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Change of H-reflex and M-wave in Cryotherapy

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Abstract To study the effect of cryotherapy in physiotherapy, the recruitment curve (RC) of Hoffman reflex (H-reflex) and motor wave (M-wave) was evoked at rest, at completion of cryotherapy and after 15 minutes. The H max/M max ratio (H max/Mmax), H threshold/M threshold ratio (Hth/Mth) and H slope/M slope ratio (Hslp/Mslp) were calculated from RC and were compared with the values at rest.

The amplitudes of H-reflex and M-wave at completion of cooling and after 15 minutes decreased in all subjects. The Hmax/Mmax, Hth/Mth and Hslp/Mslp were not significant statistically at each measurement but showed a trend of decrease compared with the values at rest.

These results suggested that the cooling is effective on the inhibition of muscles while it contributes to the inhibition of the motoneuron pool.

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Key Words : Cryotherapy, H-reflex, M-wave, Recruitment Curve

Introduction

Cryotherapy in physiotherapy is performed for inhibiting spasticity and reducing pain. The physiological responses of the living body to cooling have been studied in reference to the changes of nerve conduction velocity, and the changes of H-reflex, M-wave and tendon tap reflex of the motoneuron pool¹⁾.

The delay of nerve conduction velocity in cryotherapy decreases the sensitivity of pain and increases muscle activity. The cooling of spastic muscle which decreases the amplitude of H-reflex is clinically used as a preliminary measure for therapeutic exercise²⁾.

However, evaluation of H-reflex and M-wave is greatly influenced by the amplitude of M-wave depending on the relation between H-reflex and M-wave. Moreover, experimental results have differed by experimental method and by evaluation. In the present study, the effect of cryotherapy on the spinal reflex circuit and motor cells was investigated by analyzing the recruitment curve of H-reflex and M-wave.

Subjects and Methods

The subjects were 10 healthy male ranging in age

from 20 to 26 (mean \pm SD 21.8 \pm 1.99) years. For cooling, the muscle belly of the triceps surae of the right leg was exposed to the cold air of -20~-30 °C for 15 minutes using the special equipment (OG GIKENCO., LTD. COLD AIR HC-50).

H-reflex and M-wave evoked from the right soleus muscle were measured using the signal processor (NEC, San-ei 7S12). The measurement position was a sitting position fixed at 60 degree of the knee joint flexion and at the neutral position of the ankle. The subjects were kept at rest during the measurement.

Electric stimulation of the tibial nerve was made at the popliteal for 0.5ms at the rate of 0.5Hz until maximum M-wave was evoked while increasing the respective muscle potential by 0.5mA from the threshold of H-reflex. The muscle potential by the same stimulation was evoked 7 times, converted to AD on line, taken into computer, and processed by our own basic program to obtain the recruitment curve (RC) of H-reflex and M-wave.

RC was measured three times, i.e., at rest, at completion of cooling (finish) and after 15 minutes, and the H threshold/M threshold ratio (Hth/Mth), Hmax/Mmax ratio (Hmax/Mmax) and H slope/M slope ratio (Hslp/Mslp) of RC were compared with

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those at the 3 measurement. The skin temperature at each measurement was also measured at the muscle belly of the triceps surae.

T-test and one-way analysis of variance were used in statistical procedure.

Results

1. Skin temperature

The change of skin temperature at the muscle belly of the triceps surae is shown in Fig. 1. The mean of skin temperature was $32.2 \pm 3.0^\circ\text{C}$ at rest, $18.4 \pm 3.0^\circ\text{C}$ at finish, and $28.8 \pm 1.6^\circ\text{C}$ after 15 minutes. The skin temperature decreased by approximately $10\text{--}20^\circ\text{C}$ during the cryotherapy compared with that at rest, and increased by approximately $9\text{--}12^\circ\text{C}$ after 15 minutes.

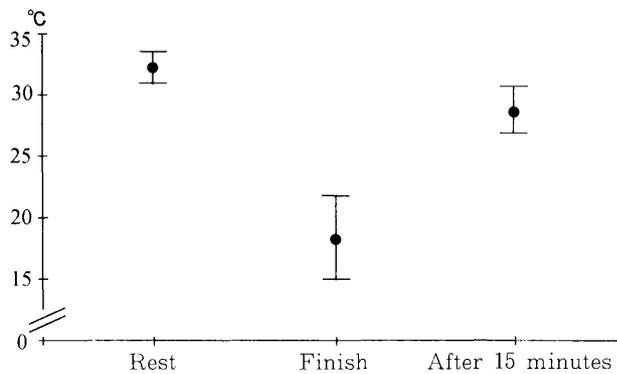


Fig. 1 Skin temperature

2. Recruitment curve

(1) Amplitude of H-reflex and M-wave

The RC of a subject is shown in Fig. 2. The X-axis shows the intensity of stimulation and the Y-axis shows the amplitude of H-reflex and M-wave. Both the H-reflex and M-wave at finish and after 15 minutes drew gradual curves compared with that at rest.

