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Restoring Functionality and Aesthetic Appearance in Hyperkinetic Disorders of the Face with Botulinum Toxin

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Abstract

This article describes the approach of facial asymmetry secondary to hyperkinetic movement disorders of the face, with the use of botulinum toxin into both facial sides. The innovative "Munich concept" injection technique aims into restoring facial symmetry, while combining functional and cosmetic improvement of mimic muscles, as it points out the necessity of synchronous treating of the healthy facial side. Main clinical conditions, associated with a facial nerve disability leading to mimicry dysfunction are hemifacial spasm and synkinesis. Common denominator is in all cases the disrupted harmony of the face at rest and in animation. It is undeniable that facial asymmetry has a great impact on quality of life, leading to psychological and psychosocial changes. Despite the extended use of botulinum toxin in Cosmetic Medicine, aesthetic concerns are rarely mentioned in literature, when it comes up to restoring facial functions with the use of neurotoxin. This work is a research and introduction of practical information for the effective use of botulinum toxin type A in the combined management of facial asymmetry, improving mimicry and aesthetic appearance. Treatment protocols and innovative, practical patterns on injection points and injection depth are being introduced, in order to guide injectors and support safe and satisfying combined treatments

Keywords: Facial dyskinetic; Botulinum toxin; Restoring functionality

Introduction

Treatments of functional disorders of the mimic muscles including dysfunctions of the facial nerve with its plexus are a multidisciplinary challenge in medicine. Despite the extended use of botulinum toxin type A in cosmetic medicine, only a minority of injectors, mainly neurologists and ophthalmologists, treat hyperkinetic movement disorders of the face with the neurotoxin. There exist few injectors who are educated in combining functional and aesthetic botulinum toxin applications to restore facial asymmetry effectively. This observation is confirmed by the very limited literature regarding the aesthetic concerns during those treatments. Therefore, thorough knowledge of hyperkinetic facial movements, facial anatomy, mimic muscles activity and technical proficiency in injections, including dosage and depth of the target muscles are required, in order to be able to develop a proper injection protocol for those patients. An intact face with normal mimicry reflects personality and character through the physical expression of emotions. The delicate mimic muscles system includes thin muscles that usually act as sphincters and dilators of facial orifices, as well as elevators and depressors of facial structures [1]. Unlike other body muscles, mimic muscles have their origin on bone with a direct insertion into the dermis, through the Superficial Musculoaponeurotic System (SMAS). This direct attachment into the dermis allows facial mimicry [2].

Patients suffering such hyperkinetic disorders are not only confronted with a functional disability, but also with an aesthetic impairment that leads consequently to stigmatization and social isolation. Main disorders with a "hyperkinetic" pattern, but with etiological differences are hemifacial spasms and synkinesis. Synkinesis occur secondary to facial nerve palsy, mostly within 6 months. Its incidence is estimated up to 55% and its main characteristic is the involuntary activity of one mimic muscle, following a voluntary movement of neighbor mimic muscles [3]. The mechanism behind this post-paralytic, troubling sequela following palsy is complex and multifactorial. An ineffective myelination or a centralized post-injury hypersensitization of the facial nucleus are discussed, so an abnormal, ipsilateral, peripheral facial nerve regeneration is held as the main cause behind a synkinetic symptomatology [4]. Lots of synkinetic patterns are described, with a common division in oral-ocular, ocular-oral, ocular-glabellar, platysmal and mental forms. Synkinesis occurs on the side of the original palsy, while there appears a hyperkinesis of the mimic muscles on the

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Table 1: Overview of the five branches of the facial nerve.

Temporal	Innervates the frontalis, orbicularis oculi and corrugator supercilia
Zygomatic	Innervates the orbicularis oculi
Buccal	Innervates the orbicularis oris, buccinator and zygomaticus
Marginal mandibular	Innervates the depressor labii inferioris, depressor anguli oris and mentalis
Cervical	Innervates the platysma

contralateral, ''healthy'' facial side. Typically, the symptoms do appear during facial expression [5].

Synkinesis has to be mainly distinguished from hemifacial spasm. Hemifacial spasm is per definition not a dystonia, but according to its pathomechanism a hyperkinetic movement disorder. It appears mostly with a unilateral, tonic-clonic facial spasm and a periocular manifestation in the beginning, which can extend even to neck muscles and platysmal bands [6]. Typically, it appears not only during mimic activity, but also in rest. Gardner and Sava had discussed back in 1962 an intracranial vascular compression of the facial nerve at its exit point through an arterial compression as an etiology [6].

