial ultrasonogram showing GMH with intra- parenchymal and intra-ventricular extension. Third and lateral ventricles are dilated.

The infant showed pallor and during the next few days developed bulbing anterior fontanelle, a rapidly increasing head circumference and convulsions. CT scan of the brain at this stage (on 30th March, 1988) confirmed grade IV P/H (Figures 2a and b).

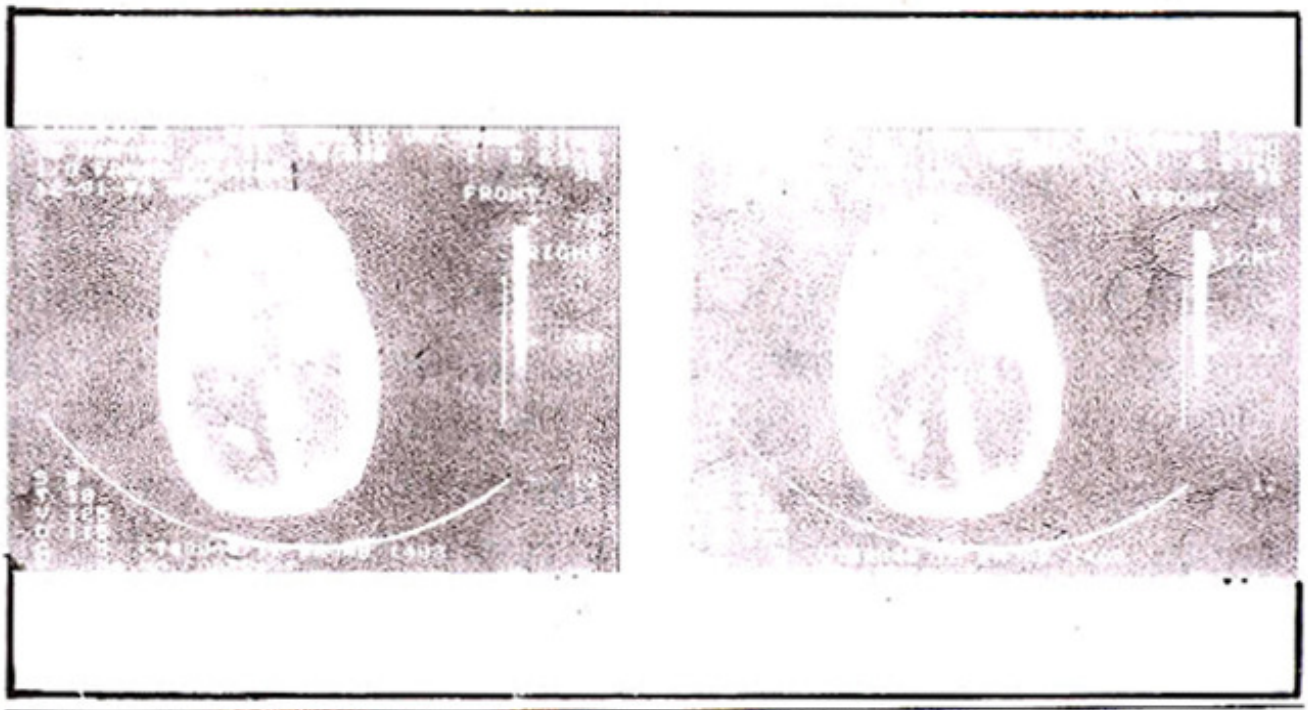


Figure 2a and b. Brain CT scan of same infant showing marked hydrocephalus, intraparenchymal haemorrhage on left side (arrow) as well as GM and ventricular haemorrhage on the right side (arrows).

Following EVD, infant's general condition improved, seizures stopped, fontanelle became slack and ventricular size reduced.

