

David M. Steventon
Philip R. John

Power Doppler ultrasound appearances of neonatal ischaemic brain injury

Received: 8 March 1996
Accepted: 28 April 1996

D. M. Steventon · P. R. John (✉)
Department of Radiology,
Birmingham Children's Hospital NHS
Trust, Ladywood Middleway,
Birmingham B16 8ET, UK

Abstract Following neonatal ischaemic brain injury, irregular vessels increase in size owing to luxury perfusion. These may be demonstrated by conventional colour flow Doppler (CFD) imaging at the periphery of the infarcted area. We present a case in which power Doppler imaging (PDI) was performed in

addition to CFD in a neonate with unexplained seizures and which proved more sensitive than CFD in demonstrating luxury perfusion. Ultrasound appearances were compared with those seen on cranial CT. PDI can be a useful adjunct to conventional CFD examination of the neonatal brain in cerebral infarction.

Introduction

Following neonatal cerebral infarction there is an increase in the size and number of vessels around the area of injury, i. e., luxury perfusion. The change in vascularity can be seen on colour flow Doppler (CFD) ultrasound, with the same changes seen on cranial CT as an area of increased density. Power Doppler imaging (PDI) is a new technique which is more sensitive to vascular flow. To the best of our knowledge its use has not been reported in the demonstration of luxury perfusion.

Case report

A 10-day-old full-term infant with transposition of the great arteries presented 2 days after a failed septostomy with generalised unexplained seizures. Cranial ultrasound with a 7- to 4-MHz phased array transducer (Ultramark 9 HDI, Advanced Technology Laboratories, Bothell, Wash.) showed an area of diffusely increased echogenicity in the left fronto-parietal area in keeping with focal ischaemic brain injury (Fig. 1). CFD, utilising maximal colour gain without background noise, showed a patent circle of Willis and major branches with similar vascularity in both the right and left middle cerebral artery territories. On PDI, increased colour flow was present on sagittal and coronal scans in the left middle cerebral artery territory corresponding to the region of abnormal cerebral parenchyma seen on grey-scale ultrasound. In particular, on PDI a

significant increase was seen in the number of vessels around the lesion compared with the normal right hemisphere (Figs. 2 a, b, 3). Cranial CT 5 days later showed increased attenuation in the left cerebral hemisphere corresponding to the abnormal region seen on ultrasound (Fig. 4). Follow-up cranial ultrasound 2 weeks after CT showed dilatation of the left lateral ventricle with adjacent periventricular cyst formation. PDI was not performed during this examination. The patient underwent cardiac surgery with a



Fig. 1 A coronal cranial ultrasound scan showing increased parenchymal reflectivity in the left hemisphere around the sylvian fissure

