Motor Nerve Conduction Velocities in Normal Children and in Children with Neuromuscular Diseases

—Especially regarding victims of cerebral palsy—

by

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An electromyogram is one of the most useful inspections as a subsidiary diagnosis of neuromuscular diseases. There are only a few reports about the peripheral motor nerve conduction velocities of those with cerebral Palsy. It is assumed that the peripheral motor nerve conduction velocity isn't marked because the cerebral palsy is caused by the cerebral difficulty and not by problems in the peripheral nerves. However, the secondary variation may occur in the peripheral nerves and the muscles due to the difficulties in the central nervous system. In fact, a lag of the peripheral motor nerve conduction velocity, an ascent of the threshold toward the nerve stimulation and a change of the induced wave pattern from the polyphasic wave to the monophasic wave are sometimes observed in children with serious cerebral palsy.

Therefore, we thought that a reference to the peripheral motor nerve conduction velocity of those with cerebral palsy would be useful and examined the following items of normal children and children with cerebral palsy: (1) relationship of motor nerve conduction velocity to age in normal children (2) effects of motor nerve conduction velocity at various skin temperatures (3) comparison of the peripheral motor nerve conduction velocity between normal children and children with cerebral palsy (4) comparison between the affected side and the non-affected side of hemiplegic children with cerebral palsy (5) effects on the motor nerve conduction velocity and the latency time caused by cooler temperature.

Methods and Materials

In this research, the motor nerve conduction velocity of the ulnar nerves and the tibial nerves were measured. The ulnar nerve was stimulated percutaneously at the elbow medial to the olecranon and at the wrist lateral and superior to the styloid process with the

stimulating cathode distal to the anode.

However, the observation of the latency time and the action potential of infants were often difficult to measure because the artifact intermixed with the action potential because of the electrostimulus. In such cases, the motor nerve conduction velocity of the ulnar nerve could not be measured. Therefore, this research mentions chiefly the results of the measurements of the tibial nerves. For ulnar stimulation, the child's arm was slightly abducted and the elbow extended. The active electrode was placed over the abductor digiti minimi. For tibial stimulation, the child was placed in the sitting position with knee slightly flexed on the mother's lap or a chair.

The tibial nerve was stimulated in the upper midpopliteal fossa and just proximal to the medial malleolus with the active electrode over the abductor hallucis.

A ground electrode was placed between stimulating and recording electrodes.

The nerves were stimulated once per second with a square wave pulse.

It had a 0.3 milliseconds duration and 70~130 volts in intensity which afforded the supramaximal.

Observations were made on 43 normal children of ages ranging from one month to 10 years, 61 children with cerebral palsy of ages ranging from one month to 10 years, 76 subjects with other neuromuscular diseases of ages ranging from one month to 74 years and 9 normal adult subjects. The skin temperature was measured at the surface above the groove of medial epicondyle for ulnar nerve and the popliteal fossa.

Results

(1) The Change of the Tibial Motor Nerve Conduction Velocity in Relation to Age in Normal Children

The mean conduction velocity of the tibial motor nerve of the normal infants under 2 months was 31.2 m/sec., that of the normal infants from 3 to 5 months was 40.0 m/sec., that of ones from 1 years to 1 year and a half was 46.3 m/sec. and that of ones from 1 year and a half to 2 years was 53.7 m/sec..

The conduction velocity of the tibial motor nerve in infancy increased rapidly until 2 years of age. It's extension decreased gradually and it came to a plateau at 3 to 5 years of age. (Fig. 1)

(2) The Relation of the Skin Temperature and the Tibial Motor Nerve Conduction Velocity

There was no significant difference of the tibial motor nerve conduction velocity in 29~33°C, which was the skin temperature of normal adults. In low temperature experiments in a large-sized refrigerated room, the tibial motor nerve conduction velocity slowed down rapidly at skin temperatures of under 25°C. (Fig. 2)

In this experiment, the skin temperature and the nerve conduction velocity were measured according to the time spent in the refrigerated room. In this way, the difference between the skin temperature and the subcutaneous temperature in which the nerves run in practice becomes an issue. In general, it is said that the difference between the skin temperature and the subcutaneous temperature is 1~3°C.

