

Optimization of Presurgical Treatment with Botulinum Toxin in Facial Scar Management

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ABSTRACT

The goal of cosmetic surgery is to improve one's appearance. Scarring is a visible sign, to make a scar inconspicuous, we require a variety of procedures during the pre, intra and postoperative phases. Botulinum toxin injection has been used for a variety of indications in humans, including blepharospasm and hyperfunctional facial lines. This article describes a novel formulation of botulinum toxin, it is injected in muscles underlying the scar before doing a surgical technique that suits the scar. This method will improve the cosmetic outcome of the facial cutaneous scar.

In conclusion, the results of this series strongly recommend the pre-operative injection of botulinum toxin before scar reversion.

INTRODUCTION

Facial scar management is considered one of the difficult problems that faces plastic surgeons. Several factors act to influence the final outcome of their management. The unique character of facial expression muscles which attach themselves to the dermis put the scar under continuous stress during the healing phase with subsequent complicated wound healing [1]. In a trial to counteract this effect, an induced muscle weakness during the healing phase might have a positive impact on the surgically revised scar and its final appearance. The role of Botulinum toxin A in induction of facial muscle weakness is now well recognized in facial aesthetic procedures. Some authors tried to apply the principle of facial muscle weakness for improvement of the aesthetic outcome of facial scar revision [2]. Although their studies were valuable in introducing a new modality in plastic surgery, yet they were lacking the objective evaluation of the exact degree of muscle weakness that can effectively abolish the muscle pull effect during the healing phase of scar revision.

In this study, we tried to refine this concept through an objective neurophysiological evaluation of the degree of muscle weakness induced by

Botulinum toxin A injection with its subsequent influence on the final outcome of facial scar appearance.

PATIENTS AND METHODS

Eleven cases of traumatic facial scars at different areas of the face were included in this study. Eight patients were males and 3 were females with their ages ranged between 6-40 years. The causative trauma was sharp objects in 6 patients, road traffic accident in 3 patients a direct blunt trauma in one patient. Two scars were in the forehead, four in midface, one in the lower face and three were in overlapped areas. The length of the linear scars ranged between 3-11cm, with bizarre-shaped scars in 2 cases. All scars showed healing by secondary intention with varying breadth ranged between 3-17mm. Accidental tattooing was found in 2 scars and visible stitch marks were found in 4 cases. Time elapsed from original trauma to patient's presentation ranged from 8 months to 9 years.

The facial muscles were examined regarding their symmetry and the possible influence of trauma on their activity. Photos were taken in 2 profiles focusing on the scar area. A diagram of facial muscles was overlapped with the patient's photo with the facial scar superimposing on the diagram, using the Adobe photoshop computer program, to evaluate which facial muscle(s) might have a tensor effect on the whole scar or even part of it (Fig. 1).

A quantitative EMG study of the defined facial muscle(s) acting on the scar on the affected side as compared with their mirror image on the contralateral side (control side) was done to evaluate the strength of muscle(s) acting on the scar to calculate the botulinum toxin dose accordingly. The injected dose of Botulinum toxin was guided by the general rules of its injection in rejuvenation procedures. In this series the dose ranged between 6 and 49 botulinum toxin* units (dilation 5.0

unit/0.1ml) injected in on or two sessions with to weeks interval (Table 1).

Two weeks should be elapsed before further EMG evaluation of the concerned muscles. A second dose of botulinum toxin injection was indicated whenever there is a degree of hypertonicity persisted following the first injection.

EMG studies were done using a Nihon Kohden (Neuropack four mini) apparatus.

The Apparatus Settings were:

- Sweep duration 100ms/divition.
- Display sensitivity 50-100 μ v.
- High and low frequency filter settings were 10kHz and 50Hz respectively.

Conventional EMG studies was carried using concentric needle electrode where the facial muscles examined during rest for spontaneous activity,

during voluntary action and during maximal contraction for interference pattern.

The facial muscles examine were O. Oculi, Masseter, Zygomaticus, Platysma, Frontalis and Buccinator muscles. EMG examination was carried bilaterally almost nearly at the same motor point to compare the side having the scar with the contralateral normal side.

When the required botulinum toxin effect is reached, surgery for scar revision was scheduled within the next few days. Scar revision was performed by 2 senior plastic surgeons using the appropriate surgical technique using 5/0 vicryl and 6/0 prolene. Sutures were removed 4 days post operatively and steri-strips were applied for further one week. Follow up for at least 6 months was needed to evaluate the scar appearance during and after the period of muscle chemo-immobilization, with a range between 6 months and 2 years.