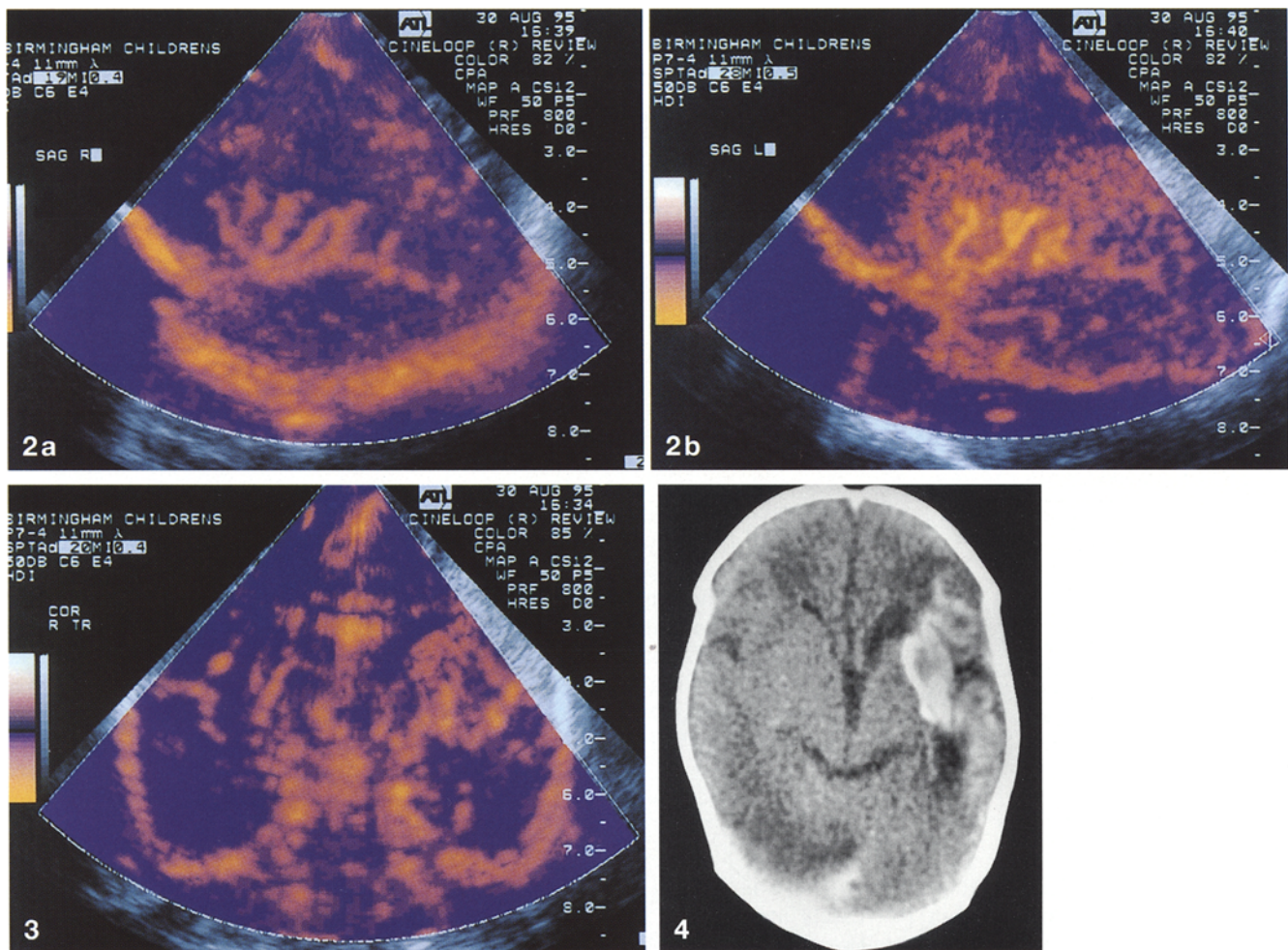


Fig. 2a,b Parasagittal cranial ultrasound with PDI through the right sylvian fissure: **a** normal vascularity; **b** increased vascularity around the left middle cerebral artery territory

Fig. 3 A coronal cranial ultrasound scan with PDI showing increased colour signal in the distribution of the left middle cerebral artery territory

Fig. 4 A cranial CT scan (non-contrast) showing high gyrus attenuation in the left middle cerebral artery territory and dilatation of the left lateral ventricle

“switch” procedure at 1 month of age. At 3 months of age he is reasonably well, with minimal hypertonia in the right limbs and poor head control.

Discussion

Luxury cerebral perfusion following ischaemic brain injury occurs as a result of the breakdown of the blood-brain barrier and neuronal disruption causing a release of vasoactive substances and local vasodilatation. Al-

though there is an increase in the size and number of vessels around the ischaemic cerebral parenchyma, the change in vascular volume may not be sufficient to be detected on CFD. Although these changes have previously been demonstrated on both CT and CFD [1, 2], we believe this to be the first report of such luxury perfusion demonstrated on PDI.

PDI is a signal-processing technique evaluating the total signal energy rather than the mean frequency as with CFD. When utilising CFD, which is based on mean frequency shift, noise in the signal appearing as speckle artefact can be misinterpreted as flow, hence “gain” and “threshold” have to be set so that noise does not submerge “true” vascular signals. In PDI the gain may be set high and, as noise is uniform throughout the image, the vascular signal is still apparent. As there is no directional encoding with PDI more processing time per pulse allows better assessment of low amplitude information. Hence PDI has been calculated to be between three and five times more sensitive for low flow [3], and this enables luxury cerebral perfusion to be more easily demonstrated, as in the case of our pa-

tient. In luxury cerebral perfusion the vascular volume changes may be more easily detected with PDI than with CFD alone owing to its increased sensitivity. As this case demonstrates, PDI can be a useful adjunct in the demonstration of luxury perfusion in neonatal ischaemic brain injury, particularly if CFD does not show any alteration in vascularity.

References

1. Taylor GA (1994) Alterations in regional cerebral blood flow in neonatal stroke: preliminary findings with color Doppler sonography. *Pediatr Radiol* 24: 111–115
2. Close PJ, Carty HM (1991) Transient gyriform brightness on non-contrast enhanced computed tomography (CT) brain scan of seven infants. *Pediatr Radiol* 21: 189–192
3. Rubin JM, Bude RO, Carson PL, et al (1994) Power Doppler US: a potentially useful alternative to mean frequency-based color Doppler US. *Radiology* 190: 853–856