The measured value of the nerve conduction velocity changes according to temperatures,

Fig. 1 Tibial motor nerve conduction velocity in relation to age in normal children

Fig. 2 Tibial motor nerve conduction velocity in relation to skin temperature in normal adults

and it become greater if the skin temperature becomes higher. Therefore, it is said that correcting the temperature is needed.

In our method of measuring, we found that the skin temperature needed to be at least 26°C and correcting the temperature wasn't needed from 29~33°C, the normal skin temperature.

(3) The Comparison of the Nerve Conduction Velocity between the Normal Children and the Children with Cerebral Palsy

The mean conduction velocity of the tibial motor nerve of the normal children and the children with cerebral palsy is indicated in Fig. 3.

Under 5 years of age, the mean nerve conduction velocity of the children with cerebral palsy tended to slow. However, for mean values, even in 4 year-old children, although there were about 7 m/sec. of difference between the five normal children (52.5 m/sec.) and the eleven children with cerebral palsy (45.1 m/sec.), t value was 2.023 in statistical analysis (t test), so t value didn't quite reach the significant level of 0.05.

In the same manner, there was no significant difference in each age, from 0~10 years.

(4) The Nerve Conduction Velocity between the Affected Side and Non-Affected Side of Hemiplegic Children

When we measure the nerve conduction velocity of the hemiplegic children, we usually are impressed that the nerve conduction velocity of the non-affected side is faster than that of the affected side. Therefore, we examined the affected side and non-affected side of hemiplegic children whether there was a difference of the nerve conduction velocity or not.

We examined the ulnar motor nerve in 8 cases, 4 right hemiplegics and 4 left hemiplegics. The t test resulted in:

$$|t| = 1.662 < t_7 (0.05) = 2.365$$

Therefore, in significant level, 0.05, a significant difference wasn't seen.

We examined the tibial motor nerve in 17 cases (in a total of 22 cases) 9 right hemiplegics and 8 left hemiplegics. The t test resulted in:

$$|t| = 1.091 < t_{21} (0.05) = 2.080$$

Fig. 3 Tibial motor nerve conduction velocity in relation to age in normal children and in children with cerebral palsy

Fig. 4 The influence of cooling on the skin temperature, latency and conduction velocity

A significant difference wasn't seen in significant level, 0.05, as was the case regarding the ulnar motor nerve.

(5) The Effects that the Cooler Temperatures Had on the Skin Temperature, the Latency Time and the Nerve Conduction Velocity

On three items, the skin temperature, the latency time and the nerve conduction velocity, we examined the influence of cooling after entering a large sized refrigerated room ($2\sim 3^{\circ}\text{C}$) for 30~40 minutes, and we examined continuously the recovery condition after leaving the refrigerated room.

We indicate an actual example of the tibial motor nerve of a normal adult in Fig. 4. We compared the normal condition with the condition after cooling in the refrigerated room for 40 minutes and we recognized the following: (1) the skin temperature changed from 33.3°C to 19.4°C (2) the latency time of the proximal stimulus slowed from 11.4 milliseconds to 15.9 milliseconds and the latency time of the distal stimulus slowed from 4.2 milliseconds to 6.9 milliseconds (3) the recovery of the tibial motor nerve conduction velocity slowed from 54 m/sec. to 42.2 m/sec.

After leaving the refrigerated room, we examined the three items in a room at 25°C . Although the skin temperature recovered around normal skin temperature after 30~60 minutes, to recover the latency time and the nerve conduction velocity, it took about twice as long as that of the skin temperature, about 120 minutes. In some cases, the time required to recover the normal conditions was about four times that of the skin temperature.

(6) The Nerve Conduction Velocity of Other Muscular or Nerve Diseases

We examined the tibial motor nerve conduction velocity and the ulnar motor nerve conduction velocity for a total of 9 times in about 6 cases of the Charcot-Marie-Tooth diseases. The nerve conduction velocities slowed in both nerves. In severe cases, the evoked potential sometimes wasn't attained and especially in the tibial nerves, the evoked potential wasn't obtained in 4 cases out of the 6.

In Guillain-Barre syndrome, Beriberi, the affected side of birth palsy, Roussy-Levy syndrome and Friedreich diseases, the lag of the nerve conduction velocity was observed. In spina bifida, although different from the levels of the palsy, the evoked potential often wasn't obtained. In dermatomyositis, the ascent of the threshold toward the nerve stimulation was recognized.

