

Line scan diffusion spectrum of the denervated skeletal muscle for early diagnosis of peripheral nerve injuries: an experimental study

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Introduction

Denervated skeletal muscle shows increased T2 in the MR images. However, it takes certain amount of time, typically up to a week, before this change becomes remarkable. Since the mechanism behind this change is considered to be increased extracellular fluid (ECF), we hypothesized that the same change can be detected earlier by measuring diffusion. We measured both T2 and apparent diffusion coefficient (ADC) in peripheral nerve injury models of rats.

Materials and Methods

Total of 18 male rats were used, weighing approximately 200g each. We made two nerve injury models; Group A (n=6) was made by transecting the left posterior tibial nerve (PTN) as a neurotmesis model and group B (n=6) was made by clipping PTN for 10 minutes as an axonotmesis model. Simultaneously, we made control group C (n=6), which was made by only dissecting PTN. At 1, 3, 5, 7, 14, 28 days after the surgery, T2 and ADC of gastrocnemius muscle, which was the target muscle of the PTN, were measured using line scan diffusion spectrum (ref 1) on a 1.5T clinical imager (Signa Excite HD; GE Medical Systems, Milwaukee, WI). The sequence parameters were: TR/TE = 4000/77.0ms, column thickness = 5.0mm, 10cm FOV. To measure T2, TE was stepped from 20 msec to 77 msec in 32 steps. To measure ADC, b-value was stepped from 0 to 2000 in 32 steps. T2 and ADC values were evaluated as ratios compared to the uninjured contralateral side.

Results

Ratios of measured T2 and ADC in group A and B are shown on Fig 1 and 2. T2 value increases gradually over two weeks, while ADC value increases right after injury and decreases 5 days after injury in both nerve injury groups (A, B). Four weeks after injury, ADC returned to normal in both groups (A, B), but T2 value showed very high value in neurotmesis group (A) and intermediate high value in axonotmesis group (B).

Discussion

Although both T2 and ADC are considered to reflect the state of extracellular fluid, our results show the clear difference between the time courses of T2 and ADC values after injury, suggesting some other mechanisms. Although clear mechanisms behind these phenomena are not clear, diffusion MRI seems to provide further information which leads to better understanding, and has a potential to be a better clinical tool for early diagnosis of peripheral nerve injury than T2-weighted MRI.

Conclusions

ADC increased quickly after injury than T2 and was detectable one day after injury in neurotmesis and axonotmesis model. Up to a week, diffusion MRI can be a useful tool for early detection of peripheral nerve injury.

References

1. Stejskal EO, et al. Spin diffusion measurements: spin echoes in the presence of a time-dependent field gradient. J Chem Phys 1965; 42: 288-292.

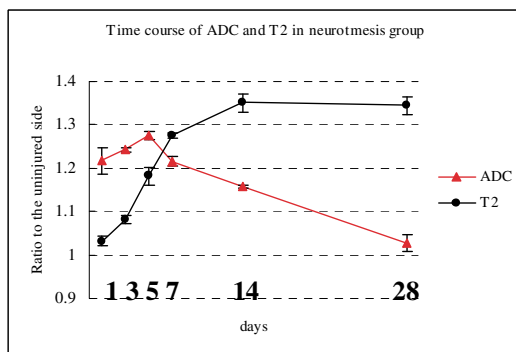


Fig. 1

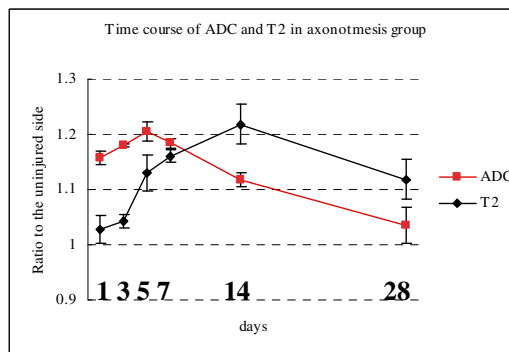


Fig. 2