Semiquantification of Fibrillation Potentials with Intramuscular Temperature Drop Using an Animal Model

It has been reported that the quantity of fibrillation potentials (FP) decreases with drop in the intramuscular temperature. However, the quantitative measurement of the FP with intramuscular temperature changes has not been reported. Under anesthesia of intraperitoneal sodium pentobarbital, the sciatic nerve of 6 rats (Sprague-Dawley) was surgically isolated. A 1-cm segment was excised after tying the proximal and distal ends of the nerve segment. A concentric needle electrode and thermometer needle probe were inserted approximately 1-cm apart into the posterior tibial muscles 3 to 4 days after the nerve segment excision. Before and during cooling the muscles with ice, FPs were evoked and printed on paper recording for later analysis. Visually recognizable potentials (30 μV or above) in each printed tracing with temperature changes (range, 37℃ to 15℃) were manually counted. A positive linear correlation was found between the intramuscular temperature changes and the quantity of FPs. The recording of FP completely ceased at about 20℃ below baseline temperature. In this study, we have successfully semiquantified fibrillation potentials in a wide range of intramuscular temperature changes. ***(JKMS 1997; 12: 550~2)***

Key Words : *Electromyography; Skin temperature; Nerve injuries*

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INTRODUCTION

Fibrillation potential in the clinical electromyography (EMG) in patients with nerve injuries indicates the presence of axonal degeneration (1-5). The appearance of this potential is influenced by many factors including intramuscular temperature. It has been described that the fibrillation potential decreases with the intramuscular temperature drop (6-9). However, the quantitative measurement of the fibrillation potentials associated with intramuscular temperature changes has not been reported. We describe the semiquantitative measurement of the fibrillation potentials with cooling the intramuscular temperature in an experimental animal.

METHODS AND MATERIALS

The proximal segment of the sciatic nerve of 6 rats (Sprague-Dawley), ranging in weight from 230 to 255 g, was surgically isolated under anesthesia using intraperitoneal sodium-barbital injection. A 1-cm segment of the nerve trunk was excised after tying both the proximal and distal ends of the surgically exposed nerve. The incision area was closed by sutures. A concentric needle electrode and thermometer needle probe were inserted approximately 0.5 to 1.0 cm apart into the posterior tibial muscles 3 to 4 days post nerve injury (Fig. 1). Before and during cooling the examining muscles with

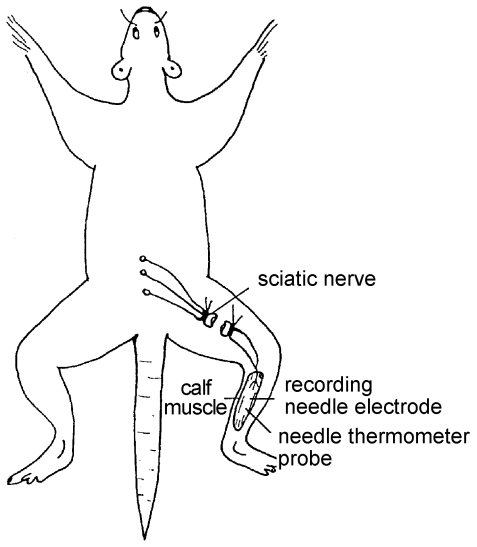

Fig. 1. Placement of recording needle electrode and thermometer probe into the posterior tibial muscles after 1 cm dissection of the right sciatic nerve in rat.