In both clinical conditions of synkinesis and hemifacial spasm, there is despite the different etiological background a common pattern of the facial dysfunction, in which one side of the face develops the pathologic muscle contractions and the contralateral, healthy side a hyperkinesis. The physical examination reveals a distinct asymmetrical facial appearance, which is in a few patients persistent and not transient as usually, leading to various psychological and functional problems. Analyzing the muscular hyperactivity of the healthy side is as important, as recognizing the paradox hyperkinetic movements on the affected side. Identifying the affected mimic muscles is essential in developing a proper, individual injection plan for each patient, but also a pre-condition for the follow-up treatments 10 to 14 days post injection, as some asymmetries have to be re-assessed. In those cases a correction through additive injection points might be necessary. Therefore, good knowledge of facial anatomy and the complexicity of mimic musculature is needed. After exiting the skull, the nerve turns superiorly to run just anterior to the outer ear. The main trunk of the facial nerve continues into the parotid gland and terminates by splitting into five main branches, although individual anatomical variations might exist. The branches are from cranial to caudal: Frontal (or temporal), zygomatic, buccal, marginal mandibular and cervical Table 1.

The most relevant target muscles to treat synkinesis and hemifacial spasm with botulinum toxin type A injections starting from top to bottom, are: The occipitofrontalis muscle, responsible for the elevation of the eyebrows and the innervation of the forehead skin with its frontal part. Through his activity horizontal forehead rhytids get visible [7]. The glabella complex refers to muscles that function primarily for the expression of the brows, including the corrugator supercilii, the paired depressor supercilia, the procerus and the orbicularis oculi [8]. The depressor supercilii contributes to the vertical frown lines, while the horizontal glabellar wrinkles are caused by the procerus muscle [9]. The corrugator supercilii exerts traction on the skin above the supraorbital margin. In the perinasal area, the nasal sphincter musculus nasalis and the levator labii superioris alaeque nasi are the muscles that are mainly involved in facial asymmetry. The second of these muscles is attached to the upper frontal process of the maxilla, inserting into the dermis of the lateral part of the nostril, functioning as its dilator. It works as well as an elevator of the upper lip and the wing of the nose [10]. In the middle parts of the face, there are muscles responsible for the oral motility, including: the zygomatic major et minor, the levator labii superioris alaeque nasi, the levator labii superioris, the levator anguli oris and the deeper laying buccinator. The perioral area with its sphincter orbicularis oris, is a region where the majority of the dyskinetic muscle contractions appear, involving sometimes also the ''smiling'' muscle, risorius [11]. In the lower third of the face the most affected muscle groups are the mentalis and the depressor muscles labii inferioris and angulioris [12]. Very often, there is a necessity to treat the neck area subcutaneously, in order to chemodenervate the platysma [12].

Methods

The use of neurotoxin type A injections has gained acceptance in functional face disorders since its very first application on subjects, back in 1973 by Scott et al. [12]. Ever since, it is increasingly used in a wide range of indications, turning out to be a therapeutic gold standard for facial dyskinesias. The practicability of injection and the possibility of adjusting treatment plans and injection points according to every patient's individual needs, established botulinum toxin as the most common approach amongst conservative therapies. In order to achieve a functional improvement on the affected side, the involuntary muscle activity has to be recognized and inhibited through injection. This is the technique that is widely practiced, offering an improvement of paradox muscle spasms and contractions, within 2 to 10 days. If this technique is combined with the treatment of the unaffected, ''healthy'' side, it offers much more facial symmetry at rest and in animation, as it minimizes the hyperkinetic movements that co-exist in those clinical entities. Understanding the necessity of functional and aesthetic improvement is not the only parameter needed, in order to offer an effective treatment to those subjects. Eliminating adverse events and increasing the efficacy and subjective satisfaction from cosmetic and medical point of view, through correct injection techniques is essential. It is a fact, that there exist studies with suggestions on treatment plans, dosages, injection areas and injection depths in literature. Despite their informative content and suggested treatment plans, it is becoming imperative to create therapeutic plans with visualization of possible injection areas, proper injection depth and needle angle on the dyskinetic side, as well of the ''healthy'', hyperactive side. Developing a guide for combined treatments on both facial sides, dyskinetic and non-dyskinetic with the toxin, offers an easy understandable and applicable tool as a assistance to every injector who wishes to offer a synchronous cosmetic and medical therapy with safety and efficacy for the patient. Since 2019 we perform injections on dyskinetic facial disorders according a technique the first author of this work developed, based on a ten years practical experience with botulinum toxin treatments on a daily basis for both aesthetic and functional indications. Subjects with functional disorders did profit from the treatments on the affected side regarding the spasm-induced pain symptoms and experienced indeed a great improvement in their deforming mimicry. Despite this fact, the observation that the remaining hyper dynamic

