



MYOMODULATION AND HYALURONIC ACID

Lakhdar Belhaouari, Manuela Tomassety, Pierre Quinodoz and Koen De Boulle explain how myomodulation helps create the aesthetic results after hyaluronic acid injections

ABSTRACT

Injections of hyaluronic acid are a routine treatment in aesthetic medical practice, used for beautification, rejuvenation, and restoration. Modulation of muscular activity after injections of hyaluronic acid has often been observed either by stimulation or through a pacifying effect depending the different muscles concerned by the treatment in the different indications and different areas of the face. We present our observations and propose our explanations of this additional benefit

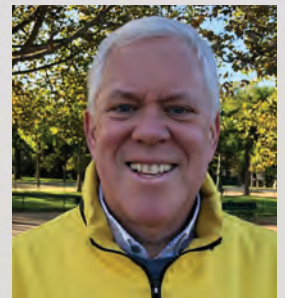
THE MODULATION OF MUSCULAR activity after injections of hyaluronic acid has often been observed. Over the last ten years, the authors have spoken about it as well as presented and published their findings, on multiple occasions, at various conferences and symposia^{1,2,3}. One can define myomodulation as the regulation of muscular activity, the dynamic of the muscle, either by stimulation or through a pacifying effect. Injections of hyaluronic acid, a routine treatment in aesthetic medical practices, have been used for beautification, rejuvenation, and restoration. Long recognised as a product for volumising, it is clear that hyaluronic acid has an additional benefit: myomodulation.

Observations Cheekbones

Hyaluronic acid injected by bolus technique in the deep malar fat beautifies the shape and restores volume to the midface. We can also observe a lifting effect of the midface. This deep injection is behind the orbicularis oculi and modulates its function by means of stimulation.

Chin

Hyaluronic acid injected at the level of the pogonion or mentum to treat retrogenia has two effects: adding volume to reshape the receding chin and modulation of the mentalis muscle through relaxation (*Figure 1*). The function of the mentalis is to lift the chin and to project the lower lip anteriorly. The injection of hyaluronic acid in the mentalis muscle changes its dynamic by relaxing the muscle, suppressing any possible hypertonia, which would otherwise create an 'orange skin' appearance. This will also reduce any ascension of the chin, correct any excessive anterior projection of the inferior lip and can gently elongate the jawline.



LAKHDAR BELHAOUARI, MD Plastic and aesthetic practitioner, Toulouse, France; **MANUELA LOPEZ-TOMASETY, MD**, Aesthetic Physician, Owner and medical director of Tomassetty clinic, Las Palmas de Gran Canaria, Spain; **PIERRE QUINODOZ, MD**, Past president, Swiss Society of Plastic Reconstructive and Aesthetic Surgery, Geneva, Switzerland; **KOENRAAD DE BOULLE, MD**, Dermatologist and Director of Aalst Dermatology Clinic, Aalst, Belgium

email Belhaouari.l@wanadoo.fr

KEYWORDS

myomodulation, muscle activity, filler, hyaluronic acid

“ Long recognised as a product for volumising, it is clear that hyaluronic acid has an additional benefit: myomodulation.

”



Figure 1 Before and after deep injection of 1.2 ml of volumising hyaluronic acid at chin level (pogonion)



Figure 2 Before and after deep injection of 0.8 ml of volumising hyaluronic acid at posterior part of the horizontal branch of the mandible, at the level of insertion of masseter muscle



Figure 3 Before and after injection of 0.8 ml at lip level. The injection is actually in the orbicularis oris muscle

▷ Contour

Hyaluronic acid injected deep in the posterior part of the jawline close to the bone to improve the contour of the face is actually placed in the masseter muscle. This has a two-fold effect: beautification and rejuvenation of the contour and jawline definition (*Figure 2*) and a relaxing of the masseter muscle. Remember, the main function of the masseter is mastication, but it is possible hypertonia can create tightness and tension and sometimes bruxism.

