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Motor Nerve Conduction Velocity in Newborn Infants and Children

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Measurement of motor nerve conduction velocity (MNCV) of the median and peroneal nerves was performed in 79 normal fullterm newborn infants and children up through the age of 329 weeks. They were divided into eight groups by age. The following study was undertaken to obtain the mean±S.D. and the regression equation of Y (MNCV) on X (age). The MNCV values of each group were compared with those of normal adults.

Key Words: Motor nerve conduction velocity (MNCV) median nerves, peroneal nerves

Although a patient's history and physical examination are important in the diagnosis and determination of the progression of peripheral nerve disorders, a neurological examination may not be easily performed in young children and the findings can be difficult to interpret (Thomas *et al.* 1960). Therefore objective measurements of the nerve conduction velocity of peripheral nerves are useful and important.

During growth, the myelination of the peripheral nerves of children is not yet complete and the diameter of their axons is smaller than that of adults, therefore the MNCV is slower in direct proportion to the axon diameter (Hursh 1939; Gasser *et al.* 1939; Thomas *et al.* 1960; Cerra *et al.* 1962; LaFratta *et al.* 1966; Schulte *et al.* 1986).

This relationship between the conduction velocity of motor nerve fibers and age has been studied by many authors (Norris *et al.* 1953; Johson *et al.* 1960; Cerra *et al.* 1962; Schulte *et al.* 1968; Blom *et al.* 1968; Moosa *et al.* 1971; Moosa *et al.* 1972; Chung *et al.* 1973).

The MNCV for healthy Koreans has been studied by Chung 1973, Chung 1975, Kim *et al.* 1976, Kim *et al.* 1983. However in their studies, the subjects were all older than five years of age at which point the MNCV values are the same as those that of adults. Therefore their findings are not valid for children under five.

The purpose of this study was to determine the conduction velocity of motor fibers in median and peroneal nerves in Korean children before these velocities attained adult values.

MATERIALS

In this study seventy-nine children ranging in age from one week to 329 weeks, were divided into groups of eight according to age in weeks (Table 1).

As there was no significant difference in the motor nerve conduction study on either side of the body (Chung *et al.*, 1975; Kim *et al.* 1976; Cho *et al.* 1985), extremities were selected based on convenience for the procedure.

Table 1. Age distribution and the number of subjects

Group	Age (weeks)	Subject
1	1-	9
2	2- 12	8
3	13- 51	8
4	52-103	7
5	104-154	10
6	155-207	13
7	208-259	11
8	260-329	13
Tatal		79

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METHODS

A TECA Electromyography Model M, equipped with an electrically isolated percutaneous stimulator TECA 9523-4 which generates square wave pulses with a caliberated duration of 0.05 msec was used.

The room temperature was maintained between 22°C and 24°C and the humidity was 60% to 70%.

A method similar to that of Baer and Johnson (1965) was used to measure conduction velocity. The subject was placed in a supine position for stimulation of the median and peroneal nerves.

To determine the conduction velocity of the median nerve segment between the elbow and the wrist, the recording electrode was placed over the thenar eminence and the reference electrode at the base of the proximal phalanx of the thumb. The ground electrode was placed over the dorsum of the hand. The median nerve was stimulated at the elbow medial to the biceps tendon with the cathode distally placed and at the wrist lateral to the palmaris longus tendon.

For the peroneal nerve between the knee and ankle, the recording electrode was placed over the extensor digitorum brevis and the reference electrode over th 5th metatarso-phalangeal joint. The ground electrode was placed over the dorsum of the foot. The stimulating electrodes were placed at the lateral border of the popliteal fossa proximal to the head of the fibula and at the anterolateral aspect of the ankle near the transverse crease.

The stimulus intensity was slowly increased until the muscle action potential no longer increased in amplitude taking care to avoid volume conduction. The time from the stimulus artefact to the beginning of the muscle action potential was measured as the conduction time (the latency of the response). The intercathodal distances from the elbow to the wrist and from the knee to the ankle where the nerve was stimulated were measured in meters to calculate the MNCV for the median and peroneal nerves respectively. The difference in conduction time (latency) between the proximal and distal responses was divided into the intercathodal distance to give the conduction velocity in meters per second.

