

Updated Management of Forehead Wrinkles: An Overview

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Abstract

The upper face is a complex and dynamic part of the face, which conveys facial expression and emotion. As one ages, youthful dynamic facial lines on the forehead and glabella change to static wrinkles, which remain on the face at rest. These permanent wrinkles can lead to the appearance of fatigue and negative facial expressions such as anger, which may influence psychological wellbeing, social confidence, and self-esteem. Forehead wrinkles are due to a combination of genetic and environmental factors, especially damage ultraviolet light. The contributions of both must be analysed when patients attend for treatment. Make sure too that they do not expect the ablation of furrows as this requires carbon dioxide laser resurfacing for maximum effect. Botulinum toxin is widely known to be an excellent treatment for smoothing out both vertical and horizontal forehead lines. Patients often ask for it to be used to treat their vertical (glabellar) frown or their horizontal lines or put in a general request for improvement.

Keywords: Forehead Wrinkles, Botulinum toxin.

Forehead Wrinkles 1-Introduction:

Older patients tend to develop deep forehead furrows from subconsciously lifting their upper lid skin and brows off the eyelids. Ptosis or blepharoplasty surgery is often accompanied by relaxation of the frontalis and elimination of such rhytids (1).

Botulinum toxin to the mid-forehead can lead to permanent atrophy of the muscle fibres, with an excellent long-lasting result. This usually occurs after five or six treatments at 14-week intervals. The glabellar muscles always seem to recover after treatment but can, with time, diminish in size and function. Most patients continue to return for glabellar and crow's feet treatment, with an annual 'top-up' to the mid-frontalis (2).

The muscles of facial expression are unique in that they have soft tissue attachments to skin through the superficial muscular aponeurotic system, unlike most muscles, which have bony attachments (Figure 1). When facial muscles contract, the overlying skin also moves, forming dynamic wrinkles perpendicular to the direction of muscle contraction (Figure 2). (3).

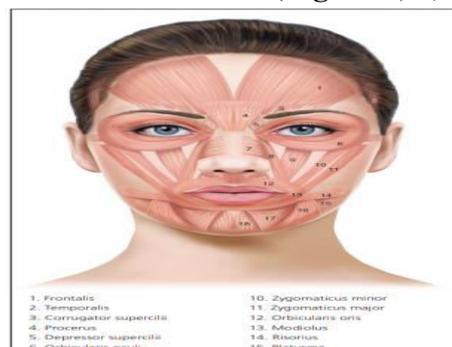


Figure 1. Musculature of the face. (3).

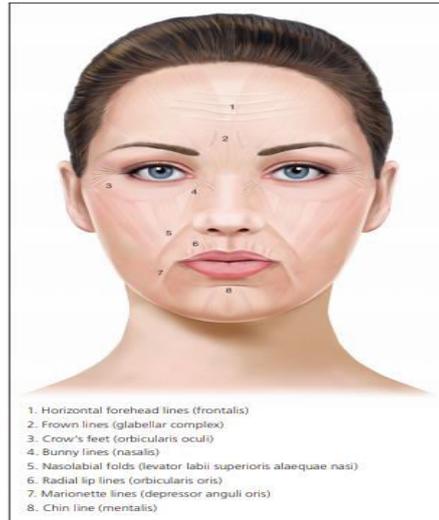


Figure 2. Wrinkles of the face (associated muscle). (3).

Glabellar wrinkles, or frown lines, are vertical lines occurring between the medial aspects of the eyebrows. The muscles contributing to formation of frown lines are the glabellar complex depressor muscles, which include the corrugator supercilii, procerus, and depressor supercilii. Contraction of these muscles pulls the brows medially and inferiorly (**Figure 3**). (4).