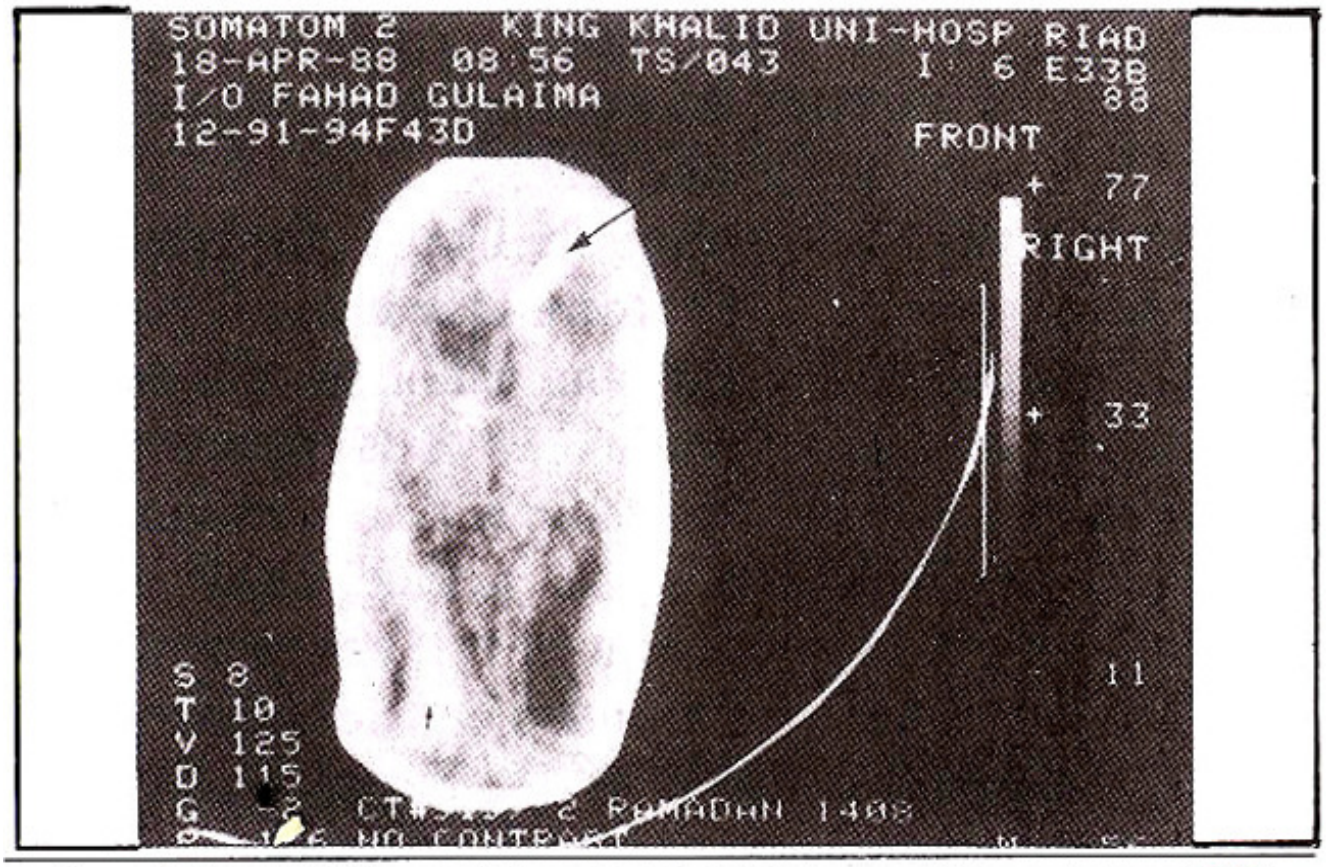


Figure 3. Post-EVD CT scan of the same infant showing complete resolution of PHH. Note (i) external ventricular drain through right frontal burr hole (arrow); (ii) normal ventricular size; (iii) intraparenchymal haemorrhage left occipital region (arrow).

