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RESEARCH ARTICLE

# H-reflex conduction velocity in babies from birth to 6 month of age

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## ABSTRACT

**Background:** The neurological assessment of newborn babies is clinically difficult due to its subjectivity. H-reflex and H-reflex conduction velocity (HRCV) are especially useful in pediatric nerve conduction studies. It evaluates proximal segment of nerve which includes Ia sensory afferent and motor component of the peripheral nerve. **Aims and Objectives:** To assess the H-reflex latency (HRL) and HRCV in first 6 months of postnatal period and their correlation with other anthropometric variable such as weight, height, and head circumference. **Materials and Methods:** 26 full-term babies between the age group from birth to 6 months of age were the study participants. HRL and HRCV were recorded in the right lower limbs at posterior tibial nerve-soleus muscle in all the babies. **Results:** The values of HRCV had significantly increased at 3-6 months of age, and it was strongly correlated with HRL but weakly correlated with age of the babies. **Conclusion:** The proximal nerve conduction velocity i.e. HRCV was significantly increased from birth time to 3-6 months of age due to rapid myelination and maturation of nerve fibers. This rise in velocity has also maintained the HRL to a comparable level in all the babies even with the increment of height. The HRL and HRCV could be useful as a complementary method along with clinical examination to assess functional integrity of the spinal cord.

**KEY WORDS:** Babies; H-reflex Latency; H-reflex Conduction Velocity; Peripheral Nerve; Proximal Conduction Velocity; Spinal Cord

## INTRODUCTION

The neurological status of the newborn and small babies may often be in doubts. Neurological screening of babies is important to know the maturity status of the nerve, both for early detection and management of any neurological pathology. A number of procedures exist for estimating the maturity of nerve. Most important is nerve conduction studies, Schulte et al.[1] and Blom and Finnstrom.[2] were the pioneer workers in this field who reported nerve conduction velocity (NCV) in babies. The NCV of peripheral nerve depends on the thickness of the myelin sheath, which increases with degree of myelination. Proximal segment nerve conduction studies in adult were done by many worker but scanty reports are available in children.[3-6]

The present study has been undertaken to measure the NCV in the proximal segment of the spinal monosynaptic reflex (H-reflex). A similar kind of study was done earlier by Vecchierini-Blineau and Guiheneuc in European children to understand the proximal conduction velocity in spinal segment with the help of H-reflex latency (HRL) and height of the baby.[4,5] They measured nerve conduction in sensory Ia afferent segment and alpha motor neuron of tibial nerve. Using this method, the estimation of proximal conduction velocity becomes easier in babies.

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H-reflex is electrically induced analogy of monosynaptic reflex. It is used to assess the spinal reflex arc having ascending Ia afferent activity, the synapse at spinal level, and the descending homonymous motor nerve efferent activity (α motor neuron) to the muscle.[7] The difference between monosynaptic reflex and H-reflex is that the H-reflex bypasses the spindle activity.[8] H-reflex conduction velocity (HRCV) studies will help to know the conduction in the proximal segment of the reflex arc. It involves both sensory and motor segment of spinal monosynaptic reflex arc. Conduction along the H-reflex pathway has been used to assess the degree of myelination of nervous system and also to assess the sensory (Ia) and motor component of reflex arc as well. Other studies such as F waves were measured to study proximal conduction studies in motor nerve only.[9] The electrophysiological study of H reflex and HRCV are of particular value in infant and children because sensory function and loss of nerve fibers are more difficult to assess clinically in children than in adults. Performing clinical examination in combination with H-reflex and HRCV could be useful as a complementary method to assess functional integrity of the spinal cord.

In the present investigation, an approach was made to study the HRL and HRCV in the first 6 months of postnatal period and their correlation with other anthropometric variables such as height, weight, and head circumference (HC).

