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Original Article

Aesthetic Outcomes of Botulinum Toxin Injection for Management of Disfiguring Forehead Scars

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ABSTRACT

Objectives: The evaluation of the aesthetic outcomes of Botulinum toxin A (BTXA) injection after the excision of disfiguring forehead scars.

Patients and Methods: 30 patients with forehead scars underwent surgical excision under local anesthesia and BTXA injection (50U/ml) after skin closure. Patients were evaluated preoperatively, at 6 and 12 months postoperatively (PO) for the evaluation of outcomes using the patient's self-assessment scar scale, the Patient and Observer Scar Assessment Scale (POSAS), and The Stony Brook Scar Evaluation Scale (SBSES). Patients' satisfaction was evaluated before and after PO using a 10-point visual analogue scale (VAS).

Results: At 12-months PO, the aesthetic outcome was very satisfactory by 18 patients, satisfactory by 5 patients, and good by 3 patients, while 4 patients found the aesthetic outcome fair and poor with a significantly higher PO satisfaction score compared to the preoperative score. PO scores of the scar-assessment scales showed progressive improvements with significant differences in comparison to preoperative scores and between 6- and 12-months scores. The satisfaction score was negatively related to female gender and body mass index (BMI). Regression analysis defined a high pre-procedural patient's self-assessment scar scale and low SBSES scores as negative significant predictors of high satisfaction.

Conclusion: BTXA injection after excision of disfiguring forehead scars provided highly satisfactory outcomes with a reduction of the scar width, irrespective of the scar shape.

Keywords: Botulinum toxin A (BTXA); Disfiguring Scar; Forehead; Patient's Self-assessment Scar Scale; Stony Brook Scar Evaluation Scale.



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INTRODUCTION

Wound repair is a highly dynamic cascade of cellular and enzymatic events to ensure rapid closure of the skin barrier; however, cascade redundancy and compensatory mechanisms may induce alterations and impairment of the process of wound healing ⁽¹⁾.

Management of ugly or disfiguring scars is still problematic despite the advances in plastic surgeries, and the problem is exaggerated if the scar is in the exposed skin, especially that of the face ⁽²⁾.

Facial wounds, especially wounds lying perpendicular to the Lines of Langer, heal poorly and result in disfiguring scars ⁽³⁾.

Disfiguring facial scars offer a unique challenge to the reconstructive surgeon due to ambiguities on facial planes, architectural distortions ⁽⁴⁾, restricted facial movement and expression, and aesthetic disfigurement that compel excellence in planning and execution of the restorative process ⁽⁵⁾.

Multiple procedures were provided for the management of facial wounds using Z-plasty, local flaps, such as square flap ⁽⁶⁾, full-thickness flap ⁽⁷⁾ propeller flap ⁽⁸⁾, and transposition flaps ⁽⁹⁾. The disadvantages of these grafts include the provision of flat and inanimate faces without character or facial expression ⁽¹⁰⁾, and these procedures are invasive with liability for complications for both the donor and recipient areas ⁽¹¹⁾.

Botulinum toxin is a neurotoxin produced by *Cl. Botulinum* can interfere with the release of acetylcholine from the presynaptic membrane of peripheral motor nerve terminals, inhibiting nerve transmission and causing muscle relaxation ⁽¹²⁾. The Food and Drug Administration initially approved the use of botulinum toxin for the treatment of strabismus, blepharospasm, and hemifacial spasms, but for its safety, efficacy, and long duration of action, it is well-accepted by patients and widely used in clinical practice ⁽¹³⁾.

This work tried to evaluate the aesthetic outcomes of Botulinum toxin A (BTXA) injection after excision of disfiguring forehead scars

PATIENTS AND METHODES

Design: Prospective selective non-randomized clinical trial

Setting: Department of Plastic Surgery, Faculty of Medicine, Port Said University in conjunction with multiple private

Aesthetic centers.

Ethical considerations: The study protocol was discussed with patients attending the outpatient clinic of Plastic Surgery with facial scars, and the patients accepted to participate in the study were evaluated for inclusion criteria. The study protocol was approved by the Faculty Ethical Committee. All enrolled patients signed the written informed consent according to the guidelines of the Local Ethical Committee.