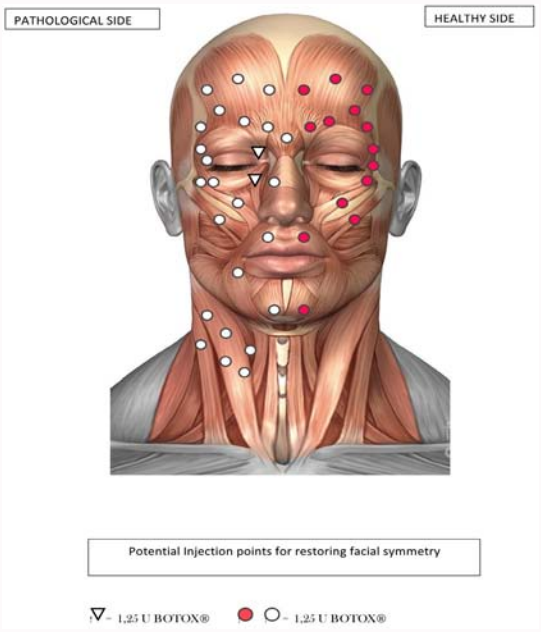

Figure 1: Suggested Injection points when approaching the dyskinetic face for combined aesthetic and functional improvement. Image from Anatomy of Human Face and Neck Muscles Digital Art by Stock Trek Medical Images (Editing Ch. Karapantzou).

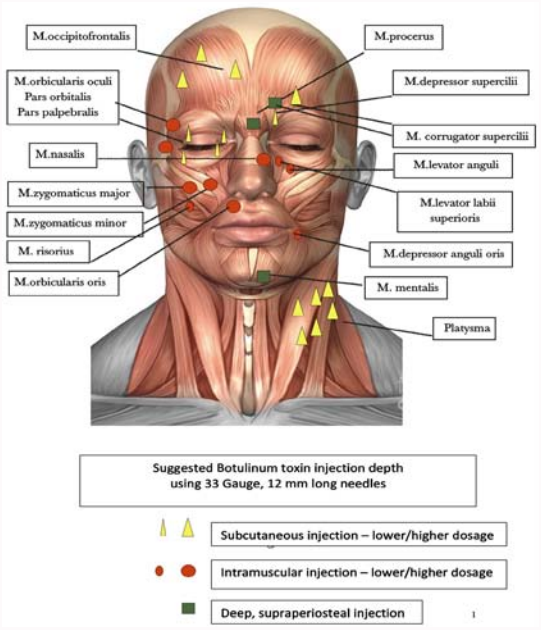

Figure 2: Suggested injection depth when injecting mimic muscles with neurotoxin type A.
Image from: Anatomy of Human Face and Neck Muscles Digital Art by StockTrek Medical Images (Editing: Ch. Karapantzou).

wrinkling of the ''healthy'' side was described as ''bothering'', with an impact on their subjective satisfaction, underlined the necessity of offering a solution to this phenomenon. The aim was to work against the observed subjective disappointment of these patients and focus on the ''healthy'' part of the face during the same session. Since the application of this combined technique, no major adverse events occurred, excluding some topical bruising. All patients need to be re-assessed in a period of 7 to maximum 14 days after the first session, in order to perform a touch-up with additional injections, whenever needed. A detailed description on our injection technique, chosen injection areas and injection depth and dosage is summarized in the overview of Figures 1, 2 and Table 2.

Empirically the face can be divided in two parts. One can imagine a vertical line staring from the frontalis with extension over the glabella, nose, lips and chin, splitting them into the middle. Making the assumption that the right facial side is the dyskinetic side, the injector has to observe and write down on the suggested plan of Figure 3, every muscle that is observed to be involved in pathological contraction.