Table (1): Case study.

Case no.	Age/sex	Scar			Muscle(s) acting on scar	Muscle tone (baseline)	Botox		
		Site	Length/cm	Breadth/mm			No. of injections visits	Dose/units	
							1st	2nd	
1	17/M	Lower face	8	16	Masseter & platysma	Normal	1	14	-
2	36/F	Lower face	6	11	Masseter & platysma	Hypertonicity	2	20	12
3	26/M	Lower face	10	13	Masseter & zygomaticus major	Hypertonicity	2	30	15
4	39/M	Middle face	10	9	Masseter	Normal	2	33	16
5	21/F	Lower face	5	7	Masseter & platysma	Normal	1	15	-
6	24/M	Forehead	8	6	Frontalis, Orbicularis oculi, & procerrus	Hypertonicity	2	18	4
7	40/M	Lower face	9	6	Masseter & platysma	Normal	2	12	10
8	24/M	Middle face	11	5	Masseter	Normal	2	16	16
9	6/M	Middle face	3	4	Zygomaticus major	Hypotonicity	1	6	-
10	16/M	Upper and middle face	15	6	Frontalis, orbicularis oculi	Hypertonicity	1	16	-
11	8/F	Upper face	8	4	Frontalis, orbicularis oculi	Normal	1	8	-

RESULTS

Baseline EMG evaluation of the muscles acting on the scars showed normal muscle tone equivalent to the mirror image muscle(s) on the other side (control side) in 6 patients, hypertonicity in 4 patients, and hypotonicity only in one patient. Although a uniform relation between muscle tone and number of Botulinum toxin A injection required could not be established, yet, the presence of a hypertonic muscle demanded repeated injections

in most cases (three out of 4 cases). Repeated injection was required in 50% of cases with normotensive muscles (Fig. 2).

In this series, there were no wound complications within the follow up period. Tendency towards scar hypertrophy was observed in 2 patients with original broad scars (13 and 16mm width). Early scar manipulation with local steroids and/or silicone gel improved their final outcome. The final results were subjectively evaluated as being good in 6 cases, accepted in 3 cases and un-accepted in 2 cases, based on clinical evaluation and patients satisfaction (Figs. 3-6).

* Botulinum toxin A (Botox ®. Allergan, IMC, Irvine, CA.



Fig. (1): A diagram of facial muscles to evaluate which facial muscles may have an effect on the scar.



Fig. (3-A): A male patient with a long scar on the left side of the face.

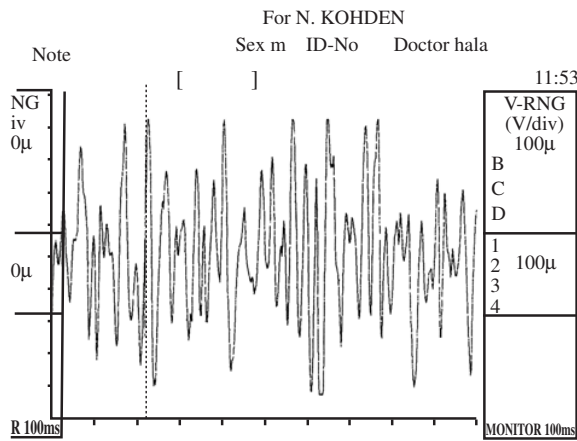


Fig. (2-A): EMG showing the interference pattern of the masseter before injection.



Fig. (3-B): Markings of the injection sites of Botulinum toxin.

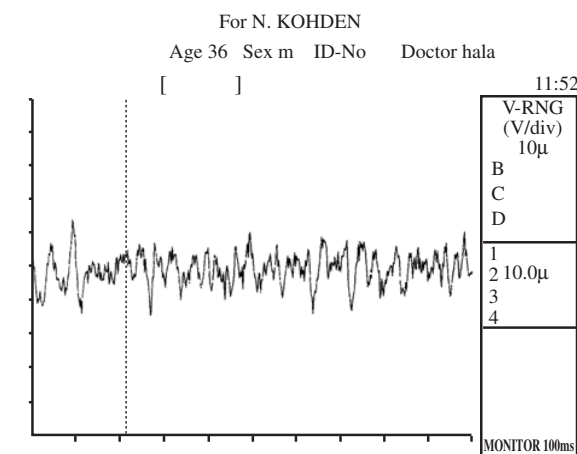


Fig. (2-B): EMG showing the interference pattern of masseter after 2 weeks of injection.



