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A clinical measurement to quantify spasticity in children with cerebral palsy by integration of multidimensional signals

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Objectives: Intramuscular botulinum toxin type A (BTX) injections reduce spasticity in children with cerebral palsy (CP) by blocking neurotransmission at the motor end plates (MEP). Injection of BTX close to the MEP zone seems crucial, but current injection techniques do not always aim for this region. Goal of this study is to find the most optimal injection technique of the gracilis muscle by comparing two injection methods: the current proximal injection versus a MEP targeted injection method.

Design: prospective, randomized study in university hospital setting.

Methods: Thirty four gracilis muscles in 27 children with CP (8.5±2.5 yrs) were injected with Botox® (fixed dosage and dilution): 17 muscles by proximal (at 25% of the length of the upper leg) and 17 muscles by MEP targeted (half the dosage at 30 and half at 60% of the upper leg) injections. Clinical (modified Ashworth scale MAS) and instrumented spasticity assessments using surface electromyography (EMG) during passive motion at different velocities were performed before and after the injections. The difference of the averaged root mean square (RMS) EMG at low versus high velocity was calculated and normalized to the pre-injection EMG at maximal voluntary isometric contraction.

Results: MEP targeted injections showed a significantly better decline in pathological EMG signal compared to the conventional proximal injections, demonstrated by a higher reduction of the median normalized RMS-EMG parameter: MEP targeted injections 6.38% (IQR 3.77) versus proximally injected gracilis muscles 1.26% (IQR 8.13%), p=0.04. The same trend could be observed for the non-normalized values, however this did not reach statistical significance with a median reduction of 4.78 μV (IQR 5.37 μV) for MEP injected muscles and of 1.35 μV (IQR 9.14 μV) for the proximally injected muscles (p=0.14). This difference could not be demonstrated using the MAS.

Conclusion: BTX injection in the gracilis muscle at the sites with a high concentration of MEPs resulted in improved spasticity reduction. For long muscles, such as the gracilis, the injection site is an important variable in the BTX injection procedure. Using instrumented spasticity assessment, different injection protocols can objectively and sensitively be compared.