Figure 3 shows post- EVD CT scan showing normal ventricular size, although parenchymal haemorrhage could still be seen. The ventricular fluid thus drained was viscous, brownish and heavily blood stained during the first week of EVD), so that the infant became anaemic and several transfusion of whole blood and fresh frozen plasma were required to replace the losses. During the third week of EVD, CSF gradually became clear, its protein content fell to 1 gin per litre and no organisms were grown from it. After 23 days of EVD, CSF was normal and amount of drainage much reduced and hence the EVD was removed and infant observed. Three days later, the head circumference started increasing again and ultrasound confirmed recurrence of PHH. A permanent VP shunt, installed at this stage, has continued to function well with satisfactory control of hydrocephalus. In addition to the IVH this baby had RDS and left- sided pneumothorax, necessitating ventilation for 23 days and insertion of chest tube. After a 3 months stay in NICU the baby was discharged in good general condition. Follow-up after one year showed well functioning VP shunt and no clinical or radiological evidence of recurrence of hydrocephalus. Delayed landmarks and limb-spasticity were present.

Case 2: W.M.

A 1410 gm preterm (gestational age 29 weeks) infant was delivered by caesarean section to a 25-year old Saudi mother. At birth the infant was pale, cyanotic and distressed and was found to have RDS and later developed left-sided pneumothorax. Neonate was intubated, ventilated and chest tube inserted to manage these conditions. Routine ultrasound of head on day 3 was not done because baby was too unstable to handle. Ultrasonography of brain on day 10 showed grade IVIVH. Head circumference, which was 28 cm at birth, started increasing at the rate of 0.5 cm/day. CT scan of the brain on day 11 (Figure 4)

