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# A complex issue

In the first in a series of articles on anatomy, **Dr Sotirios Foutsizoglou** writes about understanding the functional anatomy of the glabellar complex

I am starting off this series of articles on aesthetically oriented anatomy with the glabellar complex, one of the three most common areas treated with BTX-A along with the forehead and the orbital part of the orbicularis oculi. Historically, the glabella was the area first and most described as a potential treatment site with BTX for aesthetic enhancement. Until quite recently, it was the only facial anatomical region with both FDA and MHRA approval for the cosmetic use of BTX. Non-surgical treatment of rhytids in the glabella can be applied in various combinations to achieve the desired result.<sup>1</sup>

The glabella is loosely defined as a smooth prominence, most marked in males, on the frontal bone superior to the root or bridge of the nose that extends laterally to each side onto and just above and lateral to the medial head of the eyebrow. The “glabellar complex” often refers to a

group of the brow-associated muscles (mostly depressors in action) that function primarily for facial expression.<sup>1</sup> Muscles of the glabellar complex include the corrugator supercilii, procerus, depressor supercilii, and the medial part of the orbital orbicularis oculi. Vertical glabellar frown lines arise naturally from the repeated activity of the corrugator supercilii and medial orbital orbicularis oculi and, to a lesser extent, the depressor supercilii muscles. The three aforementioned muscles not only induce vertical descent of the medial eye brow but also cause adduction and depression of the surrounding soft tissue (Fig 1).

The paired corrugator supercilii muscle originates from the medial end of the supra-orbital ridge on the frontal bone, deep to the orbicularis oculi muscle. It passes upwards and outwards through orbicularis oculi to insert into the skin of the middle of the eyebrow and the fascia on the deep surface



Fig 1: Deep glabellar frown lines with animation on command (dynamic lines). The frown pattern can vary significantly in individuals. Demonstrated here are the obvious deep central or '11' lines originating within the glabella and extend cephalad towards the hairline. Multiple lateral smaller oblique lines over eyebrows can also be noted along with depression and adduction of the medial and middle parts of the eyebrow skin. The horizontal lines over the bridge of the nose, typically located at the most caudal aspect of the glabellar complex are a manifestation of the muscular activity of the procerus (mainly) and depressor supercilii muscles.

of the frontalis muscle. The corrugator supercilii is pierced by the supra-orbital and supratrochlear neurovascular bundles after they have exited a notch or foramen in the supra-orbital rim at a distance of 2.7cm and 1.7cm respectively from the midline. It is motor innervated by the (upper) zygomatic and temporal branches of the facial nerve and its blood supply is derived from branches of the superficial temporal artery. Contraction of this muscle causes vertical grooves or furrows in the glabellar skin and imparts an angry expression. Contraction also causes an inferomedial descent of the medial portion of the eyebrow. (Fig 1).

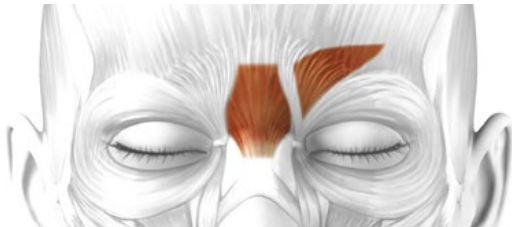


Fig 2: Note the procerus muscle in the midline and the upwards and outwards course of the paired corrugator supercilii muscle

The procerus is a midline flat and pyramidally shaped muscle vertically oriented at the root of the nose and is associated with transverse glabellar rhytids (Fig 1). The procerus originates from the periosteum and perichondrium of the nasal bones and upper lateral cartilages and from the fascia of the nasal SMAS (Fig 2). It inserts into the midline skin overlying the nasal root and thus has no bony attachments. The procerus interdigitates superiorly with the frontalis muscle, inferiorly with the nasalis muscle, and laterally with the depressor supercilii, orbicularis oculi, and deeper corrugator muscles<sup>2</sup>. The motor innervation to the procerus comes from the zygomatic branch of the facial nerve. Its blood supply is derived mainly from the angular branch of the facial artery.

BTX injection into the lateral part of the corrugators, near its insertion into the skin of the eyebrow, should be superficial; whereas placement of the toxin to the belly of the corrugators should take place deeper, just superficial to the periosteum of the supra-orbital rim

The depressor supercilii is a relatively unimportant muscle both aesthetically and functionally. Some anatomists consider it to be part of the orbicularis oculi muscle. In medical aesthetics we will view the depressor supercilii as an individual muscle. The depressor supercilii, a paired muscle, originates on the medial orbital rim, near the lacrimal bone, and inserts on the medial aspect of the bony orbit, inferior to the corrugator supercilii. In some specimens it exhibits two heads and in others, only one. Its contraction contributes to the vertical frown lines (mainly caused by the corrugator supercilii muscle) and the horizontal glabellar rhytids (caused by the procerus muscle).

