Botulinum Toxin Injection Without Electromyographic Assistance

Enrique Chipont Benabent, MD, PhD; Pedro García Hermosa, MD; María T. Arrazola, MD; and Jorge L. Alió y Sanz, MD, PhD

ABSTRACT

**Purpose:** To ascertain whether electromyographic control of the muscles when injecting botulinum toxin in the medial rectus muscles of children under sedation is necessary to obtain good results in terms of ocular alignment and postoperative complications.

**Methods:** Forty neurologically normal children 6 to 48 months of age were entered consecutively into the study once the initial diagnosis of essential infantile esotropia had been made. The children were sedated with sevoflurane and both medial rectus muscles were injected with 7 IU of botulinum toxin using an insulin syringe with a 27-gauge needle. Postoperative controls were performed at 3 days, 3 weeks, 3 months, and 6 months after the injection. The effectiveness of the injection was noted in terms of tropia, paralysis, and associated complications.

**Results:** The mean tropia at 6 months postoperatively was 8.47 prism diopters of esotropia, ranging from 25 prism diopters of esotropia to 10 prism diopters of exotropia. Fifty-three percent of the patients had an esotropia between 0 and 10 prism diopters. The most common complications were ptosis and vertical deviation, affecting 23% and 21% of the patients, respectively, followed by conjunctival hemorrhage, which was recorded in 7% of the patients. There were no retrobulbar hemorrhages, ocular perforations, or anesthetic complications.

**Conclusions:** If anesthetic risks are higher and the results are similar when using electromyographic control, we advocate not using it in congenital esotropia when injecting botulinum toxin in children.


INTRODUCTION

Botulinum toxin is one of the options for managing strabismus. One of the most common indications for it is congenital esotropia.\(^1\)\(^2\) It is also used for muscle paresis in children and in adults to prevent the contracture of the antagonist muscles mostly when the VI nerve is affected.\(^3\)

The type of complications associated with the use of this drug depend on several factors. When the general anesthetic technique is used in children, ketamine is chosen to monitor muscle activity. However, the associated complications of hallucinations, nightmares, and sensation of fear in children

---

From the Instituto Ofalmologico de Alicante, Alicante, Spain.
Accepted for publication April 16, 2002.
Reprint requests: Enrique Chipont Benabent, MD, PhD, C/Pinatar Cabrera 27, 3 Isla, 03003 Alicante, Spain.
make the use of this drug a handicap. Problems associated with the injection itself include conjunctival hemorrhage, pain or discomfort, and those related to passing the needle. The correct direction of the needle is related to a possible ocular perforation or retrobulbar hemorrhage.

There are also problems associated with the correct placement of the drug, whether it is an intravitreal, retrobulbar, or extramuscular injection. It can diffuse to other muscles, causing ptosis and vertical misalignments. Electromyographic control supposedly aids in correctly injecting the botulinum toxin into extraocular muscles. In the analysis of the different problems associated with the overall process, electromyographic control does not help the surgeon avoid complications associated with the needle injection itself or the direction.

Electromyography will ensure a correct intramuscular injection of the toxin when relatively good sound (or image in the latest electromyographs) is achieved. With general anesthesia, obtaining a good register from the electromyograph, when the muscles are in basal activity and no active contraction is performed, is difficult for the surgeon, who sometimes has to perform the injection without a clear electromyographic confirmation of the correct placement of the needle. On the other hand, if one wants to register the motor plate potentials in a child under general anesthesia, ketamine is the agent of choice because of its well-known side effects. However, other anesthetic drugs are currently available to avoid all the problems associated with ketamine.

Studies have been conducted to develop objective and reliable methods of storing and grading electromyographic signal quality obtained during botulinum injection with the aim of enhancing future studies of the complications and effectiveness of botulinum toxin injections into extraocular muscles. Substantial variability of the signal had been observed between patients. The contracting muscle had a higher total power and peak frequency in most, but not all, cases. Total signal power correlated moderately with subjective estimates of signal quality. Neither subjective nor computer-derived estimates of signal quality correlated with the response of the injection or its complications.

The use of electromyography would be justified if the intraoperative reference of the muscle, although poor, was enough to ensure better results in terms of ocular alignment and postoperative complications. The aim of this study was to ascertain whether the use of electromyographic assistance is really essential when performing botulinum toxin injection in both medial rectus muscles in children under sedation.

**Patients and Methods**

Forty neurologically normal children ranging in age from 6 to 48 months (average age, 1.8 years) were entered consecutively into the study after the initial diagnosis of infantile esotropia was made. They all suffered from congenital essential esotropia not corrected with glasses (minimum or no accommodative component by cycloplegic refraction). After parental consent was obtained, all of them were included in the protocol of the injection of botulinum toxin in both medial rectus muscles to correct the esotropia.

Once a peripheral line was in place and the child had been sedated with sevoflurane (Abbott Laboratories, S.A., Madrid, Spain), the surgical field was prepared using povidone-iodine to clean the skin and conjunctival sac. A pediatric blepharostat was used to open the eyelids. The insertion of the medial rectus was firmly grasped with conjunctival forceps (in a similar fashion to the superior rectus bridle suture in cataract surgery). A 27-gauge needle on an insulin syringe with the desired amount of toxin was passed through the grasped tendon. The eye was then rotated to the straight position and the needle introduced at a distance 5 to 10 mm in a direction parallel to the medial orbital wall. A dose of 7 IU of the drug (BOTOX, Allergan, Dublin, Ireland) was then injected. After 5 to 10 seconds passed, the needle was retrieved.

