

Crow's Feet Treatment with Botulinum Toxin Type A

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Abstract

Botulinum toxin type A is widely used for treatment of facial rhytids, often in an "off-label" fashion. The most important mechanisms of action and safety concerns for such treatments are presented, with recommendations for treatment of periorbital rhytids.

INTRODUCTION

Injection of botulinum toxin type A for the treatment of facial rhytids has become the most common nonsurgical cosmetic procedure all over the world¹. It has been in use for more than 30 years, and its popularity continues to grow. Botulinum toxin type A was first approved by the Food and Drug Administration (FDA) in 1989 to treat strabismus and blepharospasm and was then approved in 2000 for cervical dystonia. However, for facial plastic surgeons, the most significant milestone was probably April 15, 2002, when the FDA approved botulinum toxin type A for the cosmetic treatment of glabellar frown lines.

Public safety is, of course, the primary concern of the FDA, and they note that medications such as botulinum toxin type A, which are used for the treatment of conditions that are not life threatening or debilitating, "are subject to a greater level of scrutiny because of the benefit-to-risk ratio."²

An additional area of concern for the FDA is that physicians are using botulinum toxin type A for treatment of rhytids in off-label areas such as the forehead, perioral area, neck, and periorbital area. Although not officially recognized as an approved use by the FDA, treatment of areas other than the glabella has become commonplace in many practices³. As noted by the FDA, appropriate use of a medication such as botulinum toxin type A is dependent on an appropriately low risk-benefit ratio. If we assume an overall consistent rate of systemic complications regardless of injection area (which may not actually be the case), then for cosmetic use, the most important consideration will be the incidence of poor aesthetic outcome, most commonly due to ptosis or other undesired malposition of facial structures. In other words,

botulinum toxin type A is a reasonable treatment for rhytids if it is effective and only rarely causes an undesirable outcome.

Crow's feet result largely from hyperkinetic muscle function of the orbicularis oculi, and experience has shown that chemodenervation of the lateral aspect of this muscle can greatly attenuate the appearance of lateral orbital rhytids without impairing the ability to squint and protect the eyes from foreign bodies or bright light.

Apart from the obvious risks of bruising and bleeding that result from the application of botulinum toxin type A with a syringe and needle, the most common complication has been upper lid ptosis. Published reports have determined an average incidence of 6.5% for this complication. The cause is accepted to be contact of the levator palpebrae muscle with the toxin, presumably through diffusion from an appropriately distant injection site. Some researchers believe that older patients or those with loose skin or a weak orbital septum are particularly susceptible to this complication, while others believe that in some cases the problem may result from the weakening of a frontalis muscle that was compensating for a preexisting degree of ptosis.

Nonobstructive vision problems can also develop. The ocular muscles insert relatively close to the anterior aspect of the orbit; therefore, strabismus due to lateral rectus weakness can occur following treatment of crow's feet. Another possible complication is disruption of tear formation. Whether from direct injection, diffusion into a relevant orbital muscle, or direct involvement of the lacrimal gland, disruption of tear formation can occur along with an abnormal findings on a Schirmer test.

Lower eyelid ectropion can also result. As with surgical treatments such as blepharoplasty, a lower eyelid “snap-test” can provide valuable guidance regarding the risk for development of this complication. Similarly, in patients with a weak orbital septum, flaccid paralysis of the orbicularis oculi over the lower lid can lead to pseudoherniation of infraorbital fat.

Cosmetic procedures are of course intended to improve the patient's appearance, and so any result that produces a less desirable appearance should rightfully be considered a significant adverse outcome. Malposition of the eyebrow has long been recognized as a potential complication of glabellar botulinum toxin type A treatment. Similarly, excessive elevation of the lateral brow can occur following treatment of lateral periorbital rhytids. This can result in an “angry” or “sinister” appearance as the brows slope inferiorly toward the nose. Lateral perioral rhytids are caused by the sphincteric action of the orbicularis oculi as it squeezes the eyelids together. That aspect of the muscle superior to a line through the medial and lateral canthi logically has a downward force, which serves in part to balance the upward pull of the frontalis thus maintaining brow position. Release of this inferior force leads to unopposed upward displacement of the lateral skin and a superior displacement of the lateral brow. When created as part of an intentional treatment, this upward displacement can provide a nonsurgical temporal brow-lift or what some refer to as a “chemical browlift.”^{7,8}

