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Assessment of scaring in lacerated wounds with and without botulinum toxin as an adjuvant for scaring

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ABSTRACT

Background: Facial scars can have a lasting, negative impact on an individual's self-perception and social interactions. Injecting botulinum toxin type A (BTX-A) locally to produce temporary muscular paralysis to relieve the tensile forces acting on suture line, thus improving the appearance of the scar. The concept of relaxed skin tension lines (RSTL) supports this idea, as scars aligned with these lines experience reduced tension and heal better. **Aim:** This study evaluates the effectiveness of botulinum toxin on scaring after facial lacerations, comparing treated and untreated wounds based on color, width, elevation, and induration to determine its impact on scar appearance and quality.**Material and method-** In this study, patients with posttraumatic facial lacerations were locally injected with BTX-A before suturing (with vicryl 4-0 and ethilon 5-0 in layers). BTX-A reformulated with local anesthetic with vasoconstrictive was used in this study for immediate action. Patients were followed for a duration of 6 months for scar evaluation. **Result:** A total of 36 patients with traumatic facial lacerations were included in the study. This study demonstrated significantly less increase in scar width ($P = 0.000$) and irregularities ($P = 0.017$), and improved discoloration of the scar ($P = 0.000$) in patients who received BTX-A injection. The overall results showed significant ($P < 0.005$)**Conclusion:** botulinum toxin-induced chemo-immobilization significantly improved the cosmetic appearance of traumatic laceration over the face with no adverse effects.

Keywords: Scar, wound healing, botulinum toxin, RSTL(relaxed skin tention lines)

I. INTRODUCTION

Facial scars can have a lasting, negative impact on an individual's self-perception and social interactions. Wound healing is influenced by various intrinsic and extrinsic factors, including tissue type, disruption nature, and wound closure. Scar widening occurs when newly formed collagen is subjected to opposing tensile forces before reaching maturity. These forces, caused by muscle pull, skin elasticity, and external pressure, can lead to unestheticscars(1)

The concept of relaxed skin tension lines (RSTL) supports this idea, as scars aligned with these lines experience reduced tension and heal better. Conversely, scars oriented against RSTL are prone to repetitive tension, resulting in widening. This study excludes lacerations along RSTL to minimize bias. Various guidelines and approaches have been proposed to mitigate or prevent wide scars, highlighting the need for effective strategies to optimize wound healing and minimize scar visibility.

Botulinum toxin has been extensively used to treat facial rhytids since Carruthers and Carruthers described its cosmetic use in theface.(2)

Botulinum toxin's potential in reducing facial scars was first explored by Gassner et al[3] in 2002(3). Their primate study showed significantly improved cosmetic outcomes in scars treated with botulinum toxin. The neurotoxin induces chemodenervation, preventing acetylcholine release and leading to functional denervation of striated muscle for 2-6 months after injection(4). This results in muscle fiber atrophy and clinical flaccid paralysis. Temporary paralysis of facial muscles underlying the wound provides rest during healing, allowing collagen to mature. However, botulinum toxin takes 48-72 hours to achieve complete muscle paralysis, during which underlying musculature can act on the suture line. Reformulation with local anesthetic and vasoconstrictor enables immediate action, stabilizing neuronal membranes and blocking efferent fibers. This enhances local availability and efficacy. The action of the vasoconstrictive agent is to achieve its effect through its sympathomimetic properties that act on the receptors, reducing the local diffusion of the anesthetic agent, which would also prevent

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diffusion of BTX-A, thereby improving its local availability(5).

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II. MATERIALS AND METHOD

This studywas a randomized comparative clinical study conducted from November 2023-January 2025. Total 36 patients randomly divided into two groups (18 patients each) after due approval of the institutional ethical committee

The inclusion criteria were as follows:
1. Patients older than 18 years.
2. Patients with traumatic lacerations on face.
3. Patients giving consent for the procedure and agreeing for follow-up visits.

The exclusion criteria were as follows:
1. Patients younger than 18 years.
2. Wound parallel to Langer lines.
3. Pregnant and lactating female.
4. Lacerations near any neurovascular bundle or vital structures.
5. Previous injection with botulinum toxin within 6 months.
6. Allergy to botulinum toxin.
7. Patients with myasthenia gravis.
8. Patients on medications that interfere the neuromuscular conduction.
9. Patients with multiple lacerations or with tissue loss.
10. Patients not willing for the study.