T-test was performed to compare the amplitudes

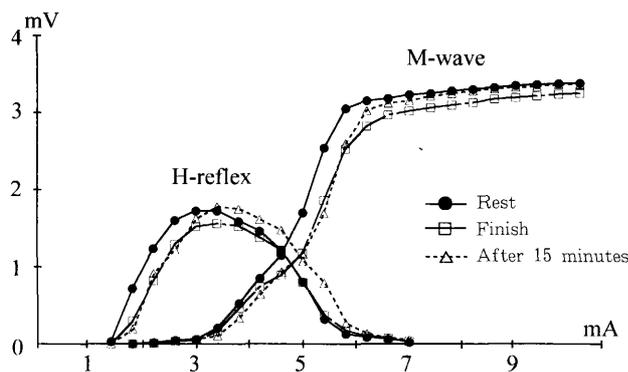


Fig. 2 Recruitment curve

of H-reflex and M-wave at rest of the subjects with the amplitudes at finish and after 15 minutes by the same stimulation. As the result, the amplitudes of H-reflex and M-wave at finish and after 15 minutes decreased in most of the subjects. However a few subjects showed no change in amplitude of H-reflex and M-wave, or no significant difference between the values at rest and after 15 minutes.

(2) Hth/Mth and Hmax/Mmax

Hth/Mth and Hmax/Mmax at each time of measurement are shown in Table 1.

The mean of Hth/Mth was 0.67 ± 0.15 at rest, 0.69 ± 0.12 at finish and 0.67 ± 0.12 after 15 minutes. There were no significant differences between them.

The mean of Hmax/Mmax was 0.44 ± 0.2 at rest, 0.41 ± 0.2 at finish and 0.39 ± 1.9 after 15 minutes. They showed a trend of decrease but no significant difference.

Table 1 Hth/Mth and Hmax/Mmax

	Hth/Mth	Hmax/Mmax
Rest	0.67 ± 0.15	0.44 ± 0.2
Finish	0.69 ± 0.12	0.41 ± 0.2
After 15 minutes	0.67 ± 0.12	0.39 ± 0.19

NS indicates no significant difference between the values at rest and after 15 minutes for both ratios.

(3) Hslp/Mslp

The RC was calculated using the M-wave maximum value as 100% and the threshold as 1 at each time of measurement. Simple linear regression was calculated up to the maximum values of H-reflex and M-wave to determine the H slope/M slope ratio. The RC and the slopes of H-reflex and M-wave in a subject are shown in Fig. 3 to Fig. 5.

The mean of Hslp/Mslp was 0.97 ± 0.8 at rest (Fig. 3), 0.79 ± 0.67 at finish (Fig. 4), and 0.67 ± 0.47 after 15 minutes (Fig. 5). Compared with the

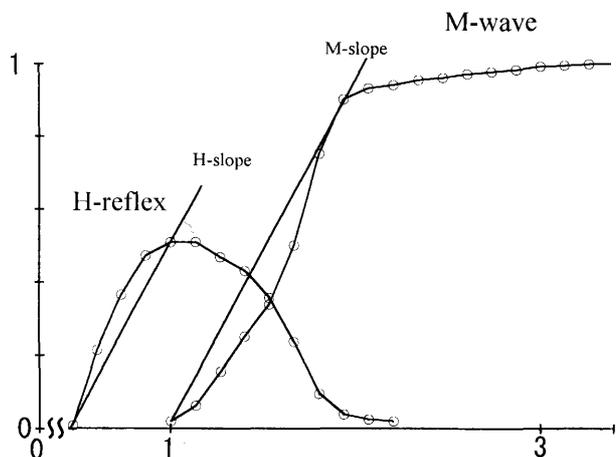


Fig. 3 H slope and M slope at rest.