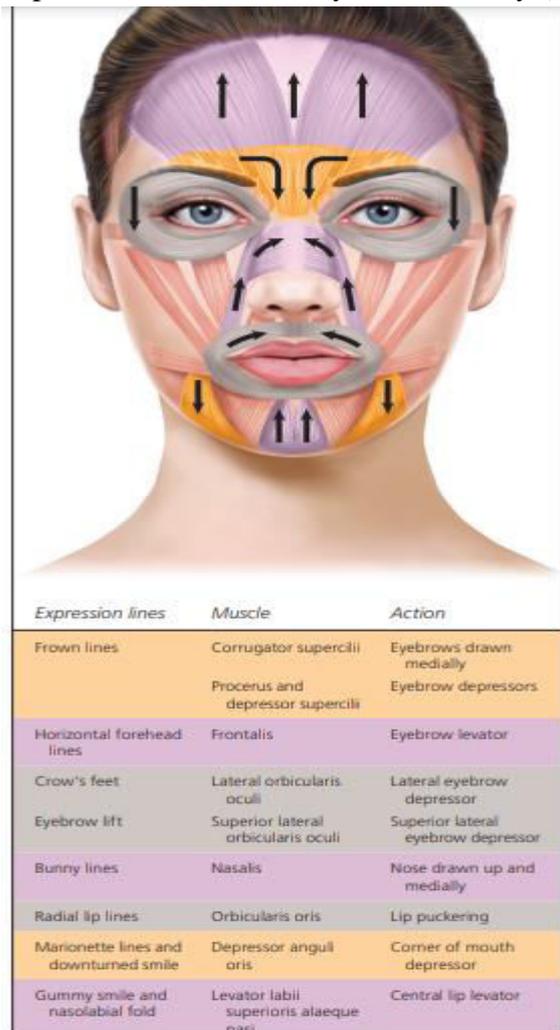


Figure 3. Functional anatomy of the face. (4).

Major factors involved in forehead wrinkle formation include dynamic frontalis muscle movement and skin aging with reduced collagen and other matrix material. Compared with other facial

muscles, the frontalis muscle usually maintains its muscle volume and sometimes even undergoes hypertrophy to prevent ptosis. Relative muscular hypertrophy of the frontalis might also play a role in forehead wrinkle formation due to decreased skin elasticity and photo-aging. Botulinum toxin and hyaluronic acid filler are effective treatment modalities that do not necessitate invasive procedures and have minimal adverse effects. However, some patients may be hesitant to use toxin or insert filler for many reasons such as the potential risks of ptosis, unnatural facial movement, and skin necrosis related to vascular occlusion by fillers (5).

Recently, polydioxanone (PDO) filaments had been introduced for wrinkle reduction with multiple applications of single PDO filament in various areas of the face. Different lengths, numbers, and thicknesses of PDO filaments and various kinds of insertion techniques have been developed by dermatologists and plastic surgeon to improve the outcome of facial lifting. However, a single PDO filament is very thin and weak so can easily dissolve within several months. To overcome this limitation, stent-shaped multi-PDO scaffolds were developed to support sustainability in wrinkle-folded skin and to stimulate new collagen formation by the subcision effects of surrounding skin (6).

Wrinkles are a natural result of ageing and are found in nearly all elderly persons. However, photo-damage and habits such as smoking, and alcohol consumption can accelerate wrinkle formation. Recently, a variety of treatments such as lasers, radiofrequency, plastic surgery, toxin, and fillers have been utilized for wrinkle correction. In some cases, these effective and powerful modalities have been used in combination to achieve a better clinical outcome. In recent years, PDO has been increasingly used for lifting and tightening of facial wrinkles. Non-absorbable polypropylene was widely used in the past, whereas absorbable PDO has recently become a popular replacement (6).

There are two different types of facial wrinkles — dynamic and static

i. Dynamic Wrinkles

Dynamic wrinkles are caused by muscle movement, such as those when you smile, laugh or squint. Common dynamic wrinkles include crow's feet around your eyes and lines on your forehead. (7).

ii. Static Wrinkles

Static wrinkles are caused by a loss of elasticity and collagen in skin, or damage caused by the sun or smoking. skin becomes thinner and drier, and the silhouette of your face changes with age due to volume loss (7).

Classification of Facial Wrinkles

Clearly, there is a need for a validated, objective, quantitative rating scale for evaluating the aesthetic signs of ageing. Furthermore, the ideal scale would allow the response of wrinkles to cosmetic treatment to be monitored. Recently, a set of validated grading scales have been published for brow positioning, forehead lines, melomental folds (marionette lines) and crow's feet. The scales are designed to be used in everyday clinical practice and could also be used in clinical trials to assess the outcomes of treatment with BoNT or facial fillers. (3).