Patients were divided to two groups
Group A- Patients with posttraumatic facial laceration were not injected with BTX-A before suturing.
Group B- Patients with posttraumatic facial lacerations were locally injected with BTX-A before suturing

Group A-

For the patients in Group A, debridement of wound was done and the surrounding skin was prepared using the standard aseptic procedure using betadine solution and normal saline. Laceration length was measured by using a measuringinstruments(Vernier Calliper, threads and millimetres scale). Local anaesthesia was attained using adequate volume of infiltration using 2% lignocaine with 1:200,000 adrenaline at operating site. Lacerations was sutured in layers with vicryl 4-0 (subcutaneous layer) and Ethilon 5-0 (cutaneous layer) sutures using simple interrupted technique.

Group B-

Every patient in Group B was subjected to an allergy skin test for BTX-A (SIAX; Aakar Pharmaceuticals, Mumbai, India). Debridement of wound was done, and the surrounding skin was prepared using the standard aseptic procedure using betadine solution and normal saline. Laceration length was measured using a measuring instruments (Vernier Calliper, threads and millimetres scale. Medication of this study was formulated by mixing 100 U of BTX- A with 10ml of 0.9% injectable saline + 3mL of solution of 2% lidocaine with epinephrine 1: 200,000 per vial (LOX; NEON Laboratories, Chandigarh, India). This yielded 13mL of solution per vial Local anesthesia was attained using adequate volume of infiltration using 2% lignocaine with 1:200,000 adrenaline (LOX). The BTX-A was injected adjacent the wound along the length of the laceration.A volume of 1.5 U (0.19mL) per cm of wound length was injected, with the needle prick placed approximately 3–4mm from the edge of the wound to the depth of expected facial musculature around the specific anatomic site of the wound(approximately 5–8mm). Lacerations was sutured in layers with vicryl 4-0 (1.5 m, 16mm 1/2 circle, round bodied, absorbable surgical suture USP synthetic; Ethicon; Johnson & Johnson Pvt. Ltd., Aurangabad, India; subcutaneous layer) and ethilon 5-0 (1 m, 12mm 3/8 circle, reverse cutting, nonabsorbable surgical suture USP; Ethicon, manufactured in India by Johnson & Johnson Pvt. Ltd.; cutaneous layer) using simple interrupted technique.

III. RESULT

A total of 36 patients with traumatic facial lacerations were enrolled in this study. The patients were randomized into two groups. The total number of females and males enrolled in the group A was 4 and 14, respectively. The total number of females and males enrolled in the group B was 3 and 15, respectively.

At the end of the study, 2 patients failed to complete the 6-month follow-up (n = 1 in the group A and n = 1 in thegroup B). Therefore, those patients were completely eliminated from the study. The minimum wound size in the groupA was 2cm and the maximum was 14cm, with mean wound size 4.27 cm (standard deviation of 2.81).

The wound size in the group B was minimum 2 cm and maximum 9cm, with a mean of 4.54cm (standard deviation of 1.96).

The mean dose of botulinum toxin injected per patient in the group B(BTX-A Group) was 6.40 U, with minimum of 3 U and maximum of 21 U. Wound was localized to the frontal bone in 63.6% of the cases in the group A and in 59% of the cases in the group B, followed by the chin region of mandible in 27.4% of the cases in the group A and 22.9% of the cases in the control group.

The parameters evaluated included color change, width, elevation, and induration of the scar. The parameters were evaluated by two surgeons and scored from 0 to 10. Mean of both the scores was used for further analysis. The descriptive statistics were expressed as mean and standard deviations. The intragroup comparison of the visual analog scale (VAS) scores of different parameters was done at 1-week, 3-month, and 6-month follow-up using one-way analysis of variance, In the group B, this comparison was statistically significant for all the parameters: color change, width, elevation, and induration (P value < 0.05) [Table 1]. In the group A, this comparison was statistically insignificant for all the parameters from 1 week to 6 months except for width that was statistically significant (P value < 0.05) from 1 week to 6 months with P value = 0.021 [Table 2]. At different time intervals, the intergroup comparison of VAS scores for different parameters was assessed using the unpaired t-test among the BTX-A group and the control group. Statistically significant differences were seen at 1-week, 3-month, and 6-month follow-up [Table 3]] (P value <0.05*)between both the groups for color change, width, elevation, and induration [Figures 6 and 7]. The scars were evaluated by patients themselves for subjective satisfaction rating (very unsatisfied, unsatisfied, satisfied, and very satisfied). Frequency analysis and the chi-square test of proportion were done to find out statistically significant differences. The scars significantly improved over the period of 6 months with patients giving positive responses of very satisfied and satisfied in the BTX group. The results were statistically significant (P value < 0.05) with P = 0.031 at 1 week, P = 0.010 at 3 months, and P = 0.001 at 6 months [Chart 2]. Significant improvement was also seen for the scar in the group A with maximum responses received as satisfied [Chart 2]. At different time intervals, the intergroup comparison of frequency of patient self-assessment scale (PSAS) responses was assessed among the BTX group and the group A [Table 4].