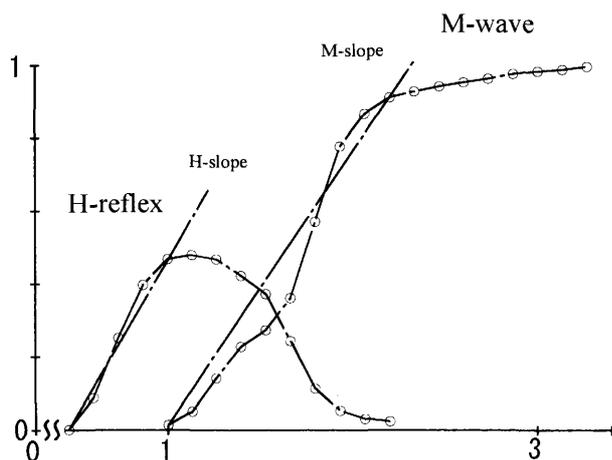


Fig. 4 H slope and M slope at finish.

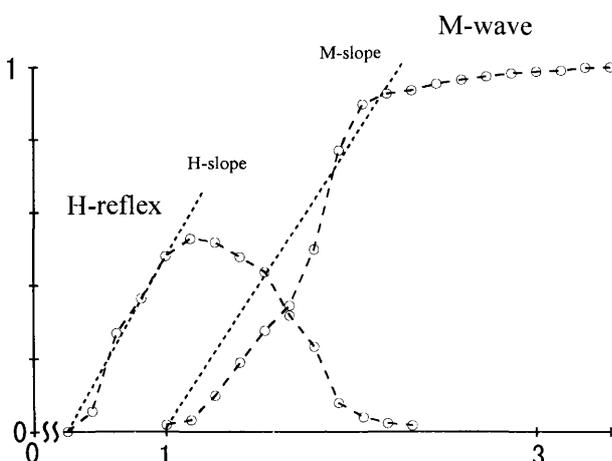


Fig. 5 H slope and M slope after 15 minute.

ratio at rest, the ratios at finish and after 15 minutes showed no significant difference although there was a trend of decrease.

Discussion

In the present study, the effect of cryotherapy on H-reflex and M-wave was investigated by analyzing the recruitment curve. The cooling decreased the skin temperature at finish to 18°C on average, and thus it was considered that physiological response of the muscle was made available. In this respect, there is a report that centripetal impulse of Group Ia fiber increases at the skin temperature of 32°C or more, and it decreases at a lower temperature³⁾. The cooling was considered adequate.

The amplitude of H-reflex and M-wave by the same stimulation at the latter two measurements decreased. In comparison of Hmax/Mmax at each measurement, there was a trend of decrease at finish and after 15 minutes although there was no significant difference. This may suggest that the cryotherapy gave some effect on the activity of the

motoneuron pool.

In comparison of Hth/Mth at each measurement, however, there was a small change between the three times of measurement.

It is likely from these findings that the 15 minute cooling generally inhibits the excitation of the motoneuron pool until 15 minutes after the cryotherapy, but the response of the nervous system is minimal.

In comparison of the Hslp/Mslp, there was a trend of decrease from the time at rest to the time at finish and after 15 minutes. The H slope is the increase rate of H-reflex at the intensity of stimulation less than the threshold of M-wave, and is not affected by the occlusion of H-reflex by the antidromic volley of active potential resulting from the occurrence of M-wave. Hence, the Hmax/Mmax is considered as the increase rate of the number of firing cells due to the increased input of Group Ia fibers⁴⁾.

As the combined results of Hmax/Mmax and Hth/Mth are reviewed, the cooling may have an inhibitory effect on the input of Group Ia fiber, indirectly affecting the response of α -motor neuron which is a centrifugal fiber.

From the results of the present study, it is considered that the effect of cryotherapy on the peripheral muscle is the major one indirectly decreasing the activity of the motoneuron pool.

Concerning the inhibition of the motoneuron pool by cooling, involvement of the autonomic nerves and cutaneous receptor⁵⁾ has been reported. It is also required to give consideration to the cooling temperature. It is intended to study further while taking into consideration the cooling method and skin temperature.

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寒冷療法実施時におけるH反射，M波の変化

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要 旨 理学療法における寒冷療法の効果について安静時，寒冷終了時，15分後のH反射・M波のリクルートメントカーブ (RC) を導出した。RCより，Hmax/Mmax比，H閾値/M閾値比，Hslp/Mslp比を求め，安静時と比較検討した。同一被験者のH反射，M波の各測定時の振幅は低下してした。Hmax/Mmax比，H閾値/M閾値比，Hslp/Mslp比は，各測定時において統計的有意差は認められないものの，安静時と比較して低下する傾向を示した。

これらの結果より寒冷刺激は，脊髓運動ニューロンプールの抑制に関与するが，その影響は筋に対する抑制が大きいものと考えられた。

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