Clinical evaluation

Patients were evaluated for age, sex, and duration of the wound; i.e. The duration since trauma inflection till enrolment and previous surgical or medical trials. Then, all patients underwent complete general examination and routine lab investigations.

Exclusion criteria

Age younger than 18 or older than 60 years, presence of keloid in the scar, unhealthy surrounding skin, failed previous surgical intervention, pregnancy, lactation, menstruation, presence of nerve affection, psychological instability, protein malnutrition, liver, kidney or cardiac disorders, forehead sebaceous or dermoid cysts, allergy to the used drugs, difficult attendance for follow-up are the exclusion criteria.

Inclusion criteria

Patients with disfiguring forehead scar that badly affects patients' aesthetic appearance, free of exclusion criteria, signed the written informed and accepted to give perioperative photos were enrolled in the study.

Pre-procedural evaluation

Local examination entailed proper determination of the scar site, shape, and dimensions of the wound area.

Patient and Observer Scar Assessment Scale (POSAS)

The current study applied the patient component of the PSOAS that assesses 6 items on a scale of 1-10 with higher values indicating the worst opinion. These items evaluate pain sensation, scratch sensation, scar color, stiffness, thickness concerning surrounding skin and scar regularity ⁽¹⁴⁾.

Patient's self-assessment scar scale

Scar aesthetic scoring was carried out using a visual analog scale of 1-10 points with a higher score indicating the worst scoring

The Stony Brook Scar Evaluation Scale (SBSSES)

The SBSSES was designed to measure short-term wound outcomes⁽¹⁵⁾ through the assessments of 5-items: wound width ($>2\text{mm}/\leq 2\text{mm}$), height (Elevated/Flat), color (Darker/Similar to surrounding skin), presence of hatch or suture marks (Yes/No), and overall appearance (Poor/Good). Each item was scored by 0 or 1 with a total score range of 0-5, where 0 indicates worst, and 5 indicates best.

Injection material preparation

Botulinum toxin A (Refinex; KC Pharmaceuticals, China) 50-U was reconstituted with 1-cc saline 0.9%.

Procedure (two cases are presented in Plates no 1 and 2)

All patients had pre-procedural photos, before and after marking the original incision site. Patients received infiltration of lidocaine 2% with adrenaline (1:200000) to provide vasoconstriction to minimize bleeding. Local anesthetic infiltration must cover the area, extending about 1 cm beyond the scar area. For irritable patients, IV sedation was provided, and all patients received preoperative IV broad-spectrum antibiotics. With patients in a semi-recumbent position with the bedhead elevated up to 45°, the scar was excised with a 3-mm healthy skin margin to allow healthy wound closure. Thereafter, injection of the prepared BTXA was started at the uppermost part and directed downwards to avoid masking the upper part of the wound after tissue inflation. The injection procedure utilized multiple injection sites according to the shape of the wound, covering the whole wound area. In the case of a unilateral scar, a BTXA injection was injected bilaterally to allow bilateral muscle paralysis to achieve forehead symmetry. Compression of injection sites was applied to stop bleeding if present, and at the end of the procedure, a light compression bandage was applied. Patients were transferred to the post-anesthetic care unit and were discharged without ward admission.

Post-procedure follow-up

Patients were prescribed oral broad-spectrum antibiotics, anti-inflammatory drugs, and analgesia, and were asked to sleep in a head-up position and avoid turning prone. At 48-h, patients re-attended the outpatient clinic for immediate PO evaluation, especially for complications, if any. Then, skin closure was reinforced using Steri-Strip (3x75 mm; Steri-Strip, 3M Health Care, Conway, USA) applied perpendicular to the wound line to be changed every 1 week for two months. Patients were asked to

re-attend the clinic at 2 weeks, 4 weeks, and 2 months for 12 months, and at the end of the follow-up, final photos were obtained.

Post-procedure Evaluation tools

Outcome assessment:

The applied scores for preoperative evaluation were repeated at 6- and 12-months PO. Satisfaction by the outcome was evaluated at 12-m PO using a 6-point verbal analogue score (Vr-AS) constructed as very satisfactory, satisfactory, good, fair, poor, and unsatisfactory.

