Novel Uses for Botulinum Neurotoxin in Upper Limb Surgery

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To the Editor: Recent years have seen Botulinum Neurotoxin (BoNT) injections emerge as a treatment option in the management of muscle spasticity. Spasticity is observed in many upper motor neuron problems but stroke and cerebral palsy are two of the more common conditions for which BoNT has been used to reduce muscle spasticity, release contractures and improve function [1]. Spasticity in the hand and forearm can be particularly problematic due to the prominent role of the upper extremity in activities of daily living [2]. BoNT exerts its effect at the neuromuscular junction to block acetylcholine release into the synaptic cleft and cause muscle relaxation [3]. Its use is limited by the ability of axons to regenerate at the neuromuscular junction; hence the effects of toxin injections are only temporary. There are also limitations in cases of prolonged muscular contracture which result in postural abnormalities and commonly require corrective surgery. Toxin use is often used as an alternative to tendon lengthening or tendon transfer; however our centre is now implementing a number of novel uses for BoNT injections with a view to improving outcomes in our cerebral palsy patients. We report a 16 year old patient with cerebral palsy who underwent a left flexor carpi radialis (FCR) to extensor carpi radialis longus (ECRL) tendon transfer with release of flexor digitorum superficialis (FDS) and flexor pollicis longus (FPL). Ultrasound guided BoNT injections were administered 2 weeks preoperatively to FCR, FDS, FDP, and FPL. The 2 week delay allowed the BoNT to exert its full effect and

achieve a maximum preoperative reduction in muscle tension. We typically use doses of 50 units BoNT per muscle. Our main finding is that BoNT injections can be valuable when used in conjunction with tendon lengthening and tendon transfer techniques, as a combination of surgery and injections produce a synergistic effect. With regards to tendon lengthening in FDS and FPL, preoperative reduction in muscle tension made achievement of optimum tendon length and hand position a more straightforward process. Reduced muscle tension makes the surgeon's task easier and leads to a better postoperative result. This finding supports results in animal models where manipulation of the muscle-tendon unit was made easier by preoperative injection of BoNT [4]. The benefits of this technique are also seen in tendon transfer. Firstly, reducing tension in the transferred FCR tendon allows for an easier transfer, attachment and attainment of an optimum hand position. Secondly, by reducing tension on antagonistic muscles (wrist flexors FDS and FDP), the ability to achieve an optimum hand position is more straightforward and, theoretically, the risk of post operative failure is reduced as the antagonistic force across the transferred tendon is less. At present, this technique has been used on a number of patients at our centre and so far the results are promising with the surgeon noting the ease with which a good hand position is achieved intraoperatively compared with cases where preoperative BoNT were not used. Feedback from hand therapists has also been encouraging, particularly with regards to protecting tendon transfers with BoNT injection to antagonistic muscles, which also permits earlier mobilisation. Formal assessment of post-operative outcomes has not yet been carried out at our centre. Preoperative BoNT injection may also act as a useful predictor of which patients are likely to respond positively to surgical intervention [5].

The principle of protecting tendon repairs also applies in patients with recurrent tendon rupture, where BoNT injection reduces muscle force generating potential thus minimising the

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chance of repair failure. This concept of ‘bioprotection’ with BoNT has already been demonstrated effectively in animal models. [6]. Indeed, there are case reports which support this as an effective technique [7]. A case series in children also suggested that this technique is of particular value for improving postoperative rehabilitation [8]. Furthermore, there are reports of promising results regarding improved postoperative rehabilitation in poorly compliant adult patients [9].

In addition to muscle spasticity, our centre has used BoNT injections as a therapeutic option in vasospastic conditions such as Raynaud’s disease. It has been suggested that the vasodilatory response observed following BoNT injection is caused by inhibition of the sympathetic nervous system on local blood vessels. This was postulated following work on a rat model which also demonstrated an increase in arteriolar diameter with a resultant increase in blood flow following BoNT injection [10]. A recent review by Mannava et al. looked at injection of BoNT to treat refractory Raynaud’s disease in humans, concluding that it has the potential to decrease pain and improve hand function [11]. It is possible that this technique would be of benefit in the management of post-traumatic vasospastic problems; however the authors are not aware of any evidence to date which demonstrates this.

The above examples illustrate just a few novel uses for BoNT in surgery of the upper limb. They have shown that this neurotoxin can be used synergistically with surgical interventions, which may lead to improved outcomes and quality of life. Further development and formalised analysis of such uses are needed, which we aim to carry out in the future.

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Conflict of Interest All named authors hereby declare that they have no conflicts of interest to disclose.

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