## MATERIALS AND METHODS

This cross-sectional study comprised 26 babies. The age of babies was from birth to 180 days. All were full term (37 to 41 weeks post-menstrual age) and having appropriate birth weight (above the 10th percentile of the Indian local standard with their gestational age).[10] Infants born to diabetic mothers or those who suffered from birth anoxia, septicemia, meningitis, and hypoglycemia or having other congenital malformation such as hydrocephalus or chromosomal anomalies or hemodynamically unstable were excluded from the study. These babies were taken randomly from outpatient department (OPD) of the S. S. Hospital, Banaras Hindu University, who came for general checkup. The study protocol was duly approved by the Ethical Committee of Institute of Medical Science, Banaras Hindu University, India. Depending on availability, the babies were categorized into three study groups according to their age: Group I (Birth to 30 days of age, $n = 12$), Group II (31-60 days of age, $n = 7$) and Group III (61-180 days of age, $n = 7$). Non-invasive electrophysiological examinations were performed at the Neurophysiology Unit, Department of Physiology, Institute of Medical Science, Banaras Hindu University; only after taking proper consent (informed and signatory) from their parents in compliance with declaration of Helsinski (1964) amended at Edinburgh (2000).

Electrophysiological parameters such as HRL and motor responses latency (MRL) were recorded from the conventional site of posterior tibial nerve-soleus muscle of the right limb of babies.[11-13] The babies were comfortably placed in prone position on the lap of mothers with a small pillow underneath the lower limb; therefore, limbs remained extended. Investigations were done with the help of Biopac Student Lab Advanced System and GRASS stimulator (model S88). After proper skin cleaning with soap/water and acetone swab, infant size surface recording electrode (Ag-AgCl) were placed over calf muscle (soleus) of right lower limb along with electrolyte jelly. The active recording electrode was placed specifically on the belly of the soleus muscle in the midline, at the junction of upper two-third and lower one-third of the calf region. The reference electrode was placed on the tendo Achilles just posterior to the medial malleolus. The above recording site was used to achieve the maximum reflex excitability of motor neurons with the least variations on serial recording.[11] Surface cathodal stimulating electrode was placed over the posterior tibial nerve in the popliteal fossa and anodal stimulating electrode was placed on the lateral side of knee. Ground electrode was placed midway between stimulating and recording electrodes. The trigger level of the recorder was set above the baseline electromyography amplitude. Square wave pulses with 0.1-0.2 msec duration were delivered percutaneously at midpopliteal region to stimulate posterior tibial nerve. The procedure has been standardized over the years in our laboratory.[11-14] The strength of stimulus for eliciting the H-reflex was submaximal, it preferentially activate the large Ia sensory fibers. Whereas it was supramaximal strength of stimulus for observing maximum (MRL).[11]

HRL measures the total traversing time of the nerve impulse along the monosynaptic spinal reflex arc, from the stimulus point at posterior tibial nerve till the recording of compound muscle action potential (CMAP) at soleus muscle.[12] Latencies were measured from the stimulus artifact to the onset of the wave. The time taken by the muscle to initiate a CMAP after direct stimulation of distal motor segment of posterior tibial nerve was (MRL).[12]

H-reflex conduction velocities were calculated as per formula given by Vecchierini-Blineau and Guiheneuc,[4] i.e., 0.8 × height (height in mm)

$$\text{HRCV (m/sec)} = 0.8 \times \text{height (height in mm)} / [\text{HRL-MRL}]\text{-}1 \text{ (latency in msec)}$$

In this formula, the distance travelled by nerve impulse in the soleus H-reflex pathway has been calculated as 80% of the height of children. This was based on studies of adult cadavers along with the knowledge of development of the femur and the trunk during the first year of life.[4] The conduction time in the proximal segment of reflex arc is calculated with the start point from the popliteal fossa (Ia afferent) and endpoint again at popliteal fossa (α motor neuron) (HRL-MRL). Central synaptic delay time is taken as 1 msec, which was deducted to calculate HRCV [(HRL-MRL)−1].[4] The investigation was concluded in a single sitting for each baby.

**Statistical Analysis**

The arithmetic mean and standard deviation (SD) were calculated for anthropometric and electrophysiological parameters. Student *t*-test has been used to test the significant difference between the groups examined. Furthermore, SigmaPlot software version 10 was used and data were analyzed for statistical significance using spearman correlation test. To find out the significant association between two variables, coefficient of correlation ($R^2$) was calculated.

## RESULTS

As shown in Table 1, data represent the anthropometric and electrophysiological findings of the study participants. The mean ± SD were calculated and study groups were compared using *t*-test and *P* value was calculated. Anthropometric parameter; weight, height, and HC in Group I (mean age 14.42 ± 9.62 days) were 2.81 ± 0.34 kg, 49.37 ± 11.10 cm and 33.06 ± 1.39 cm, respectively. These values had significantly increased according to age among groups.