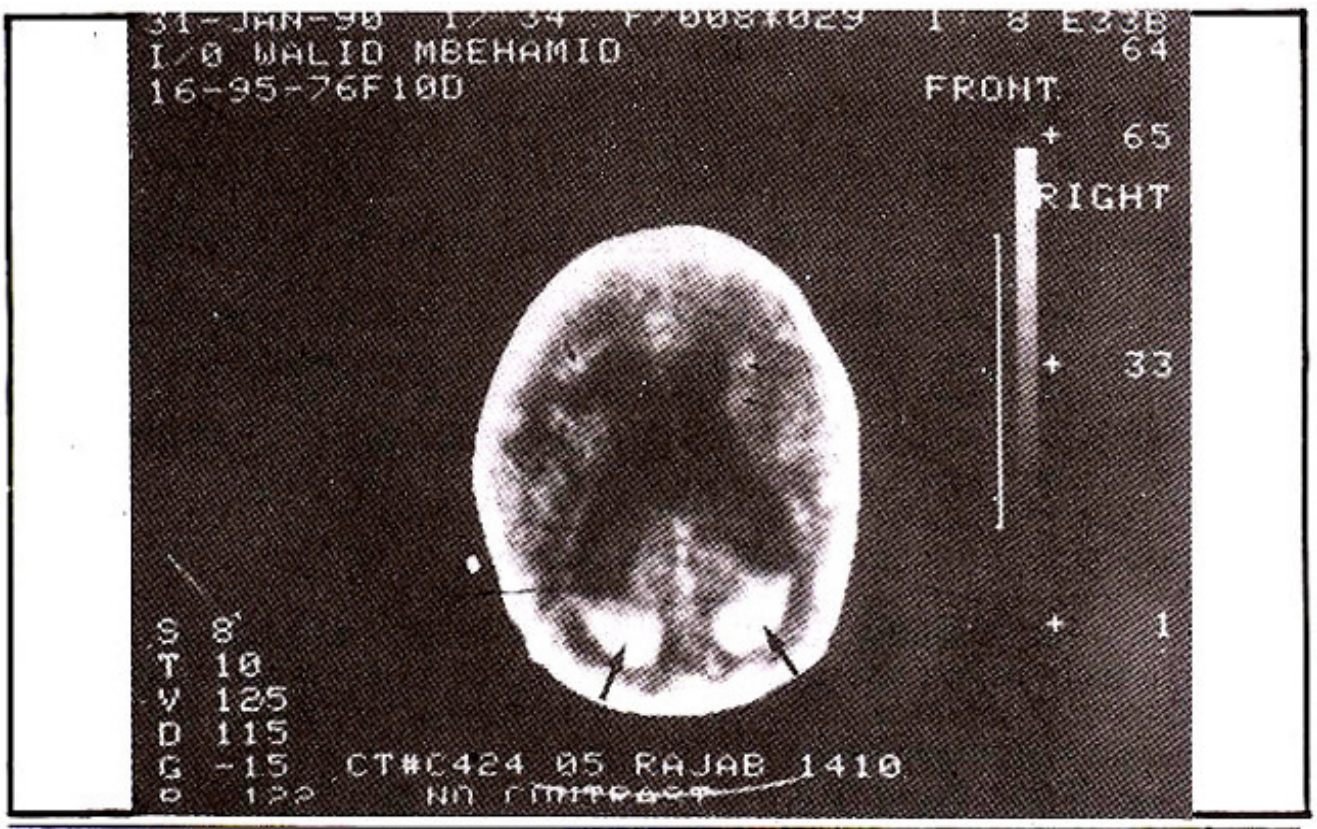


Figure 4. CT scan second case showing marked PHH. Note (i) GMH (small arrows); (ii) IVH (large arrows).

confirmed the diagnosis of PHH. EVD was done on day 12 and continued for 10 days. CSF, which was heavily blood stained initially, rapidly cleared and volume of drainage reduced markedly. Ultrasound and CT scan one week after EVD confirmed a resolution of PHH. Ventricular drain was removed after 10 days and continued follow-up of the infant showed no recurrence of PHH. An ultrasound 2 months later showed normal ventricular size and resolution of parenchymal haemorrhages. In this case an adequate early, as well as sustained and permanent, control of PHH was achieved by EVD alone as shown at 2 years follow-up when he still had quadriparesis and retardation.

Discussion

When considering the management of MH, one must first consider the possibility of prevention. Prevention of premature birth is not easily achieved. Pre- and post-natal measures that have been attempted to decrease the risk of IVH include: Betamethasone administration to the mother[15], control of arterial blood pressure and rapid correction of hypoxia in neonate[11] and pharmacological means to prevent IVH[2,16-19]. Clinical features of P/H are non-specific and diagnosis may be impossible to make on clinical grounds alone, with some studies showing only a 50% accuracy of clinical diagnosis[11] - IVH usually occurs within 48 hours of birth and will occur in the first 24 hours in 50% of the cases[20]. Three modes of clinical presentation were noted in our cases; 16(15.5%) infants had atypical hyper-acute presentation with a catastrophic neurological deterioration that evolved in minutes to hours and consisted of stupor, respiratory distress, generalized seizures, fixed dilated pupils and flaccid paralysis, resulting in deep coma. Additional features included full fontanelle, falling blood pressure, pulse and haematocrit as well as temperature instability and metabolic acidosis. Many infants with such acute presentation did not survive. A sub acute presentation was seen in 31 (30.1%) infants. The clinical