Patients were observed during 6 months. Postoperative controls were performed at 3 days, 3 weeks, 3 months, and 6 months after the botulinum injection.

The effectiveness of the injection was noted in terms of tropia, paralysis, and other associated complications. The degree of paralysis was recorded as 0 (no paresis); 1 (paresis that passed the midline); 2 (paresis that reached the midline); 3 (paresis that did not reach the midline); or 4 (total paralysis).

Tropia was measured at 60 cm with the prism ruler and alternate cover test when possible. The
Hirschberg or Krimsky test was used for an approximate measurement of the tropia in uncooperative children.

Complications were recorded at every visit, with special attention paid to proptosis and iatrogenic vertical deviation. Funduscopic control was performed in both eyes at day 3 after injection.

RESULTS

Preoperative esotropia was in the range of 15 to 60 prism diopters, with an average of 25.8 prism diopters. The mean postoperative degree of exodeviation was 39.3 prism diopters at 3 days (range, 10 to 70 prism diopters). At 3 weeks, the mean deviation was 32.1 prism diopters of esotropia (range, 5 prism diopters of esotropia to 50 prism diopters of esotropia). At 3 months, deviation on average was 18.3 prism diopters of esotropia (10 prism diopters of esotropia to 25 prism diopters of esotropia). At 6 months, the residual deviation was an average of 8.5 prism diopters of esotropia (25 prism diopters of esotropia to 10 prism diopters of esotropia).

The degree of parietes at day 3 was an average of 2.8 on our numeric scale (range, 0 to 4). The degree of parietes after 3 weeks decreased to 2.6 (range, 0 to 4). At 3 months, the mean value of parietes was 1.3 (range, 0 to 3). At 6 months, there was no evidence of parietes in any injected muscle.

The tropia was between 0 and 10 prism diopters of esotropia in 53% of the patients. No statistically significant relationship was found between the amount of preoperative deviation and a good final result (defined as less than 10 prism diopters of esotropia). There was a strong clinically significant relationship between the degree of muscle parietes and a good final outcome ($P = .03$), as well as the degree of esotropia and a good final outcome ($P = .002$).

Proptosis was present in 23% of the injected eyes. It was transient and not present at 3 months of follow-up. Vertical deviations were observed in 21% of the patients. Conjunctival hemorrhage was observed in 7% of the patients at either the puncture site or the areas of forceps grasping. No retrobulbar hemorrhage or ocular perforation was recorded in any eye. There were no anesthesia-related complications, and awakening from the anesthesia was uneventful in every case.

DISCUSSION

To the best of our knowledge, this is the first report of botulinum toxin injection into extraocular muscles without electromyographic assistance. There are several advantages to using this technique over others with electromyographic support in children under anesthesia. The use of electromyographic control requires a good needle-electrode recording of a basal motor plaque potential. The only suitable anesthetic agent to achieve this is ketamine. The effects of ketamine are based on the induction of a dissociate state of mental disconnection and analgesia with high muscular tone and uncoordinated ocular movements. The anesthetic begins to take effect 1 minute after administration and the effects last for 15 minutes. This drug is associated with nightmares, hallucinations, and increased salivation. It has been contraindicated in ophthalmic surgery because of the potential risk of diplopia, exaggerated ocular movements, blepharospasm, and nystagmus. However, its use in pediatric sedation is extended.

In this study with no electromyographic control of the injection, muscle tone was not required and therefore anesthesia was performed in a safer way. We used sevoflurane, a nonirritating gas that does not increase mucous secretion for the induction and the anesthesia. It maintains heart rate and blood pressure and relaxes bronchial muscles, so it can be used in patients with asthma. Induction is reached 1 minute after administration, and the patient is fully conscious and responds to commands 5 minutes after clearance. No anesthetic complications were observed in our series, in contrast with nausea and vomiting with ketamine in a previous study.

The possible complications or side effects of a given technique, such as the use of ketamine, could be justified if, by using it, we obtained better results in the correction of tropia in children. Our results are not different from those of other studies of congenital essential esotropia. They range from 50% of esotropia less than 10 prism diopters reported by Ing et al. to 89% reported by McNeer et al., with some instances of multiple injections in the latter study. Complications in our series were similar to those reported by others using electromyographic control, with ptosis ranging from 31% to 53% and vertical deviations of 16%.

Twenty-three percent of our patients had ptosis
and 21% had induced vertical deviation. If the anesthetic risks are higher and the results obtained are similar, we advocate not using electromyographic control in congenital esotropia when injecting botulinum toxin in children and avoiding ketamine. Newer, safer drugs should be used for sedation and anesthesia in children.

Additionally, electromyographic control in adults, as well as when injecting into other muscles such as the inferior oblique or the inferior rectus, is an important element in avoiding complications, especially vertical misalignments, and it provides confidence regarding the site of injection. If the use of electromyography in children is associated with a higher anesthetic risk, it should be evaluated by those who use botulinum toxin.

REFERENCES


