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H-reflex and motor nerve conduction studies in growth retarded newborn babies

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Abstract

Objective To demonstrate the accelerated postnatal maturation/myelination in growth retarded babies compensating the deficit suffered by them during intrauterine life. *Methods* We studied 16 babies within the first 3 days of birth. These included 6 full term appropriate for gestational age babies (FT AGA) and 10 full term intrauterine growth retarded (FT IUGR). A separate group of 16 babies was examined at 2 months of age. In this group 7 were FT AGA and 9 were FT IUGR at the time of birth. H-reflex latency (HRL), motor nerve conduction velocity (MNCV) and H-reflex excitability (H/M) were measured in the right lower limb. Anthropometric measurements of the babies were also recorded meticulously. All the babies were neurologically normal on clinical evaluation. *Result* At birth, MNCV was significantly lower in FT IUGR babies compared to FT AGA babies. However at the age of 2 months the MNCV of both FT AGA and FT IUGR was comparable. Other parameters (HRL and H/M) in the IUGR babies were comparable with normal babies both at birth and 2 months of age. In FT IUGR babies crown heel length and weight was significantly lower than FT AGA babies both at the time of birth and at 2 months of age. *Conclusion and significance* The findings suggest that FT IUGR babies demonstrate accelerated postnatal peripheral neural maturation. At 2 months of age, the motor nerve conduction velocity of these growth retarded babies were comparable to that observed in normal AGA babies of similar age. This provides an insight into the functional aspect of the proven theories of decreased peripheral myelination in FT IUGR babies with subsequent rapid postnatal myelination that renders these babies neurologically equivalent to FT AGA babies despite not achieving comparable anthropometric parameters.

Keywords: H-reflex; Intrauterine growth retardation; Motor nerve conduction velocity; Neuronal excitability; Newborn

Full term intrauterine growth retarded (FT IUGR) newborn babies show similar neurological maturity to that of full term appropriate for gestational age (FT AGA) babies on clinical examination [17]. Warshaw [29] stated that brain growth and head circumference are spared at the expense of both weight and linear growth in newborns with intrauterine growth retardation at birth. However, some studies have shown defective myelination of the nervous system in IUGR babies [7,8,10]. Westwood et al. [30] conducted a follow-up study and concluded that full term non-asphyxiated small for gestational age infants had an impaired potential for physical growth but a relatively good prognosis for neurological and cognitive development. The neurological assessment of newborn babies is clinically difficult due to its subjectivity.

The Hoffmann reflex (H-reflex) is a useful tool to assess the motor neuronal excitability and the function of the peripheral nerve in clinical neurophysiology [1]. The H-reflex has been described as a monosynaptic reflex, and as an excellent tool in determining magnitude and distribution of spindle input to a motoneuronal pool [20]. We recorded electrophysiological parameters such as H-reflex latency (HRL), H_{max}/M_{max} ratio in % (H/M), and motor nerve conduction velocity (MNCV) to elicit any sub clinical neurological differences between FT IUGR and FT AGA babies at birth [15,16,18,21,22,27,28]. A cross-sectional study of both FT AGA and FT IUGR babies was carried out at the age of 2 months to document differences in neurological maturation between these groups.

The study comprised babies admitted in the Division of Neonatology, Department of Pediatrics, Institute of Medical

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Table 1
10th percentile weight at different gestational ages

Weeks of gestation	10th percentile weight (g)
37	2035
38	2195
39	2290
40	2340
41	2360
42	2340

Adapted from Bhatia et al. [3].

Sciences, Banaras Hindu University and those babies who attended the follow-up clinic. Babies born to diabetic mothers or those who suffered from birth anoxia, septicemia, meningitis, hyperbilirubinemia, hypoglycemia or those having congenital malformations or chromosomal anomalies were excluded. All the babies in our study were born at term (gestation 37–41 weeks). The calculated gestational age was corroborated clinically with the new Ballard score [2]. Babies were grouped as AGA and IUGR based on their birth weight. Babies with birth weight below the 10th percentile of local standards [3] for that gestational age were grouped as IUGR and those with birth weight between the 10th and the 90th percentiles were grouped as AGA (Table 1).

We examined 16 babies within the first 3 days of their birth. Out of them, 6 babies were FT AGA and 10 were FT IUGR. A separate group of 16 babies were examined at 2 months. This cross-sectional study at 2 months of age had to be undertaken owing to the drop-out from follow-up in the babies examined at birth. In this group, 7 were FT AGA and 9 were FT IUGR at the time of birth. The babies examined at 2 months of age had not suffered from any ailment since birth, and were exclusively breast fed with no nutritional supplement. Infants were neither restrained nor sedated during electrophysiological tests.