In the next step a treatment plan based on the observed mimicry dysfunction has to be developed, including the used neurotoxin amount per injection point and other helpful information like side effects or complications during former injections date of last session etc. (Figure 3). The creation of individual treatment plans helps mainly in preventing adverse events and developing optimized injection concepts for each patient. Moreover, the injector has a guide that assists in applying safe and effective injections.

After developing the individual therapeutic injection plan, the injection points and injection doses on the target-muscles have to be marked on this plan (Figure 3). The treatment begins starting with the upper facial third, where more than 5 injection points (a 2.5 to 5 Units) are placed on the healthy side of the frontalis muscle to inhibit hyperdynamic rhytids (Figure 1, 4, 6). Parallelly, the periocular area is approached mainly with 3 injection points (a 2.5 Units) into the lateral fibers of the M. orbicularis oculi, in order to open the orbital margin on the ptotic side and elevate the eyebrow (Figure 1, 6). Important is to place the upper point approximately 5 mm lower than the eyebrow tail hairs, in order to ensure eyebrow elevation and not inject into frontalis muscle fibers that can anatomically insert below the boarder of the lateral eyebrow (Figure 1). If hyperdynamic rhytids are observed on the pathological side along the nasal dorsum, there can be placed one to two injection points (a 2.5 Units) into the middle part of the transverse part of the nasalis muscle (Figure 1). Injecting into the punctum maximum of the muscular contraction of these ''bunny'' lines using low injection doses, prevents diffusion into the M. levator labii superioris alaeque nasi. A real challenge is the treatment of the middle facial part, as it is very often involved in hemifacial spasms and synkinetic disorders. In the midface, contracted muscles on the pathological side are observed and treated carefully with very low doses, starting with single injections of 2.5 Units per point. Overtreatment's should be avoided, as they lead to immediately visible asymmetries of the area. According to our concept, the contralateral midface muscles of the healthy side have to be necessarily approached as they appear more prominent, due to their normal activity. The aim is to ''flatten'' them through injection, as we observe optically an asymmetry compared to the malfunctional other side. Main muscles we inject to inhibit the healthy midface side are the M. levator angulioris and the M. zygomaticus minor as seen in Figure 1 in order to flatten the midface and reduce normal upper lip activity into upward direction. The perioral area can be assessed with one injection into the M. zygomaticus major of the healthy side, as it is responsible for drawing the angle of the mouth, allowing smiling often more superiorly than on the contralateral dyskinetic side. A single injection of 2.5 Units can be placed into the fibers of the M. orbicularis oris superior to the upper lip and sometimes into the M. risorius, in order to balance out the hyperdynamic activity we observe on the healthy side (Figure 1). If there appear contractions

Table 2: Anatomy and results.

Muscle	Origin	Insertion	Function-Innervation	Dosage-Points Of Injection	Injection Depth – Technique
(Mm. epicranii) **a)** **Frontalis =** **Venter frontalis =** **Occipitofrontalis**	Dermis of the eyebrow Middle fibers = Process of the M. procerus Lateral fibers = Connection with the M. corrugator supercilii & M. orbicularis oculi	Galea aponeurotica	Upward movement of the eyebrows, frontalis innervation Antagonist of the M. orbicularis oculi, opens the palpebral fissure together with the M. levator palpebrae superioris **Innervation=** Rami temporales, N. facialis (VII)	3 to 10 points 0,5 to 2,5 U / point	Injection with a 33 Gauge, 12 mm long needle Insertion of 10% of the needle angled to cranial direction. Prevent the ''Mephisto – effect'' by injecting laterally along the lateral part of the eyebrow. Inject 1-1,5 cm above the eye-brow, in order to avoid brow or upper eyelid ptosis through diffusion
b) Corrugator Supercilii	Pars nasales of theosfrontale	Galea aponeurotica, dermis above the middle third of the eyebrow	Pulls eyebrows downward and toward the midline of the nose, produces the vertical rhytids of the glabella en **Innervation=** Rami temporales, N.facialis (VII)	1 point at its origin – 3 to 5 U/point 1 point at its tail- 2 to 4 U/point	Deep injection at its origin – 50% of the 12 mm needle More superficial at its tail – insertion of 10% of the needle
(M. orbicularis oculi) **a. Pars palpebralis** **b. Pars orbitalis** **c. Pars lacrimalis**	Lig.palpebrale mediale Crista lacrimalis anterior Crista lacrimalis posterior	Lig.palpebrale laterale Concentric around the lateral canthus Pars palpebralis	Lid closing reflex, Lid closing Lid closing Directed drainage of tears **Innervation=** Rami temporales & zygomatici of the N. facialis (VII)	Inject never more than 25 U per eye 3 to 8 points 2,5 to 5 U/ per point Use always max. 1,25 U near the lower lid and strict subcutaneous	Direct the injection always away from the eye Insertion of 50% of the needle into the lateral lines Insertion of 10% of the needle near the lateral end of the brow Strict subcutaneous injections 0,5 -1 cm away from the lower lid due to ectropion danger or visual complications due to diffusion possibility
(Nosemuscles) **a) Procerus** **b1) Nasalis, Pars transversa** **b2) Nasalis, Pars alaris**	Os nasale Maxilla, skin over the canine tooth Skin over the lateral incisor	Dermis between the eyebrows Nasal dorsum Greater alar cartilage	Synergist of the M. Corrugator supercilii, draws down the dermis of the medial part of the eyebrows to the root of the nose, creates the horizontal lines located at the root of the nose **Innervation=** Rami buccales, N. facialis (VII) Compresses the nostrils Dilates the nostrils **Innervation=** Rami buccales, N. facialis (VII)	1 to 2 points 5 to 7,5 U/point 1 to 2 points 2,5 – 5 U/point 1 point 2,5-3 U/point	Deep injections – insertion of 50% of the 12 mm long needle. Intramuscular insertion of the needle under an angle of 45oto the skin and with a direction towards the nasal dorsum -inject inferior to the angular vein Intramuscular injection in the middle part of the nostril