The overall assessment of the PSAS responses states that approximately an average of 72% patients were very satisfied with the BTX-A treatment as compared to an average of 15% of patients who were very satisfied with the scar in the control group. Therefore, the overall assessment of the patients' responses using PSAS scales for all the parameters states that the patients were more satisfied with BTX-A treatment than the group A

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Table 1: Intragroup comparison of VAS score of different parameters at 1-week follow-up in the BTX-A group and control group

Group A-VAS score		F value	P value
Color change	1 week	1.781	0.183
	3 month		
	6 month		
Width	1 week	3.996	0.003*
	3 month		
	6 month		
Elevation	1 week	2.371	0.213
	3 month		
	6 month		
induration	1 week	4.756	0.153
	3 month		
	6 month		

Group B(BTX Group)-VAS score		F value	P value
Color change	1 week	7.133	0.001*
	3 month		
	6 month		
Width	1 week	6.211	0.020*
	3 month		
	6 month		
Elevation	1 week	4.771	0.013*
	3 month		
	6 month		
induration	1 week	3.527	0.081*
	3 month		
	6 month		

VAS = visual analog scale, BTX-A = botulinum toxin type A. *P value < 0.05

VAS score	Follow-up	Intervals	Mean difference	P value
Color change	1week follow-up	3- month follow-up	-0.94	0.252
		6- month follow-up	-1.29	0.078
	3 month follow-up	6- month follow-up	-0.35	0.823
	1-week follow-up	3- month follow-up	-1.08	0.17
		6- month follow-up	-1.62000*	0.021*
	3 month follow-up	6- month follow-up	-0.54	0.635
	1-week follow-up	3- month follow-up	-0.76	0.417
		6- month follow-up	-1.1	0.165
	3 month follow-up	6- month follow-up	-0.34	0.837
	1-week follow-up	3- month follow-up	-1.01	0.227
		6- month follow-up	-1.32	0.083

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	3 month follow-up	6- month follow-up	-0.31	0.867

Table 2: Intragroup pairwise comparison of VAS score of different parameters at 1 week, 3 months, and 6 months in the BTX-A group

VAS = visual analog scale, BTX-A = botulinum toxin type A. *P value < 0.05

Table 3: Intergroup comparison of VAS score of different parameters at 1-week, 3-month, and 6-month follow-up between the group A and group B(BTX-A Group)

Vas score		1 WEEK			3 MONTH			6 MONTH		
		Mean	t value	p value	Mean	t value	p value	Mean	t value	p value
Color change	Group B(BTX-A)	1.31	4.04	0.000*	1.3	6.09	0.000*	1.64	4.31	0.000*
	Group A									
Width	Group B(BTX-A)	1.8	4.89	0.000*	1.61	5.89	0.02*	1.67	4.3	0.000*
	Group A									
Elevation	Group B(BTX-A)	0.68	2.27	0.028*	0.81	3.32	0.001*	1.11	2.47	0.017*
	Group A									
Induration	Group B(BTX-A)	0.95	2.89	0.006*	1.02	3.58	0.000*	2.93	1.75	0.02*
	Group A									

