Augmented Recession by Intraoperative Botulinum Toxin-A Injection in Large Angle Horizontal Deviation

Mohammad-Reza TalebNejad, MD • Mohammad Sharifi, MD • Mohammad-Hossein NowroozZadeh, MD

Abstract

Purpose: The aim of this study is to evaluate the effectiveness of intraoperative botulinum toxin-A (BTA) injection as an adjunct to the surgical treatment of large-angle esotropia or exotropia.

Methods: Thirteen patients were included in this interventional case series study. Mean age of the patients was 23.31±13.29 years (range: 5-43 years). Of these 13 patients, 6 were exotropic and 7 were esotropic. The average preoperative esodeviation was 79.29±16.44 prism diopters (PD) (range: 60-100 PD) and exodeviation was 75.83±11.14 PD (range: 65-90 PD). Depending on the degree of deviation ten or twenty units of Dysport were injected intraoperatively into the recessed horizontal rectus muscles in all of the patients.

Results: The average follow-up was 7±1 months (range: 6-8 months). The average final deviation in the esotropia group was 8.57±10.69 PD of esotropia. The average final deviation in the exotropia group was 14.17±12.00 PD of exotropia. The final deviation of the 69% patients was within 15 PD of esotropia or exotropia.

Conclusion: This study shows that the combination of BTA injection with recession may be a useful treatment option in cases of large angle horizontal deviation.

Keywords: Recession, Botulinum Toxin, Exotropia, Esotropia

Introduction

Botulinum toxin-A (BTA) has been used to cause long-term weakening of an injected extraocular muscle since the early 1980s. BTA blocks release of acetylcholine, resulting in paralysis of injected muscle about three days after injection, and thereafter in myofibrillary atrophy. The proposed mechanism of action involves a temporary paralysis and stretching of the injected muscle and contracture of the ipsilateral antagonist (altered length-tension curve).

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Large angle horizontal deviation greater than 50 prism diopter (PD) may require 3 or 4 horizontal rectus muscle surgeries. However, the combined use of BTA with surgery may have an additive effect on the angle of deviation. The potential benefits of operation on fewer muscles include: less surgical time; less risk of complications such as scleral perforation, retinal detachment, and endophthalmitis; less scar tissue formation; reduced risk of anterior segment ischemia and to keep some of the muscles unoperated for possible reoperation. Some adverse effect of BTA injection include: vertical deviation, ptosis, hemorrhage and perforation. In this interventional case series study, we analyzed our data to evaluate the effectiveness of intraoperative BTA injection as an adjunct to the surgical treatment of large-angle esotropia or exotropia.

**Methods**

Thirteen patients (4 men and 9 women) with large-angle esotropia or exotropia referred to strabismus clinic were included in this study with determined criteria.

The mean age of patients was 23.31±13.29 years (range: 5-43 years). They all had undergone a complete preoperative and postoperative eye examination. Written informed consent was obtained from all patients before surgery in accordance with declaration of Helsinki, and the study was approved by the local ethics committee.

The inclusion criteria were horizontal deviation greater than 50 PD, no concomitant vertical deviation and follow-up period of 6 months or longer. Exclusion criteria were history of previous strabismus surgery and restrictive or paretic strabismus.

