ORIGINAL ARTICLE

Visual development in infants with prenatal post-haemorrhagic ventricular dilatation

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Objective: The aim of this study was to assess visual function in 13 infants with evidence of prenatal post haemorrhagic ventricular dilatation.
Design: Infants were assessed at 5, 12 and 24 months using a battery of tests specifically designed to assess various aspects of visual function in infancy. Visual findings were correlated with several variables, including extent of the lesion and presence of epilepsy.
Results and conclusions: Abnormalities of visual function were frequent (over 60%) in our cohort at age 2 years, ranging from isolated abnormal ocular movements to severe abnormalities of all the aspects of visual function assessed. The most severe and persistent abnormalities of visual function were found in infants with grade IV intraventricular haemorrhage and shunted hydrocephalus who also had epilepsy in the first year.

It has recently been reported that a proportion of infants with post haemorrhagic ventricular dilatation has abnormal acuity and visual fields[1–4] and that the severity of visual abnormalities is not always related to the severity of intraventricular haemorrhage (IVH).[3] Visual abnormalities are more frequent in the first months but in some cases subsequently improve.[1 3] All the previous studies mainly included preterm infants with postnatal onset of haemorrhages, and less has been reported about the development of visual function in infants with post haemorrhagic ventricular dilatation of prenatal onset. The aim of the present study is to evaluate various aspects of visual function in infants with prenatal post-haemorrhagic ventricular dilatation and to correlate visual responses to imaging and clinical findings.

Subjects and methods

All infants born at the Catholic University of Rome between January 2000 and December 2003 with ultrasound (US) prenatal diagnosis of ventricular dilatation were selected and enrolled when the following criteria were fulfilled:

1. evidence of prenatal post haemorrhagic ventriculomegaly (PHVM) or prenatal post haemorrhagic hydrocephalus (PHH) on cranial US performed at birth and neonatal brain MRI. The diagnosis was based on the persistence of ventricular dilatation and at least one of the following findings:[4]

- residual intraventricular clots
- unilateral porencephalic cyst in the periventricular white matter communicating with the ipsilateral ventricle
- periventricular venous infarction partially cavitated

2. no evidence of intrauterine infections, congenital malformations, chromosomal abnormalities and metabolic disorders at clinical and laboratory investigations routinely performed in the neonatal period in this group of patients.

The study was approved by the Research Ethical Committee of the Catholic University.

Neonatal assessment

All neonates enrolled in the study were submitted to clinical and laboratory investigations including ophtalmologic evaluation, TORCH and karyotype.

Neonatal US were always performed by the same investigator (RL) using a Hewlett-Packard Image Point equipped with a multifrequency beam (5–7, 5 MHz). US were always performed on the first day after birth and re-evaluated at least 1 week and 3 months later. Ventricular width of lateral ventricles was evaluated measuring the ventricular index according with Levine.[5] We also measured the vertical depth of the frontal horn of the lateral ventricles immediately anterior to the thalamo-caudate notch to define the ventricular dilatation as mild, moderate or severe when this dimension exceeded 3, 5 and 10 mm respectively.[6] Brain MRI were performed in the first week after birth using a 1,5 Tesla magnet with standard T1 and T2 sequences.

Ventricular dilatation was defined as not hypertensive ventriculomegaly or as hydrocephalus on the basis of neuroimaging and clinical data. All neonates were evaluated by a paediatric neurosurgeon consultant in order to establish treatment indications.

Follow up assessment

All infants have been regularly followed for at least 24 months with a standardized neurological and visual assessment at 24 months. Infants born after December 2002, were also regularly assessed at 5 and 12 months. The assessment included:

Oculomotor behaviour

This assessment was based on fixation and following reactions. Quality of fixation, extension of the arc in following, asymmetric reactions, abnormal ocular movements and strabismus were noted.

Acuity

This was tested using the forced choice preferential looking. Stimuli consist of black and white stripes of varying spatial frequencies presented at the infant's eye level on either side of the midline and paired with a uniform grey background on the

Abbreviations: IVH, intraventricular haemorrhage; PHH, post haemorrhagic hydrocephalus; PHVM, post haemorrhagic ventriculomegaly