In order to obtain reliable statistics of the mean values in children in this study and then compare them with the mean values of adults from another study, the mean values of each experimental group were multiplied until that value was the same as an adult value. These were then compared with Kim's findings (1976).

RESULTS

The range and mean MNCV for each age group are shown in Table 2. The MNCV obtained showed an increase as the chronological age increased.

A statistical analysis of correlation was done to show the relationship between nerve conduction velocity and age. The regression equation of Y (MNCV) on X (age) is given for the median motor nerve as $Y=37.045+0.075X$ with $r=0.828$ and $R=0.68$ ($t=13.51$, $df=84$), and for the peroneal nerve $Y=36.495+0.076X$ with $r=0.775$, $R=0.60$ ($t=11.383$, $df=86$).Figures 1 and 2 show the MNCV for each subject plotted against age.

The multiplication factors used in each group to reach the adult value are presented in Table 3. Table 4 is a comparison of each group with the results of Kim's study of the subjects in their 20's.

DISCUSSION

Hursh's study in 1939 concluded that conduction

Table 2. Motor nerve conduction velocities

Group	Median Nerve				Peroneal Nerve			
	No. of Nerves	Range (m/sec)	Mean	S.D.	No. of Nerves	Range (m/sec)	Mean	S.D.
1	11	22.8-37.9	32.30	5.48	9	21.9-43.3	32.71	6.62
2	11	26.0-37.8	32.10	3.80	8	26.1-37.0	33.00	3.39
3	9	34.2-54.4	42.73	6.04	9	39.6-45.5	42.01	2.30
4	7	41.6-53.5	49.54	3.92	8	36.6-50.3	43.91	5.28
5	13	46.1-60.0	53.33	4.86	13	43.7-59.1	50.01	4.25
6	13	44.0-58.4	50.49	4.65	17	40.3-53.3	46.02	3.91
7	11	47.7-60.0	53.32	3.75	11	41.5-53.1	47.68	3.83
8	13	48.5-62.7	57.48	3.93	13	41.4-61.9	53.88	4.99

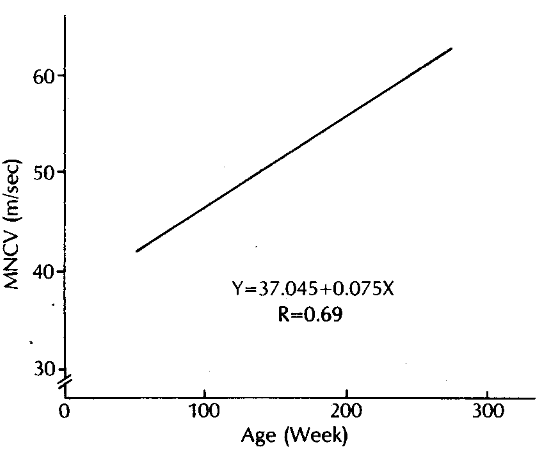

Fig. 1. Regression of median MNCV on age.

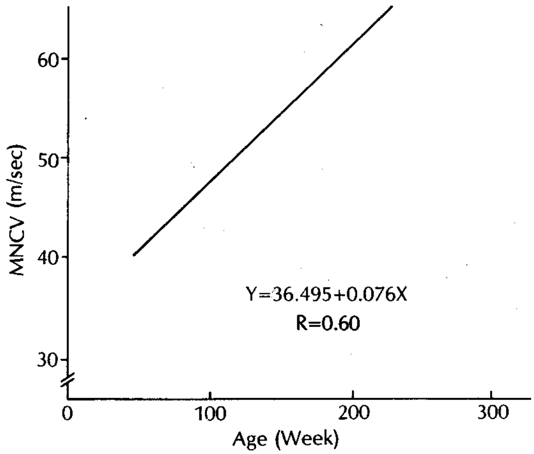

Fig. 2. Regression of peroneal MNCV on age.