Statistical analysis:

The obtained results were analyzed by the paired-*t* test and Chi-square test using a software program IBM Statistics (SPSS, version, 22, 2017, IBM, USA) with a P-value of 0.05 as the cutoff point for the significance of the differences. Categorical variables were summarized using relative frequencies and percentages, while continuous variables were summarized by the arithmetic mean and standard deviation (SD). Regression analysis was performed to determine the predictors of outcome.



Plate (1a): Pre-procedure photo



Plate (1b): The wound area was marked.



Plate (1c): two months post-procedure



Plate (2a): Pre-procedural photo for the forehead scar



Plate (2b): 2-m post-procedural photo for the forehead

RESULTS

The study started in December 2019 and was extended till December 2020 to allow at least 2-m follow-ups for the last case enrolled in the study. During the study duration, 47 patients were evaluated, but 15 were excluded for the presence of scar extension to involve the upper eyelid in 3, glabella and upper part of a nasal bridge in 3 and was associated with other facial wounds in 4 patients, two patients had associated nerve injury, two patients refused to participate in the study, and one patient had psychological upset. Thirty-two patients undertook the procedure, but unfortunately, two patients were lost during follow-up and were excluded from the study, and the outcome of 30 patients was presented in the study (Figure 1).

The study included 22 males and 8 females with a mean age of 29.6 ± 6.6 years and a mean body mass index (BMI) of 29.4 ± 1.5 kg/m². Twenty-one scars were in the range of 5-8 cm in length, 3 scars were 9-10 cm in length, and 5 scars were <5 cm in length, while one scar measured 11 cm. Eight scars appeared as three-armed scars extending between the two frontal prominences and reaching above the glabella as shown in photo numbered 1a. Seven scars appeared as an obtuse angular line, 10 scars appeared as curved lines and 5 scars appeared as straight lines (Table 1).

Subjectively, Patients' self-evaluation scores showed progressive significant ($P < 0.001$) improvement during follow-up (Figure 2). Also, patients' scar assessment scale score significantly ($P < 0.001$) decreased at 12-m PO in comparison to preoperative and 6-m PO assessments with significantly ($P < 0.001$) lower scores at 6-m PO than preoperative scores (Figure 3). Further, objectively SBSSES score increased significantly ($P = 0.0001$) at 6-m PO than preoperative score and at the 12th month PO the determined score was significantly higher in comparison to preoperative score ($P < 0.001$) and compared to the 6-m PO score ($P = 0.004$) as shown in Table 2, Figure 4).

At the end of 12-m PO, 18 patients (60%) found the aesthetic outcome was very satisfactory, 5 patients (16.6%) found it satisfactory, 3 patients (10%) commented by good, 4 patients found the aesthetic outcome fair ($n=2$; 6.7%) and poor ($n=2$; 6.7%) in comparison to the preoperative aesthetic appearance (Fig. 5). Mean satisfaction scoring was significantly ($P < 0.001$) higher by the PO aesthetic appearance (8.2 ± 1.8) in comparison to preoperative (2.4 ± 0.8) appearance (Figure 6).

The satisfaction score by outcome showed a negative significant correlation with female gender ($r = -0.487$, $P = 0.006$) and patients' BMI ($r = -0.371$, $P = 0.044$), while showing a positive non-significant correlation with patients' age ($r = 0.290$, $P = 0.119$). Further, the at 2m post-procedure satisfaction score showed a negative significant correlation with the patient's scar aesthetic score ($r = -0.452$, $P = 0.012$) and POSAS ($r = -0.494$, $P = 0.006$), while showing a positive significant correlation with the SBSSES score ($r = 0.522$, $P = 0.003$). Multivariate Regression Analysis defined a high pre-procedural patient's scar aesthetic score as a significant negative ($\beta = -0.417$, $P = 0.007$) predictor, while a high SBSSES score was a positive significant ($\beta = 0.492$, $P = 0.002$) predictor for high satisfaction by outcome.

