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Staged Scar Revision of Angulated Facial Scar

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Scar revision techniques are chief among the most important skills for facial plastic and reconstructive surgeons. In order to achieve the least amount of scarring following a surgical procedure, it is crucial that the surgeon always consider skin tension. In our hospital, staged scar revision was conducted on patients with angulated facial scars in order to reduce skin tension.

We conducted a retrospective chart review of patients undergoing staged scar revision for angulated facial scars at our hospital from July 2002 to September 2010. The follow-up period was at least six months. All pre-and post-operative photographs were analyzed by two independent plastic surgeons. And the patients were asked to rate their overall satisfaction with their scar revision as very satisfied (5), satisfied (4), neutral (3), dissatisfied (2) or completely dissatisfied (1).

Staged scar revision was used in 51 patients with angulated facial scars. Overall, a significantly improved scar and above (score ≥ 4), graded by an independent plastic surgeons, was notes in 47 patients (92.1%). And, 45 patients (88.2%) were satisfied with their scar revisions. In all cases, the postoperative clinical course was uneventful without any complications.

In conclusion, staged scar revision is considered a good option for the treatment of angulated facial scar.

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Key Words: Tension, Scar, Surgical revision

I. INTRODUCTION

The process of scar formation results in mending and healing of bodily tissues after dermal injury.^{1,2} Although scars are vital in the reparative process, they can be cosmetically and functionally disruptive, affecting the person's

self-image. In particular, people perceive their facial scars as visually disfiguring and undesirable. Thus facial scars are one of the most common problems addressed by plastic surgery departments. Patients frequently call upon facial plastic surgeons for the revision and correction of scars. Although complete removal of scars to a preinjury state is unrealistic, scar revision techniques have been developed and modified to manage and reduce scars. In order to obtain the least amount of scarring following scar revision, it is crucial that the surgeon always consider skin tension. Whether the result of scar revision is good or not is closely related to skin tension. Therefore, plastic surgeons should attempt to minimize skin tension at wound edges during surgery.^{2,3}

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In the case of angulated facial scars, more tension is applied when a one-step operation is performed. Accordingly, in our hospital, staged scar revision, in which the operation is divided and performed in at least two steps, was performed to minimize skin tension in patients with angulated facial scars. And we would like to review our experience about it.

II. MATERIALS AND METHODS

A. Patients and Methods

This study involved retrospective review of charts from patients treated for angulated facial scars at Kangbuk Samsung Hospital from July 2002 to September 2010. Staged scar revision was used in 51 patients with angulated facial scars. In this study, 51 patients were followed-up for at least six months after secondary scar revision. The results were assessed both objectively using serial photography and subjectively according to patient assessment. For the objective assessment, two plastic surgeons who were not involved in the surgeries assessed the surgical outcomes using serial photography. For the subjective assessment, six months after the second operation, the results of the revision were evaluated by the patients based on their postoperative satisfaction ratings on a scale from 1 (completely dissatisfied) to 5 (very satisfied).

B. Comparing the skin tension: One-step scar revision versus Staged scar revision

The ends of the angulated facial scars were denoted as A and B , respectively, and the angle between A and B was denoted as θ . The skin tensions that affected A and B were denoted as x and y , respectively, assuming that the forces that affected A were bilaterally identical, as were the forces that affected B (Fig. 1).

When scar revision was performed in one step, the vector of the downward force was computed with the following formula: $\sqrt{x^2 + y^2 - 2xy \cos(180 - \theta)}$. The vector of the upward force was computed with the following formula: $\sqrt{x^2 + y^2 - 2xy \cos(\theta - 180)}$. The aforementioned force vectors that affected the scar during one-step revision were shown to be greater than x and y , respectively.