Table 3. Multiplication factors used to reach the adult value

Group	Factor	Adult value (m/sec)			
		Median Nerve		Peroneal Nerve	
		Mean	S.D.	Mean	S.D.
1	1.75	56.52	9.58	57.24	11.58
2	1.75	56.18	6.79	57.57	5.92
3	1.30	55.54	7.86	54.62	3.00
4	1.20	59.45	4.71	54.42	9.58
5	1.10	58.72	5.37	55.01	4.66
6	1.10	55.54	5.11	50.63	4.30
7	1.10	58.66	4.12	52.45	4.21
8	1.00	57.48	3.92	53.88	4.99

Table 4. Comparison of the factored values of each group with Kim's study

Group	Median Nerve		Peroneal Nerve	
	t-value	df	t-value	df
1	17.76	19	7.42	17
2	16.26	19	6.73	16
3	11.49	17	10.38	17
4	2.25	15	3.13	16
5	8.67	18	10.38	23
6	12.05	21	2.17	25
7	4.35	19	5.28	19
8	7.31	21	5.76	21

velocities correlated positively with the outside diameter of nerve fibers in the various nerve trunks of the cat and the kitten, and that the best curve relating velocity and diameter was a straight line. In 1939 Gasser and Grundfest found that the velocity of nerve conduction was approximately proportional to the axon diameter. Cottrell (1940) reported that the axons of peripheral nerves have a diameter ranging between one and three microns in newborns and one and seven microns in four year olds. He found that the degree of myelination is very slight in newborns and increases as the diameter of the axon increases. No increase in diameter occurs after the age of nine years. Therefore the increment of MNCV measured in growing children may be axplained in part by the following major factors: increasing or changing diameter of nerve fibers and myelination of the nerves.

In this study, the findings on MNCV for children younger than 329 weeks of age agree substantially with those reported in the literature (Hursh 1939; Gasser *et al.* 1939; Thomas *et al.* 1960; Cerra *et al.* 1962; LaFratta *et al.* 1966; Schulte *et al.* 1968). The data for 79 children, on whom MNCV studies of the median and peroneal nerves were performed, showed, a progressive increase with age (Figs. 1,2). Also the magnitude of increases was similar to that reported by Baer (1965).

The rate of increment of MNCV was more rapid in the first three groups. Dubowitz (1968) also showed in his study, whose purpose was to develop an index of neurological maturity in newborn infants, that the rate of increments of increse in MNCV in similar groups of infants was rapid.

In subsequent groups, the change in nerve conduction velocity showed small but generally steady increased until 329 week of age. However the MMCV's in the these groups were considerably greater than those found by other authors (Baer *et al.* 1965).

The median nerve conduction velocity was higher than the peroneal nerve values in the younger groups, and this result was the reverse of that reported by Baer (1965).

According to several authors nerve conduction velocity in newborn infants appears to be approximately one-half that of adults (Thomas *et al.* 1960; Johnson *et al.* 1960; Baer *et al.* 1965; Alexander *et al.* 1980). In another words the adult values are twice that of infants' conduction values.

In this study, 1.75 times the mean values of groups 1 and 2 would equal those of adults, a result which is similar to other authors (Thomas *et al.* 1960; Johnson *et al.* 1960; Baer *et al.* 1965; Alexander *et al.* 1980). In the same manner, the values for group 3 may be multiplied by a factor of 1.3 to equal the equivalent adult value. Subsequent serial studies revealed the attainment of low normal adult values by multiplying by 1.2 in group 4 and by 1.1 in groups 6 and 7.

Consequently for clinical application, the normal motor conduction velocities for the ulnar and tibial nerves in corresponding age groups which were not been included in this study, could be estimated from adult values using these results.

SUMMARY

Motor nerve conduction velocities for the median and peroneal nerves were studied in 79 normal children ranging in age from one week full-term infants to 329 weeks.

1) There appeared to be a significant and substantial increment in the values of motor nerve conduction velocity with increasing age in these children.
2) In the first three groups of children, the values could be made equal to adult values by multiplying with factors of 1.75, 1.75 and 1.3 respectively. The values in group 4 began to approach the low normal values of adults.
3) For clinical application, if there are no availabele normal values for young children, it should be possible to estimate motor nerve conduction velocities for children based on adult values.

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