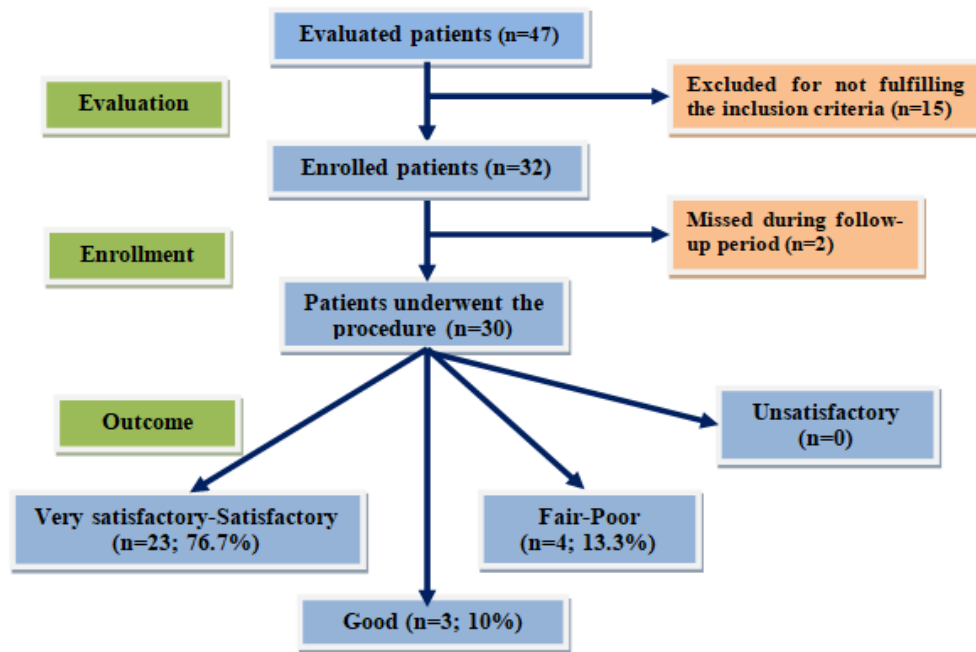


Figure 1: Study Flow Chart

Table 1: Patient demographic data and scar descriptions

Data		Findings
Age (years)	<30	16 (53.3%)
	30-40	11 (36.7%)
	>40	3 (10%)
	Mean (±SD)	29.6 (6.6)
Gender	Males	22 (73.3%)
	Females	8 (26.7%)
Body mass index (kg/m ²)	<30	23 (76.7%)
	>30	7 (23.3%)
	Mean (±SD)	29.4 (1.5)
Length of the scar (cm)	<5	5 (16.7%)
	5-8	21 (70%)
	9-10	3 (10%)
	>10	1 (3.3%)
Shape of the scar	Straight line	5 (16.7%)
	Curved line	10 (33.3%)
	Obtuse angular line	7 (23.3%)
	Three arms with a common center	8 (26.7%)

Table (2): Preoperative and PO scar assessment scores

		Preoperative	6-m PO	12-m Po
Patient's self-assessment scar evaluation	Mean(±SD)	5.8±1.5	2.8±0.7	1.5±0.6
	P1		<0.001	<0.001
	P2			<0.001
Patient and Observer Scar Assessment Scale	Mean(±SD)	23.1±2.9	10±1.9	3.6±1.5
	P1		<0.001	<0.001
	P2			<0.001
Stony Brook Scar Evaluation Scale	Mean(±SD)	2.9±1.1	3.9±1	4.7±0.5
	P1		0.0001	<0.001
	P2			0.004

P1 Preoperative versus postoperative 6 and 12 months; P 2, Postoperative 6 versus 12 months postoperatively.

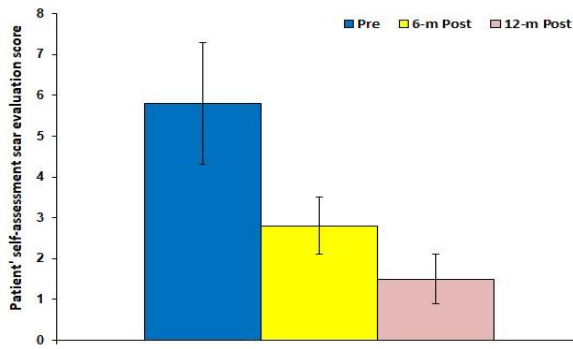


Fig. (2): Mean value of the patient's self-assessment scar evaluation score of studied patients