C. Surgical Technique and Postoperative Care

Based on the fact that skin tension is greater in the one-step correction of angulated scars than it is in the staged correction, staged revision was performed in our

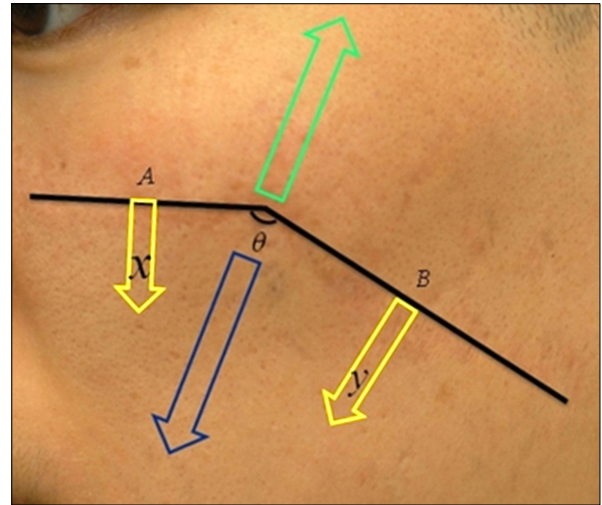


Fig. 1. The length of a facial angulated scar was denoted as A and B , respectively. The angle between A and B was denoted as θ . The skin tension that affected A and B were denoted as x and y , respectively.

hospital among patients with clear angulated scar on their face which could be observed with naked eyes (about $(180 - \theta) > 30$).

The primary excision range of the scar was determined, and the elliptical excision line was marked on the skin using a skin-marking pen. The wound was anesthetized with 1% lidocaine with 1:100000 epinephrine administered through a 5-mL syringe and a 30-gauge needle for enhanced patient comfort. Following administration of the anesthetic, an incision was made with a no. 15 scalpel blade, and the scar was excised to the level of healthy subcutaneous tissue. Bleeding was controlled via bipolar coagulation. To reduce wound tension, lateral skin edges were undermined with scissors held horizontally in the level of the upper fat.

The wound was then closed in two layers; dermis and subcutaneous tissue were closed with 5-0 polyglactin (Vicryl) sutures in an interrupted fashion, and 6-0 black monofilament nylon sutures were used to create a running double-locked skin closure. After intradermal closure, we induced frostbite injury on the wound edge using dry ice which was developed and has been used in our hospital since 2003.⁴

After surgery, wound dressing was performed on either postoperative day 1 or 2, and stitches were removed on one of postoperative days 4 through 6. After the stitches were removed, tape was applied over the wound for three weeks to reduce skin tension. During outpatient follow-up after the first operation, a secondary operation for the remaining

scar was planned.

The secondary scar revision was performed using the same protocol at least six months after the first scar revision. The patients were followed-up for at least another six months. Photographs of the scars were taken before the first scar revision, and then serial photographs were taken of the scars at each consultation to allow for comparison.

D. Statistical Analysis

All statistical analyses were conducted using IBM SPSS version 18.0 (IBM, Armonk, New York, USA). The descriptive statistics were presented as both numbers and percentages of patients or as means and standard deviation (or range). For patient satisfaction and doctor's evaluation score, measured on a five-point scale, nonparametric statistics were used and were presented as median (25~75th). Mann-Whitney test was used to determine statistical significance for scar etiology and postoperative result. Kruskal-Wallis test was used to determine statistical significance for scar location and postoperative result. Post hoc comparison was performed using the Duncan method using ranks. A value of $p < 0.05$ was considered statistically significant.

III. RESULTS

Of the 51 patients, 19 (37.3%) were male and 32 (62.7%) were female patients. The patients age ranged from 13 to 61 years (mean, 29.3 years). This study was conducted on patients with angulated facial scars; 20 patients (39.2%) had cheek scars, 13 (25.5%) had scars on their forehead, six (11.8%) had scars in the mentum area, five (9.8%) had scars in the nasolabial area, four (7.8%) had scars in the glabella area, and three (5.9%) had temple area scars. All scars initially resulted from traumatic injuries, with sharp objects being the cause in 24 cases (47.1%) and blunt objects in 27 cases (52.9%)(Table I). Wound lengths ranged from 3 to 16 cm (mean, 6.8 cm).

