The neonatal cerebellum

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Chapter 10

Summary

In this thesis we study the incidence and characteristics of cerebellar injury in both preterm and full-term infants and the role of different neuroimaging techniques for its detection. We also investigate the clinical consequences of the detection of small hemorrhagic brain lesions in preterm infants.

Chapter 1 provides background information on the development of the cerebellum, which is extremely rapid in the late fetal period. As a consequence the cerebellum is vulnerable to a variety of insults that can occur in the preterm infant. When injury occurs it can have important consequences for subsequent cerebellar development. Cerebellar hemorrhage (CBH), being the most frequently occurring form of cerebellar injury in preterm infants, and cerebellar injury in full-term infants are discussed in more detail. We discuss the advantages and limitations of neuroimaging techniques that can be used for the detection of cerebellar injury in the newborn infant and we provide information on the consequences of cerebellar injury for neurodevelopmental outcome.

Part I Neonatal neuroimaging

Chapter 2 describes the standard cranial ultrasound (CUS) procedure and alternative imaging techniques including the use of additional acoustic windows, different transducer types, and the adaptation of transducer frequencies and focus points. **Chapter 3** additionally discusses the indications, scanning protocols and limitations of CUS. It also provides background information on common abnormalities that can be encountered in both preterm and full-term neonates. For illustration numerous CUS images are provided.

Part II Cerebellar injury in the preterm neonate

Chapter 4 investigates the incidence and characteristics of cerebellar injury in a prospective cohort of very preterm infants using mastoid fontanelle (MF) and posterior fontanelle views in addition to routine CUS through the anterior fontanelle (AF) and compares the results of CUS with MRI. It shows that cerebellar injury is a frequent finding in very preterm infants, occurring in 19% of the study population, and that the addition of MF views leads to an improved detection compared to AF-CUS alone.

The posterior fontanelle approach does not contribute to the detection of cerebellar injury. We conclude that the high incidence of cerebellar injury warrants routine CUS examinations that include MF views in very preterm infants. Small, punctate hemorrhagic lesions remain beyond the scope of CUS and can only be detected with MRI. The prognostic implications of these small lesions are unclear and need further investigation.

Chapter 5 investigates, in a prospective cohort of very preterm infants, perinatal and postnatal factors that may affect the occurrence of small hemorrhagic lesions (< 4 mm) in the cerebellum, assesses their relationship with supratentorial brain injury, and evaluates the effect of small CBH on neurodevelopmental outcome. Small hemorrhagic lesions were detected by MRI at term age in 16 (15%) of the 108 infants and were associated with low gestational age at birth. High-frequency oscillation ventilation, used as a rescue strategy in severe respiratory failure, and grade III-IV intraventricular hemorrhage were independent predictors of small CBH. There was no association between small CBH and neurodevelopmental outcome at 2 years of age. We conclude that in contrast to large CBH, small CBH have a favorable short-term prognosis.

Chapter 6 investigates the presence of both supra- and infratentorial hemosiderin deposits, as detected by T2*-weighted gradient echo MRI, in an unselected cohort of very preterm infants and correlates the presence and location of hemosiderin deposits with white matter injury and neurodevelopmental outcome at 2 years of age. Hemosiderin was detected in 38 (40%) of the 95 infants. Small hemosiderin deposits in the ventricular wall correlated with white matter injury on MRI at term age and with a lower psychomotor developmental index at 2 years of age. After correction for clinical parameters (gestational age, gender, intra uterine growth restriction) and white matter injury, the latter correlation was no longer significant. We conclude that the clinical importance of detecting these small hemosiderin deposits using gradient echo MRI is limited as there is no independent association with neurodevelopmental outcome. We therefore do not propagate the routine use of T2*-weighted gradient echo MRI in very preterm neonates.

Part III Posterior fossa abnormalities in the full-term neonate

Chapter 7 describes the technical aspects of MF ultrasonography in full-term neonates and the features of posterior fossa abnormalities that may be encountered in various neonatal disorders such as hypoxic-ischemic encephalopathy, central nervous system infection, intracranial hemorrhage, inborn errors of metabolism and congenital posterior fossa malformations. Numerous CUS and MR images are provided for illustration. The advantages, pitfalls and limitations of the MF approach are discussed.

Chapter 8 investigates the incidence and characteristics of posterior fossa abnormalities in a retrospective cohort of high-risk term infants and compares the diagnostic accuracy of CUS, including both AF and MF views, with the results of MRI. It shows that posterior fossa abnormalities occur frequently in high-risk term infants and that the addition of MF views to standard AF-CUS improves the detection of major and clinically relevant abnormalities. Acute hypoxic-ischemic cerebellar injury, small subdural hemorrhage, and punctate CBH often remain beyond the scope of CUS and are better detected by MRI. We conclude that CUS examination should include MF views in high-risk term neonates.