MRI of denervated skeletal muscle for the diagnosis of peripheral nerve injury

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Introduction

T2-weighed MR image of denervated skeletal muscle shows high signal intensity, so it is useful tool for the diagnosis of peripheral nerve injury. However, the relationship between the degree of peripheral nerve injury and the signal intensity is still unknown. In this study, we investigated the signal changes in T2 weighed images and measured the T2 value using various degrees of nerve injury models of rats.

Material and Methods

Total of 30 male rats were used, weighing approximately 200g each. We made four nerve injury models using the left posterior tibial nerve (PTN). Those are group A (n=6): transected the nerve (irreversible neurotmesis model), group B (n=6): transacted the nerve and repaired immediately (reversible neurotmesis model), group C (n=6): clipping the nerve for 30 minutes (severe axonotmesis model) and group D (n=6): clipping the nerve for 15 minutes (moderate axonotmesis model). Simultaneously, we performed sham operation (only exploration of the nerve), defined as the control group E (n=6). At 3 and 5 days, 1, 2, 3, 4, 6, 8, 12 weeks after the surgery, we observed the signal change of gastrocnemius muscle, which was the target muscle of PTN, in the T2-weighted images on a 1.5T clinical imager (Signa Excite; GE Medical Systems, Milwaukee, WI). We also measured T2 in vivo using Carr-Purcell-Meiboom-Gill (CPMG) method (ref 1), fitting the data points to an exponential curve. Sequence parameters were: TR/TE = 4000/77.0ms, column thickness = 5.0mm, 10cm FOV. Gait functional assessment was performed by calculating Print Length Factor (PLF), comparing the length of footprint between the damaged and undamaged sides (ref 2).

Results

In the T2 weighed images, we could recognize the change 7days after the surgery in all four nerve injury groups. There were significant differences in T2 values between the nerve injury groups (A,B,C,D) and control (E) (fig 1). T2 value of group A stayed high value two weeks after the injury. Group B presented the different recovery pattern comparing with group C and D. The PLF values began to decrease rapidly three days after the surgery in group C and D. As opposed, in group B, the PLF values kept high until three weeks after the surgery then decreased (Fig.2). In axonotmesis model (C and D), the functional recovery was always faster compared with the MR findings. However, in neurotmesis model (A and B), MR findings were almost parallel to the function as PLF

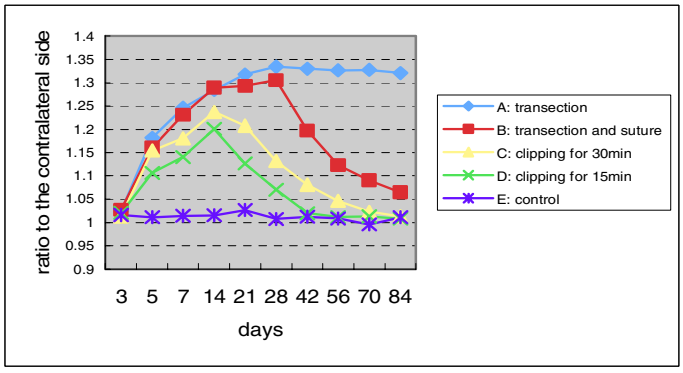

Fig 1: Time course of T2 value

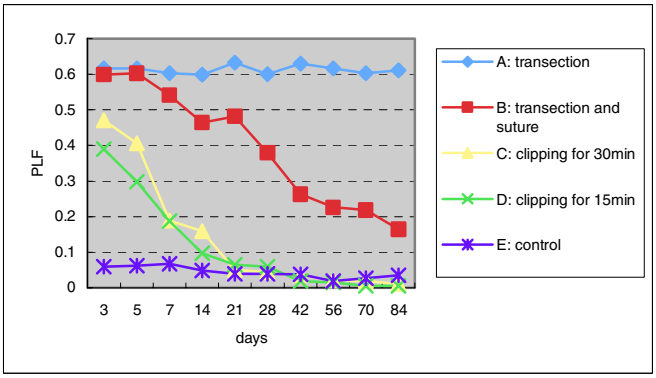

Fig 2: Time course of PLF

Discussion

Differences in the signal intensity of the denervated muscle depending on the degrees of nerve injury can be quantified by measuring T2 value of the target denervated muscle. It was clarified that the axonotmesis models tend to recover earlier than the neurotmesis model. We conclude that we can evaluate the degree of nerve injury with the changes in signal intensity of target muscle in the T2-weighted images and the time course of T2 value.

References

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