FETAL BEHAVIOURAL STATES AND PHYSIOLOGICAL FUNCTION

Jan G. Nijhuis

Catholic University of Nijmegen, St. Radboudhospital,
Department of Obstetrics and Gynaecology, PO Box 9101,
6500 HB, Nijmegen, The Netherlands

The use of ultrasound techniques in obstetric practice have introduced possibilities to study the human fetus non-invasively, and in its natural environment. Direct assessment of the condition of its most important organ, the Central Nervous System (CNS), is not yet possible, but fetal behaviour can be studied and is a direct expression of CNS activity. In a longitudinal study in low risk pregnancies, two real-time ultrasound scanners (eye and body movements) and a cardiotocograph (fetal heart rate pattern, FHRP) were used simultaneously to record fetal behaviour from 32 weeks onward. Observation sessions lasted 2 hours and were repeated at 2-weekly intervals. From 36-38 weeks it was possible to define four behavioural states which resembled those in the neonate as described by Prechtl (3). They were therefore designated 1F to 4F ("F" for fetal), although somewhat different criteria had to be used (1).

STATE 1F: quiescence, sometimes interrupted by a brief body movement, mostly a startle. Eye movements absent. Stable FHRP with a small bandwidth, and isolated accelerations may occur, strictly related to movements (FHRP A).

STATE 2F: frequent and periodic gross body and extremity movements. Eye movements continually present. The FHRP B shows a wider oscillation bandwidth than FHRP A, with frequent accelerations in association with movements.

STATE 3F: gross body movements absent, eye movements present FHRP C is stable, but with a wider bandwidth than FHRP A.

STATE 4F: vigorous activity with many trunk rotations eye movements present. FHRP D is unstable with many longlasting accelerations, sometimes fused into a sustained tachycardia. It must be emphasized that the existence of states can only be accepted if three criteria have been fulfilled: the combinations must be specific, must be stable over time (at least 3 min), and clear state-transitions must be present. Before 36 weeks periods of "coincidence" of parameters do occur and may mimic a state, but the other requirements are not satisfied. Fetal breathing is not continuously present in the human fetus and cannot be used as a state-criterion. However, fetal breathing is much more regular in 1F than in 2F, and regularity can be used as a state-concomitant (2). Furthermore, fetal breathing incidence is much higher in 2F (5). Other phenomena such as fetal micturition, are also related to states (4).

A study of behaviour in growth-retarded fetuses (6) demonstrated a reduction of time spent in state 1F and some disorganization of the states as reflected in less stable combinations and in the fact that many transitions lasted longer than 3 min. These preliminary results indicate that the study of behavioural states may be of value in detecting neurological dysfunction in utero. If so, it could be the beginning of an "intra-uterine" neurological examination, which is essential for the precise evaluation of the condition of the human fetus.

References:

1. Nijhuis JG et al 1982 Early Human Dev 6:177
2. Nijhuis JG et al 1983 Early Human Dev 9:1
3. Prechtl HFR 1974 Brain Res 76:185
4. Visser GHA et al 1981 Br J Obstet Gynaecol 88:803

5. Van Vliet MAT et al 1985 Am J Obstet Gynecol 153: 582

6. Van Vliet MAT et al 1985 Early Human Dev 12:183

BRAIN DAMAGE

Joseph J Volpe, A. Ernest and Jane G. Stein
Department of Pediatrics, Washington University,
Saint Louis, Missouri 63178

CLINICAL APPLICATIONS OF POSITRON EMISSION TOMOGRAPHY

Positron emission tomography (PET) has provided the capability of obtaining in vivo regional biochemical and physiological information about human brain in health and disease. This capability, not long ago considered an unattainable fantasy, is the product of four major developments in the necessary technology; specifically, the apparatus for nuclear bombardment, i.e., the cyclotron, to produce positronemitting isotopes, the techniques for rapid synthesis of radiopharmaceuticals necessary for biochemical and physiological studies, the mathematical models and practical algorithms to obtain the critical information from the data, and the PET instrumentation to detect safely the radiopharmaceuticals in vivo in a regional and quantitative manner.

The only extensive appearance with PET in pediatrics has been in the study of the newborn, specifically the premature infant with intraventricular hemorrhage (IVH) and hemorrhagic intracerebral involvement, and the asphyxiated term infant with hypoxic-ischemic encephalopathy (HIE). These studies are reviewed briefly next.

IVH WITH HEMORRHAGIC INTRACEREBRAL INVOLVEMENT

The magnitude of the problem of IVH with hemorrhagic intracerebral involvement is emphasized by our study of 460 premature infants by cranial ultrasonography; thus, IVH occurred in 38% (n=177), and of these, 20% (n=34) had the lesion under discussion. IVH with hemorrhagic intracerebral involvement accounts for the vast majority of the deaths and subsequent neurological morbidity in all infants with IVH. To define the basic nature and probable pathogenesis of the critical intracerebral involvement, we have measured regional CBF by PET in 12 premature infants with the lesion.

The clinical features of the infants have been generally similar. All have had severe respiratory distress syndrome; approximately 50% have experienced perinatal asphyxia. Cranial ultrasonography consistently has demonstrated IVH and a globular collection of blood within the frontal white matter, i.e., the hemorrhagic intracerebral involvement. The lesion has occurred on the left in two-thirds of the cases.

Regional CBF has been determined by PET after intravenous injection of $H_2^{15}O$. The findings have been similar and dramatic. First, anteriorly, in the region of the hemorrhagic intracerebral involvement, CBF is reduced markedly (as expected). Second, and unexpectedly, markedly diminished CBF is observed in posterior cerebral (parieto-occipital) white matter in the same hemisphere. Third, CBF is reduced, albeit to a lesser extent, in cortical regions, including posterior parietal and Sylvian cortex. Thus, the impairment of CBF in the hemisphere containing the intracerebral blood is much more extensive than could be accounted for by the locus of the intraparenchymal blood. This larger lesion presumably accounts for the serious neurologic deficits nearly uniformly observed in the survivors.