Table 1 Neonatal, brain MRI and clinical findings at 2 years

	Sex	GA	BW (g)	VD	Clots	Shunted Hydrocep	Venous infarct	PV WM	BGT	Epilepsy	Motor outcome	Oculomotor behaviour	Nystagmus	Acuity	Visual fields	Fixation shift
1	F	33	1680	moderate	X	–	–	–	–	–	○	○	○	○	○	○
2	M	36	2630	severe	X	–	–	–	–	–	○	○	○	○	○	○
3	F	37	2830	severe	X	–	–	–	–	–	○	●	●	○	●	○
4	M	38	3250	moderate	X	–	–	loss	–	generalised 2nd year	●	●	○	○	○	○
5	M	37	3100	severe	X	X	–	–	–	–	○	○	○	○	○	○
6	M	39	4100	severe	X	–	left	–	X	–	●	○	○	○	○	●
7	M	37	3180	moderate	X	–	right	–	–	–	○	●	○	●	○	●
8	F	33	1650	moderate	X	X	left	–	–		○	●	○	○	○	○
9	M	35	2090	severe	X	X	left	loss	X		●	●	○	○	◐	◐
10	F	37	3300	severe	X	X	left	–	–	early partial	●	●	●	●	●	●
11	F	38	2310	severe	X	X	right	–	–	West	●	●	●	●	●	●
12	M	33	1900	severe	X	X	left	–	–	West	●	●	●	●	●	●
13	F	37	3630	severe	X	X	left	cPVL	–	West	●	●	●	●	●	●

○ normal, ● abnormal, ◐ asymmetry; *M*, male; F, female; GA, gestational age (in weeks); BW, birth weight; VD, ventricular dilatation; hydrocep = hydrocephalus; PV WM, periventricular white matter; BGT, basal ganglia and thalamus, cPVL, cystic periventricular leukomalacia.

other side. The level of acuity is measured as the finest grating for which the infant shows a consistent preference, and correlated to age-specific normative data.[7]

Visual fields

These were tested by using a small white ball (Stycar ball) of 40 mm of diameter, gradually moved from 90 degrees laterally inwards towards the midline. Head and eye movements were observed to estimate the outer limit of the fields and their symmetry. The results were correlated to age-specific normative data.[8]

Fixation shift

This is a test of visual attention evaluating the direction and the latency of saccadic eye movements in response to a peripheral target (alternating black and white stripes) in the lateral field. A central target was used as a fixation stimulus before the appearance of the peripheral target. While in some trials the central target disappeared simultaneously with the appearance of the peripheral target (non competition) in others the central target remained visible and created a situation of competition between the two stimuli. Details of the methodology have been previously described.[9 10]

Normal children can reliably shift their attention in a situation of non competition during the first few weeks after birth at term, but brisk refixations in a situation of competition is only found after 6–8 weeks and reliably by 12–18 weeks of age. Absent or delayed (a latency of more than 1.2 sec) refixation at 5 months of age, or beyond, is considered abnormal.

Results

Of the 14 infants who fulfilled the inclusion criteria, one was lost at follow up. Of the remaining 13 (7 males, 6 females), 10 were born preterm (range 33–37) and three at term (range 38–42), and were all included in the study. None of the infants had retinopathy or other structural eye abnormalities. All had assessment of visual function at 24 months corrected age. Eleven of the 13 infants had sequential assessments at 5, 12 and 24 months.

Brain imaging

Table 1 shows details of neonatal US and MRI.

Neurological follow up

At 2 years, six infants had normal motor outcome and seven had cerebral palsy. Five of the 13 also developed epilepsy, four in the first year (three West syndrome and one partial seizures) and one in the second year (generalised seizures) (table 1).

Visual outcome at 2 years

At 2 years, three of the 13 infants had normal results on all the tests assessing visual function, while the remaining 10 had at least one abnormal result on one of the tests (table 1).

Oculomotor behaviour

Four infants had completely normal ocular movements and eight had strabismus, associated with nystagmus in four of the eight. The remaining child had mild nystagmus but not strabismus.

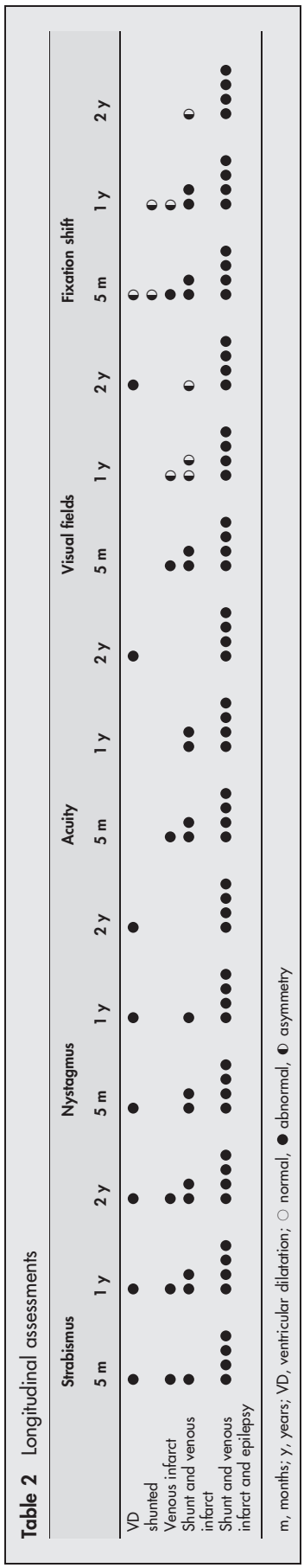
Visual acuity

Eight infants had normal and five abnormal acuity.

