Superior rectus underaction following botulinum toxin injection to induce protective upper eyelid ptosis – a comparative study of two techniques

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ABSTRACT

Background: Botulinum toxin A (BTXA) injection to the levator palpebrae superioris muscle to induce a protective ptosis can adversely cause reduced upgaze due to diffusion of BTXA to the superior rectus muscle.

Purpose: To compare the incidence of reduced upgaze in transcutaneous versus transconjunctival administration of BTXA to induce protective ptosis in patients with exposure keratopathy due to facial nerve palsy.

Methods: All patients included in this study suffered from acute exposure keratopathy and they all required chemodenervation of the levator muscle to induce a protective ptosis. Patients in group A received BTXA (Dysport) transcutaneously through the upper eyelid skin crease. Patients in group B received BTXA (Dysport) into the subconjunctival space at the superior border of the tarsal plate of the upper eyelid transconjunctivally.

All subjects were closely monitored after BTXA injection and during each follow-up assessment the upper eyelid was lifted in order to uncover the effects on ocular motility. All patients had a follow-up of at least 1 year following injection of BTXA for their facial nerve palsy and its complications.

Results: In group A, 20 patients were included. Reduced upgaze occurred in 9 patients (45%). Five required treatment with a Fresnel prism or ocular occlusion to avoid intractable diplopia. There were 15 patients in Group B, and only 2 of them developed post-treatment superior rectus underaction. One of these patients resolved spontaneously and the other patient required treatment with a spectacle-mounted Fresnel prism for diplopia. The difference in incidence of reduced upgaze between the 2 techniques was statistically significant (Fisher’s exact test, \( P = 0.0493 \)).

Conclusion: Injecting BTXA to induce protective ptosis via a transconjunctival supratarsal route was significantly less likely to induce superior rectus underaction than when given via the transcutaneous route.

Keywords: Binocular vision, botulinum toxin, diplopia, dysport, neuro-ophthalmology, ptosis, plastics/oculoplastics

INTRODUCTION

Botulinum toxin A (BTXA) injection to the levator palpebrae superioris muscle is now a widely accepted method of inducing a protective ptosis for the treatment of corneal exposure and non-healing epithelial defects.\(^1\)\(^2\) BTXA administration to the levator palpebrae superioris muscle is minimally invasive and can be performed without any anesthesia.\(^1\) One major disadvantage of this procedure is superior rectus (SR) underaction and diplopia due to diffusion of BTXA to the SR muscle. In some reports up to 68% of patients are reported to be affected.\(^3\)

In our previous publication,\(^1\) 45% of patients encountered reduced upgaze or diplopia when BTXA was administered transcutaneously at the level of the skin crease of the upper eyelid. Following this observation, the technique of administration of BTXA was changed to a transconjunctival route at the superior tarsal border. In this paper the authors compare these two injection techniques, with
special attention to the incidence of reduced upgaze and diplopia in these two groups of patients, namely “transcutaneous” versus “supratarsal transconjunctival” when administering BTXA.

MATERIALS AND METHODS

The ophthalmic clinical records of all consecutive patients who received BTXA transconjunctivally to induce a protective ptosis to treat acute exposure keratopathy mainly from facial nerve palsy were reviewed retrospectively. These patients were compared with the patients in our previous publication,1 who also received BTXA transcutaneously for the same reason.

In both techniques, BTXA (Dysport) was dissolved with sterile saline to a final concentration of 100 units/ml. A dose of 10 units (0.1 ml) of BTXA was administered to all patients in group A and a mean of 54.8 units (0.548 ml) (range 6–125 units) of BTXA was required by the patients in group B to produce complete ptosis.

The patients of group A received their BTXA injections via the central portion of the upper lid skin crease with an insulin syringe perpendicular to the skin.

In group B (subconjunctival supratarsal injection), the eye was anesthetized with topical anesthetic, the upper eyelid was everted, and BTXA (Dysport) was administered into the subconjunctival space at the superior border of the tarsal plate along the central 75% of the eyelid using an insulin syringe (see Figure 1). A higher dose of BTXA (range 6–125 units) was required in order to produce complete ptosis in most patients. All injections were performed by an experienced consultant ophthalmologist.

The patients had follow-ups soon after the BTXA injections. The eyelid was lifted in order to assess the degree of improvement of exposure keratopathy, as well as elicit the presence of diplopia/SR underaction in primary and upgaze. For the purpose of this study, patients’ notes were reviewed until the corneal exposure and the protective ptosis had fully recovered following injection of BTXA or for 1 year (whichever was the longest), although many patients were followed up for much longer due to their facial palsy and related complications.

Statistical analysis comparing the incidence of reduced upgaze between group A and group B were performed using Fisher’s exact test.

RESULTS

In group A, 20 patients underwent BTXA to induce protective ptosis. The average age of the patients was 50.2 years. The mean dose of BTXA was 10 units (0.1 ml). Reduced upgaze occurred in 9 patients (45%) (Table 1). The orthoptic assessment revealed a SR muscle underaction of −2 in eight patients and −3 in the other patient. Five patients required treatment for diplopia with a Fresnel prism or temporary ocular occlusion throughout the follow up period of 1 year.

