Neurological and visual assessments in very and late low-risk preterm infants

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Abstract
In this review, we report our experience on early neurological and visual developments in preterm infants assessed during the neonatal period using the Dubowitz neonatal neurological assessment and a new battery for visual assessment. The assessments were performed in both very and late low-risk preterm infants and in healthy term-born infants. We report the findings in the three cohorts, evaluating the influence of gestational age and extrauterine exposure on both neurological and visual developments.

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1. Introduction
Several studies have reported assessment of neurological and visual functions in newborn infants [1–5]. Some of these assessments have recently been adapted and validated also for infants born prematurely [5–11]. While many of the previous studies mainly reported the use of such tools in very preterm infants, more recently, increasing attention has also been devoted to their use in late-preterm (LP) infants, i.e. those born at 34–36 weeks gestational age (GA). Although these infants represent the great majority of infants born prematurely (~70%), there is much less information on their outcome because they are not routinely followed up [12,13].

In this paper, we review our experience on the assessment of both very and late preterm infants, providing an overview of the neurological and visual findings at different GAs. As normative data using the same tools are also available for term infants, we also aim to explore the possible influence of GA and extrauterine exposure in these cohorts.

2. Neurological assessment

2.1. Very preterm infants
The neurological assessment of the newborn has been widely studied in both preterm and full-term infants using the examination developed by Dubowitz and Dubowitz in 1981 [2] and updated in 1998 [3]. We recently reported the application of the same examination to a cohort of 380 low-risk preterm infants born between 25 and 34.9 weeks’ GA [11]. In this cohort of low-risk preterm infants, the range of findings was much wider than in term-born infants, especially for items pertaining to tone and behaviour.

At term-equivalent age (TEA), low-risk preterm infants had less flexor limb tone and poorer head control than term-born infants, probably because term-born infants have a longer exposure to marked intrauterine pressure in a flexed posture. Preterm infants were also more hyperexcitable, as demonstrated by the high rate of brisk reflexes, stronger palmar grasps, startles, and tremors. Moreover, preterm infants showed better visual responses than term-born infants, as postnatal exposure allows preterm infants at TEA to be more capable of coordinating ocular movements when tracking a visual target. For 28/34 of the neurological items, the range and median scores were similar across GAs.

2.2. Late preterm
We also performed the same examination in 375 low-risk LP infants [14]. While in infants born at 34 weeks’ GA, the assessment at term age showed similar median scores to those obtained in full-term infants in 25/34 items, in those born at 35 and 36 weeks’ GA, the number of scores similar to full-term infants increased to 29/34. The main differences involved the tone items, with more marked flexor tone in the limbs and better head control for those born at 35 and 36 weeks’ GA. The changes observed between infants born before and after 35 weeks’ GA are probably due to the critical
period of brain growth and development occurring at this GA, related to the increasing of the volume of both grey and myelinated white matter.

3. Visual function in preterm infants

Our group has recently developed a structured protocol for the assessment of different aspects of neonatal visual function [5]. The protocol includes 9 items assessing ocular movement (spontaneous and with the target), horizontal, vertical, and arc tracking, reaction to coloured target, discrimination of stripes with increasing spatial frequency, and attention at distance. The examination has been validated in low-risk term-born infants and in a cohort of low-risk infants of 25–32 weeks’ GA in order to assess the onset of other aspects of visual function [7]. This study has suggested that the examinations can be applied in preterm infants as young as 32 weeks.

3.1. Very preterm

The assessment of visual function was also used in a cohort of 109 low-risk preterm newborns (25.0–30.9 weeks’ postmenstrual age) assessed at 35 and 40 weeks’ postmenstrual age (term equivalent) to address the possible role of extrauterine life on the early development of visual function [6]. Preterm infants assessed at 35 weeks’ postmenstrual age were generally less mature in their visual responses than at term-equivalent age, but the differences were only significant for three items (tracking a coloured target, attention at distance, and stripe discrimination). The comparison between the results in preterm infants and those reported in term-born infants at 48 h from birth showed that ocular movements (spontaneous or following a target) and tracking a black/white target vertically and in an arc, were more mature in preterm infants at both 35 and 40 weeks’ postmenstrual age. The abilities to fix centrally and track horizontally were not different among the three groups. These results demonstrated that some of the early aspects of visual function are probably related to subcortical rather than to cortical systems. The maturation of these “subcortical” aspects of visual function can be accelerated by preterm extrauterine exposure and early extra visual and visuomotor experiences.

In contrast, other responses (responses to colour contrast, attention at distance, and discrimination of stripes), were less mature in preterm infants at 35 weeks’ postmenstrual age compared with both preterm infants at term-equivalent age and term-born infants. These aspects of visual function are likely to require more cortical input and more mature subcortical/cortical connectivity. These more cortically mediated aspects of early visual development are likely to be more dependent on postmenstrual age than on the length of extrauterine life.

3.2. Late preterm

The same structured assessment was used in 60 healthy infants born between 34 and 36 weeks’ GA, without major brain lesions, evaluated between 48 and 72 h from birth and at TEA [15]. LP infants at birth are already able to fix and follow a target for horizontal, vertical, and arc tracking, and to respond to more complex visual stimuli, completing items such as reaction to colour, discrimination of black and white stripes, and attention at distance. In four items (vertical and arc tracking, ability to discriminate striped black/white targets, and attention at distance) LP infants at TEA showed more mature findings than at birth, confirming that the last weeks of gestation, from 34 to 36 weeks onwards, are crucial for the development of these abilities.

4. Conclusions

In this review, we report how structured neonatal neurological and visual assessments can be easily and reliably used in both very and late preterm infants. Our previously published data can help as a reference when examining preterm infants to see where the individual child stands compared with age-matched low-risk infants and to identify signs that may be outside the reported range. These tools should be used routinely in the neonatal unit, at least in infants at risk of neurological abnormalities. These examinations have been used in preterm infants with lesions showing that they can reliably identify infants at risk of developing neurological and visual abnormalities [8,11,16,17].

The possibility to identify early neurological and visual abnormalities will allow early referral of these infants for rehabilitation and appropriate support for the families.

Conflict of interest

None to declare.

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