Consensus ratings by the two independent plastic surgeons found that outcomes were very much improved (5) in 17 (33.3%) patients, significantly improved (4) in 30 (58.8%) patients, and no change (3) in 4 (7.9%) patients. The average score was 4 (4~5). No outcomes were rated as significantly worse (2) and very much worse (1). The patients were asked to rate their overall satisfaction with their scar revision as very satisfied (5), satisfied (4), neutral (3), dissatisfied (2) or completely dissatisfied (1). 14 patients

(27.4%) rated their scar revisions as very satisfied, 31 (60.8%) were satisfied, five (9.8%) were neutral, and one (2%) thought dissatisfied. The average score was 4 (4~5). None of the patients rated the outcome as completely dissatisfied. Overall, 88.2% of the patients were satisfied with their scar revisions. In all cases, the postoperative clinical course was uneventful without complications (Table II, III).

The result was sorted by the etiology and location of the scar. As for the patient satisfaction score by the etiology of the scar, it was 4 (4~4.75) in the case of stab, and 4 (4~5) for blunt injury, there were no statistically significant differences, and there were also no significant differences between doctors'

Table I. Patient's Characteristics

	Total patients (n=51)
Age, years	29.3 (range, 13 to 69 years)
Gender	
Male, n (%)	19 (37.3%)
Female, n (%)	32 (62.7%)
Location	
Cheek, n (%)	20 (39.2%)
Forehead, n (%)	13 (25.5%)
Mentum, n (%)	6 (11.8%)
Nasolabial area, n (%)	5 (9.8%)
Glabella, n (%)	4 (7.8%)
Temple, n (%)	3 (5.9%)
Etiology	
Sharp injury, n (%)	24 (47.1%)
Blunt injury, n (%)	27 (52.9%)

Table II. Post-treatment Outcomes according to Plastic Surgeon Consensus

Outcomes	No.	%
Very much improved (5)	17	33.3
Significantly improved (4)	30	58.8
No change (3)	4	7.9
Significantly worse (2)	0	0
Very much worse (1)	0	0
Total	51	100

evaluation results by the cause. And as for the results by location of the scar, patient satisfaction values showed no significant differences ($p=0.069$), but there were significant differences of doctors' evaluation results ($p=0.041$)(Table IV). Case examples are shown in Figs. 2~4.

Table III. Overall Patient Satisfaction after Scar Revision

Outcomes	No.	%
Very satisfied (5)	14	27.4
Satisfied (4)	31	60.8
Neutral (3)	5	9.8
Dissatisfied (2)	1	2
Completely dissatisfied (1)	0	0
Total	51	100 (%)

IV. DISCUSSION

A scar is a mark that is produced during the normal healing process. Scars, particularly facial scars, cause significant social and mental stress. With modern society's growing interest in aesthetics, patients with scars have become more sensitive and more frequently visit cosmetic surgeons to correct their scars. Accordingly, many techniques that reduce scars have been studied and developed. Methods that deal with scar correction can mainly be classified into non-surgical methods, such as steroid injection, laser therapy, dermabrasion, and filler injection, and surgical methods, such as fusiform excision, z-plasty, and w-plasty.^{5,6} Surgical methods are needed to achieve satisfactory outcomes.⁷ Factors associated with scar formation should be considered to achieve satisfactory surgical outcomes. Such factors include the relationship between the scar and the relaxed skin



Fig. 2. A 15-year-old boy presented with a angulated scar of the right nose and alar-facial groove following repair after laceration. (Above, left) Preoperative view. Scar revision was planned about the upper part of scar (Above, right) 6 months after the initial scar revision. The next operation was planned about the middle part of scar. (Below, left) 3 years after a second stage scar revision. scar revision was planned about the rest of the lower part. (Below, right) Final results; 42 months after the initial scar revision. A marked improvement in appearance and a smooth nose and alar-facial junction were achieved.

