Needle EMG Guidance Is Useful

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Botulinum toxin (BTX) is used increasingly in neurologic practice. Needle electromyographic (EMG) analysis of muscles in disorders treated with BTX is often useful in diagnosis, assessing treatment response, and searching for denervation when neutralizing antibodies are suspected. These are important uses of needle EMG. Although needle EMG guidance for injection of BTX is an accepted technique, some argue over whether this technique increases treatment efficacy.

Needle EMG guidance is more important in some diseases than others. For example, it is hard to argue in support of needle EMG–guided BTX injection for the treatment of cosmetic wrinkles (although a recent review in the dermatologic literature claimed benefits for its use). By contrast, it would be difficult to treat laryngeal dysphonia without it. The essential difference between these examples is the location and accessibility of the target muscles, being easily accessible in patients with wrinkles, but difficult in the setting of spasmodic dysphonia. The main advantage of needle EMG guidance is precision of toxin placement.

Does precision improve treatment efficacy? There are theoretical advantages of needle EMG–guided delivery of BTX. First, clinical examination alone is often incapable of detecting dystonic muscles. Examination has a sensitivity of only 0.35 and specificity of 0.74 — a finding that holds even for superficial muscles such as the trapezius and scalenus posterior. The sensitivity of clinical examination would be lower for deeper muscles, where needle EMG guidance would likely improve injection accuracy.

The importance of targeting the motor endplate has been emphasized in animal models. Using rat anterior tibialis muscle, Shaari and Sanders demonstrated that toxin injection into the motor endplate region produces the greatest paralysis. Injections only 0.5 cm away from the region resulted in a 50% decrease in paralysis. In a canine model, placement of BTX at the motor endplate potentiated the toxic effect and decreased muscle force generation. These results support the premise that the closer the toxin is placed to the motor endplate, the greater the effect and the lower the toxin requirement.

Is exact localization of muscles advantageous? The answer probably depends on the disease. In blepharospasm and hemifacial spasm (HFS), the involved muscles are superficial and needle EMG may not be necessary. The small lower facial muscles in HFS may be hard to locate exactly, and any misinjection may lead to more extensive diffusion of toxin along fascial planes and increase unwanted cosmetic side effects. Limb dystonia, such as occupational cramp, often involves small extrinsic and intrinsic hand muscles that lie in close proximity to one another. Inappropriate toxin placement can worsen the functional outcome by weakening nondystonic adjacent muscles. Furthermore, it is occasionally important to weaken particular fascicles of individual muscles.

Abbreviations: BTX, botulinum toxin; EMG, electromyography; HFS, hemifacial spasm
Key words: botulinum toxin; dystonia; treatment; EMG guidance; hemifacial spasm; motor endplate
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muscles. Needle EMG also includes the technique of electrical stimulation. This technique ensures the localization of the desired fascicle or muscle, especially in sedated patients or those who otherwise have difficulty with fine motor control, such as children or poststroke patients. Cervical dystonia usually involves superficial muscles that may be readily palpated. However, needle EMG exploration of the dystonic neck often reveals involvement of deeper muscles that would be difficult to access without this technique. Furthermore, as in the forearm, muscles with opposing actions are often in close proximity, making it possible to do more harm than good with poorly targeted injections.

There are few studies that determine whether this added precision improves treatment efficacy. These same studies, however, make a strong case for needle EMG guidance. An early report in patients with cervical dystonia demonstrated the safety of needle EMG guidance and that there was no substantial increase in the time required for injection. In addition, there were fewer side effects, such as neck weakness and dysphagia, compared with prior studies, which the investigators attributed to the accuracy afforded by needle EMG guidance. A frequently cited study of patients with cervical dystonia compared injection guided by clinical examination versus examination plus needle EMG. There was no difference in the percentages of patients responding to treatment, but the response was greater in patients treated with needle EMG–guided injections. The results are even more impressive given that the aforementioned study was performed by neurologists with extensive experience in the use of BTX, unlikely to be matched by the average practitioner. Furthermore, it is reasonable to assume that the accuracy of injection provided the increased benefit because both groups received similar doses of toxin.