The mean ± SD values of HRL and MRL in Group I (mean age 14.42 ± 9.62 days) were 12.93 ± 1.23 msec and 0.38 ± 0.21 msec, respectively. The values of HRCV in these infants were 34.64 ± 4.75 m/sec. When the whole Group I was compared with Group II (mean age 48.14 ± 8.61 days), all electrophysiological parameters were statistically similar. However, when Group I (mean age 14.42 ± 9.62 days) were compared with Group III (mean age 132.86 ± 41.92 days) values of all the electrophysiological parameter were statistically similar except HRCV (42.41 ± 8.02 m/sec) which was significantly increased in Group III infants (Figure 1). It was also observed that the HRL had strong correlation with HRCV ($r = 0.86$, $R^2 = 0.74$, $P \leq 0.0001$) (Figure 2). HRCV was also significantly correlated with other anthropometric parameter, i.e., weight, height, and HC (Table 2). Electrophysiological parameters of Group II and Group III were statistically similar.

## DISCUSSION

The present study provides normal data of proximal conduction velocity and HRL in the posterior tibial nerve in healthy babies. From the above result, it appeared that conduction velocity in proximal segment of posterior tibial nerve i.e. HRCV was significantly increased at 3-6 months of age and it was strongly correlated with HRL. Proximal segment of motor nerve can also be evaluated by F-response by means of centrifugal discharges from individual motor neuron which is initiated by antidromic volley in the axon.[9] Sensory NCV were normally obtained by orthodromic technique, using supramaximal stimuli by digital ring electrode on finger and

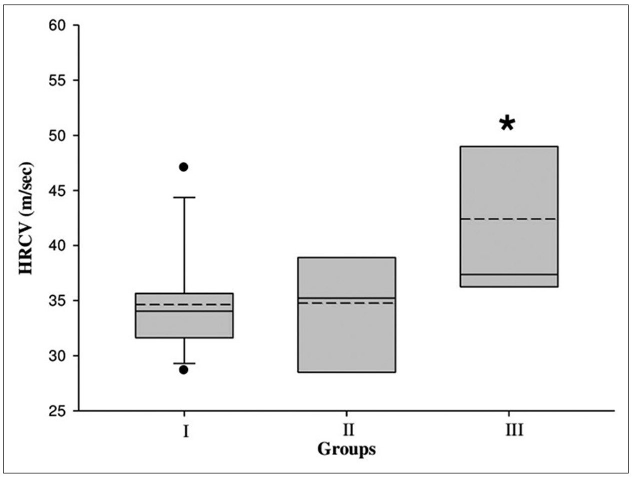


**Figure 1:** Boxplot representation of H-reflex conduction velocity in study participants groups. Horizontal dashed line is mean; solid line is median. Lower and upper borders of each box mark 25th and 75th centiles, respectively. Error bars mark 5th and 95th centiles. Points lying beyond error bar mark 5th and 95th centiles. *P < 0.05

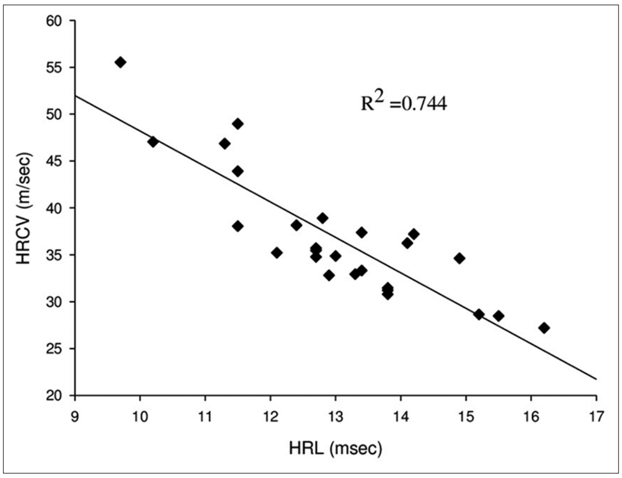


**Figure 2:** Scatterplot and fitted regression line of soleus H-reflex conduction velocity in relation with H-reflex latency in study participants