The eyes

Hyaluronic acid injected close to the bone at the lateral part of the orbit to redesign the superolateral part of the midface is, in fact, placed into the muscle because the space between the bone and the muscle is virtually non-existent. This injection improves the shape but also lifts the tail of the eyebrow by relaxing the lateral part of the orbicularis oculi muscle. It is important to remember the

function of this part of the orbicularis muscle is to lower the tail of the eyebrow, noting that there is no antagonist because the frontalis muscle is not present in the external part of the forehead.

Forehead

An injection of hyaluronic acid, either via fanning or micro-bolus, improves the shape of the forehead and fills any hollows. In fact, hyaluronic acid is in the muscle because the sliding space between the bone and the muscle (Merkel space) is virtually non-existent. The hyaluronic acid injection modulates the function of the frontalis by relaxing the muscle and can reduce horizontal forehead wrinkles. It is important to remember that the function of the frontalis is to elevate the eyebrow, which provokes frontal wrinkles, for which the treatment of choice is botulinum toxin due to its neuro-relaxation properties.

Nasolabial fold

A deep bolus injection of hyaluronic acid is used to fill the hollow of the upper part of the nasolabial fold. At this level, the product is actually placed into the Levator labii superioris alaeque nasi muscle. The filling injection erases the hollow but also modulates the muscle with a minor improvement of the gummy smile. It is important to note that the function of this muscle is to lift the upper lip and keep in mind that the gold standard treatment for gummy smile is botulinum toxin due to its neuro-relaxation properties.

Lips

A hyaluronic injection gives varying degrees of shape and fullness to the lips. Softening the smile is an added benefit in cases where the lips are somewhat tight. This is due to myomodulation through relaxing the orbicularis oris muscle, which is, in fact, the injection site (*Figure 3*). As a result, the practitioner can achieve fullness, eversion and projection in addition to hydration with a 'gloss' effect to the lips.

This is not an exhaustive list and there are other zones where this power of myomodulation can be observed, as we will see later. Practitioners can now understand the modulation of muscular activity. Although not previously recognised to be a regulator of activity, as opposed to the known mechanisms of botulinum toxin, hyaluronic acid can, in fact, modulate either by muscular stimulation or relaxation.

Myomodulation by muscular stimulation

It is essentially at the midface level that myomodulation is evidenced by muscular stimulation.

How can we explain that even a minimal injection of volumising hyaluronic acid into the deep malar fat can have a lifting effect on the midface?

The first piece of evidence is the mechanical effect: a volumetric input fills and rounds and by this, shortens and elevates the midface. The analogy of the apple and the pear is an illustration—a round apple is more

“Hyaluronic acid injected deep in the posterior part of the jawline close to the bone to improve the contour of the face is actually placed in the masseter muscle.”

compact, shorter, less sagging than a pear where the top part is 'emptied'. Similarly, a bag of wheat is more 'lifted' than a bag half-empty.

The second important point is the rheological characteristics of hyaluronic acid. Elasticity G' and cohesivity are essential to create a projection. A hyaluronic acid gel with high G' and high cohesivity possesses a strong resistance to vertical pressure, which in turn creates a capacity to lift tissue. The ability of a gel to stick together, to stay attached to itself due to its high cohesivity confers stability to the bolus and hence an absence of gel migration—the product stays where injected. The hyaluronic acid must, therefore, have high cohesivity, high elasticity and good resistance to vertical compression, in order to have a perfect volumising effect and lifting capacity.

The third aspect is an understanding of the physiology. Remember that the principle motor element at the level of the midface is the orbicularis oculi muscle. This ascends the superficial compartments constituted by the coupling of the skin and superficial malar fat while the deep malar fat (SOOF) stays fixed, attached to the underlying bone^{4, 5}. Furthermore, as all striated muscle, the orbicularis oculi has a muscular tonicity that permits it to be in a permanent state of tension, persisting even with voluntary relaxation. This tonicity is dependent on a reflex activity of medullary origin.