The benefits of using needle EMG guidance greatly outweigh the disadvantages. The additional cost of needle EMG is minor in comparison to the cost of the procedure and the toxin. Exact localization of toxin allows for a lower dose to produce an equivalent effect; given the high cost of toxin, localization could negate the additional cost of needle EMG. Furthermore, lower toxin doses will decrease the chance of developing neutralizing antibodies, and may also allow the injection of more muscles in patients with more widespread disease, such as in spastic hemiparesis or paraparesis. Therefore, based on both direct evidence and theoretical advantages, the use of needle EMG guidance for the delivery of BTX should be recommended in the majority of patients.

REFERENCES

**Needle EMG Guidance Is Rarely Required**

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Since the first report of clinical application of botulinum toxin (BTX) in 1984, this most potent biological toxin has become a powerful therapeutic tool in a variety of neurologic and other disorders. The widest application is for the treatment of disorders manifested by abnormal, excessive, or inappropriate muscle contractions, but the use of BTX is rapidly expanding to include treatment of a variety of oph-
thalmolologic, gastrointestinal, urologic, orthopedic, dermatologic and cosmetic conditions. The focus of this review is on the use of BTX in the treatment of hyperkinetic movement disorders — particularly the technique of BTX injection in the treatment of dystonia.

Although the efficacy and safety of BTX in focal and segmental movement disorders is well established, there are still some areas of controversy regarding the optimal technique for administering BTX. For example, should a single bolus injection be administered to the target muscle or the total dosage divided and injected into multiple sites? This issue is relevant not only to the technique of injection, but also to the potential outcome with respect to efficacy and safety. Because local complications of BTX injections are thought to be due to unwanted diffusion of the toxin into adjacent muscles, it is medically prudent to employ techniques that prevent such spread. The size of the denervation field is largely determined by the dose and volume. This investigator and others believe that multiple point injections along the affected muscle rather than a single point injection should therefore contain the biologic effects of the toxin in the targeted muscle and minimize the spread to adjacent muscles and structures.

Another controversy, the focus of this commentary, is whether BTX should be administered with needle electromyographic (EMG) guidance or whether a clinical examination provides adequate information for the proper selection of involved muscles (Table 1). There is a general consensus among experts that selection of the appropriate muscle and subsequent injection of the optimal dose are the most important determinants of the outcome of BTX treatment. Although the present investigator initially employed needle EMG in the treatment of cervical dystonia, long-term experience with the use of BTX in thousands of patients, treated on repeated occasions since 1983, has led to a reexamination of this approach with the conclusion that needle EMG guidance is rarely needed when treating typical cases of focal dystonia.

Although the issue of EMG-guided injections has been debated since BTX was first introduced for clinical use, only one study has attempted to determine its usefulness in the treatment of cervical dystonia. The investigators randomized 52 patients with cervical dystonia into two groups. In the first, muscles were selected for BTX injection, using both clinical and needle EMG examination, and were then injected with EMG assistance (N = 24). In the second group, muscle selection was based solely on clinical examination and the patients were injected without EMG assistance. The investigators concluded that needle EMG assistance did not increase the number of patients who improved compared with those injected clinically. They further noted, however, “a significantly greater magnitude of improvement,” and that there was “a significantly greater number of patients with marked benefit” in the group randomly assigned to the needle EMG–assisted method of treatment. Although the conclusions of the study seem to favor the use of needle EMG assistance, there are many problems with the study methodology and the interpretation of the results that invalidate the study. The following are some of the many concerns with the study: (1) the criteria for selection into the study were not clearly defined; (2) the majority (70–79%) of patients were previously treated with BTX, and some may have experienced residual effects from previous injections, making the interpretation of the results difficult (i.e., the latency between last injection and enrollment into study was not provided); (3) all patients previously treated with BTX, and some may have been unfavorably biased against the non-guided approach; (4) the reliability of clinical/EMG criteria for muscle selection and of video assessments was