**Table 1:** Anthropometric and electrophysiological data of the study group

| Groups | Age (days) | Weight (kg) | HC (cm) | Height (cm) | HRL (msec) | MRL (msec) | HRCV (m/sec) |
|---|---|---|---|---|---|---|---|
| Group I | 14.42±9.62 | 2.81±0.34 | 33.06±1.39 | 49.37±11.10 | 12.93±1.23 | 0.38±0.21 | 34.64±4.65 |
| Group II | 48.14±8.61* | 3.14±0.51* | 35.57±1.39* | 51.07±3.06* | 13.47±1.78 | 0.48±0.17 | 34.77±6.06 |
| Group III | 132.86±41.92* | 5.56±0.41* | 40.71±0.90* | 58.57±1.13* | 12.73±1.91 | 0.37±0.17 | 42.41±8.02* |

HC: Head circumference, HRL: H-reflex latency, MRL: Motor responses latency, HRCV: H-reflex conduction velocity. *$P<0.05$

**Table 2:** Correlations of HRCV of participants with variables

| Association | $R^2$ | *P* |
|---|---|---|
| HRCV of participants and weight of participants | 0.33 | <0.001 |
| HRCV of participants and height of participants | 0.42 | <0.001 |
| HRCV of participants and HC of participants | 0.26 | <0.01 |
| HRCV of participants and H-reflex latency | 0.74 | <0.01 |

HRCV: H-reflex conduction velocity, HC: Head circumference

recording electrode over the nerve.[15] In this study, we used a simple method to evaluate the conduction velocity in proximal segment of tibial nerve H-reflex. This includes the conduction in both Ia afferent and α motor neuron of H-reflex pathway.

In the present cross-sectional study, the HRL value was 12.93 ± 1.23 m/sec in babies of 0-30 days age. It was less than that observed by other workers.[12,14] HRL had weak correlation with age as almost similar values were observed between the three Groups which were studied. HRL values are dependent on the increase in the length of reflex arc with height, and the maturation/myelination of nerve fiber from birth to 6 months of age.[4] The increase in NCV compensates the increment in length of reflex arc and therefore the HRL value is maintained in all the groups. A significant increase in HRCV in Group 3 supports this observation. However, in newborns that were studied within 72 h of birth in our laboratory, the HRL was higher in pre-term babies compared to full term with almost insignificant difference in height.[12,16,17] HRCV values (34.64 ± 4.65 m/sec) of full-term babies (Group I, 0-30 days) were similar to the values obtained by Vecchierini-Blineau[4] and Troni.[5] These values were higher than that reported by Prakash et al. (26.32 ± 2.16 m/sec).[12]

The values of HRCV had significantly increased at 3-6 months of age (42.4 ± 8.02 m/sec) and it was strongly correlated with HRL but weak correlation was observed with age of the babies. This suggests that all the factors which affect the HRL of the babies can affect the HRCV. At birth, the nerve trunk diameter is nearly half of the adult values. A rapid increase in nerve conduction during the first few months of life is dependent on the thickness of myelin sheath and remodeling of node of Ranvier.[18] Motor NCV in distal segment of posterior tibial nerve was reported as 27.6 ± 3.5 m/sec in earlier study from our laboratory.[19] This distal segment conduction velocity was significantly less than proximal segment conduction velocity (HRCV 34.64 ± 4.65 m/sec) reported in this study. As the myelination progresses from the spinal root toward the periphery, the value of proximal conduction velocity would be higher than distal segment in developing nerve trunk.[20,21] At the age of 3-6 months, the proximal nerve conduction was significantly increased due to increased spurt of growth in myelination process. All these factors facilitate NCV and explain its rapid increase during the first 6 months of life. Weight and HC reflects the nutrition status of the body and thereby the myelin formation.[22] However, weight and HC had weak correlation with HRCV.

This is preliminary study of small sample size. We did not observe the HRL and HRCV in >6 months old babies as we were fully dependent on the OPD follow-up and cooperation of parents. The data collection, however, strongly suggest that the HRCV (proximal conduction velocity) were dependent on height of the baby and maturation process of the nerve. This study corroborates with the work of Kumar et al.[23] They also confirmed that the height of subject had substantial effect on NCV.

## CONCLUSION

The present study gives an idea about the maturation of proximal segment of peripheral nerve with the advancement of age. This non-invasive technique of measurement of HRL and HRCV can enhance the knowledge of peripheral nervous system of babies.

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