Table IV. Result of Stated Scar Revisions (n=51)

Scar	No.(%)	Patient rating score	Doctors rating score
Location			
Cheek	20 (39.2)	4 (4~4)	4 (4~4.75)
Forehead	13 (25.5)	4 (4~5)	5 (4~5)
Mentum	6 (11.8)	3.5 (2.75~4)	4 (3~4) [†]
Nasolabial area	5 (9.8)	5 (4~5)	5 (4~5) [†]
Glabella	4 (7.8)	4 (4~4.75)	4 (4~4) [†]
Temple	3 (5.8)	4 (3~ ·)	5 (4~ ·) [†]
<i>p</i>		0.069	0.041 *
Etiology			
Sharp injury	24	4 (4~4.75)	4 (4~5)
Blunt injury	27	4 (4~5)	4 (4~5)
<i>p</i>		0.607	0.965
Average		4 (4~5)	4 (4~5)

*: Statistically significant, $p < 0.05$

[†]: $p < 0.05$ compared with the mentum group

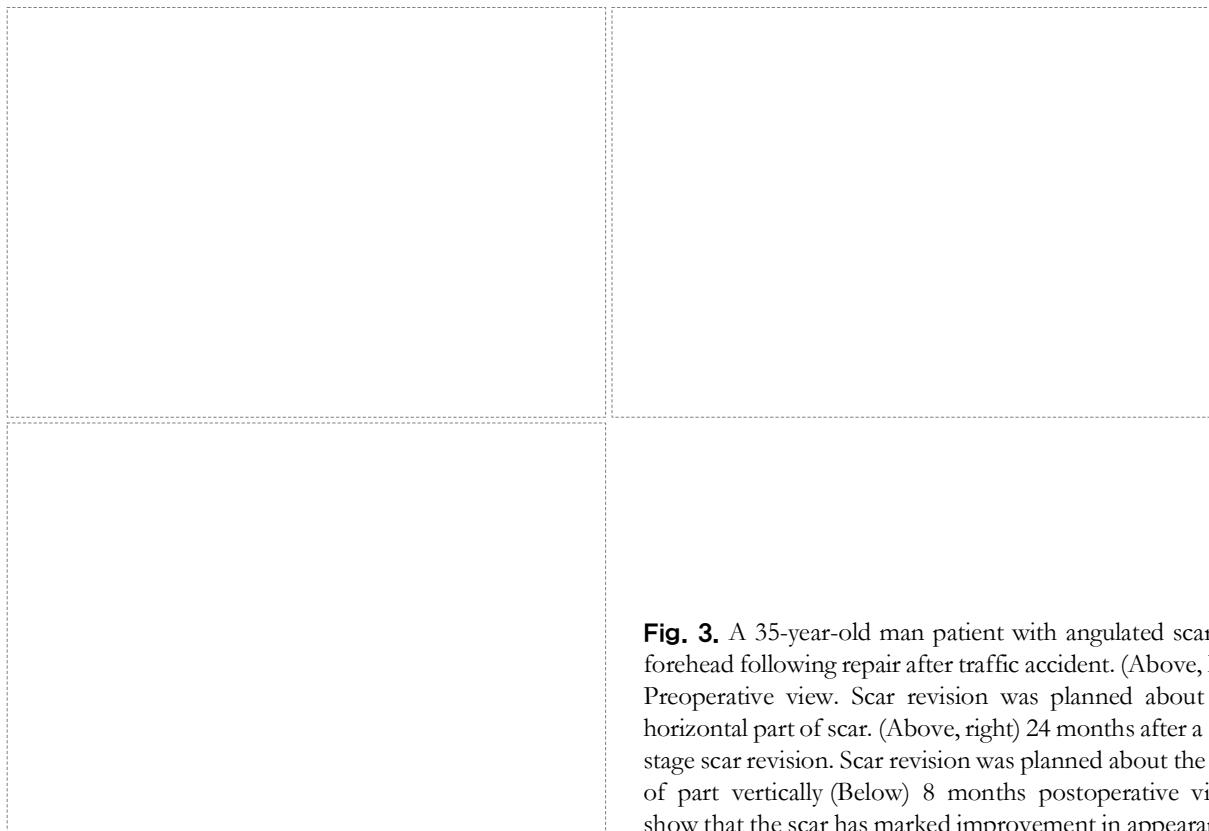


Fig. 3. A 35-year-old man patient with angulated scar on forehead following repair after traffic accident. (Above, left) Preoperative view. Scar revision was planned about the horizontal part of scar. (Above, right) 24 months after a first stage scar revision. Scar revision was planned about the rest of part vertically (Below) 8 months postoperative views show that the scar has marked improvement in appearance.