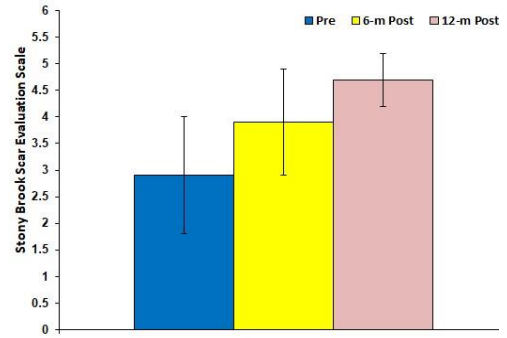


Fig. (4): Mean value of the Stony Brook Scar Evaluation Scale score of studied patients

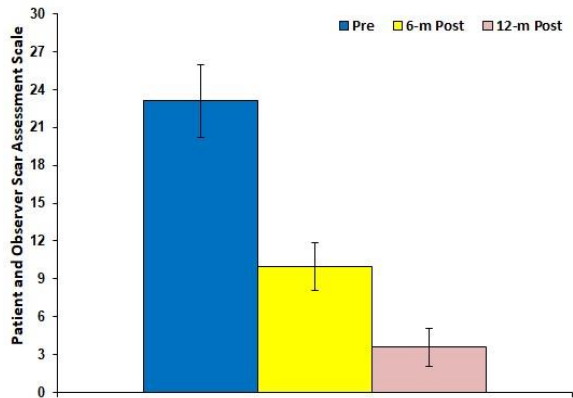


Fig. (3): Mean value of the Patient and Observer Scar Assessment Scale score of studied patients

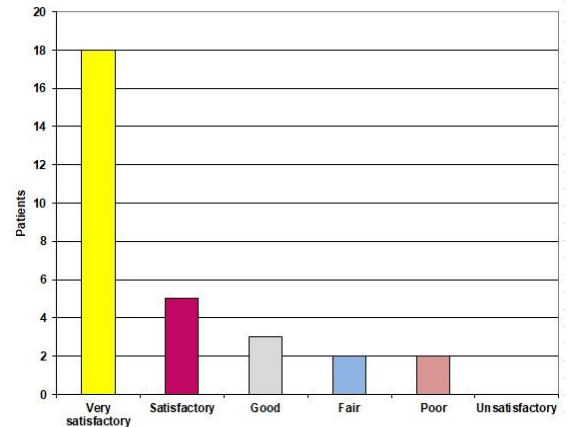


Fig. (5): Patients' distribution according to their satisfaction by outcome at 12-m PO

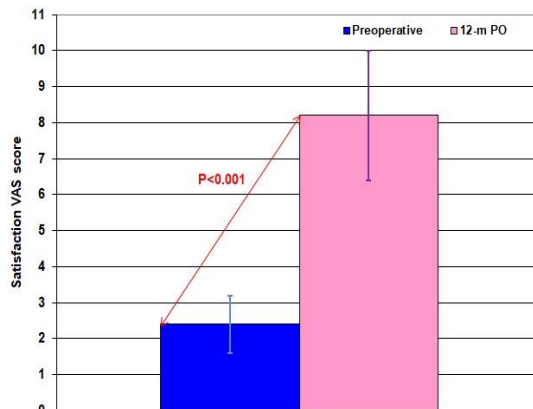


Fig. (6): Preoperative and Postoperative mean (±SD) score of satisfaction VAS score of studied patients

DISCUSSION

The current study tried to provide a non-invasive procedure for the management of disfiguring scars in a highly exposed area, the forehead skin, which is responsible for the bulk of facial expression and provides a major part of aesthetic appearance. The aesthetic outcome as scored on the VAS scale showed a mean score of 8.2, and 6 patients (20%) scored the aesthetic outcome with a VAS score of 10. Such a mean score was superior to that obtained by **Rao et al.**⁽¹⁶⁾ who reported an aesthetic outcome with a mean VAS score of 7.1 (±1.26) using

fat grafting to improve aesthetic and functional outcomes in facial scars.

