Short reports

Determinants of major handicap in post-haemorrhagic hydrocephalus

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SUMMARY The outcome of 54 low birthweight (<2500 g) infants treated by ventriculoperitoneal or ventriculoatrial shunting for post-haemorrhagic hydrocephalus over six years is reviewed. Prognosis correlated with cranial ultrasound appearances in the neonatal period but not with factors relating to the aetiology or extent or management of the hydrocephalus.

Post-haemorrhagic hydrocephalus in low birthweight infants is almost always associated with severe respiratory distress syndrome and one of its principal complications, periventricular haemorrhage. Improved survival of these infants in recent years has meant that some infants who previously died from respiratory causes now survive, but with neurological complications, such as progressive hydrocephalus. Although a number of non-surgical treatments have been advocated, only surgical diversion of cerebrospinal fluid has yet been shown to effect a permanent solution to the problem. This study examines the outcome of low birthweight infants treated by this method in a single centre and relates the findings to perinatal, ultrasound, and therapeutic factors.

Patients and methods

Between July 1979 and June 1985, 54 low birthweight infants were treated for post-haemorrhagic hydrocephalus by means of ventriculoperitoneal or ventriculoatrial diversion of cerebrospinal fluid. They represented 1.8% of all low birthweight infants admitted to this unit during that period. Most of these infants were referred either in utero or postnatally from other centres, and so this figure undoubtedly overestimates the incidence of the problem.

Cranial ultrasound scans were performed on

admission, daily for the first week of life and weekly thereafter until discharge. Results were recorded as written reports together with Polaroid prints of changes seen. Early signs of periventricular haemorrhage and the occurrence during subsequent weeks of unilateral or bilateral cystic lesions of periventricular leucomalacia and porencephaly were recorded. The decision to treat an infant surgically was made on clinical grounds by one of four paediatric consultant surgeons. The ultrasound scans were available but never used as the sole criterion for surgery. Hakim low pressure, low profile ventriculoperitoneal shunts (Cordis UK Limited) were used in most infants. A few infants initially managed with ventriculoatrial shunts were subsequently revised to ventriculoperitoneal types. No particular weight had to be achieved before shunt surgery, but no infant who weighed less than 1300 g was operated on. To control the rate of head growth or symptoms attributable to hydrocephalus, intermittent spinal or ventricular needle taps were used before insertion of the shunt in most of the infants.

Data on perinatal factors, factors relating to aetiology and severity of hydrocephalus, and therapeutic interventions were recorded.

Outcome was assessed in 44 cases by regular follow up at the regional centre with a neurological examination and use of the Denver development screening test. In six children in whom distances precluded this reports from district child development centres and other consultant paediatricians were used. Specialist referral was made to the regional development centre where indicated. The duration of follow up ranged from one to six years. Follow up data were available on all survivors. As a result of the variety of sources of assessment, outcome has been graded for the purposes of this study into four broad categories: 'Normal', with no major impairments; 'Normal and cerebral palsy', with normal cognitive development but with some

degree of motor impairment; 'Moderate delay (developmental quotient <80) with or without cerebral palsy'; and 'Severe delay (developmental quotient <50) with or without cerebral palsy'. The significance of statistical associations was tested using Fisher's exact test.

Results

The outcomes of the infants are summarised in the Table. Of the 54 infants treated, 76% weighed less than 1500 g at birth, and 80% had a gestation of 30 weeks or less. There were four deaths, due to necrotising enterocolitis, endocarditis, pneumonia, and post-anaesthetic problems, respectively. All the babies who died had a birth weight less than 1500 g. Of the survivors, 38% have required a shunt revision to date, half of these on two or more occasions.

Perinatal factors, such as gestation, birth weight, sex, place of birth, mode of delivery, Apgar scores, maternal illness or labour complications, and dura-

tion of ventilation, did not relate significantly to outcome category. Factors relating to the hydrocephalus or its management, such as maximum cerebrospinal fluid protein or pressure, occipital-frontal head circumference at operation below 10th centile, number of cerebrospinal fluid taps before operation, and age at operation also did not relate significantly to outcome.

Outcome related principally to two factors—namely, the occurrence of fits in the neonatal period ($p=0.0006$) and the presence of parenchymal cysts on ultrasound scan ($p=0.008$), particularly if they were bilateral in distribution. In 17% of infants clinically evident convulsions occurred before the end of the first week and in 46% between seven and 28 days. The time of occurrence did not relate to outcome, but in most cases the convulsions occurred during the period of ventricular dilatation rather than at the time of the haemorrhage. In 15 infants porencephalic cysts were first seen at a median age of 14 days (range four to 28 days) and in 21 infants small cysts of periventricular leucomalacia were seen at a median age of 18 days (range eight to 28 days). These changes preceded extensive ventricular enlargement, although they often worsened as hydrocephaly proceeded.