Of these 13 patients, 7 had esotropia and 6 had exotropia. The deviation measured by alternate prism and cover test with corrected glasses in near and distance. No difference was found between near and distance deviation. No patients had duction deficiency. Stereopsis was measured by Titmus stereacoquity test before and after surgery. The average preoperative esodeviation was 79.29±16.44 PD (range: 60-100 PD) and exodeviation was 75.83±11.14 PD (range: 65-90 PD). Depending on preoperative deviation 0.1 ml contains ten or twenty unit of BTA (Dysport [Ipsen, Biopharm Ltd., Wrexham Industrial Estate, Wrexham, LL13 9UF, UK]) was injected intraoperatively 10 mm posterior to insertion in the belly of muscle by a 27 gage needle. For prevention of leakage, the needle was held in the muscle for 30 seconds and then gently removed. Then muscle recession was done. In recession, muscle sutured to sclera by 6/0 vicryl at predetermined distance to insertion. All esotropic patients underwent bilateral medial rectus muscle recession (7 mm) and toxin injection in both recessed muscles. Two exotropic patients underwent monocular recession (range: 9-10 mm), and resection (range: 5-6 mm) and injection of toxin into the recessed muscle. The four exotropic patients underwent bilateral lateral rectus muscle recession (10 mm) and toxin injection into both recessed muscles. If preoperative deviation was less than 70 PD, 10 units of toxin and if greater than 70 PD, 20 units of toxin was injected intraoperatively. Postoperative information was collected regularly at 1, 7, 30, 90 days and final follow-up (6 months).

The information was stored and analyzed using SPSS version 11.5 (SPSS Inc., Chicago, IL, USA). A P-value less than 0.05 was considered statistically significant.

**Results**

The follow-up ranged between 6 and 8 months (mean: 7±1 months). Stereopsis was absent in all of the patients pre and postoperatively. In the exotropic eyes the mean preoperative angle of deviation decreased from 75.83±11.14 PD (range: 65-90) to 14.17±12.00 PD (range: 0-30) postoperatively (P<0.001). In the esotropic eyes the mean preoperative angle of deviation decreased from 79.29±16.44 PD (range: 60-100) to 8.57±10.69 PD (range: 0-30) postoperatively (P<0.001). The mean reduction in deviation was greater in esotropic eyes (70.83±14.29 PD) in comparison with exotropic eyes (61.67±11.25 PD); but this difference was not statistically significant (P=0.191). Both groups had acceptable result of surgery at last follow-up.

In the postoperative period, transient small vertical deviation (less than 10 PD) or mild ptosis caused by leaking BTA from the muscle belly occurred in 7 and 5 patients, respectively.
The final deviation was within 15 PD of esotropia or exotropia in 69% of the patients and defined as acceptable surgical outcome. The preoperative and postoperative results and performed surgeries appear in detail in Tables 1 and 2. The comparative average of preoperative and postoperative measurements of esodeviations and exodeviations are shown in Table 3.

### Table 1. Summary of pre and postoperative data of patients with exotropia

<table>
<thead>
<tr>
<th>N</th>
<th>Age</th>
<th>BCVA</th>
<th>Dev (Preop)</th>
<th>Surgery</th>
<th>Dev (1 Mo)</th>
<th>Dev (Final)</th>
<th>Duction (Final)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>43</td>
<td>R: 3/10 L: 1/10</td>
<td>80 BI</td>
<td>R: LR Rec (10 mm) + 20 IU Dys L: LR Rec (10 mm) + 20 IU Dys</td>
<td>Ortho</td>
<td>Ortho</td>
<td>R: Full</td>
</tr>
<tr>
<td>2</td>
<td>43</td>
<td>R: 6/10 L: 9/10</td>
<td>90 BI</td>
<td>R: LR Rec (10 mm) + 20 IU Dys L: LR Rec (10 mm) + 20 IU Dys</td>
<td>40 BI</td>
<td>30 BI</td>
<td>R: Full</td>
</tr>
<tr>
<td>3</td>
<td>24</td>
<td>R: 2/10 L: 9/10</td>
<td>65 BI</td>
<td>R: LR Rec (9 mm) + 10 IU Dys R: MR Res (8 mm)</td>
<td>Ortho</td>
<td>Ortho</td>
<td>R: Full</td>
</tr>
<tr>
<td>4</td>
<td>19</td>
<td>R: 7/10 L: 1/10</td>
<td>60 BI</td>
<td>L: LR Rec (10 mm) + 10 IU Dys L: MR Res (5 mm)</td>
<td>20 BI</td>
<td>15 BI</td>
<td>R: Full</td>
</tr>
<tr>
<td>5</td>
<td>40</td>
<td>R: 3/10 L: 3/10</td>
<td>80 BI</td>
<td>R: LR Rec (10 mm) + 20 IU Dys L: LR Rec (10 mm) + 20 IU Dys</td>
<td>20 BI</td>
<td>20 BI</td>
<td>R: Full</td>
</tr>
<tr>
<td>6</td>
<td>14</td>
<td>R: 10/10 L: 8/10</td>
<td>80 BI</td>
<td>R: LR Rec (10 mm) + 20 IU Dys L: LR Rec (10 mm) + 20 IU Dys</td>
<td>20 BI</td>
<td>20 BI</td>
<td>R: Full</td>
</tr>
</tbody>
</table>