Each scale was developed as a five-point scale using computer-simulated photography. Specific anatomical changes resulting from ageing were identified in consultation with a clinician and were incorporated into photographs to create five representative images, with the aspect under

consideration showing a stepwise variation (**Figures 1 – 4**). When ‘lines ’were formed as a result of movement of different muscle groups (e.g., crow’s feet and forehead lines), static and dynamic pictures were included.

Approximately 50 images (per scale validation set) were selected from a database of photographs from 100 individuals, based on quality and equal distribution across each representative scale. Using a standardized computer randomization program, 35 images per target area or validation set were randomly selected from the 50 for final inclusion in the pool (**5**).

The scales were assessed and validated at an international meeting of physicians involved in aesthetic medicine, representing a number of specialties, including dermatology, ophthalmology, plastic surgery and dermatologic surgery. As part of the development process, the expert panel, all of whom were formally trained in using the scales, discussed each scale and graded them twice using an overnight break between the two ratings. Intra- and inter-rater variability analysis was performed for each scale. (**6**).

The Brow Positioning Grading Scale was developed to provide objective quantification of the severity of eyebrow malposition. The scale ranges from 0 (youthful, refreshed look and high-arch eyebrow) to 4 (flat eyebrow with barely any arch, marked visibility of folds and very tired appearance) (**Figure4**). Intra-class correlation coefficients (ICCs) for the two evaluations of the scale were 0.697 and 0.660, suggesting an acceptable level of agreement between the experts. Test – retest correlation coefficients ranged from 0.678 to 0.912 (**6**).

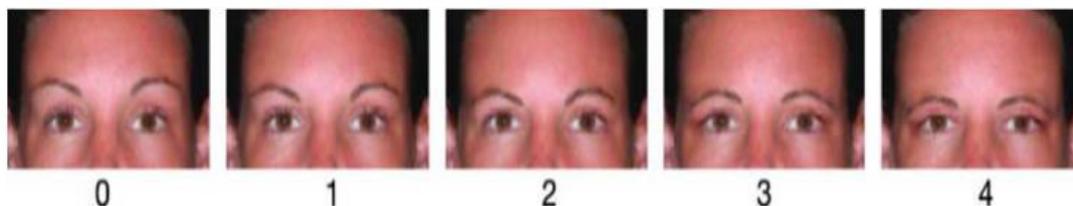


Figure4. Reference images for the five-point Brow Positioning Grading Scale (**6**).

The Forehead Lines Grading Scale was developed to objectively quantify resting (static) and hyperkinetic (dynamic) forehead lines, and ranges from 0 (no wrinkles) to 4 (deeper wrinkles at rest and deeper furrows with facial expression) (**Figure 2**). ICCs were calculated for the first and second ratings, respectively, for static (0.846 and 0.863) and dynamic (0.852 and 0.892) forehead lines, with a high level of agreement between the experts. The test – retest correlation coefficients (static forehead lines, 0.846 – 0.942; dynamic forehead lines, 0.859 – 0.941) were also high for each expert. (**8**).

