What happens when extracorporeal shock waves are applicated to muscles?

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Introduction

Extracorporeal shock wave therapy (ESWT) for spasticity is not only highly safe, but also provides clinical efficacy comparable to botulinum toxin. However, treatment protocols vary from report to report, and clinical outcomes vary widely, making the development of protocols to elicit better therapeutic effects of extracorporeal shock wave therapy an important clinical issue.
Although individual differences in response to ESWT are thought to exist, the prediction of therapeutic efficacy can be inferred by research because it is a physical therapy.
Therefore, we are exploring the principles of ESWT to elicit effective therapeutic effects through animal experiments. In this presentation, we will report the results of our research on what happens when extracorporeal shock waves are irradiated to muscles, with some discussion of the literature.

Material & Method:

Factors that we can determine for treatment are the irradiation site, application energy, and number of shots. Therefore, we evaluated the muscle and surrounding tissue after irradiation using electron microscopy. We also measured compound muscle action potential (CMAP) as a neurophysiological change after irradiation.

We applied 2,000 radial pressure waves (rPWs) at 0.18 mJ/mm^2 at a frequency of 15 Hz to the right calf of male SD rats and examined NMJ morphology using electron microscopy.

To confirm the relationship between applied energy of rPWs and therapeutic efficacy, we compared the CMAP amplitude of the rat gastrocnemius muscle based on the following six treatment protocols of rPWs in different energy flux densities (EFD) and pulses to the right calf of each rat : 1) 8000 pulses at 0.045 mJ/mm2; 2) 4000 pulses at 0.09 mJ/mm2; 3) 2000 pulses 0.18 mJ/mm2; 4) 4000 pulses at 0.045 mJ/mm2; 5) 2000 pulses at 0.09 mJ/mm2; and 6) 1000 pulses at 0.18 mJ/mm2. The left calf muscles were considered controls.

Results

All rESW-exposed muscles exhibited NMJs with irregular end plates, and the mean inter-junctional fold interval was significantly increased compared to controls. However, axon terminals and muscle fibers surrounding NMJs with irregular end plates were unchanged. (Figure 1)

There was a significant reduction in the CMAP amplitude between control and rESW-exposed muscles in the groups that received 4000 pulses with energy flux density (EFD) of 0.09 mJ/mm^2 and 2000 pulses with EFD of 0.18 mJ/mm^2. However, there was no significant difference between the group that was treated with 8000 pulses with EFD of 0.045 mJ/mm^2 and the groups treated with 180mJ.

Figure 1.

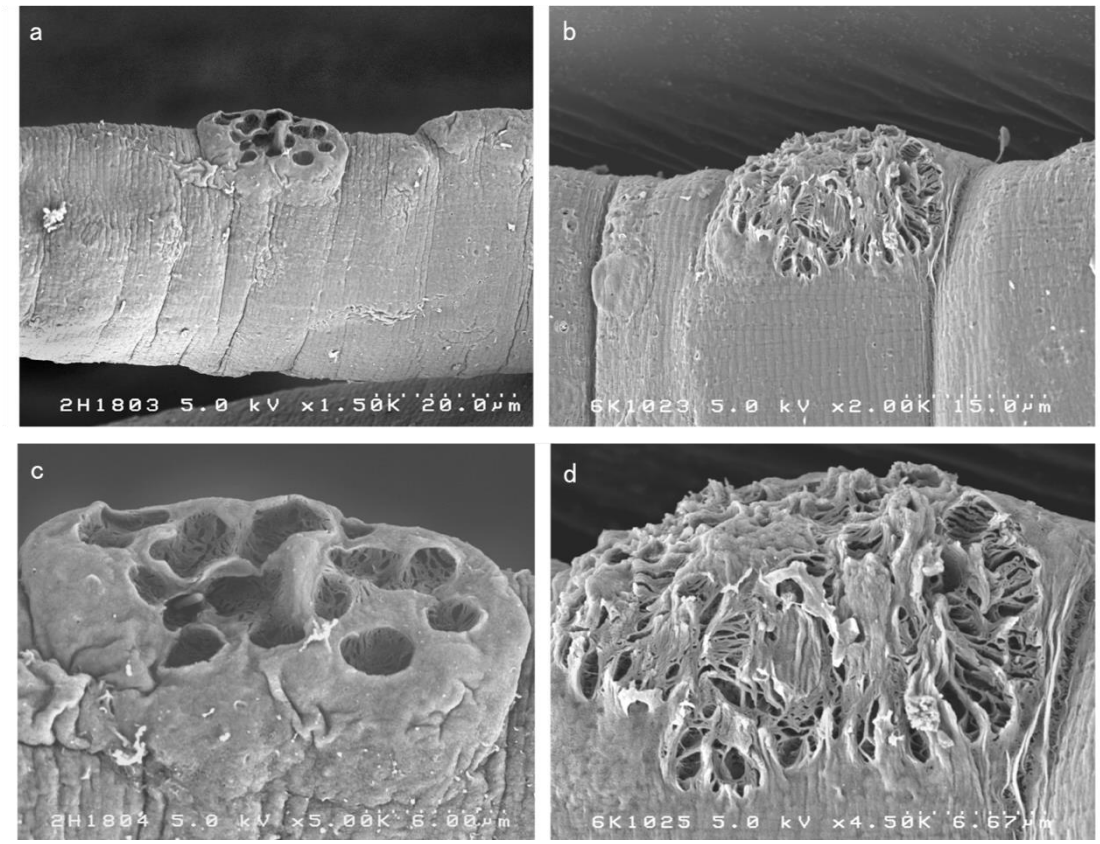

Figure 1 Morphological appearance of the neuromuscular junctions in the gastrocnemius muscles of rats exposed to radial extracorporeal shock waves by scanning electron microscopy.

Discussion

This localized destruction of end plates may be caused by differences in acoustic impedance induced by the density of the AChRs. Our findings provide a potential mechanism for the effectiveness of rPWT for spasticity and dystonia. Moreover, our results suggest that both EFD and total energy are important for determining the appropriate protocol for rESWT.

Technology: Radial Pressure Waves

Device and Manufacturer: Swiss DolorClast (EMS, Nyon, Switzerland)

COI: No conflict of interest