

Introduction

Diffusion is movement of botulinum toxin (BT) beyond the immediate injection site by Brownian motion and is determined by concentration gradient and the molecular size. The widespread use of BT in spasticity management, expense, and detrimental impact from movement into non-injected muscles mandates a better understanding of BT movement within muscles. We describe the use of T2-Mapping in Magnetic Resonance Imaging (MRI) to quantify the botulinum toxin muscle effect (BTME) at baseline and 2 months (M) and 3M after injection.

Methods

5 subjects (3 male, age=61.8±12.5y & time post-stroke=4.6±3.2y) had at least one ischemic or hemorrhagic strokes of any chronicity, clinically significant lower extremity (LE) spasticity and a clinical indication for BT injection. Three standardized injections of 0.25cc saline were delivered along the lateral gastrocnemius muscle (LGM). The proximal and distal injections also contained 25 units of onabotulinumtoxinA (Botox®; OBT-A) and the center injection contained saline only. The lateral soleus muscle (LSM) was examined for diffusion beyond LGM and tibialis anterior (TAM) muscle was *not injected* in any subject (i.e., control).

MRI data were acquired on a 3.0 Tesla Siemens TIM Trio MRI Scanner using an 8-channel knee coil at baseline before and 2M and 3M post-injection. T₂ mapping sequence used a TR of 2500 ms and 8 echo times from 13.8 ms to 110.4 ms. The entire muscle of interest was manually outlined at baseline on the first echo (13.8 ms) to create a histogram of T₂ relaxation times. A Gaussian function was fit for baseline T₂ relaxation time histogram. BTME at 2M and 3M was defined by voxels ≥3SD above the baseline mean for that subject and muscle. BTME voxels in each MRI was converted to a volume in cc (0.0015cc/voxel) and graphed.

Results

BTME for LSM, LGM and TAM at baseline, 2M & 3M for the 5 subjects are presented to the right. **Solid vertical lines represent the estimated slice of BT and dashed line the slice of the placebo saline injection.**

As expected, there was no BTME at any TAM. An increase in BTME was seen at most, but not all, LGM sites of BT injection and a drop of BTME at most, but not all, saline sites. Two subjects demonstrated diffusion, or mis-injection, into the LSM.

Conclusions

- We describe a MRI technique using a T2 threshold approach to delineate the intramuscular effect of botulinum toxin (BT)
- If valid, the volume of muscle impacted by a small dose & volume of BT is substantial
- Our goal is to identify a method to compare muscle effect of different doses, dilutions and serotypes of BT

FIGURES 1A-E Abbreviations: BTME – botulinum toxin muscle effect, Cc – cubic centimeters, subj – subject, m – month. Slice 0 = most proximal slice closest to knee