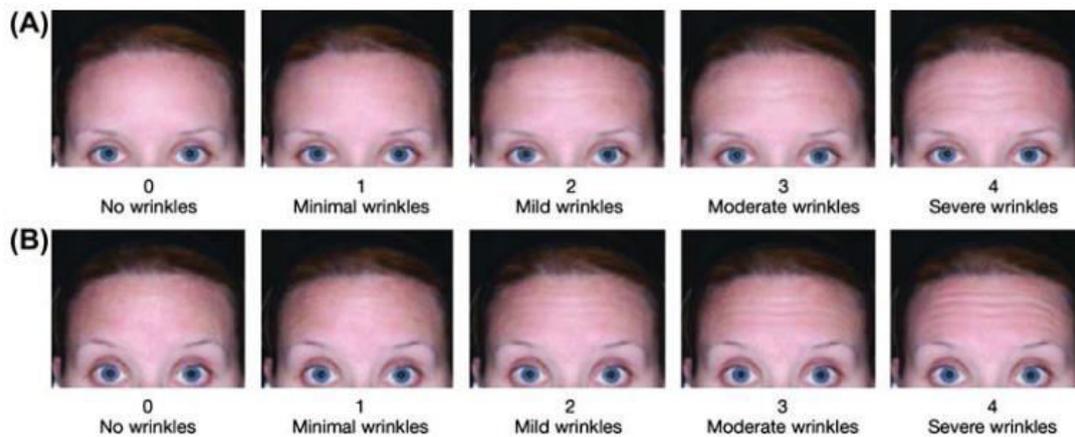


Figure 5. Reference images for the five-point Forehead Lines Grading Scale: (A) static grading scale; (B) dynamic grading scale (8).

The Crow's Feet Grading Scale was developed to quantify the severity of lateral canthal lines at rest (static) and at maximum contracture of the orbicularis oculi muscle (dynamic). The scale grades wrinkles from 0 (none) to 4 (severe) (Figure 4). Based on the ICCs, there was considerable agreement between the experts. For the static scale, the ICCs were 0.893 and 0.882 for the first and second ratings, respectively, while those for the dynamic scale were 0.879 and 0.892. Intra-rater test – retest correlation coefficients were 0.904 – 0.968 for the static scale and 0.888 – 0.951 for the dynamic scale (7).



Figure 6. Reference images for the five-point Crow's Feet Grading Scale: (A) static grading scale; (B) dynamic grading scale (7).

The treatment of facial wrinkles, furrows, and folds has become a major issue in many offices of plastic surgeons, dermatologists, and aesthetic surgeons. The judgment of its success, however, still depends on the subjective feelings of the physician and on the positive or negative perceptions of the patient. Little has been published on objective measurements of wrinkles, furrows, and folds, and physicians are overly dependent on the manufacturers' information and reliability (8).

New filler substances are developed every year. Based purely on patient and physician satisfaction, some manufacturers claim a lasting effect of their injectables without objective assessment before and after injection. Other companies are convincing physicians and patients with preinjection and postinjection photographs without information on the time interval between pictures. Furthermore, there is a difference in long-term quality and persistence of a filler substance in animal experiments and in humans: whether it is implanted as a bulge under the skin of a rat's forehead or injected intradermally into a dynamic facial wrinkle. The onus is on all serious physicians to objectively evaluate these products before they become extensively implemented (7).

A discussion of wrinkles, furrows, and folds is difficult because there is no commonly accepted classification or body of terminology that is based on anatomic, dimensional, or etiologic criteria. Words such as wrinkles, lines, furrows, and folds are used with heavy reliance on the intuitive grasp of such terms(9).

Superficial wrinkles are associated with textural changes of the skin surface caused by intrinsic aging and photoaging of topographically defined areas. The fine lines of wrinkling may be discrete at first and then, over time, become grouped and multidirectional as noted by Stegman. Apart from cutis rhomboidalis caused by elastosis, they occur as wrinkling in the face or as regional static wrinkles over the whole body. Wrinkle lines are usually limited to superficial dermal creasing; thus, they are amenable to treatments such as chemical peeling, dermabrasion, and laser resurfacing (10).

Mimetic wrinkles, commonly referred to as lines (partial thickness) or furrows (full thickness), are the visible effects of deep dermal creasing caused by repeated facial movement and expression combined with dermal elastosis. They are therefore perpendicular to the direction of the underlying facial muscles. They occur with aging as forehead and glabellar lines, nasolabial folds, radial lip lines, marionette lines, and lines in the corners of the mouth (11).

Glabellar lines result from frequent frowning, and periorbital lines and nasolabial folds result from smiling. Radial lip and marionette lines, however, are caused by concomitant movement of mimetic muscles during chewing. Therapeutically, mimetic wrinkles or furrows do not respond well to resurfacing procedures, but react preferentially to muscle resection (musculus frontalis, musculus corrugator palpebrae), botulinum toxin, or injectable skin filler materials (11).