Even a minimal volumetric input, from 0.5cc to 1cc of hyaluronic acid into the deep malar fat behind the orbicularis oculi will mechanically project the orbicular muscle anteriorly and elongate its fibres: it will bulge like a drawn bow. This elongation will cause a myotatic reflex (Figure 4). This reflex occurs due to the principle of the relation between tension and length of a muscle. The macromolecular architecture of a muscle (skeletal or smooth) explains the augmentation of global tension of a muscle with light elongation⁶.

The elongated muscle causes the tension to effect a reflex contraction in response to its elongation.

This active tension is, in fact, parabolic (Figure 5). The active tension is at a maximum for a length of muscle that is as close as possible to the length at rest and which diminishes progressively when the length of muscle significantly lessens or increases⁶.

Maximal tension is due to the overlapping of the fine and thick filaments with maximal actin-myosin linkages. However, if one stimulates the muscle when it is elongated over 115% of its length at rest, there are fewer linkages and hence little force. This underlies the resultant mechanism of inverse myotatic reflex^{1, 6}.

The bow reflex (Figure 4) is constituted by:

- The secondary nerve endings of sensitive neuromuscular spindles at elongation
- The type II nerve fibres and collateral IA fibres: afferent fibres that terminate in the grey substance of the medulla to connect to the alpha motoneurons. The axons of the alpha motoneurons innervate the efferent fibres.

Through this medullary reaction, the signal will be given to the orbicular oculi muscle to contract after its

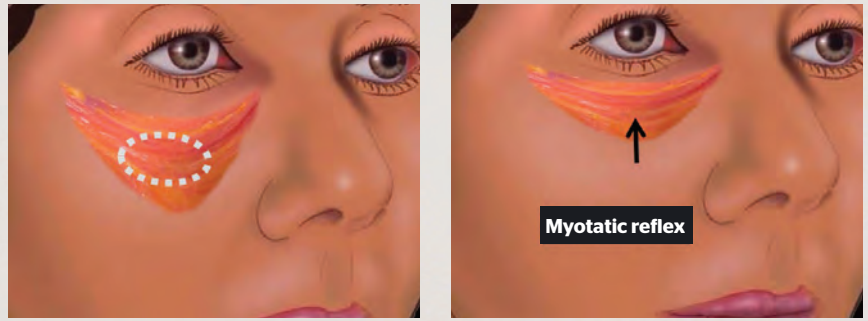


Figure 4 The bow of the myotatic reflex of extension for the myomodulation via stimulation of the orbicularis oculi muscle after injection of hyaluronic acid into the deep malar fat behind the orbicularis oculi muscle.

gentle elongation caused by the injection in the deep malar fat. The dynamic response is a light contraction of the orbicular muscle, which will elevate the overlying tissues, the superficial malar fat and its cutaneous covering, causing a lifting effect:

- Elevating the medial part of the midface
- Elevating the palpebral-malar groove by lifting the superficial malar fat
- Shortening the lower eyelid
- Causing a small improvement of the nasolabial fold by lifting the superficial malar fat and skin.

Classically, a reflex is a mechanism of rapid secondary contraction in response to a rapid elongation. It can be concluded that the tension caused by the light elongation persists as long as the hyaluronic acid has not degraded.

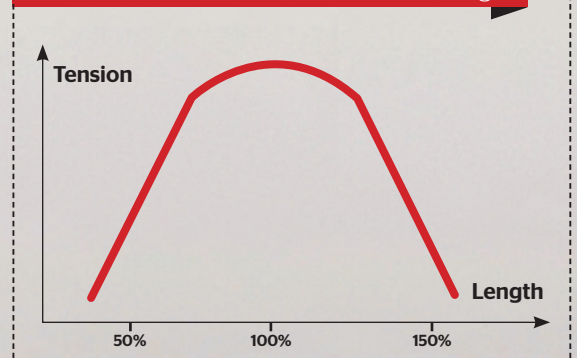
The lifting effect remains as long as the light lengthening continues, and the muscular tension exists, which may be many months. This is the authors' clinical observation.