(Oral muscles) **a1) Zygomaticus major**	Anterior of zygomatic	Modiolus of the mouth	Pulls the angle of the mouth up and backwards, depresses the nasolabial fold during smiling	1 to 2 points 2,5 U/point	Superficial injection. Insert 30% of the 12 mm long needle
a2) Zygomaticus minor			Moves upper lip upward **Innervation=** Rami zygomatici, N. facialis (VII)	1 point 2,5 U/point	Superficial injection. Insert 30% of the 12 mm long needle
b) M. orbicularis oris **b1) Pars marginalis**	Mandible, Maxilla, Perioral skin	Skin around the lips	Closing the mouth, pucker up the lips	4 to 6 points 1,25 U/point	Superficial injection. Estimatedly 2 mm to 3 mm above the vermilion border. Insert 10%-20% of the needle
b2) Pars labialis			Closing the mouth, Pressing lips against the teeth **Innervation=** Rami buccales & Ramus marginalis mandibulae, N. facialis (VII)		

in the dyskinetic mental area, that might cause asymmetry, we inject 2 points a 2.5 Units into the M. mentalis and place also 2.5 Units with a single injection into the contralateral mentalis (Figure 1and 5). Important is to avoid injections into the lower part of the M. depressor angulioris and the depressor labii inferioris as this will cause lower lip asymmetry.

Results

The grade of the achieved muscle relaxation on the affected side is a main factor that contributes in increasing or balancing a facial asymmetry that is observed after regular botulinum toxin treatments in facial dyskinesias. The reason behind this phenomenon is, that botulinum toxin gives a ''softer'' appearance to the dysfunctional face part, while the ''healthy'' side appears with much deeper rhytids, especially during mimicry, due to the undisrupted, remaining normal muscle contraction. This is a ''pseudo effect'' that leads consequently to an increased asymmetry between ''treated'' and ''untreated'' facial side. So therapies which are limited to the dyskinetic side have the risk of improving the unwanted ''spasms''. They increase the asymmetry on the ''healthy'' side, which keeps forming hyperdynamic rhytids, that additionally might become deeper and turn from dynamic to a static state, as the muscles of the injected side start getting inhibited by the injected toxin. The necessity of botulinum toxin injections in intervals of 3 to 5 months in order to treat the dyskinetic side lead to a muscle thinning and atrophy of the injected muscle groups. This is one more factor that leads to an imbalance on muscle dynamic and symmetry, between dyskinetic and healthy side. Exactly this specific observation explains the importance of creating a combined aesthetic-functional treatment plan, where both sides, dyskinetic and ''healthy'' are treated during one session. Through this technique the imbalance between the two facial sides can be improved and harmony with an almost normal facial mimicry and a symmetric cosmetic outcome can be achieved. In order to avoid overtreatment's of the ''healthy'' side, the depth of the injections has to be considered. We created a treatment plan as a guide for proper injection areas, depth and dosage, aiming to increase effectiveness and safety of combined treatments. Through the assistance of this guide, optimal therapeutic