Folds are the result of overlapping skin caused by genetic laxity, intrinsic aging, loss of tone, bony atrophy, gravity, and consequent sagging. They occur as upper and lower lid folds in blepharoptosis, as nasolabial folds in midface sagging, and as horizontal neck folds in lax skin. The correction of folds requires tightening procedures such as blepharoplasty, face lift, or direct skin excision. Augmentation of the bony skeleton by implants, bone grafts, or skeletal osteotomies may also be necessary to treat folds in properly selected cases. Combinations of mimetic wrinkles and folds are commonly present. For example, a sagging nasolabial fold may be temporarily eliminated by manual elevation, exposing a crease or furrow in its center (11).

The Wrinkle Assessment Scale was an easy, consistent, and reliable tool for the assessment of deep facial wrinkles. The scale correlated well with an objective profilometry measurement of the

wrinkle depth (12).

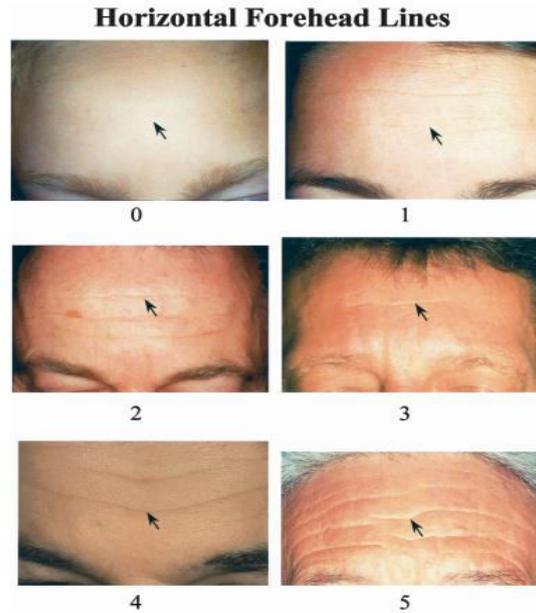


Fig. 7. Wrinkle Assessment Scale of horizontal forehead lines (12).

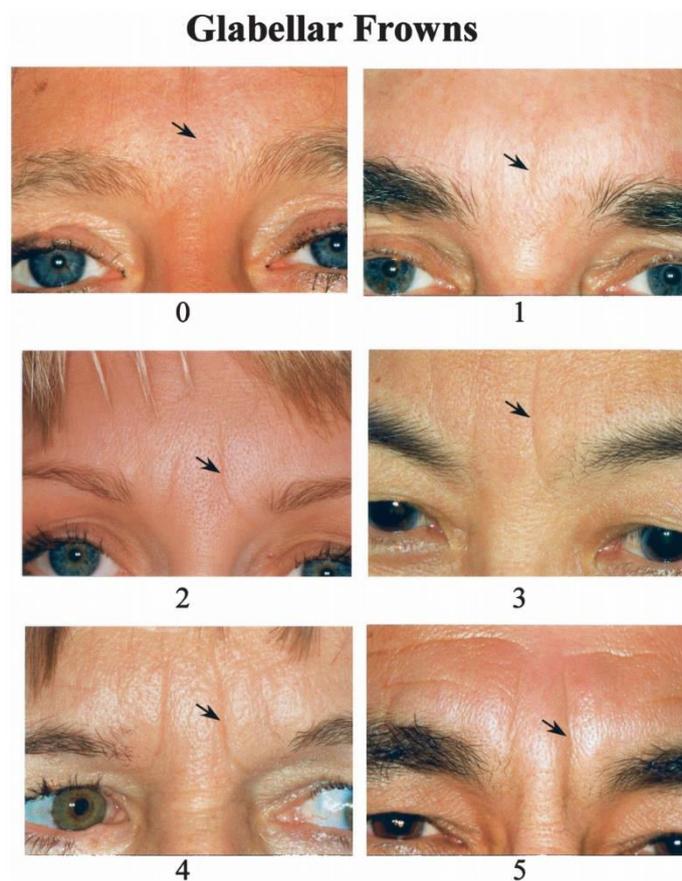


Figure 8: Wrinkle Assessment Scale of glabellar frown lines.(13)

The most accurate description of the photographed lines and creases in wrinkle scale is probably furrows, not folds or wrinkles. The etiology of mimetic wrinkles or furrows is rather simple and does not differ from that of the wrinkles or creases in the fabric of one's gloves or shoes. Smooth when new, the fabric develops grooves at sites of long-sustained stress. There is no chemical or architectural alteration, purely a conformational change. Wrinkles occur with relaxation of the skin caused by receding papillae and degeneration of elastic and collagen fibers at the dermal-

epidermal junction. This degeneration starts as early as age 30 and increases with time, regardless of care and protection (14).