Discussion

There is a report by R. D. Baer and E. W. Johnson on motor nerve conduction velocities in normal children. They state that the nerve conduction velocity of newborns is about half of that of adults, and soon after children become 4 years old, their values become equal to those of adults. In our research, almost the same results were obtained.

Johnson and Olsen report on the relationship between temperature and nerve conduction velocity. If the temperature changes 1°C , the nerve conduction velocity changes around 5%.

Again, Buchthal and Rosenfalck state that the tibial nerve conduction velocity slows at the rate of 2 m/sec. if the subcutaneous temperature changes 1°C .

We found that, in our experiments, the skin temperature needed to be at least 26°C (or more than 26°C), the corrected temperature wasn't needed within the limits of $29\sim 33^{\circ}\text{C}$ of the skin temperature in normal adults, and the regular value could be obtained if the room temperature was kept at level of 20°C .

We also found that the influences on the latency time and the nerve conduction velocity made by the cooler temperatures remained for a longer time than expected. This may suggest that neuromuscular dysfunction is involved in the causes of cooling disorder.

Summary

We examined the motor nerve conduction velocity of the ulnar and tibial nerves of normal children, children with cerebral palsy and children with other neuromuscular diseases.

(1) The conduction velocity of the tibial motor nerve increased rapidly until 2 years of age. It came to a plateau at 3 to 5 years of age and remained constant until coming of age.

(2) The average conduction velocity of the tibial motor nerve affected by a change of the skin temperature remained constant from 26 to 34°C , but it slowed down sharply under 25°C .

(3) Between the normal and the cerebral palsied children of each age from 0 to 10 years, there was no significant difference in the motor nerve conduction velocity of the ulnar and tibial nerves.

(4) There was also no significant difference between the affected side and non-affected side of hemiplegic children.

(5) We noticed that there was a lag in the nerve conduction velocity in children suffering from Charcot-Marie-Tooth, Friedreich and Beriberi.

(6) In order to test the recovery time of skin temperature, latency time and nerve conduction velocity, normal adults were placed in a refrigerated room ($2\sim 3^{\circ}\text{C}$) for 30~40 minutes. After leaving the refrigerated room, the recovery time required was 2 to 4 times the cooling time. This may suggest that neuromuscular dysfunction is involved in the causes of cooling disorder.

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筋, 神経疾患の末梢運動神経伝導速度について

正常児, 脳性麻痺児および各種の筋・神経疾患についてその末梢運動神経伝導速度を調べた。

神経刺激は, 持続時間 0.3 m sec, 電圧は supra-maximal が得られる 70~130 ボルト, 1 秒 1 回の矩形波によった。皮膚温度は尺骨神経では尺骨神経溝のやや遠位部, 脛骨神経では膝窩部に測定した。

1) 年齢別脛骨運動神経伝導速度は, 2 才までは急速に早くなり, 3~5 才ではほぼプラトーに達し, 以後成人に到るまで一定であった。

2) 皮膚温度の変化による脛骨運動神経の平均伝導速度は, 34~26°C の範囲ではほぼ一定であったが, 皮膚温度が 25°C 以下になると神経伝導速度は急激に遅くなっていた。

3) 正常児と脳性麻痺児とで, 尺骨神経, 脛骨神経の伝導速度に有意差はみられなかった。

4) 片麻痺児の健側と患側との神経伝導速度にも有

意差はみられなかった。

5) Charcot-Marie-Tooth 病, Friedreich 病, 脚気などの疾患で, 神経伝導速度の遅れがみられた。

6) 約 30 分間, 冷蔵庫に入って, その後の皮膚温度, 潜時, 神経伝導速度の回復を調べたところ, それらがもとに回復するには, 入庫時間の 2~4 倍の時間を要していた。

質 問

佐賀医大 渡辺 英夫

脳性麻痺のタイプによる差はありませんか。

回 答

長崎県立整肢療育園 川口 幸義

脳性麻痺のタイプ別の神経伝導速度についてですが, アテトーゼ型では正常, 痙直型では平均すると遅い傾向にあるのですが, 統計的に有意差はありませんでした。