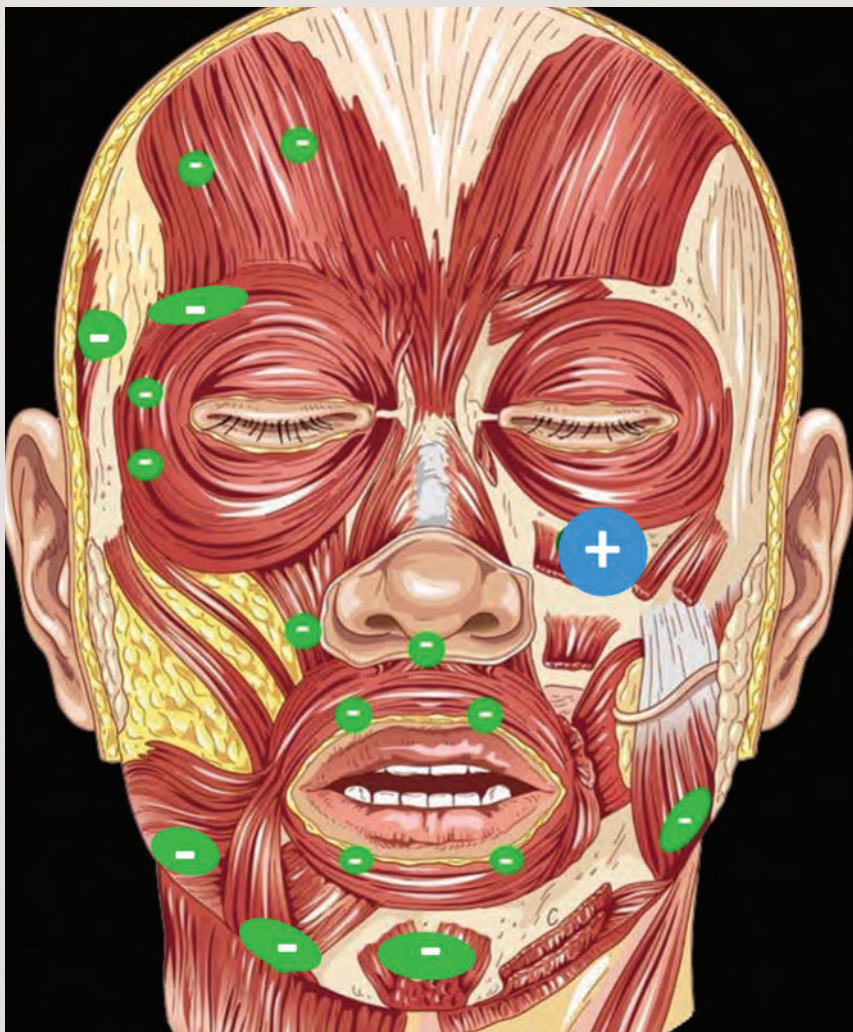
The question that must be put forward is whether this effect is proportional to the injected volume?

The logical approach would be that the more HA injected, the more the orbicular muscle is elongated and the greater the reaction, with a proportional lifting. In practice, the authors have not witnessed this to be the case. On the contrary, they have observed a certain heaviness with the opposite result: the lifting effect no longer occurs.

The concept of myotatic reflex no longer applies, ▷

Figure 5 Parabola showing the relation between active tension and muscle length





▷ this is logical with the understanding and application of the inverse myotatic reflex. The inverse myotatic reflex replaces the myotatic reflex when the elongation is too significant. An excessive volumetric application annihilates the myotatic reflex—the lifting effect no longer occurs, and on the contrary, it causes an opposite effect.

These anatomic pathways are the organs of Golgi (receptors), sensitive to the augmentation of muscle tension. The centripetal pathway is comprised of IB fibres, where the cellular body is situated in the spinal ganglion. The centre is the medulla, and at this level the IB fibres connect with two inter-neurons: one inhibits the alpha motoneuron agonist and the other stimulates the alpha motoneuron antagonist.