Considering the forehead skin was part of the face that was mostly related to bones— frontal bone, anterior temporal lines, glabella, and orbital bone —and characterized by multiple furrows, it required meticulous wound repair. The satisfactory outcomes despite these considerations make the applied procedure more advantageous than the Rhombic flaps applied by **Agrawal**⁽¹⁷⁾ and provide excellent resurfacing for facial scars and defects elsewhere on the face than for scars on the bony

prominence.

In line with the obtained results, **Suh *et al.***⁽¹⁸⁾ evaluated the outcomes of triamcinolone with botulinum toxins, or CO₂ fractional lasers versus taping, silicone sheets, and ointments as prophylaxis in patients with facial laceration and reported significant differences in the used evaluation scores in favor of triamcinolone with botulinum toxin. Thereafter, **Lee *et al.***⁽¹⁹⁾ reported that, there was significant improvement of VSS scores, reduced wound width and scar discoloration among patients treated with BTXA than control group. These differences were recorded at the 6-month visit. However, values at the first month visit was statistically non-significant. This could be attributed to the significant inhibition of scar hyperplasia and reduction of a smaller scar width. Thus, improving the quality of the scar.

Also, **Guo *et al.***⁽²⁰⁾ performed a meta-analysis to assess the efficacy of BTXA in improving scar quality and wound healing. They reported that, BTA treatment group had significantly higher Visual Analog Scale scores, lower Vancouver Scar Scores, and thinner scars. Patient satisfaction was higher in the BTXA group than the control group (risk ratio: 1.25, 95% CI: 1.06 to 1.49, P = 0.01). Trivial adverse events were recorded.

In addition, **Bertucci *et al.***⁽²¹⁾ documented that Daxibotulinumtoxin-A (DAXI) was significantly more effective than placebo in reduction of glabellar line severity and maintained none or mild severity of the glabellar line for a median of 24.0 weeks. It was also well tolerated and treatment adverse effects were most commonly headache (6.4% vs 2.0%) and pain at the injection site (3.7% vs 3.9%).

In support of the efficacy of BTXA injection, **Gassner *et al.***⁽²²⁾ concluded that, BTXA induced immobilization of the wounds in the forehead. Thus, enhancing the healing. They advocated the use of BTXA in selected subjects to improve the final cosmetic appearance of the scar.

Furthermore, **Elshahed *et al.***⁽⁴⁾ found that BTXA is associated with clinical and aesthetic improvement than the control group. They added, it could be used as an adjunctive and useful tool to improve the scar cosmetic outcomes.

As further evidence for the efficacy of BTXA injection for scar refashioning and improving skin functionality, studies

using intra-lesional BTXA injection in keloids and hypertrophic scars detected efficiently improved associated itching and pain, scar pliability, erythema, and thickness⁽²³⁾ with highly significant difference between baseline and at end of 6-m follow-up clinical and histological aspects⁽²⁴⁾.

In a trial to investigate the mechanisms of action of Botulinum toxin type A (BTXA) on wounds and scar formation, **Zhou *et al.***⁽²⁵⁾ using immediate BTXA injection after wounding in an animal model, found BTXA injection inhibited microvessel density (MVD), and vascular endothelial growth factor (VEGF) expression in the treated than the control groups, on a time-dependent manner. This was associated with subsequent reduction of angiogenesis. Thus, inhibiting the formation of hypertrophic scars.

Evaluation of the ability of validated scar-assessment scales that were assessed pre-procedural for prediction of post-procedure satisfaction by outcome, defined high patients' self-assessment of scar and the Stony Brook Scar Evaluation Scale (SBESS) scores as negative and positive predictors, respectively for the satisfaction by outcomes. In line with these findings, multiple recent studies assured the ability of patient scar assessment and SBESS scores to evaluate scar outcomes^(18, 26).

Conclusion: Botulinum toxin injection after excision of disfiguring forehead scars provided highly satisfactory outcomes with a reduction of the scar width, irrespective of the scar shape. Scar evaluation scales showed significant differences at 6-m and 12-m PO in comparison to preoperative scales. Female gender and obesity could predict poor outcomes of the procedure. Also, a high patient self-assessment scale and SBESS could significantly predict the outcomes of aesthetic procedures.

Conflict of interest: None

Financial Disclosure: None

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