The thickness of the living dermis can be determined by either ultrasound or xeroradiographic technique. Skin thickness increases linearly up to the age of 20 years and decreases linearly with age subsequently. Depending on race, genetics, and location of measurement, the thickness of the dermis will vary. For example, dermal thickness in the medial forearm varies from 0.6 to 1.0 mm in women and from 0.8 mm to 1.2 mm in men. In the lateral arms or legs, Tan et al. found a mean dermal thickness of 1.32 mm, on the chest of 1.62 mm, and on the back of 2.50 mm (14). In the face, the dermal thickness increases from lids (~ 0.2 mm), to corners of the mouth (~0.4 mm), to nasolabial folds (~ 0.6 mm), to forehead and glabellar dermis (~0.8 mm).¹⁰ For comparison, a 30-gauge needle has an outer diameter of 0.3 mm, and a 26-gauge needle has a diameter of 0.45 mm (14).

The Wrinkle Assessment Scale is intended to bring objective and comparable measurements into the field of aesthetic medicine. Aside from the standard of collagen injections, new injection or filler alternatives arrive on the market every 6 months. Other resorbable filler materials such as hyaluronic acids (Restylane, Hylaform), autologous collagen (Autologen), allogeneic collagen matrix (Dermalogen, AlloDerm), dextran microspheres (Reviderm), polymethylacrylate particles (Dermalive), and others have gained increased popularity. All claim to last longer than collagen, but none have shown any statistically convincing proof. On the other hand, long-term persistence of artificial products (Artecoll, Softform) may also cause problems after poor placement and subsequent dislocation (2).

The Wrinkle Assessment Scale should be an excellent tool in the hands of every aesthetic surgeon or dermatologist to objectively assess the short-term and long-term effects of an injected product and to establish a real pricevalue relationship for patients (2).

Botulinum Toxin Type A (Botox)

I. Overview

Wrinkle treatment options are increasingly abundant. There are numerous over-the-counter products, and people are also turning to their healthcare providers for longer-lasting options. Botulinum toxin type A (Botox) and dermal fillers are both long-lasting treatments. Each procedure can be used for wrinkles, but there are several differences between the two to consider (15).

II. Uses

Botox and dermal fillers alike may be used to treat wrinkles on the face. Each treatment is also delivered via injection. Still, both options have slightly different uses (16).

1. Botox

Botox itself is a muscle relaxer made from bacteria. It's been on the market for over two decades, and has been used to treat neurological disorders that cause muscle weakness. It's also used for the treatment of migraines and other medical conditions (17).

For wrinkle treatment, Botox is primarily used to treat dynamic wrinkles. These wrinkles occur naturally around the eyes and mouth, as well as in between your eyebrows. They become more pronounced with age. Botox injections relax the muscles near these wrinkles. Not allowing the muscles to move reduces the appearance of dynamic wrinkles (18).

Botox is not used for fine lines caused by collagen breakdown. Healthcare provider will inject the muscles that contribute to the specific wrinkles to be treated. The injection process itself takes just a few minutes with noticeable results within two weeks (19).

2. Dermal fillers

Dermal fillers also treat wrinkles on the face. They're primarily used to treat smile lines, though the fillers can also be used to plump up the lips or cheeks. Sometimes, they're used for hand treatments or to reduce the appearance of scars. Dermal fillers aren't approved for plumping up other areas of the body, though, such as the breasts (20).

Dermal fillers come in different forms, and like Botox, they're injectable. Some are temporary and used primarily for soft tissues in the face along the smile lines. The U.S. Food and Drug Administration Trusted Source has approved the following options: (7).

- calcium hydroxylapatite (Radiesse), a temporary gel solution that lasts for 18 months
- collagen, a temporary material that lasts for up to four months
- hyaluronic acid, a temporary material that loses its effect after 6 to 12 months
- poly-L-lactic acid (Sculptra, Sculptra Aesthetic), a man-made material that lasts about two years
- polymethylmethacrylate beads, the only permanent type of dermal filler available

(7).