VAS = visual analog scale, BTX-A = botulinum toxin type A. *P value < 0.05

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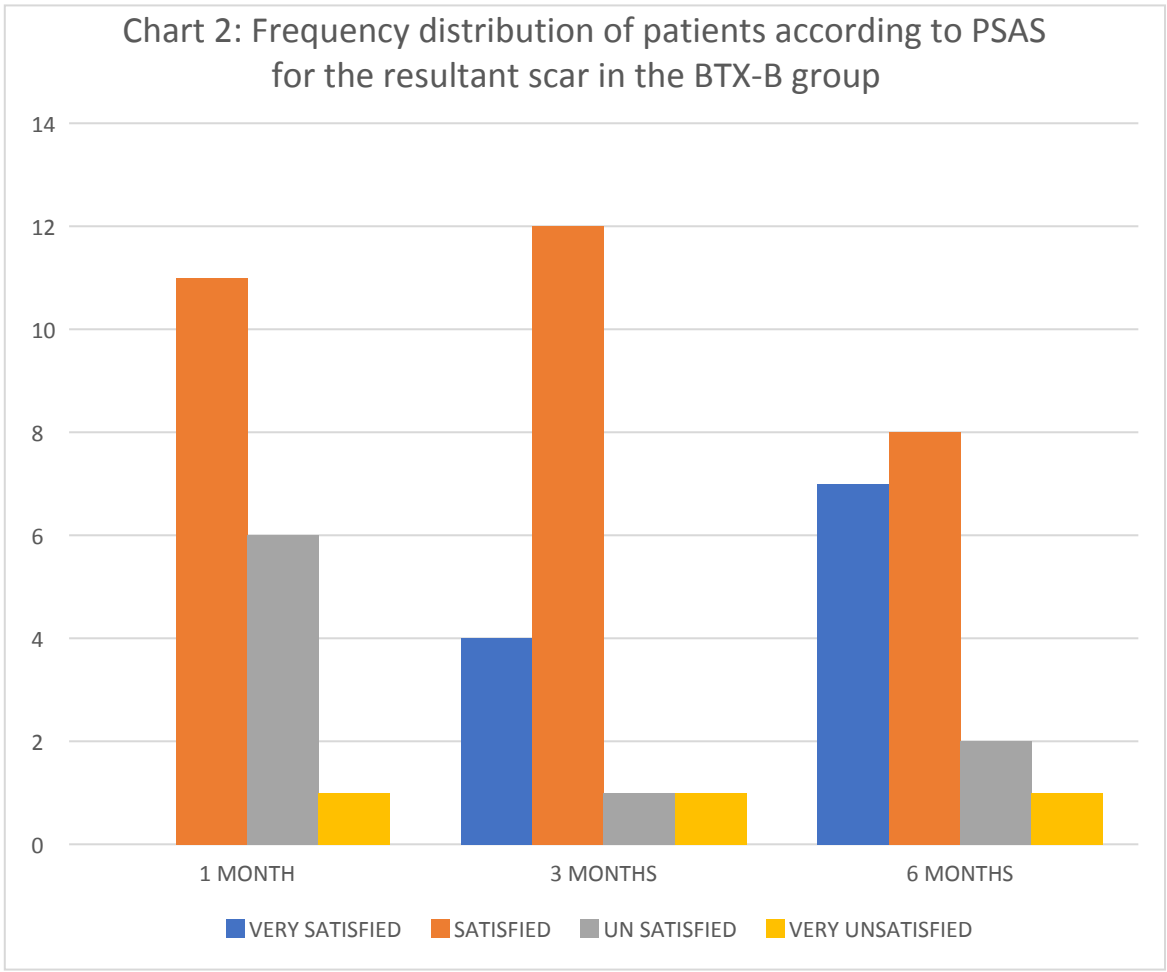

