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The Role of Ultrasound Guide for Botulinum Toxin Injection in Neurological Diseases

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Introduction

Botulinum toxin type A (BoNT-A) is the gold-standard therapy for many neurological diseases, and the accuracy in delivering the toxin may influence the treatment outcome.

The accuracy of administration of BoNT-A into the target muscle is primary to obtain a reduction of movement disorders in dystonia patients or spasticity in subjects with upper motor neuron syndrome. Indeed, incorrect needle placement can result in complete failure of treatment causing also weakness or paresis, particularly for small muscles of the hand and forearm in writer's or musician's cramp. Several injection techniques can be used in common practice even if clinicians not always have the possibility and the time to inject with a guide.

Although electromyographic guidance represented the "first historical" tool employed to observe the denervation of BoNT-A in the injected muscle and to distinguish spasticity or muscle contractures, sometimes it does not consent to identify single muscles. Target muscle identification with palpation and anatomical landmark localization represented a common type of BoNT-A administration with many doubts for the precision of needle placement.

Therefore, guidance is recommended where the goal of treatment is the modulation of muscle hypertonia to improve the dexterity of spastic muscles, as well as for deep and small muscles of the limbs, whereas it is considered optional for larger easily palpated muscles: in this case manual needle placement using surface anatomy landmarks or palpation can be sufficient in subject without fat mass. In obese patients, the needle needs has to pass through the fat between skin and superficial Apo neurosis of each muscle, so it is important to observe where the needle is inserted.

Moreover, it is known that immobilization and spasticity lead to changes in muscle morphology over time, represented by atrophy, fibrosis and fat replacing sarcomeres. Ultrasonography allows observing these muscle alterations avoiding the BoNT-A administration. The advanced ultrasound machines show the exact muscle depth measured in centimeters, allowing the choice of a specific sized needle for injection.

The possibility to use an instrumental guide, such as electromyography (EMG), electrical stimulation (ES) and ultrasonography (US) permits to identify muscles to be injected with the typical sound (EMG), visible contraction (ES) and viewing muscles, nerves and vessels, enhancing the accuracy of BoNT placement. So the use of various guidance techniques may improve both effectiveness and safety, decreasing the occurrence of side effects.

In recent years, the availability of portable ultrasound devices has facilitated the application of ultrasound technology for guidance in BoNT injection procedures both in adult than in children. It is easy, quick, painless and available in most hospitals.

Ultrasound guidance avoids administration of BoNT-A into fibrotic or fatty areas and increases its accuracy. Several published paper described the effectiveness of BoNT-A treatment ultrasound guided: Berweck and colleagues [1] demonstrated, after 6000 ultrasound-guided BoNT-A injections, that the average time to identify and inject the gastrocnemius muscle was 5 seconds, whereas 30 seconds are needed for deep-seated muscles such as the tibialis posterior or the iliopsoas muscle: so, an additional advantage of ultrasound guidance may also be a reduction in the time required for muscle identification [2,3].

Yang [4] observed that the injection into lateral gastrocnemius was more difficult using anatomical Landmark for the thickness reduced at the needle insertion site, whereas it is easier into gastrocnemius medialis, bigger than lateral gastrocnemius.

There are many papers comparing different injection techniques: Py and colleagues [5] showed the effectiveness of ultrasonically guided BoNT injections into the lower limbs of children with spastic cerebral palsy in terms of greater functional improvement respect subject treated with manual needle placement. Kwon [6] compared gait pattern and hindfoot position–maximum foot/floor contact during stance after US and ES guided injections in patients with cerebral palsy: subjects treated with US improved more than those with ES: so the author concluded that visual feedback by ultrasonography could improve the accuracy of selective neuromuscular blocking of the gastrocnemius muscles.

Henzel et al. [7] showed significant differences between surface and ultrasound coordinates for several forearm flexor muscles, suggesting that ultrasound localization may improve accuracy of toxin placement in patients with upper-limb spasticity. Furthermore, Picelli et al. [8] and colleagues showed that US and ES are better than manual needle placement for BoNT-A injections improving clinical outcomes in patients with spasticity after stroke.

Santamato et al. [9] compared the effect of BoNT-A treatment administrated into upper limb spastic muscles using US and manual needle placement: subjects treated using US showed a greater effect than patients in which the muscles were identified with surface anatomy landmarks: the author concluded that US for botulinum toxin type A injections could improve clinical outcome measures better than surface anatomy landmarks and manual needle placement in post-stroke patients with spasticity.

In conclusion it is possible affirm that injection technique, especially ultrasound guide, during BoNT-A injections can be used to reduce spasticity or movement disorders more precisely than manual needle placement by surface anatomical landmarks and palpation. At present, it is not possible to identify a golden standard among injection techniques, but ultrasound guide may help to avoid BoNT-A injection into fat, fibrosis, vascular, and nerve structures, minimizing spread of toxin outside the targeted muscle belly and improving clinical outcomes for this treatment.

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