III. Efficacy

1. Is Botox effective?

Botox injections produce results for most people, according to the American Academy of Ophthalmology (AAOS). Noticeable effects within a week of the injection will be seen. Side effects are minimal, and most go away after a short time. The full effects of Botox if you have certain conditions that prevent them. You'll need to talk to your healthcare provider about all these potential risks ahead of time (17).

Once you receive the injections, you'll be able to continue your daily activities without any recovery time. The effects of Botox last about 3 to 4 months. Then, you'll need additional treatments if you want to maintain the results (17).

IV. Side effects

As with all medical procedures, both Botox and dermal fillers can come with the risk of side effects. There are also special considerations to discuss with your healthcare provider if you have preexisting medical conditions. Weigh all the following risks and benefits thoroughly (15).

1. Botox risks and side effects

According to the AAOS, Botox is only recommended for people in good health to reduce the risk of side effects (21).

Possible side effects include:

- bruises at the site of injection
- drooping eyelids, which can take several weeks to resolve
- eye redness and irritation
- headaches

(21).

Taking eye drops before receiving Botox injections may help reduce the chances of some side effects. You should also stop taking any blood thinners a few days before to prevent bruising (21).

Some of the limitations of this procedure include the fact that the effect is localized to the injection area and more distal skin areas with fine lines or texture imperfections are not affected. In addition, there are potential side issues such as relaxation of neighboring tissue, including eyelids, as well as loss of sensation. The procedure is viewed as minimal in its invasiveness and can be administered outside of the professional's offices (16).

Clinically, the results can be dramatic and, appear rapidly after treatment to the patient, with no significant downtime which is an important fact for the patient. In addition to the treatment of glabellar frown lines, other benefits have also been reported for other skin-aging symptoms including frown lines and treatment of the neck area for sagging skin. The effects can last up to six months, with some patients noticing the reappearance of wrinkles after two to three months. While a re-treatment will have an immediate effect as before, it is not clear what longer-term side effects can occur from repeated treatments on muscle and skin integrity (15).

In contrast to the mechanistic action of Botox on temporarily impacting muscle contractions, another injection procedure that is very popular is the usage of dermal fillers to temporarily efface fine lines and wrinkles. In this case, the wrinkled area of the patient's skin is injected with a sterile solution comprised of collagen and hyaluronic acid, or a combination of both. The material is deposited in the dermal area around the injection site, and it serves as a physical filler that pushes out from underneath to minimize the appearance of fine lines and wrinkles. Effects can be seen rapidly, but side effects include temporary pain discomfort to the patient, as well as bruising and swelling (3).

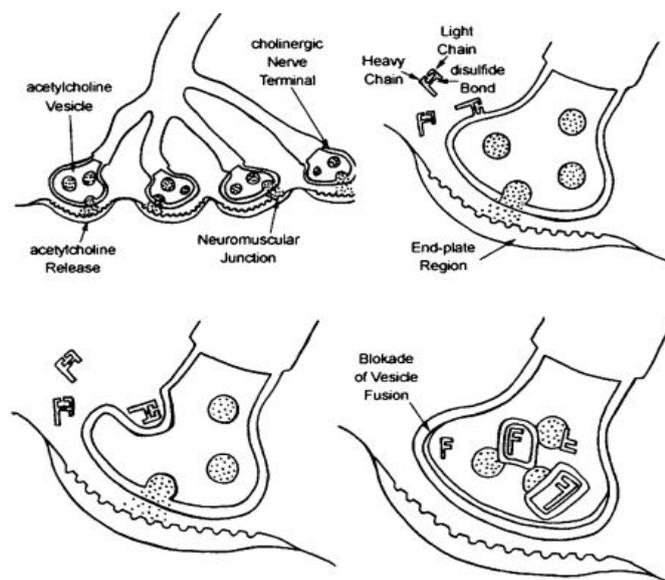


Figure 9: Description of the various steps in which Botox reduces neuromuscular activity. Binding of the neurotoxin dichain near the nerve synaptic region allows for internalization and subsequent blocking by the light chain domain to acetylcholine vesicles (22).

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