picture evolved in hours to days and consisted of irritability, deterioration in level of consciousness, decrease in tone and movement, pallor, seizures, as well as abnormal eye movements. Diagnosis in this group was suspected but was confirmed only by ultrasound. In the third, the largest group of 56 (54.4%) infants, the haemorrhage was silent and diagnosis was only made byultrasonography. In infants who developed PHH, ultrasonic evidence of progressive ventricular enlargement was present for days or weeks before rapid increase in head circumference, bulbing fontanelle or suture diastasis became apparent. This sequence has also been noticed by others[11] and may be of some importance as diagnosis may be missed until PITH becomes marked. CT scan of the brain and real-time ultrasonography are the most useful means of diagnosis and follow-up of IVH and PHH (Figures 1,2,3 and 4). These investigations not only show the presence of a GMH but also give valuable information about the extent of haemorrhage and ventricular size. Several treatment modalities were described, including medications to decrease CSF production and intermittent drainage procedures[2,21-24]. Neurosurgical intervention aims at protecting the cerebral cortical mantle by normalizing ICP and consists of various CSF drainage procedures. Thus, the surgical options for the management of PHH include, lumbar punctures, serial ventricular punctures, continuous EVD, primary (early) VP shunting, secondary VP shunting after a period of EVD and the use of subcutaneous ventricular reservoir. Selection of one or a combination of these modalities for a particular infant with PHH requires experience and clinical judgement. Neonatologists have recommended serial lumbar punctures for the treatment of PHH[2,11]. Our experience with repeated lumbar punctures has not been encouraging. Using pre- and post-lumbar puncture ultrasound, we found little response of PHH to this procedure. In very acute cases with massive WH, the clot blocks the aqueduct to produce acute non-communicating hydrocephalus with alarming rise in ICP evidenced by apnoea, unreacçive pupils and tense bulging fontanelle. In these hyperacute cases lumbar puncture may be positively dangerous. We have found that in such hyperacute cases ventricular puncture, through the outer angle of anterior fontanelle, can be life-saving and result in dramatic improvement in neurological condition. In such emergencies, this approach is used in our unit as an interim measure to control acute rises in ICP and acute PHH prior to EVD. Serial ventricular punctures have been mentioned in literature as an alternative treatment option for PHH[2]. We do not recommend it as definitive treatment because of the transient nature of the ICP control that it provides and the known risks of multiple taps, including parenchymal or subdural haemorrhage and development of porencephalic areas[2]. Routine primary VP shunting leads to unacceptably high incidence of shunt blockage and revisions due to bloody or proteinaceous CSF[25]. However, in selected cases where CSF protein is less than 2 gm/litre and blood staining is minimal, an early primary VP shunt is a valid treatment option, as can be seen from 6 of our cases. Continuous EVD has been our initial treatment of choke and was used in 26(70.2%) of our cases with PHH. By using EVD as a first step in the definitive management of majority of our cases with PUN the following advantages were noticed:

1. Early, consistent and reliable control of PHH and ICP was achieved in all the cases.
2. Late and permanent control of PUN was obtained in small but significant number (6 cases = 16.2%) of our cases, thus obviating the need for permanent internalized VP shunt and its accompanying complications and revisions. EVD, by removing blood products, cellular debris and highly proteinaceous ventricular CSF, the presumed cause of chemical arachnoiditis causing PHH, may promote CSF circulation and resolution of PHH in some cases.
3. Permanent VP shunt, when required, can be done under optimal circumstances after CSF has cleared and medical problems have been resolved. Thirty-one infants required pennanent VP shunt; 20 after a variable period of continuous EVE); 5 following subcutaneous ventricular reservoir and 6 who were primarily shunted. Our shunt infection and revision rates were comparable to other centres[26], 2 infants required revision during the NICU stay (within 3 months of life) and 3 were revised within one year.

Another drainage option is the use of subcutaneous ventricular reservoir[26-38]. The technique involves performance of a single ventricular cannulation for placement of catheter in the lateral ventricle which is connected to subcutaneous reservoir. This reservoir can be aspirated percutaneously with a butterfly needle, daily or as frequently as necessary to control ICP and ventricular size. This method has been found to be safe and effective treatment alternative for PHH[26-28]. However, in our experience, subcutaneous ventricular reservoir was less satisfactory than EVE) because of the following reasons (i) control of PHH and ICP was intermittent and inconsistent, (ii) because of repeated needle aspiration, the system is not "closed", thereby increasing the risk of infection, (iii) proteinaceous and heavily blood stained ventricular fluid could not be adequately aspirated by thin butterfly needles. Outcome regarding neuro-developmental handicap was best in infants with grade I haemorrhage (Tables V and VI) and worst in grade W, where handicap rate approached 100% in the surviving infants (Table VI). In the intervening grades II and III, PUN was the major determining factor. We have been concerned about the high incidence of major neurological handicap in grade 1VWH in spite of aggressive management. Final outcome and degree of handicap appears to correlate with severity of haemorrhage[29], presence of PHH[10], other factors of prematurity and developmental anomalies[29] and other insults (hypoxic, ischaemic, metabolic) [2] inflicted on the infant brain. We are currently investigating the value of such prognostic criteria. As more premature infants with WH survive, better prognostic indicators of long-term morbidity may be found. But until such time every preterm infant with WH should receive optimal management. While several acceptable surgical options are available for the management of raised ICP and PHH, a definitive effective treatment plan (Table IV) should be followed for optimal results.

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