Four infants had severe visual impairment without retinopathy and were thought to be cortically blind. All had extensive bilateral subcortical cysts. Five other infants have less severe visual loss associated with retinopathy or optic atrophy. Two had severe bilateral hearing loss. In one of these infants hearing was normal until 18 months when shunt obstruction necessitated a revision. Three others has lesser degrees of hearing impairment but required aids.

Discussion

Although a number of small series of low birth-weight infants treated surgically for post-haemorrhagic hydrocephalus have been reported in recent years,¹⁻⁵ this is the largest from one centre.

The follow up data were collected from a variety of sources but are complete and enable broad categories of outcome to be defined in terms of major impairments. It is important to note, however, that minor motor deficits and coordination problems are proving common in the older infants, even in the 'normal' category, and schooling problems are arising from these.

The finding that neonatal fits and parenchymal cysts were related to major impairment later on was not surprising as both are known as good predictors of neonatal outcome in general. Parenchymal cysts, whether of leucomalacia or porencephaly, represent cerebral atrophy occurring before extensive hydro-

Table Outcome of the 50 surviving low birthweight infants (grouped according to outcome categories) with post-haemorrhagic hydrocephalus treated by ventriculoperitoneal or ventriculoatrial shunting

	Outcome group			
	No major impairment	DQ>80 with cerebral palsy	DQ 50-80 with or without cerebral palsy	DQ <50 with or without cerebral palsy
n	13	11	17	9
Sex (M/F)	9/4	8/3	14/3	3/6
Median gestation (weeks)	28	30	29	28
Birthweight (g):				
Median	1246	1322	1270	1138
Range	730-2070	976-2050	910-2214	884-1310
Inborn	2	1	4	2
In utero transfer	6	3	5	3
Postnatal transfer	5	7	8	4
Days ventilated:				
Median	9	11	13	14
Range	0-95	2-25	0-54	5-41
Taps:				
No	7	10	11	8
Range	0-33	0-20	2-20	0-22
Age at operation (days):				
Median	80	37	48	83
Range	26-252	32-150	32-207	37-154
Fits:				
None	10	5	4	0
Yes	3	6	13	9
Cysts:				
None	9	3	4	0
Unilateral	3	5	7	2
Bilateral	1	3	6	7

DQ=Developmental quotient.

rocephaly. After shunting, however, ventricular size failed to return to normal in many infants, indicating further atrophy possibly related to hydrocephaly itself. The perinatal factors examined related to the occurrence of hydrocephalus but not obviously to its eventual outcome. Therapeutic variables, such as the age at surgery and the number of spinal or ventricular taps before shunting, did not seem to relate to later major impairment. But these treatments were determined by a number of other factors, such as the condition of the infant, rate of progression of the hydrocephalus, and changing management policies, and were not randomised. Current trials may clarify the place of such management.

The strong relation of major impairment to cerebral cysts that were present before the hydrocephaly and indicated brain injury may indicate, however, that any benefit from early treatment of hydrocephalus will not be seen in a reduction in major early impairment but possibly later in the minor motor disabilities and coordination problems that characterise other forms of hydrocephalus. Follow up into primary school may be needed to detect this in such trials.

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Evaluation of nebulisers for bronchial challenge tests

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SUMMARY The reproducibility of the output of seven different nebulisers was tested. Nebulisers with a minimal increase in output at higher flow rates had less variability in the output. The selection of a nebuliser for bronchial provocation tests depends on the intranebuliser variability. Two nebulisers had highly reproducible outputs.

Recently, bronchial challenge tests have been used increasingly for research and clinical purposes.¹ The solutions used for these tests are nebulised and administered by using either a dosimetric technique² or inhalations from a nebuliser for two minutes.³ The results from the two techniques have been shown to be quantitatively similar. Many workers prefer to use the latter method ('tidal breathing' technique), because although it is more time consuming, it is much cheaper. In addition, only this

method is feasible in young children. Bronchial provocation tests are quantitative and therefore the administered dose must be accurate. Among the important factors determining the amount of substance inhaled is the output of the nebuliser, which must be constant throughout the test. In the present study we have determined the reproducibility of the output of seven commercially available nebulisers under standardised conditions to assess their accuracy and suitability for use in bronchial challenges.

Material and methods

A single device of seven different commercially available nebulisers was evaluated (Table). Each device was tested 10 times under identical conditions. Before and after use the nebuliser was cleaned with industrial alcohol, dried, and filled to half its maximal capacity with distilled water. The device was then put into a thermostatically controlled bath