In the treatment of periorbital rhytids, there is a risk for lip ptosis due to inadvertent weakening of the zygomaticus major and levator labii superioris muscle groups.⁹ It has been suggested that this complication is most likely to occur in patients who have previously had blepharoplasty or other facial plastic surgery, although these same authors would appear to refute the idea of abnormal anatomy as the primary risk. Rather, the risk is present in all patients owing to the insertion of the zygomaticus major near the lateral aspect of the orbicularis oculi.^{11,12}

ANATOMY-PHYSIOLOGY

Maximizing results and minimizing complications are both achieved by a thorough understanding of how botulinum toxin type A works and a detailed knowledge of the muscular anatomy in the areas being treated. Botulinum toxin type A is 1 of 7 known serotypes of botulinum toxin produced by the bacterium *Clostridium botulinum*, and 1 of 2 serotypes clinically available (A and B). This potent

neurotoxin blocks the release of acetylcholine at the presynaptic neuromuscular junction with resultant flaccid paralysis of the muscle. This stands in important contradistinction to the effect of the tetanus neurotoxin from *Clostridium tetani*, which prevents the release of neurotransmitters in the spinal cord, thus resulting in spastic paralysis. Botulinum toxin (1) stays local in the presynaptic neuromuscular junction and (2) provides a flaccid paralysis, both of which permit its use for the safe attenuation of rhytids.

Figure 1
Picture 2: Botulinum Toxin Type A injections Work Sheet

Patient name:		Date of birth: .../.../...	Date first treatment: .../.../...
Sex: <input type="radio"/> Male <input type="radio"/> Female			
Indication:		Medical History:	Complications:
Cosmetic		Pregnancy	allergic reaction
Functional		Breast feeding	bruising
		Bleeding disorders	headache
		Alcohol	brow ptosis
		Medication	eyelid ptosis
		Allergy	strabismus
			ectropion

Sites:		--- * treatment
0 glabella		units/ml:
0 horizontal forehead wrinkles		0 glabella
0 crow's feet		0 forehead
0		0 lateral orbit
		next treatment:

Sites:		--- * treatment
0 glabella		units/ml:
0 horizontal forehead wrinkles		0 glabella
0 crow's feet		0 forehead
0		0 lateral orbit
		next treatment:

Sites:		--- * treatment
0 glabella		units/ml:
0 horizontal forehead wrinkles		0 glabella
0 crow's feet		0 forehead
0		0 lateral orbit
		next treatment:

Clearly, effective use of botulinum toxin type A requires careful placement of the medication. Diffusion of the medication can occur and depends on tissue characteristics, placement, and dilution. There is little evidence to suggest that the doses used for facial musculature allow for distant diffusion, although it is known that this can occur in the higher doses used for other applications such as the

treatment of muscle spasms in large muscle groups.^{9,13} Exactly how far the medication in facial application diffuses is not clear: some authors suggest 1 cm,¹⁴ whereas others advise that it can travel 3 cm or more.¹⁵ These larger distances for diffusion seem unlikely: radio-labeled botulinum toxin type A studies have shown minimal movement. In any case, the total number of units injected in any 1 area is relatively low, and if the medication were to diffuse over a 3-cm radius, its clinical effect, if any, would probably be small.¹³

Additionally, authors do not agree on where to inject the material for maximal efficacy. Some have suggested that injection into the belly of the muscle is the best approach to minimize diffusion and maximize effect,¹⁴ whereas others propose that a subcutaneous injection is both safe and effective.

CROW'S FEET TREATMENT

For treatment of periorbital rhytids, the primary muscle of concern is the orbicularis oculi. This sphincteric muscle sits circumferentially around the eye and has the important function of providing deliberate closure of the eyelids to protect the globe. The muscle has been considered to have 3 distinct subparts: the orbital, palpebral, and lacrimal portions. The lacrimal portion of the muscle travels deep to the lacrimal sac and inserts on the upper and lower eyelids at the tarsal plates. Contraction of this part of the muscle draws the eyelids against the globe and compresses the lacrimal sac, thus assisting tear flow. The palpebral portion passes into the eyelid superficial to the septum from the bifurcation of the medial palpebral ligament to the lateral palpebral raphe. The palpebral portion is considered to have a preseptal and a pretarsal part, depending on which portion of the eyelid the muscle is superficial to. Contraction of this part of the muscle provides less forceful closure of the eyelid, as with blinking.