In Group B, 15 patients underwent a subconjunctival supratarsal injection of BTXA (Dysport) to treat

![Figure 1. The technique of BTXA injection along the superior border of the tarsal plate transconjunctivally.](image)

<table>
<thead>
<tr>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transcutaneous</td>
<td>Supratarsal -transconjunctival</td>
</tr>
<tr>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>Number of subjects</td>
<td>55.4</td>
</tr>
<tr>
<td>50.2</td>
<td>54.8 (range 6–125 units)*</td>
</tr>
<tr>
<td>Mean age (years)</td>
<td>0.548 ml</td>
</tr>
<tr>
<td>10 (all patients received 10 units each)</td>
<td>2 patients (13.3%)</td>
</tr>
<tr>
<td>Mean number of units of BTXA injected</td>
<td>1 (6.67%)</td>
</tr>
<tr>
<td>0.10 ml</td>
<td>Number of subjects requiring treatment for diplopia lasting for 12 months or more (Fresnel prism/temporary ocular occlusion)</td>
</tr>
<tr>
<td>Mean volume of BTXA injected</td>
<td>1 (6.67%)</td>
</tr>
</tbody>
</table>
| 9 patients (45%) | *One patient received 6 units of Botox® (Allergan); one patient with proptosis received 125 units of Dysport. If these two are excluded, the range was 30–100 units.
corneal exposure or a non-healing epithelial defect. The average age of the patients was 55.4 years. The cumulative average dose of BTXA (Dysport) was 54.8 units (0.548 ml) (range, 6–125 units; mode, 50 units). The patient who received 6 units actually received Botox® (Allergan) rather than Dysport. The patient who received 125 units had severe exposure keratopathy due to proptosis caused by a plasmacytoma requiring a higher dose. If these two outliers were excluded the average dose of BTXA (Dysport) administered was 53 units (range 30–100 units). Only 2 of the 15 (13.3%) patients had post-treatment SR underaction (Table 1). The orthoptic assessment revealed a SR muscle underaction of −2 in both these patients. In one patient this resolved spontaneously and the other had diplopia requiring a Fresnel prism throughout the duration of the 1-year study period.

The results were analyzed by Fisher’s exact test and the differences in incidence of reduced upgaze between the 2 techniques was statistically significant (P = 0.0493).

DISCUSSION

BTXA injected into the levator palpebrae superioris muscle produces a flaccid ptosis of the upper lid and provides a safe and effective protection for the cornea to aid healing in indolent ulceration or as prophylaxis in patients with facial nerve palsy. However, this treatment has the disadvantage of causing impaired upgaze and diplopia due to diffusion of BTXA to the SR muscle. In addition, the underaction of SR impairs the Bell’s phenomenon, which would otherwise protect the cornea by elevating the eye on attempted eyelid closure. This in turn can negate the benefits of the induced protective ptosis.

Adams et al. first presented their experience in BTXA injection inferior to the superior orbital margin to a depth of 25 mm. This was successful in inducing a ptosis, however there was an 80% incidence of SR muscle underaction post treatment. In some reports, the diplopia caused by BTXA administration to levator palpebrae superioris muscle has been persistent and severe enough to warrant strabismus surgery. On the other hand, some report very low incidence of SR underaction and in a non-comparative case series of 10 patients Naik et al. observed no SR underaction.

In an effort to reduce the incidence of diplopia, some clinicians administer BTXA more inferiorly to try to minimize the possibility of it diffusing towards the SR muscle. In our study, 45% of patients in the transcutaneous group encountered reduced upgaze. Although half of these resolved completely, the remainder required treatment with a Fresnel prism or by ocular occlusion. None of our patients required strabismus surgery. In our patients BTXA was administered with an insulin syringe and this may explain the reduced incidence of SR underaction in our patients.

Ellis and Daniell encountered diplopia in 5 out of 21 patients when BTXA was injected transcutaneously, but the diplopia resolved in all cases.

Our study shows that injecting BTXA (Dysport) to induce protective ptosis via a transconjunctival supratarsal route was significantly less likely to cause reduced upgaze and diplopia than when given via the skin crease. We have used this approach to administer BTXA since our first study in order to minimize the incidence of SR paralysis and unwanted diplopia. This method is also more likely to preserve the protective Bell’s phenomenon, which is of paramount importance in protecting the ocular surface in the patients with facial palsy on attempted closure of the eye. We postulate that this is because of a relatively low possibility of diffusion of BTXA into the SR muscle during transconjunctival administration as the BTXA is injected into a relatively more dependent part of the eyelid well away from the SR muscle. However, we learned from experience over time that a greater dose (54.8 units) and volume (0.548 ml) of BTXA (Dysport) was required when it was injected subconjunctivally compared with the transcutaneous administration of 10 units (0.10 ml). While it is unclear why a higher dose is required, we believe this higher dose to be safe. It causes fewer unwanted complications. In the transcutaneous method, a lower dose is purposely given in order to reduce the risks of diffusion to the SR muscle. In some cases this dose of BTXA may be inadequate to produce a complete ptosis, on occasions requiring repeated injections to achieve the desired effect. With a larger dose given subconjunctivally, the desired degree of ptosis can be produced in most cases in the first instance. Even if re-injection is required, this has not seemed to have caused any further complications.

CONCLUSION

According to the our study, transconjunctival supratarsal BTXA injection to induce protective ptosis is less likely to interfere with SR function and cause diplopia compared with the transcutaneous route. However, due to the small number of patients recruited to this study, a larger randomized, controlled study is needed to investigate this further.

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Downes and Richard Gregson who taught these methods of BTXA administration.

Authors confirm that this study has been conducted in compliance with the required ethical requirements of the Declaration of Helsinki.

**DECLARATION OF INTEREST**

The authors declare no conflicts of interest.

**REFERENCES**


