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RESEARCH ARTICLE

Motor nerve conduction velocity in normal children under 5 years of age

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ABSTRACT

Background: Development of peripheral nerves is age dependent. It begins during fetal life and gets completed at around 5 years of age. Conduction velocity of any nerve is determined by myelination, diameter of the fiber, and internodal differences. Since all these three factors are remodeled during normal development of a nerve, motor nerve conduction velocity (MNCV) varies in different age groups in under-five children. **Aims and Objectives:** The aim of this study was to evaluate the MNCV of ulnar, median, and common peroneal nerve during the 1st years of life and to examine correlation between age factor and MNCV in these participants. **Materials and Methods:** Nerve conduction study was performed prospectively on median, ulnar, and common peroneal nerves with Neuroperfect electromyography/nerve conduction velocity/evoked potential system, and MNCV was measured in 106 normal children under 5 years of age. Results were analyzed using the Statistical Package for the Social Science (17.0) software. **Results:** There was a steady increase in MNCV of all three nerves from birth to 5 years of age. A significant positive correlation was found between age and MNCV of ulnar, median, and common peroneal nerve. **Conclusion:** MNCV of nerves of both upper and lower limbs varies significantly with age in children under 5 years of age. Thus, it is essential to have standard values of MNCV for the different age groups of under-five children while conducting nerve conduction studies.

KEY WORDS: Motor Nerve Conduction Velocity; Children; Ulnar Nerve; Median Nerve; Common Peroneal Nerve

INTRODUCTION

First 5 years of life of children are critical for neurocognitive development as the nervous system of body develops and gradually matures during this period. During the development of nervous system, peripheral nerve myelination begins at the 15th week of gestation[1] and it gets completed at around 5 years of postnatal life.[2,3] The axons also undergo maturational changes during these prenatal and postnatal periods.[4]

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Electrophysiological study of nerve conduction is an important tool to evaluate abnormalities of peripheral nerves in children.[5] Nerve conduction velocity is the speed at which an impulse travels along a nerve. It is a common measurement made during nerve conduction study and is a dependent variable of myelination, diameter of the fiber, and internodal differences.[6] Nerve conduction velocity of any particular nerve, therefore, changes significantly with age in the first few years of life before attaining the normal adult values. However, data regarding normal nerve conduction velocity during period of nerve maturation are very limited. Moreover, standard values of nerve conduction velocity for both upper and lower limbs are important to diagnose peripheral nerve disorders in infants and children.[7] Hence, this study was carried out to evaluate the motor nerve conduction velocity (MNCV) in carefully screened normal healthy infants and children <5 years of age.

MATERIALS AND METHODS

The present study is a cross-sectional prospective study. The study was conducted in the Department of Physiology, J N Medical College and Hospital, Aligarh Muslim University, Aligarh. Institutional Ethical Committee approval was obtained before commencing the study. 106 healthy children under 5 years of age born at term without any neuromuscular problem, attending the Paediatrics outpatient department for ambulatory checkups, were included in the study after taking informed consent of their parents/guardian. The sample size was estimated at conveniences.

MNCV study was performed on median, ulnar, and common peroneal nerves with Neuroperfect electromyography/nerve conduction velocity/evoked potential system. Depolarizing square wave electrical pulses were applied to the skin over the peripheral nerves for stimulation. Belly-tendon montage was used keeping the active surface electrode close to the motor point and the reference to the tendon.

Statistical Analysis

The Statistical Package for the Social Science (17.0) for Windows Software was used for the statistical analysis. The mean values of MNCV of different age groups were compared using one-way analysis of variance (ANOVA) tests. Karl Pearson's correlation was used to show the correlationship between age and MNCV. $P < 0.05$ was taken as statistically significant.

RESULTS

In the present study, 106 children were recruited and they were divided into six age groups for statistical analysis [Table 1].

Table 1: Age and sex distribution of study participants

Groups	Age (months)	Sex	
		Male	Female
Group 1	0–6	8	5
Group 2	>6–12	9	8
Group 3	>12–24	9	10
Group 4	>24–36	11	9
Group 5	>36–48	11	8
Group 6	>48–59	10	8

MNCV was measured for ulnar nerve, median nerve, and common peroneal nerve in all study participants in different age groups, and their values were expressed in mean and standard deviation [Table 2]. One-way ANOVA test was used for statistical analysis of the results in different age groups.