The orbital portion of the muscle is that portion of the muscle over the bony aspect of the orbit and beyond. This muscle is near the surrounding musculature and can be seen to blend into the frontalis, corrugator, and zygomaticus major muscles at its margins. In addition to providing forceful eye closure and eyebrow depression, this aspect of the muscle creates the lateral orbital rhytids by its pull on the overlying skin. Typically it is this area that is treated with botulinum toxin type A, although, the preseptal aspect of the inferior palpebral portion of the orbicularis oculi can be treated in some situations

It is evident that the muscle groups are in continuity with one another in these areas, and knowledge of the specific muscle relationships may help reduce the incidence of complications such as lip droop due to inadvertent treatment of the zygomaticus major or levator labii superioris muscle groups. An analysis of the relative muscle positions observed during cadaver dissections provides some guidance by describing specific muscle relationships in 48 facial sides. The relationship between the orbicularis oculi and lip elevators was determined relative to clinically useful landmarks, including the midpupillary line, the lateral canthus, and then at 1 and 2 cm directly lateral to the lateral canthus. It was observed that at 2 cm lateral to the lateral canthus, the orbicularis oculi was superficial to the zygomaticus major but was only an average of 0.5 cm superficial to the lip elevator, with women having a deeper zygomaticus major than men. At 1 cm lateral to the lateral canthus, a widely used landmark for botulinum toxin type A injections in this area, the zygomaticus major muscle interdigitated with the orbicularis oculi an average of 1.4 cm inferior to the Frankfort horizontal line. However, in 29% of cases, the zygomaticus was less than 1 cm from the Frankfort line in this area. In the midpupillary dissection, the orbicularis oculi was significantly less than 1 cm superficial to the levator labii superioris.

Figure 2

Picture 1: Blue line is Frankfurt line. The red vertical line is drawn 1cm approximately from the lateral canthus at the bony margin of the orbit. The yellow oval designates the area for safe and effective injection of Botulinum toxin Type A.



RECOMMENDATIONS

It would appear based on anatomic studies that many of the conventionally touted anatomic landmarks for periorbital

botulinum toxin type A administration place the toxin in excessively close proximity to muscle groups, which can result in undesired aesthetic outcomes. For example, the malar eminence is frequently considered a useful landmark for periorbital botulinum toxin type A treatments, and the practitioner is cautioned to not go below the malar eminence. However, in the anatomic dissections described, the lip elevators were commonly less than 1 cm from the orbicularis oculi at the Frankfort line, which is at the superior edge of the malar eminence. If one accepts that botulinum toxin type A can diffuse 1 or even 3 cm, the malar eminence is clearly too far from the periorbital area to serve as an appropriate guideline.

Similarly, 1 cm from the bony orbital ridge is often considered an appropriate guideline for safety. This guideline strives to avoid the complications of strabismus or blepharoptosis that can occur as described by staying beyond the 1-cm accepted diffusion for botulinum toxin. Clinical experience would suggest that this is a practical landmark, since the incidence of these complications is low. However, the zygomaticus major muscle can be less than 1 cm from the orbicularis in areas commonly treated for crow's feet, and the levator labii superioris is found less than 1 cm from the orbicularis in the midpupillary line, as might be used to treat lower lid rhytids. Many articles show pictures with recommended injection sites too close to adjacent muscle groups or in areas where no facial muscle is present. Careful study of the relevant facial anatomy and relative muscle positions will allow for a more informed choice of treatment sites.

In treatment of glabellar rhytids, particularly near the medial clubhead of the eyebrow, injection into the body of the muscle may be the safest and most effective treatment approach.¹⁵ However, in the treatment of periorbital rhytids, a superficial injection is more appropriate. Injection just deep to the dermis provides effective treatment of those aspects of the orbital portion of the orbicularis oculi that pull on the temporal and lateral periorbital skin while maximizing distance from the surrounding musculature.

CONCLUSIONS

Although technically an off-label application, treatment of lateral periorbital rhytids with botulinum toxin type A can be safely performed if strict attention is given to the pharmacology of reconstituted botulinum toxin and the anatomy of periorbital muscles. Physicians who desire to treat periorbital rhytids are advised to stay superior to the

Frankfort line, avoid overdilution, and limit the overall number of units of botulinum toxin injected to this area. A superficial injection just subcutaneous provides effective treatment while minimizing exposure of the nearby lip elevators.

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