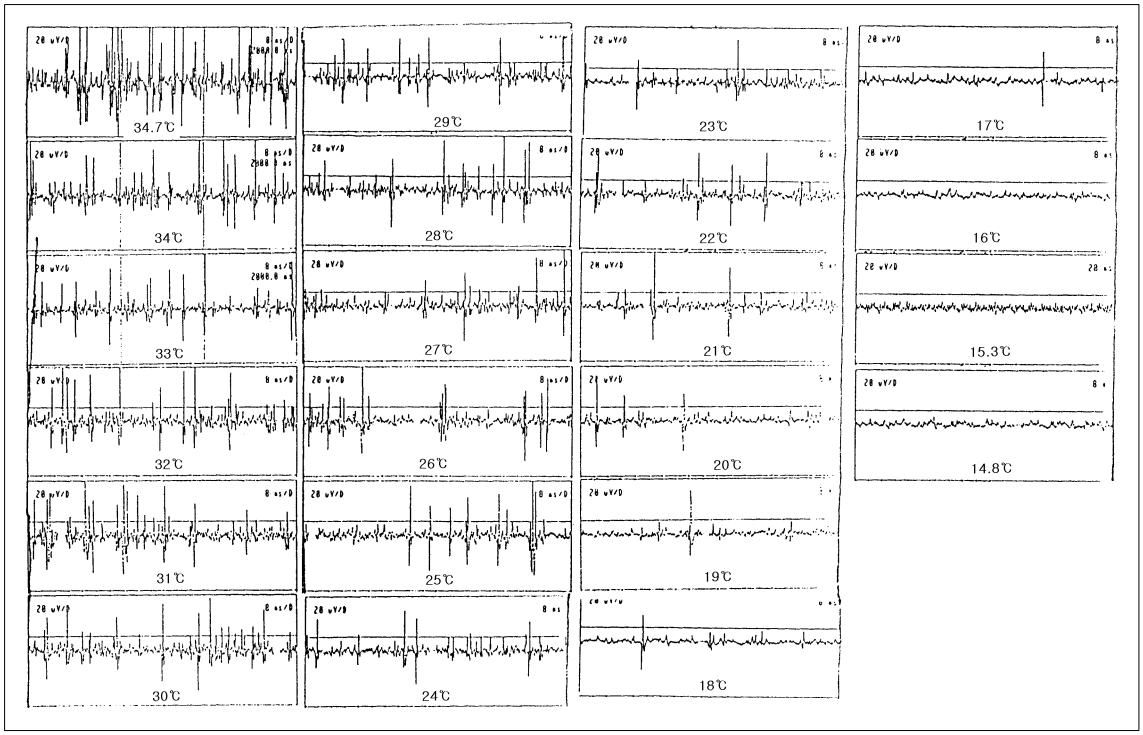

Fig. 2. A typical picture of fibrillation potentials recorded with intramuscular temperature changes (rat #3).

ice cubes, fibrillation potentials and positive sharp waves were evoked by needle insertions. After needle insertion into the muscle, the needle was fixed in one area using a forcep. Dantec counterpoint MK II was used for the recordings of potentials. The filter setting was 20 Hz to 10 kHz, sweep speed was 10 ms/division, and sensitivity was 20 μV/division. The paper recordings of fibrillation potentials were made for later analysis with each degree of the temperature drop if possible. Figure 2 (experiment rat #3) illustrates the recording of denervation activities with intramuscular temperature changes. Statistical analysis was performed using a regression curve.

RESULTS

The denervation potentials were recordable in a wide range of intramuscular temperature changes (range, 37 to 15℃). The recording of denervation activities completely ceased at approximately 20℃ below the baseline temperature. Visually recognizable fibrillation potentials (30 μV or above in peak-to-peak amplitude) in each printed tracing were manually counted. A positive linear correlation was found between the quantity of denervation activities and the intramuscular temperature changes (Fig. 3).

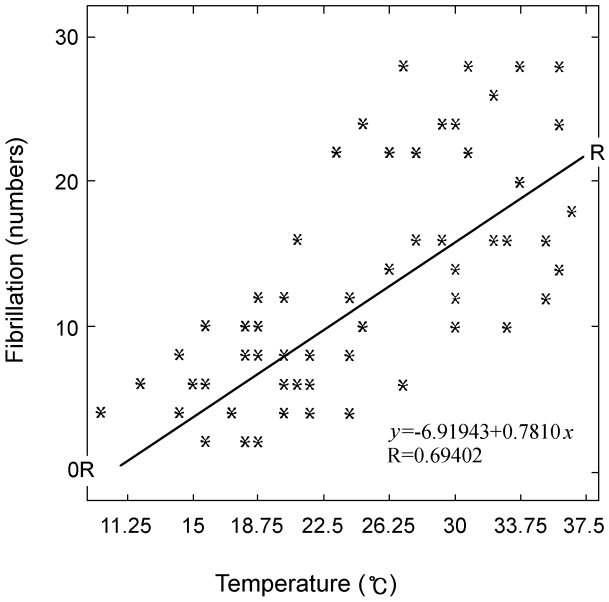

Fig. 3. Regression curve made between the intramuscular temperature changes and the quantities of fibrillations in 6 rats.

DISCUSSION

Fibrillation potentials, the electric activity associated with a spotaneously contracting individual muscle fiber, have been the subject of observation since it was described by Schiff (10). It has been suggested that to detect the fibrillation potentials in the denervated cold muscles, the study should be done after adequate warming. Langley (6) and Marinacci (11) stated that fibrillation is increased by warmness and decreased by cold. Feinstein and his associates (8) using different animal models presented the relation between fibrillation and metabolic activity. They observed the facts that bathing with cool (18℃) Ringer's solution stopped the fibrillation activity, which was restored by warming (38℃). Bowman and Raper (7) reported that a 1℃ fall in muscle temperature showed a mean reversible reduction of 11.5% in the frequencies of the fibrillation. We observed similar findings, but about a 10℃ drop from the normal temperature showed approximately 42% reduction in the quantity of the fibrillation activities. Moreover, the activity of fibrillation completely ceased following an average 20℃ drop. It was technically difficult to maintain the temperature at a certain degree to record the fibrillation activities because the temperature continuously dropped on cooling. However, a regression curve demonstrated a moderate to high degree of a linear relationship. After 20℃ or more drop, a heat lamp was applied to restore the normal temperature, pre-cooling temperature, while recordings of fibrillation potentials were made. In our study, the quantities of fibrillation potentials were not the same but much less in quantity at the same temperature during the rewarming process compared to cooling process on the same animal model. This discrepancy may need to be answered with further research. Denys (9) stated that the changes of the ionic refluxes in the denervated muscle fiber in response to cooling are influenced in the changes of amplitude and duration of the fibrillation potentials and positive sharp waves (PSWs). Buchthal (12) described that the amplitude of motor unit decreased by 2 to 5% per degree Celcius due to temporal dispersion with temperature drop. It is unknown whether these ionic reflux changes are affected in the amount of denervation potentials or not.

In conclusion, we have semiquantified the fibrillation potentials in the posterior tibial muscles using an animal model in a wide range of intramuscular temperature changes. We also found a positive linear correlation between the quantity of fibrillation potentials and the intramuscular temperature changes. To establish more accurate diagnosis of lower motor neuron disease, a needle electrode examination for the cold extremity should be performed after adequate warming.

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