

多周波インピーダンスを活用した 筋肉内部温度の非侵襲的測定の試み

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Attempts to Noninvasive Measurement of Internal Muscle Temperature by Using Multiple Frequency Impedance

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ABSTRACT

In the human body, electric resistance varies depending on the temperature of the muscle tissue. In the present study, the effect of cooling on electric resistance was investigated using multi-frequency impedance device while cooling the aorta in the popliteal region in addition to local cooling from the skin surface of the triceps surae. Subjects were ten healthy male students (age: 21.1 ± 1.5 years) of our university. Impedance was measured by the tetrapolar impedance method using a multi-frequency impedance device (MFBI-07, Tanita) with a frequency at 50 kHz, 100 kHz and 250 kHz. The current (I) electrodes and the sensing (V) electrodes were attached longitudinally to the calf. In order to measure impedance, the distance between the two sensing (V) electrodes were placed at a distance of 15cm. The current electrodes were set at 2cm, 3cm, and 4cm from the V electrode on the distal side. Measurements were obtained following either cooling of the sural region only or cooling of the sural and the

popliteal region. During cooling, impedance and skin temperature were measured every 5 minutes for 30 minutes. Temperature was measured at 2cm, 3cm, and 4cm depths from the skin surface of the triceps surae. Under both cooling conditions, a decrease in temperature was observed over time. In addition, the changes in cooling temperature decreased with increase in depth from the skin surface. The effect of cooling was greater while cooling the aorta in the popliteal region than while cooling the sural region only. Therefore, the cooling effect could be enhanced by cooling the aorta on the central side with simultaneous local cooling.

要 旨

本研究は電気抵抗が組織の温度に依存して変化するという電気的特性を応用し、腓腹筋の皮膚表面からの局所冷却に加え、膝窩部の大動脈を冷却した場合の冷却効果について多周波インピーダンスを用いて検討した。被験者は男子大学生10名を対象とした。インピーダンス測定時の電極配置は両検出(V)電極の間隔を15cmに設定し、末梢側の電流(I)電極はV電極から2cm、3cm及び4cmとした。測定条件は腓腹部のみ冷却条件及び腓腹部+膝窩部冷却条件とした。冷却中のインピーダンスと皮膚温の測定は5分毎に30分間行った。温度の推定は皮膚表面から2cm、3cm、4cm深部までの3種類とした。両条件とも時間の経過とともに温度の低下が確認された。また両条件とも皮膚表面から深部になるにつれ冷却温度の変化は小さかった。膝窩部の大動脈を冷却した場合には腓腹部のみ冷却条件よりも冷却効果が優れていることが明らかとなった。以上より局所冷却に加え、中枢側の大動脈の冷却を行うことで冷却力を高めることが窺えた。