This theory of myotatic reflex and inverse myotatic reflex explains the lifting effect with a minimal volumetric injection and is corroborated by practical experience. This is the myomodulation the authors have described and published in 2014 as the myotatic reflex of extension¹.

Myomodulation by means of muscular relaxation

In this case, the regulation of the muscular activity is by

Figure 6 Principal muscles of the facial dynamic. The green points show the muscles where the hyaluronic acid injection is into or in direct contact with the muscle, resulting in myomodulation due to muscle relaxation. In blue, the deep injection is into the deep malar fat, behind the orbicularis oculi muscle with a myomodulation caused by stimulation due to a myotatic reflex

virtue of it being relaxed, clinically observed when the injected hyaluronic acid is in direct contact or inside the muscle. This phenomenon is observable for the chin, contour, forehead, lips, lateral part of the orbit, the upper part of nasolabial folds and in other zones referred to earlier.

How do we explain this effect? In all these zones (Figure 6), the injection is into the muscle. When hyaluronic acid is in direct contact, we can understand that the product is spread between the muscular fibres and enters inside the muscle to modulate it in a calming manner.

In the mentalis, at the level of the chin, with an indication of retrogenia, and receding chin, the injection is made by bolus technique at the level of the pogonion in direct contact with the mentalis muscle: the hyaluronic acid penetrates the muscle, immersed inescapably between its fibres. This infiltration effects a relaxing of the muscle, which suppresses any muscular tightness. Recall that the mentalis is responsible for the ascension of the chin, the anterior projection of the lower lip and the wavy aspect of orange skin in the chin, where there is hypertonia (Figure 1). The result will be two-fold: treat the retrogenia and a myomodulation of the mentalis.

In the lateral-orbital part of the orbicularis oculi muscle, at the level of crow's feet, in order to reshape the superolateral part of the midface, the injection is into the muscle, in direct contact with the muscular fibres. The effect is twofold: a fullness of the supero-external section of the midface with a harmonious 'Ogee' curve and also a lifting effect of the tail of the eyebrow, achieved through relaxing the lateral part of the orbicularis oculi, which is responsible for lowering the tail of the eyebrow. The effect can even be three-fold because the wrinkles of the crow's feet are improved by myomodulation due to muscular calming.

To reshape the contour of the face (Figure 2), the injection is on the jawline. It can be superficial, subcutaneous by fanning technique or deep by bolus technique in contact with the bone of the posterior part of the horizontal branch of the mandible. The resultant beautification or rejuvenation by the lifting effect, due to reshaping of the contour, is well perceived by patient and practitioner alike. When the injection is deep in the posterior part of the jawline, it is de facto into the masseter muscle at the level of its bony insertion. Hyaluronic acid infiltrates the muscle imbibing the muscular fibres, which gives the effect of relaxing the face, easing the tension of the masseter - the source of tightness as seen in bruxism.

To recontour and embellish a flat forehead, the hyaluronic acid injection is made supra-periosteal, in direct contact or inside the frontal muscle as the Merkel space between the frontal bone and the muscle is virtually non-existent. The myomodulation, easing the frontal muscle, improves the horizontal forehead wrinkles.

The injection into the canine fossa builds up the hollow of the upper part of the nasolabial fold. The product is actually inside the levator labii superioris. The calming caused by myomodulation ameliorates a gingival smile.

An injection of hyaluronic acid into the orbicularis oris muscle to give fullness to thin lips has a myomodulation effect, easing the tension of the muscular fibres, the cause of any tightness of the lips (*Figure 3*) Lip fullness and the smile are enhanced.

To treat temple hollows, the injection of hyaluronic acid can be either superficial above the temporal fascia or deep in the temporal fossa, under the deep temporal fascia. The result is to reshape and flatten the temple area. When the injection is deep, it is de facto inside the temporal muscle. In this case, the hyaluronic acid infiltrates the muscle spreading between the muscular fibres allowing the myomodulation effect by relaxing the muscle. This acts to combat any tightness of the masticatory muscles.