Fig. 4. (Above, left) Preoperative view of a 40-year-old woman patient with angulated scar on mentum following repair after traffic accident. Scar revision was planned about the right of oral commissure and the vertical scar of the left side. (Above, right) 6 months after the initial scar revision. Scar elevation and redness are still remaining. (Below, left) At 12 months postoperatively, scar elevation and redness have improved, so planned operation was performed horizontally for the rest. (Below, right) 15 months after a second stage scar revision. Note the residual elevation of the scar, although the overall appearances were noticeably improved.

tension line (RSTL); skin tension; scar location, depth, and color tone; severity of the wound; mechanism of injury; and patient age and pigmentation.⁸ Among these factors, skin tension is the strong force that acts to separate the borders of a wound and tends to widen linear scars. Tension or mechanical factors are known to play an important role in determining the final appearance of a scar.^{3,8,9}

The wound healing process, which involves the process of scar formation, consists of the following subprocesses: inflammation, proliferation, and remodeling. Inflammation is the first stage of wound healing and includes hemostasis. In this stage, various inflammatory factors are released to promote fibroblast activation. In the second stage of proliferation, the extracellular matrix, which consists of proteoglycan, hyaluronic acid, fibronectin, and collagen, is

formed through the activities of fibroblasts. In addition, angiogenesis and re-epithelialization are achieved during this stage. In the third stage, the generation and degradation of collagen and the extracellular matrix are balanced, and the wound tensile strength increases, resulting in the formation of a mature scar through wound scar remodeling.

In the wound healing process, mechanical tension not only drives fibroblast proliferation and collagen synthesis but also induces dermal remodeling.

In the case of scar widening or hypertrophic scarring, significant tension exerted in many directions serves to oversituate the fibroblast producing excess collagen which is the main constituent of the scar. And the distracting tensile forces applied on the evolving collagen molecule

determine the direction of covalent crosslinks, rendering the newly formed collagen resistant to vectors in a particular direction.⁸⁻¹⁰

Therefore, in order to obtain the least amount of scarring following a scar revision, it is crucial that the surgeon always consider skin tension.

To reduce skin tension at the suture area, sufficient undermining tissue¹¹ and rigid intradermal suture, and taping have been widely used.² In addition, a method, which reduces skin tension via muscle paralysis through Botox injection has recently been introduced.¹² Furthermore, in the revision of a scar that is inconsistent with the facial RSTL, a method that repositions the scar parallel to the RSTL as much as possible using z-plasty or w-plasty may be considered. However, this method has several disadvantages, such as inevitable scar extension, unnecessary removal of some normal tissue, flap necrosis due to incomplete suturing of the small triangular flap edge, potential risk of trapdoor deformity scar formation, and longer operation time.^{13,14} To avoid the aforementioned problems, scar revision with a method of fusiform was conducted on patients with facial scars in the authors' hospital.¹⁵ The authors used the method of fusiform excision wherein the excision was made along the border line of the scar regardless of the scar and the facial RSTL. In addition, staged scar revision was performed to reduce skin tension after scar revision. In theory, as explained before, for facial angulated scars, when scar revision was performed in one step, scar widening may happen because the tension works a lot; and in the matter of fact, the tension which work on the two sides become different, and results like trapdoor deformity happen once in a while. So, our hospital performed staged scar revision for the patients who come for their facial angulated scars.