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<th>Table 1. Disadvantages of routine needle EMG guidance of botulinum toxin injections.</th>
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<td>1. Need for additional equipment (hollow EMG needle, EMG machine and connecting cables)</td>
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<td>2. More painful (larger diameter needles)</td>
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<td>3. More time-consuming</td>
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<td>4. More expensive</td>
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<td>5. Determination of initial placement of EMG electrode is still dependent on clinical examination</td>
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<td>6. If a muscle is obviously contracting and/or is hypertrophied, needle EMG is redundant (unless it is the antagonist muscle, which can be determined only by clinical examination, not by EMG)</td>
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<td>7. The exact anatomic location of the EMG needle tip cannot be verified</td>
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<td>8. Needle EMG may not differentiate between contractions produced by agonist versus antagonist muscles (and may thus lead to injection of the wrong muscle)</td>
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<td>9. Needle EMG may be misleading—patients often “tense” otherwise uninvolved muscles during EMG</td>
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<td>10. Single bolus EMG-guided injection leads to a greater risk of spread to adjacent, uninvolved unwanted muscles</td>
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<td>11. The results of BTX treatment without needle EMG are so good that the small additional improvement (even if proven) does not justify the routine use of EMG</td>
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not assessed; (5) the absence of EMG auditory/visual feedback normally present when the injection is performed with needle EMG guidance may have adversely biased the “no-EMG” group; (6) the patients treated without needle EMG assistance received a higher dose (scalenus, 49 versus 73 U; levator scapulae, 82 versus 105 U; posterior vertebrals, 75 versus 108 U), and this difference may indicate more severe dystonia at treatment onset and explain the lesser degree of observed improvement; and finally (7) the single bolus injection used in this study may not be the optimal approach and the overall results may not be comparable to those of other studies that utilize multiple injections.

To my knowledge this is the only published study comparing the two approaches; other studies have recommended the use of the needle EMG–guided approach without any supporting evidence. One study, for example, concluded that needle EMG guidance and application of BTX into deep cervical muscles may further improve the clinical effect,2 but no data were provided to support this conclusion. Table 1 illustrates other concerns shared with colleagues experienced with BTX treatment regarding the routine use of needle EMG–guided injections.3

The most important reason why I do not recommend routine use of the EMG-guided approach is that even if there is minimal increase in improvement, over the 90% benefit reported by most studies, it does not justify the increased discomfort, time, and expense of this approach, as compared with clinical examination. The general consensus among most BTX users is that needle EMG is not needed in the vast majority of patients, except in rare instances when the muscles cannot be adequately palpated or the patient does not obtain adequate relief of symptoms with the conventional approach.

The routine use of needle EMG should not be recommended for BTX treatment of cervical dystonia. There are several unique instances in which needle EMG guidance is essential or necessary to achieve optimal results. These include the percutaneous injection of BTX into vocal cords to treat spasmodic dysphonia11 and the treatment of certain task-specific dystonias (e.g., in keyboard and string musicians).9 Musicians are particularly difficult to treat because their performance is exquisitely dependent on accurate and well-coordinated hand and finger movements. Even in patients with occupational cramps, such as dystonic writer’s cramp or focal hand tremor, an injection into the forearm flexor muscles (e.g., flexor carpi radialis and flexor carpi ulnaris) can be successfully performed without needle EMG guidance by using well-defined anatomic landmarks.10 Indeed, Rivest and colleagues12 concluded that benefits were obtained from local BTX injections in patients with dystonic writer’s cramp that were similar to the benefits seen using complex EMG and fine-wire electrodes to localize bursts of muscle activation during the task, and by injecting the toxin through a hollow EMG needle into the belly of the most active muscle.3

In conclusion, the published reports on the treatment of cervical dystonia with BTX, most of which do not utilize needle EMG, coupled with the present investigator’s experience, leads to the conclusion that needle EMG guidance is rarely required for the administration of BTX. The needle EMG–guided approach may be necessary occasionally to localize involved muscles that cannot be palpated and to guide the injection of muscles that are difficult to access. Finally, it is important to point out that greater reimbursement is a rarely disclosed, but potentially important, financial incentive for the routine use of needle EMG guidance in BTX treatment.

REFERENCES