Discussion

Practitioners need to understand the anatomy and dynamics of all of these muscle sites; to understand the injection techniques and precise location of the injected hyaluronic acid; to understand that injection is into or in direct contact with the muscle, and that the hyaluronic acid injected can interfere with the dynamic of the musculature.

Permeation of the muscle by the hyaluronic gel, which spreads between the muscular fibres reduces the muscular tension, reduces the movement, and eases the contractile function of the muscular fibres, without blocking them or changing their viscoelastic properties. The tension, function, and muscular movements become softer and calmer. The muscular function is still retained but modulated.

By the mechanism agonists-antagonists of muscular balance, we understand that other muscles can be impacted. Their tonus of contraction evolves in the same manner of modulation.

Mauricio De Maio⁷ published (in 2018) a different approach, to the concept of myomodulation, one that the authors do not share, but is interesting to note. He suggests it is due to the location of the hyaluronic acid injection, deep or superficial, depending on the muscle:

- Deep under the muscle, the injection of hyaluronic acid acts as a pivot to augment the mechanical advantage and improve the muscular force.
- Superficial above the muscle, the hyaluronic acid injection reduces the contraction.

The clinical applications

For the indications described above, the benefits of myomodulation offer enhanced beautification, rejuvenation, and volume creation.

Conclusion

The authors' concept of myomodulation by injection of hyaluronic acid, either by means of stimulation, for the orbicularis oculi where the injection in the SOOF gives fullness to the midface, or by means of relaxation, for all the other muscles, is described above.

This concept allows us to give a nod to Einstein who stated: 'a theory is something nobody believes except the

“Permeation of the muscle by the hyaluronic gel, which spreads between the muscular fibres reduces the muscular tension, reduces the movement, and eases the contractile function of the muscular fibres, without blocking them or changing their viscoelastic properties.”

person who made it' adding 'an experiment is something everybody believes except the person who made it.'

It is more than a theory: it is a clinically supported concept, backed by observations that the authors have described over a number of years.

Hyaluronic acids, in addition to their currently well-documented indications, can become, by the myomodulation effect, a possible alternative to botulism toxin with its myorelaxation properties. There are obvious parallels between myomodulation and myorelaxation.

To date, hyaluronic acids have not revealed all their secrets; the same can be said for botulism toxin.

► **Declaration of interest** None

► **Acknowledgements** With a huge thanks to Joy Rosenfeld from Australia for the translation

► **Figures 1-6** © Lakhdar Belhaouari

References

1. Belhaouari L. J. Méd. Esth. et Chir. Derm. Vol. XXXXI, 164, décembre 2014, 203-209
2. Belhaouari L. Myomodulation, communication 39ème Congrès SFME Paris 7 sept 2018
3. Belhaouari L. et al. Myomodulation et acide hyaluronique, J. Méd. Esth. et Chir. Derm. Vol. XXXXVI, 183, septembre 2019, 219-225
4. Belhaouari L., Gassia V. L'art de la toxine Botulique et des techniques combinées en esthétique, éditions Arnette Wolters Kluwer France 2013
5. Margareta Nordin, Victor Hirsch Frankel. Basic Biomechanics of the Musculoskeletal System, Wolters Kluwer/Lippincott Williams & Wilkins Health, 2012
6. PAILLARD J. Le pilotage du moteur musculaire. In: Eléments de Neurobiologie des comportements moteurs, G AZEMAR, H RIPOLL (eds), pp 9-35 Editions INSEP Paris, 1982
7. de Maio M. Myomodulation with Injectable Fillers: An Innovative Approach to Addressing Facial Muscle Movement. Aesthetic Plast Surg. Juin 2018;42(3):798-814

Key points

- ① Myotatic reflex explain the myomodulation by stimulation of the orbicularis oculi observed when the injection of hyaluronic acid is in the deep malar fat for mid face improvement which elongates the muscle
- ① Myomodulation through a pacifying effect is observed when the injection is in or around the muscles with spreading and penetration of hyaluronic acid inside to modulate it in a calming manner
- ① Myomodulation changes the game by an additional dynamic benefit to filler injections