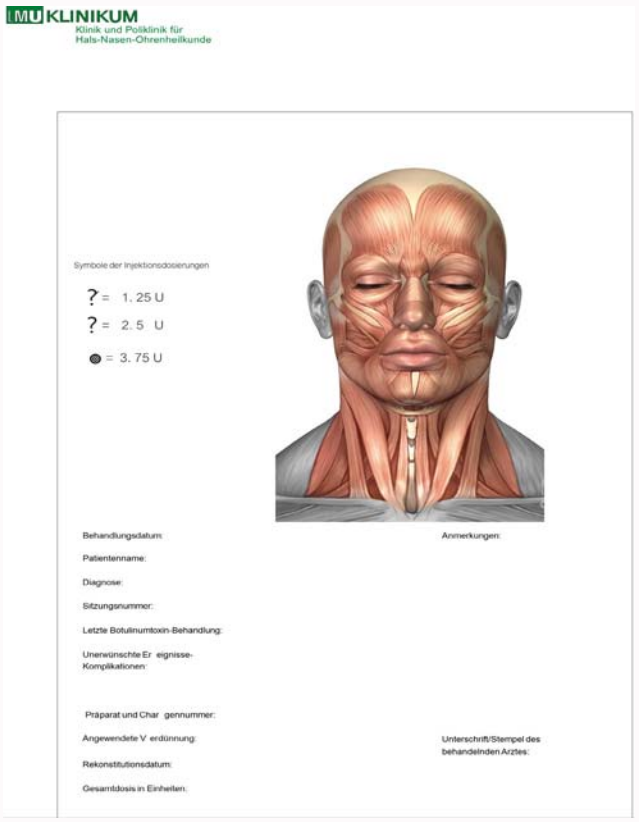

Figure 3: Suggested protocol for the development of a proper treatment plan for patients with facial dyskinesia.

results can be gained, even by injectors who aren't familiar to either aesthetic or functional botulinum toxin treatments. In our clinic we apply since more than 3 years these treatment plans in patients with synkinesis and hemifacial spasm. We came to the conclusion, that following this concept through this period of time and while having treated 30 patients according to the suggested injection depth and points of Figure 1, 2, we did not experience any major complications

Figure 4: Patient with posttraumatic synkinesis on the right side. Visible hyperdynamic rhytids of the ''healthy'' frontalis half on the left, which are treated with botulinum toxin type A injections. Results only 10 days post injection.

Figure 5: 5a) Capturing the mouth angle on the healthy side with an upwarded direction during facial activity and the lower standing left mouth angle on the synkinetic side.
5b) Capturing the more symmetric mouth angles during facial expression, following botulinum toxin injections into the M. orbicularis oris and the upper part of the Depressor angulioris of the healthy right side. (functional – aesthetic combined treatment result, in order to restore facial harmony and symmetry).

beside some expected hematomas on the injection points. Moreover, the affected side needed an average of 18 units of botulinum toxin type A, while the non-affected side 50% less neurotoxin, which is translated into approximately 9 units of toxin. The use of 33 Gauge, 12 mm long needles contributed to almost painless injections, so that local anesthetic creams where not needed.

Conclusion

Through a minimal invasive technique we could achieve an important objective improvement of facial function and symmetry, accompanied by a high patient satisfaction rate. Patients who had

Figure 6: 6a) Status prior to botulinumtoxinTyp A-treatment; visible, hyperdynamic rhytids along the right part of the frontalis. Important facial asymmetry, due to the upwards directed frontalis and eyebrow position on the right.
6b) Status after a combined, bilateral, functional/aesthetic botulinum toxin therapy, in order to inhibit the dynamic movement of the right part of the frontalis, while creating a more balanced cosmetic appearance of the upper facial part. Results only 5 days post-treatment. A touch-up injection 5 days later optimised the aesthetic result even more.

previous experience on one-sided treatments where in the point of our interest, as they could confirm a much higher satisfaction rate after undergoing the combined treatment. As for achieving a symmetry of the two facial sides there is needed very few additional toxin, offering much greater cosmetic and functional results, we suggest, based on our research results bilateral facial injections as a necessary therapeutic perspective for both genders and of any age. Affecting the aesthetic integrity of the face positively is of extraordinary importance, as the mimic expressivity needs to reflect the emotional status of every subject.

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