**Table 1. Summary of pre and postoperative data of patients with exotropia**

- **BCVA**: Best corrected visual acuity; **BI**: Base in; **BO**: Base out; **Dys**: Dysport; **L**: Left; **LR**: Lateral rectus; **MR**: Medial Rectus; **N**: Number; **R**: Right; **Rec**: Recession; **Res**: Resection

### Table 2. Summary of pre and postoperative data of patients with esotropia

<table>
<thead>
<tr>
<th>N</th>
<th>Age</th>
<th>BCVA</th>
<th>Dev (Preop)</th>
<th>Surgery</th>
<th>Dev (1 Mo)</th>
<th>Dev (Final)</th>
<th>Duction (Final)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>R: CSM L: CSM</td>
<td>75 BO</td>
<td>R: MR Rec (7 mm) + 20 IU Dys L: MR Rec (7 mm) + 20 IU Dys</td>
<td>20 BI</td>
<td>Ortho</td>
<td>R: Full</td>
</tr>
<tr>
<td>2</td>
<td>23</td>
<td>R: 2/10 L: 2/10</td>
<td>80 BO</td>
<td>R: MR Rec (7 mm) + 20 IU Dys L: MR Rec (7 mm) + 20 IU Dys</td>
<td>25 BI</td>
<td>Ortho</td>
<td>R: -1 Abd</td>
</tr>
<tr>
<td>3</td>
<td>25</td>
<td>R: 10/10 L: 9/10</td>
<td>100 BO</td>
<td>R: MR Rec (7 mm) + 20 IU Dys L: MR Rec (7 mm) + 20 IU Dys</td>
<td>20 BI</td>
<td>10 BO</td>
<td>R: Full</td>
</tr>
<tr>
<td>4</td>
<td>11</td>
<td>R: 5/10 L: 7/10</td>
<td>60 BO</td>
<td>R: MR Rec (7 mm) + 10 IU Dys L: MR Rec (7 mm) + 10 IU Dys</td>
<td>20 BI</td>
<td>10 BO</td>
<td>R: Full</td>
</tr>
<tr>
<td>5</td>
<td>35</td>
<td>R: 3/10 L: 3/10</td>
<td>60 BO</td>
<td>R: MR Rec (7 mm) + 10 IU Dys L: MR Rec (7 mm) + 10 IU Dys</td>
<td>25 BI</td>
<td>Ortho</td>
<td>R: Full</td>
</tr>
<tr>
<td>6</td>
<td>9</td>
<td>R: 5/10 L: 8/10</td>
<td>80 BO</td>
<td>R: MR Rec (7 mm) + 20 IU Dys L: MR Rec (7 mm) + 20 IU Dys</td>
<td>15 BI</td>
<td>10 BO</td>
<td>R: Full</td>
</tr>
<tr>
<td>7</td>
<td>12</td>
<td>R: 10/10 L: 10/10</td>
<td>100 BO</td>
<td>R: MR Rec (7 mm) + 20 IU Dys L: MR Rec (7 mm) + 20 IU Dys</td>
<td>10 BO</td>
<td>30 BO</td>
<td>R: Full</td>
</tr>
</tbody>
</table>