Birth weight, crown heel length and head circumference were measured accurately by standard techniques. The electrophysiological parameters were conducted at the Neurophysiology Research Unit, Department of Physiology, Institute of Medical Sciences, Banaras Hindu University. Informed parental consent in compliance with the Declaration of Helsinki was obtained for performing electrophysiological studies and the Post Graduate Board of the Institute of Medical Sciences (Banaras Hindu University) approved the study protocol. The instruments used were: Biopac Student Lab Advanced System (Biopac Systems Inc., 42 Aero Camino, Santa Barbara, California-93117, USA) with filter setting between 5 Hz and 5000 Hz, and GRASS Stimulator model S88 (Grass Medical Instruments, 101 Old Colony Avenue, Quincy, Massachusetts-02169, USA).

The babies were comfortably placed prone on the lap of an assistant and the electrophysiological studies were performed while the babies were fully awake, i.e. state 3 or 4 [23]. Disposable neonatal surface Ag-AgCl electrodes were applied on the skin surface. The stimulating electrodes were placed on the skin above the tibial nerve in the popliteal fossa after applying conducting jelly, the cathode being placed distal to the anode with respect to the recording electrode. The recording electrode was placed over the soleus, at the junction of upper 2/3rd and lower 1/3rd of the calf. The reference electrode was placed close to the medial malleolus, one centimeter medial to a line drawn from popliteal fossa to insertion of tendo-achilles at its lower one third. The ground electrode was placed over the soleus muscle in between the stimulating and the active recording electrodes. The above recording site was used to achieve the maximum reflex excitability of motor neurons with least variations on serial recordings. We applied wave pulses of 1 ms duration with an interstimulus interval of at least 10 s. This procedure has been standardized over the years in our laboratory [4,15,21,22].

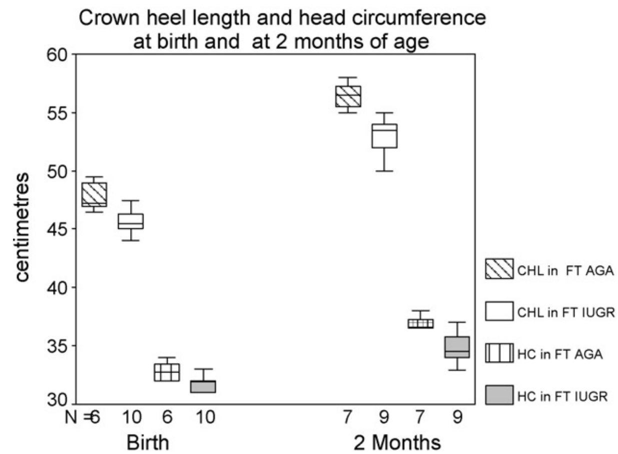

Fig. 1. Box plot for crown heel length and head circumference values of FT AGA and FT IUGR babies examined at birth and at 2 months of age. The box plot shows non-parametric descriptive statistics. The box shows the mean (horizontal line within the box) and lower and upper quartiles (upper and lower extremes of the box). CHL = crown heel length; HC = head circumference; FT = full term; AGA = appropriate for gestational age; IUGR = intrauterine growth retarded, *N* = number of cases in each group.

H/M, which represents the proportion of reflexly excitable motor neurons, is a good index for comparison between subjects and between different studies [5,11]. The maximum amplitudes of H and M waves were measured in the right lower limb (posterior tibial nerve-soleus muscle). As their values may alter with electrode position [9,24], the placement of electrodes on the limb was kept constant in all the subjects. HRL was also measured.

The MNCV was derived by stimulating the right posterior tibial nerve at two different points along its course: the popliteal fossa and behind the medial malleolus [18,19]. The active recording electrode was placed over the abductor digiti minimi muscle on the lateral aspect of sole.

The arithmetic mean and standard deviation was calculated for quantitative variables. The number of cases in each group being small, the data was not normally distributed. Therefore, the non-parametric Mann–Whitney *U*-test was applied. SPSS 11.0 software and MS Excel were used for the statistical and graphical analyses. p value of less than 0.05 was considered significant.

Table 2 shows the mean and standard deviations of the anthropometric parameters, gestational age, postconceptional age, H-reflex parameters and nerve conduction velocity in different study groups. Fig. 1 is a boxplot representation of the crown heel length and head circumference. Fig. 2 shows the weight and Fig. 3 depicts the MNCV values at birth and at 2