### USE OF BTX-A FOR AESTHETIC ENHANCEMENT OF THE GLABELLAR REGION

The importance of attenuating the action of the procerus and corrugator muscles for aesthetic improvement of the glabellar lines was recognised by Salvatore Castaneres in 1964. Until the emergence of BTX-A as a safe and effective non-surgical alternative to upper face cosmetic surgery that could only be achieved by resection of the corrugator and procerus muscle fibres near their origin in the glabella region through an upper blepharoplasty incision. In 1992, Carruthers et al injected 18 patients with BTX-A for the treatment of glabellar frown lines following keen observation of the improved appearance of facial soft tissue in patients who received the toxin for a spectrum of disorders related to facial dystonia<sup>3</sup>. Sixteen of 17 patients showed improvement for varying lengths of time with few side effects. This initial paper sparked a frenzy of interest across the globe. Following a number of publications, two randomised, placebo-controlled studies involving 537 patients confirmed the impressive safety and efficacy of the injection of BTX-A for the glabellar rhytids. This led to the Food and Drug Administration (FDA) approval of BTX-A for the treatment of glabellar lines in 2002. In 2006 BTX-A was also granted a license from the Medicines and Healthcare products Regulatory Agency for the temporary improvement in the appearance of moderate to severe glabellar lines in women and men aged 65 or under when the severity of these lines has a psychological impact for the patient.

The strength and size of the muscles of the glabellar complex varies significantly from patient to patient. In general men have a larger glabellar muscle. Doses as high as 80U have been used in males with significant improvement of the glabellar dynamic furrows without experiencing an increase in adverse events<sup>4</sup>. In addition, the individual dynamics (the way we use our muscles) is another important variable that needs to be taken into consideration along with the level of the desired effect when calculating the appropriate dosing. Although the most common treatment pattern utilises two injections to each corrugator and one centrally to reduce procerus activity, individualising treatment doses and sites to each patient will optimise results (Fig 3). >

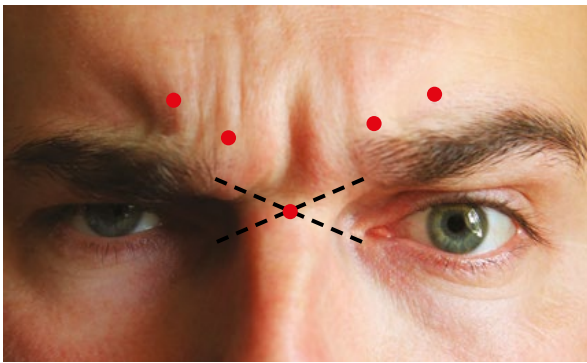


Fig 3: Standard sites for treatment to the glabellar complex

Injection of toxin into the corrugators decreases the vertical frown lines and causes mild lateralisation of the medial brow.

**Tip 1:** As the muscle courses laterally, it becomes superficial, with its ending point being at a variable location in the eyebrow skin. Therefore, BTX injection into the lateral part of the corrugators, near its insertion into the skin of the eyebrow, should be superficial; whereas placement of the toxin to the belly of the corrugators should take place deeper, just superficial to the periosteum of the supra-orbital rim. Care should be taken to avoid puncturing the periosteum with the needle as this can cause headaches and post-injection pain, probably due to periosteal inflammation.

**Tip 2:** Compensation for the reduced contraction of treated muscles by untreated neighbouring muscles is called "recruitment". Accurate pretreatment assessment with regards to "potential recruitment" can prevent untoward secondary adaptational effects such as deterioration of "bunny lines", over-elevated lateral eyebrow or "Mr Spock's look", brow malposition and asymmetry.

**Tip 3:** Overdiluted BTX-A injected into the corrugators near or at the supra-orbital rim can lead to diffusion of



the toxin into the upper eyelid retractors (i.e. levator palpebrae superioris) causing ptosis (Fig 4). Use higher concentration, therefore reduced volume, and apply a "high-glabellar technique", that is at least 1.5cm above the orbital rim in order to minimise risk of eyelid ptosis.



Fig 4: Left eyelid ptosis (without eyebrow repositioning) and spontaneous resolution two months after. Note the softer vertical frown lines on the ptotic picture indicating that the glabellar complex has been injected



Fig 5: Injection technique to the glabella region

- Non-dominant thumb protects orbital rim
- Non-dominant hand rests securely on patient's face
- Injecting hand rests on non-dominant hand for accuracy and security
- Syringe rests on non-dominant thumb

I would like to conclude my first piece by emphasising that in the ever-growing spectrum of medical aesthetic treatments, optimal results are achieved only with the highest level of understanding of the causes of ageing and the associated pathophysiology, sound anatomical knowledge, refined skills, effective and safe treatment modalities, and appreciation of the aesthetic result desired by our patients. **AM**

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**Dr Sotirios Foutsizoglou** developed a particular interest in anatomy during his time working in plastic and reconstructive surgery in the NHS. He became heavily involved in teaching anatomy and physiology to medical students and junior doctors and has worked as an anatomy demonstrator for Imperial College. Since 2012, in his role as the lead trainer of KT Medical Aesthetics Group, he has been training practitioners in Facial Anatomy and advanced non-surgical treatments and procedures. He has written and lectured on Facial Anatomy and complications associated with injectables both nationally and