**Table 2. Summary of pre and postoperative data of patients with esotropia**

- **Abd**: Abduction; **BCVA**: Best corrected visual acuity; **BI**: Base in; **BO**: Base out; **Dys**: Dysport; **L**: Left; **LR**: Lateral rectus; **MR**: Medial Rectus; **N**: Number; **R**: Right; **Rec**: Recession; **Res**: Resection
Table 3. Comparative pre and postoperative measurements of deviations

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
<th>Deviation (PD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Preoperative</td>
</tr>
<tr>
<td>Esodeviation</td>
<td>7</td>
<td>79.29±16.44</td>
</tr>
<tr>
<td>Exodeviation</td>
<td>6</td>
<td>75.83±11.14</td>
</tr>
</tbody>
</table>

PD: Prism diopter.

Discussion

This study was performed to assess the results of our experience using BTA combined with horizontal eye muscle surgery in large angle deviations. In most of our patients we performed the maximal amount of surgery. According to the preoperative angle of deviation, we injected 10 units of Dysport into the recessed muscle in some patients and 20 units in others, however, the rate of overcorrection seems not related to the dose of toxin.

Owens et al. evaluated the effect of intraoperative BTA and mono-oocular recession-resection surgery in 3 large-angle exotropia patients who had a deviation greater than 70 PD. In that study, 3 patients underwent monocular recession (10 mm) and resection (10 mm) along with intraoperative BTA injection of 10 units into the recessed muscle. All 3 patients were reported to have satisfactory cosmetic results. They concluded that intraoperative BTA injection provided an alternative for the surgical correction of large-angle exotropia by operating only on 2 horizontal rectus muscles. In our study, although improvement in stereopsis was not obtained in any patients, satisfactory cosmetic results were obtained in most of our patients. Accordingly, 69% of patients demonstrated acceptable surgical outcome (within 15 PD deviation).

BTA acts selectively on peripheral cholinergic nerve endings to inhibit acetylcholine release. The toxin binds to the specific receptor on the cell surface and induces severe muscle palsy without causing damage to the rectus muscle or the peripheral nerve. The goal of this treatment is to create adequate weakness of sufficient duration in the injected muscle so that it becomes slightly atrophied and stretched while the antagonist muscle takes up the slack with some degree of contracture. Consequently, the BTA alters the passive stiffness in eye muscles, which suggests that toxin has fiber-specific consequences that permanently alter the muscle behavior. The possible alteration in sarcomere number, histochemical properties, and structural changes of the extraocular muscles seem responsible for the permanent augmentation effect of BTA with recession. Furthermore, even after full recovery from the paralysis, a permanent disturbance of the pattern of motor innervation in the treated muscle is demonstrated.

In this study, we observed significant limitation of ductions and overcorrection due to the effect of BTA in the early postoperative days. During this period, the eye remains in a certain position similar to that provided with traction suture. With the induced change in the eye position that was obtained with a traction suture, Scott showed that the number of sarcomeres in the contracted muscle decreased whereas it increased in the stretched muscle. Similarly, the changes occur in the horizontal rectus muscles for the permanent additive effect of BTA.

In our study, all of six patients with early postoperative overcorrection showed satisfactory surgical outcome at final follow-up (less than 15 PD deviation). Therefore early postoperative overcorrection is desirable for achieving permanent satisfactory outcomes.

There are some disadvantages of combined use of BTA and recess surgery. The patients must be informed in detail about the significant over correction and diplopia during the early postoperative phase. In our study, six patients had significant over correction but didn’t develop intolerable diplopia. Again seven patients developed...
transient small vertical deviation and five patients developed mild ptosis postoperatively that were not significant and disappeared during a 3 month follow-up period.

**Conclusion**

In summary, in large-angle horizontal deviations, the combined use of BTA and surgery may be a good alternative for the surgical correction of large angle exotropia by operating only on 2 horizontal muscles. This strategy may decrease the complications associated with surgery on more muscles and provide more unoperated muscles for possible reoperation. The early postoperative overcorrection is desirable for achieving permanent satisfactory outcomes. Although providing encouraging outcomes, this study is limited by the lack of a comparison group and small sample size.

**References**