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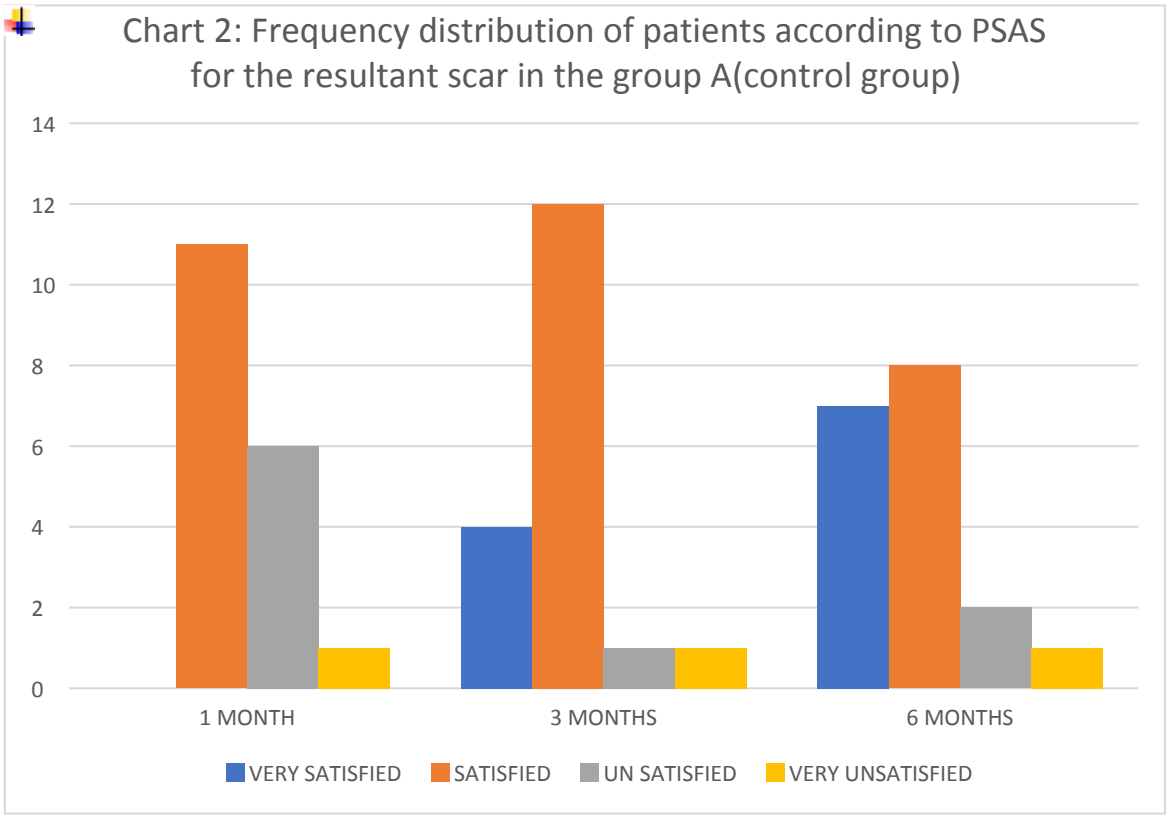

Chart 2: Frequency distribution of patients according to PSAS for the resultant scar in the BTX-B group and group A at different time intervals.

Table 4: Intergroup comparison of PSAS score of different parameters at 1-week, 3-month, and 6-month follow-up between the BTX-A group and control group

Parameters	PASAS reponses-1 week follow-up Very satisfied(%) Satisfied(%) Unsatisfied(%) Very unsatisfied(%)							
	Group A	Group B	Group A	Group B	Group A	Group B	Group A	Group B
Scar satisfaction at 1 week		45.5	45.5	50	50	4.5	4.5	-
Scar satisfaction at 3month	18.2	81.8	72.7	18.2	9.1	-	-	-
Scar satisfaction at 6 month	31.8	90.9	63.6	9.1	4.5	-	-	-

IV. V. DISCUSSION

Wide ugly looking scars, especially on the visible areas of face, trigger varying levels of psychological distress and contribute to a lowered self-esteem and social awkwardness. Suturing of posttraumatic lacerations over face is usually followed by scarring and remains a frequent concern faced by the surgeons.

Tension is one of the chief factors determining the degree of scar formation, this

principle also holds true in skin lesions(6) Various techniques, such as placing scars in line with the relaxed skin tension lines, using local flaps, or undermining wound edges, are applied to reduce excessive tension on incisions.(7) These techniques, however, minimize rather than eliminate the tension acting on the healing wound. Repeated microtrauma, caused by continuous displacement of injured tissue, induces a prolonged inflammatory response and an increased metabolic activity during the healing process. As a consequence, extracellular deposition of collagen and glycosaminoglycans can intensify and lead to hypertrophic scars.

Temporary paralysis of the muscle underlying a wound is a new technique to minimize tension on the healing wound edges.

Surgeon can achieve such paralysis with local botulinum toxin A injection in a predictable fashion and thus precisely immobilize the skin adjacent to certain cutaneous wounds. Botulinum toxin A injections are safe and reliable when performed by an experienced surgeon. The dosage required for local immobilization of a facial wound usually does not exceed 1 unit of Botox/kg of body weight. In a previous primate study, no systemic side effects were observed at dosages below 33 units/kg body weight.(8)

VI. CONCLUSION

The ultimate goal of wound management is to achieve a functional and cosmetically acceptable scar. One way to improve the appearance of the scar is to eliminate the tension caused by pull of underlying muscles that exerts pull on the wound margins. Temporary denervation with a chemical agent is a convenient and useful option to achieve the desired effect of reducing the muscle pull, subsequent microtrauma, and eventually scar hypertrophy during wound healing, thereby improving the appearance of the scar. It was observed that botulinum toxin-induced chemoimmobilization significantly improved the cosmetic appearance of traumatic laceration over the face with no adverse effects.

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Conflicts of interest
There are no conflicts of interest

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