And as we introduced before, our hospital uses frostbite using dry ice which has little side effects like pigmentation and has the similar effect as laser or dermabrasion. It can be easily made, simply used, and it's a means of low-price with which we could improve scars. When finished suturing the dermis, using dry ice stick, frostbite in a local area of the two edges of the sutured part. This method has little hyperpigmentation due to the sensitivity of melanocytes to cold injury. And the tissue destruction is progressed selectively because of the resistance of collagen against the cold injury and the preserved dermal fibrous network as the structural framework.⁴

During outpatient follow-up after the initial scar revision,

a secondary operation for the remaining scar was planned. The interval between the first and second scar revisions was at least six months, well into the final phase of wound healing when mature collagen makes up most of the bed.⁶

The authors sorted the results by the etiology and location of the scar, and in this study no correlation could be found between the etiology of the scar and the final outcome. However, the doctors' evaluation by location of scar, there were statistically significant low satisfaction differences in mandibular area than other parts. It might be because it's the area where powerful muscle is located and more tension is working.

Although staged scar revision has a disadvantage taking a long time for the treatment of patients in comparison to the one-step scar revision, we could proceed to take this with the consent of the patient through enough explanations of the relationship between the skin tension forces and the scars. Through staged scar revision we could get the satisfactory results. For these reasons we present this case as a way of a scar revision worth considering for the patients with facial angulated scars.

V. CONCLUSION

Most patients seeking treatment of a scar wish to correct their scar through one-time scar revision. However, in the case of angulated scar or a wide scar, if the one-step scar revision is performed, much skin tension works, and it often can lead to disappointing results. In this case, the authors had chosen the way of staged scar revision so that there would be reduced tension. The authors achieved satisfactory results from the staged scar revision that they performed on patients with angulated facial scars and such results are reported in this paper.

Conflict of interest statement

The authors have no conflicts of interest, no financial or personal relationships with other people or organizations that could inappropriately influence this work.

REFERENCES

1. Dunkin CS, Pleat JM, Gillespie PH, Tyler MP, Roberts AH, McGrouther DA: Scarring occurs at a critical depth of skin injury: precise measurement in a graduated dermal scratch in human volunteers. *Plast Reconstr Surg* 119: 1722, 2007

2. Widgerow AD, Chait LA, Stals R, Stals PJ: New innovations in scar management. *Aesthetic Plast Surg* 24: 227, 2000
3. Sommerlad BC, Creasey JM: The stretched scar: a clinical and histological study. *Br J Plast Surg* 31: 34, 1978
4. Park JH, Chang CH, Seo SW, Song JY: Scar Revision with Frostbite Using Dry Ice. *J Korean Soc Plast Reconstr Surg* 31: 144, 2003
5. Thomas JR, Prendiville S: Update in scar revision. *Facial Plast Surg Clin North Am* 10: 103, 2002
6. Horswell BB: Scar modification. Techniques for revision and camouflage. *Atlas Oral Maxillofac Surg Clin North Am* 6: 55, 1998
7. Westine JG, Lopez MA, Thomas JR: Scar revision. *Facial Plast Surg Clin North Am* 13: 325, 2005
8. Su CW, Alizadeh K, Boddie A, Lee RC: The problem scar. *Clin Plast Surg* 25: 451, 1998
9. Brody GS, Peng ST, Landel RF: The etiology of hypertrophic scar contracture: another view. *Plast Reconstr Surg* 67: 673, 1981
10. McGaw WT, Ten Cate AR: A role for collagen phagocytosis by fibroblasts in scar remodeling: an ultrastructural stereologic study. *J Invest Dermatol* 81: 375, 1983
11. McGuire MF: Studies of the excisional wound: I. Biomechanical effects of undermining and wound orientation on closing tension and work. *Plast Reconstr Surg* 66: 419, 1980
12. Wilson AM: Use of botulinum toxin type A to prevent widening of facial scars. *Plast Reconstr Surg* 117: 1758, 2006
13. Park BY, Yoo WM: Scar Revision with W-plasty. *J Korean Soc Aesth Plast Surg* 2: 87, 1996
14. Salam GA, Amin JP: The basic Z-plasty. *Am Fam Physician* 67: 2329, 2003
15. Choi HG, Lee SH, Kim SH, Shin DH, Uhm KI, Kim HJ, Choi JK: More Effective Facial Scar Revision in Asian. *J Korean Soc Aesth Plast Surg* 14: 33, 2008