Fig. (3-C): Post-operative view after 1 year.



Fig. (4-A): A young girl with a longitudinal scar of the forehead and Rt. eyebrow.



Fig. (4-B): Markings of the injection sites of Botulinum toxin.



Fig. (4-C): Post-operative view after 10 months.



Fig. (5-A): An 20 years female with a transverse scar of the face.



Fig. (5-B): Post-operative view after 6 months.



Fig. (6-A): A young girl with a scar in Rt. cheek.



Fig. (6-B): Post-operative view after 6 months.

DISCUSSION AND CONCLUSION

Facial scar management has been a subject of continues interest to plastic surgeons. The disappointing surgical results for both partners, patient and surgeon, stressed a continuing quest for the development of new procedures or modification of existing ones in a trial to improve the final outcome of facial scar revision [3].

A major goal of elective surgical incision closure is to minimize the scar. One of the greatest factors determining the final cosmetic appearance of a cutaneous scar is the tension on the wound edges during healing [4]. In general, relaxed skin tension lines (RSTL) lie perpendicular to the tension vector of the underlying muscular contraction. Scars aligned with RSTL are subject to reduced tension and heal well, whereas scars oriented against RSTL are subject to repetitive tension and result in scar hypertrophy [5]. Many techniques are used to minimize wound tension including skin undermining, use of deep sutures and flap or graft reconstruction. Such techniques however minimize rather than eliminate the tension that is caused by muscle pull acting on the healing wound [6,7]. An interesting way to eliminate the tension caused by local muscle pull would be to immobilize the muscles pulling on the scar during the critical period of scar healing. It seems reasonable that interference with this factor may bring much improvement on the final outcome of scar revision.

Muscle immobilization during a healing phase is a universal medical role that can be applied to any part of the body except the facial muscles. Chemo-immobilization is a concept that has been developed for the management of muscle spasticity attacking specifically certain muscles to treat special problems. The same concept has been picked up by some authors with limited experimental and clinical trials. Although they succeeded to introduce a new concept that gave them the credit for introducing a new adjuvant for facial scar management, yet their clinical trials lack a proper formulation of the treatment plan based on objective criteria [2].

The proper definition of specific muscle(s) acting on the scar, their tone and strength, dose calculation of the appropriate amount of botulinum toxin to be injected, and the muscle response to the injected dose and whether a second dose is needed or not are all considered corner stones for proper evaluation of such kind of treatment.

In this study, a pre and post injection of botulinum toxin were evaluated by EMG studies of the

activity of muscle(s) surrounding the scar, compared to the mirror image muscle on the contralateral control normal side. This was a valuable determinant for dose adjustment and optimization of botulinum toxin pre-surgical treatment.

Botulinum toxin is a potent neurotoxin that weakens the overactive underlying muscle contraction, causing a relaxation and flattening of the facial skin [8].

For many years, the application of botulinum toxin has proved safe and effective in the treatment of various disorders, including blepharospasm, spastic dysphonia and hyperfunctional facial lines [9]. Botulinum toxin acts at the neuromuscular junction, inhibiting the release of acetylcholine from the nerve terminal. This causes weakness or a flaccid paralysis of the muscle.

There have been no long term adverse effects or health hazards related to the use of botulinum toxin so far. When side effects of botulinum toxin treatment occur they are usually related to the transient paralysis of adjacent muscle groups with a resultant temporary functional deficit. To minimize this side effect and maximize the precision of intramuscular injection, electromyographic guidance has been useful [10]. Some of the clinically relevant side effects are directly associated with the administration technique localized pain and hematoma can occur after intramuscular or subcutaneous injection of the toxin [11].

In some patients, they may become unresponsive to treatment after one or more botulinum toxin type A injections. The formation of neutralizing antibodies has been implicated as the cause of treatment failure in most of these cases. The main risk factors for the development of neutralizing antibodies appear to be the injection of the neurotoxin at frequent intervals or at higher dose [12].

In most individuals the clinical effects of botulinum toxin A begin to appear at 1-2 days, peak in 1-4 weeks and gradually decline after 6-12 months after injection. Particularly in those individuals who have undergone a series of treatments, it seems the total number of treatment sessions may increase the duration of clinical effect [13].

In conclusion, the results of this series strongly recommend the pre-operative injection of botulinum toxin before scar revision. Further studies are needed for a larger number of patients to adjust the proper dosage and accurately define the injection sites around the scar.

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