Table 3 shows the correlation between age and MNCV of different nerves. Karl Pearson's correlation was used to assess the correlation between MNCV and age.

DISCUSSION

The present study evaluates the MNCV of the commonly tested nerves in the upper and lower limbs of healthy children under 5 years of age. We have grouped our study participants into six groups based on age. There was a steady increase in MNCV of all three nerves from Group 1 to Group 6. Comparison of mean MNCV of ulnar, median, and common peroneal nerve between different age groups was statistically significant ($P < 0.05$). Moreover, there was a significant positive correlation between age factor and MNCV with $r = 0.897$, 0.908, and 0.859, respectively, for ulnar, median, and common peroneal nerve.

These findings agree with the results of many previous studies.[8-11] Peripheral nerve conduction in normal infants and children was studied by Gracia *et al*.,[7] and they have reported steep increase in conduction velocity during the 1st year of life, which is consistent with our study. The causative factor may be the rapid maturation of myelination early in development.[12] Ghosh *et al*.[13] studied MNCV of ulnar, median, and common peroneal nerve in children aged from 6 months to 4 years and reported its steady increase with age. They reported highest values of MNCV at around 4 years of age. However, our study has included children under 5 years of age and has found statistically significant increase even after 4 years of age. The progressive linear increase in conduction velocity of nerves found in our study also corroborates the findings of earlier researchers.[14,15]

The steady increase of MNCVs in all 3 nerves with age may be explained in relation to the maturational factors of peripheral nerves. Peripheral nerves' myelination begins usually around 4th month of intrauterine life and continues up to 5 years of age.[16] The axons also undergo maturation during this period, beginning at 20 weeks' gestation and it is complete between

Table 2: Comparison of MNCV of ulnar nerve, median nerve, and common peroneal nerve between the six age groups

Parameters	Mean±SD						*P*-Value
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	
MNCV (m/s) (ulnar nerve)	35.25±1.74	41.50±2.34	49.32±2.99	52.68±2.38	55.23±1.97	56.46±2.40	<0.001*
MNCV (m/s) (median nerve)	34.14±2.40	41.20±3.25	46.51±2.57	49.96±2.45	52.84±2.33	55.85±2.63	<0.001*
MNCV (m/s) (common peroneal nerve)	31.93±2.53	40.85±2.70	45.81±3.86	48.39±2.10	51.11±1.44	52.66±2.37	<0.001*

*P<0.05 significance. SD: Standard deviation, MNCV: Motor nerve conduction velocity

Table 3: Effects of age on MNCV in the study participants by correlation analysis

Nerve	Parameters	*r*-value	*P*-value
Ulnar nerve	MNCV	0.897	<0.001
Median nerve	MNCV	0.908	<0.001
Common peroneal nerve	MNCV	0.859	<0.001

Correlation is significant at the 0.05 level. MNCV: Motor nerve conduction velocity

ages 2 and 5 years.[4] Ratio between the inner and outer diameter of a nerve fiber (g-ratio) is higher than adults during these 1st years of life and it indicates hypomyelination.[17] Moreover, remodeling of the nodes of Ranvier continues during maturation, and the peak internodal distances are found at around 5 years of age.[18] Thus, the progressive increase in MNCV seen during infancy and childhood is most likely due to the maturation of myelination. These features are in accord with histological changes determining the conduction velocity of myelinated fibers.[19] The strengths of the present study include evaluation of MNCV of nerves of both upper and lower limbs in carefully screened normal infants and children. Limitation of our study is the estimation of sample size at conveniences.

CONCLUSION

MNCV of ulnar, median, and common peroneal nerve increases steadily during normal development from birth to 5 years of age, and a significant positive correlation exists between age factor and MNCV in these children. Thus, it is essential to have reference values of MNCV for the different age groups of children under 5 years of age while conducting electrophysiological studies on nerve conduction. Maturation of myelination during the formative years of life may be the causative factor for the significant increments in MNCV with age as reported by our study, but further studies should assess the children of all ages.

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