Visual fields

Seven infants had normal, one asymmetric and five abnormal visual fields.

Table 2 Longitudinal assessments



m, months; y, years; VD, ventricular dilatation; ○ normal, ● abnormal, ◐ asymmetry

What is already known on this topic

- It has been reported that preterm infants with postnatal onset of haemorrhages may have abnormal visual function and that the severity of visual abnormalities is not always related to the severity of intraventricular haemorrhage.
- Less has been reported about the development of visual function in infants with post haemorrhagic ventricular dilatation of prenatal onset.

What this study adds

- When assessed at 2 years, abnormal ocular movements were the most frequent abnormalities (69%) often associated with some abnormalities on the tests assessing visual function.
- The severity of visual impairment was not always related to the severity of the haemorrhage and the most severe abnormalities of visual function were found in infants who had epilepsy in the first year.

Fixation shift

Six infants had normal, one asymmetric and six abnormal re-fixation.

Correlation with brain imaging and epilepsy

All neonates had moderate/severe not hypertensive ventriculomegaly or hydrocephalus requiring shunt insertion.

Five of the 13 infants had ventricular dilatation without venous infarct (only one of them requiring shunting) and all had normal visual function or mildly abnormal ocular movements.

Two infants with ventricular dilatation and venous infarct not necessitating of a CSF shunt also had mildly abnormal ocular movements.

Six infants had both venous infarct and shunt, all had abnormal visual function. The four patients in this subgroup who had the most severe visual abnormalities also had epilepsy in the first year of life.

Longitudinal assessments

At 5 months none of the 11 infants evaluated longitudinally had a completely normal assessment of visual function. There was a variable degree of improvement that was more obvious in the second year in the infants who did not have epilepsy in the first year (table 2).

DISCUSSION

The aim of this study was to assess visual function in infants who had evidence of prenatal post haemorrhagic ventricular dilatation. We used a battery of tests specifically designed to assess various aspects of visual function in the first years of life previously validated in low risk infants and used in several studies in both full term and preterm infants with brain lesions.[9–13]

When assessed at 2 years, abnormal ocular movements, mainly strabismus and/or nystagmus, were the most frequent abnormalities (69%) and, with two exceptions, were always associated with some abnormalities on the other tests assessing behavioural aspects of visual function. Although severe visual abnormalities only occurred in patients with severe IVH 4 and

shunted hydrocephalus, other patients with similar lesions had better results on the visual tests, confirming previous observations that the severity of visual impairment is not always related to the severity of IVH.[3] Two of the infants in our cohort had additional involvement of basal ganglia and thalami, but this was not associated with severe visual abnormalities, as previously reported in full term infants with neonatal encephalopathy and in preterm infants with cystic PVL.[11 13] The timing of the lesions and of MRI in the present study were, however, different from the previous studies and this makes the correlation difficult.

Previous studies in preterm infants with post haemorrhagic hydrocephalus occurring after birth have reported a strong association between visual abnormalities and cerebral palsy.[14 15] In our cohort all infants with severe visual abnormalities also had cerebral palsy but the opposite did not always hold true, as cerebral palsy was also present in children with normal visual function or only minor abnormalities. The presence of early epilepsy was in contrast always associated with severe visual abnormalities. In keeping with previous recent studies suggesting that West syndrome and early severe epilepsy can affect visual behaviour[16] we also found that early epilepsy was associated not only with abnormal visual findings at the time of onset of the seizures but also with a reduced chance of recovery. While the three infants with shunt and venous infarct who did not have epilepsy showed an improvement of behavioural visual tests after the first months, all the four patients with early epilepsy did not show any recovery. It is of interest that while in preterm infants with postnatal PHH the acuity improves by the end of the first year[1 17] in our cohort with antenatal PHVM the maturation mainly occurred between 12 and 24 months.

In conclusion, our results suggest that infants with prenatal post haemorrhagic ventricular dilatation often have abnormal ocular movements and other abnormalities of visual function but that severe and persistent abnormalities only occurred in infants who also developed early epilepsy. As the number of infants in this study is too small to allow any meaningful multivariate analysis, further studies in larger cohort are needed to establish the extent of the effect of the epileptic disorder per se or whether the presence of epilepsy is only a marker of a more severe underlying lesion that is responsible for both epilepsy and abnormal visual function.

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