Review Article

Capsula Eburnea

# SCAR REVISION PRINCIPLES APPLIED TO EXCISIONAL, IRREGULARIZATION AND V-TO-Y ADVANCEMENT FLAP TECHNIQUES

**Susanna Polotto**

## SUMMARY

In adults, every cutaneous tissue injury reaching the dermis layer leads to scar formation. Scars may bring significant problems of both a functional and aesthetical nature and this often causes patients to seek surgical scar revision. For this reason, several scar revision techniques have been developed, in order to adapt to the specific scar characteristics. For the most part, widened scars are treated with excisional techniques, whereas scars which are not situated parallel to Relaxed Skin Tension Lines (RSTLs) or are retracted are treated with irregularization techniques. It is the responsibility of the attending physician to choose the appropriate technique to treat the scar. Pre-operative planning and timing of the treatment are also important in order to obtain a satisfactory result.

## Introduction

Scars are the result of the natural healing process of an injury. Indeed, all non-fetal wounds reaching the reticular dermis heal with a scar in spite of technological and surgical advances [1]. Wound's characteristics, such as its traumatic or non-traumatic origin, its length, orientation, location, contour and typology, are fundamental in its healing process, in the scar typology which goes to repair it and in the scar revision techniques available. Also the amount of lost skin and soft tissue affects both scar appearance and the degree of tissue distortion, which could also involve adjacent structures. Other factors like scar orientation and position in respect to Langer's lines, patient age, genetic factors and moreover, surgical techniques used in wound closure affect healing and the scar formation process [2]. The scar deformity spectrum is wide, but the most significant scar variations are hypertrophic, atrophic, depressed, irregular, raised, wide, poorly oriented in regard to Relaxed Skin Tension Lines (RSTLs) [3], poorly colour matched or associated to adjacent structure distortion scars. The main duty of the surgeon is to identify the nature of the problematic scar, in order to decide whether or not to proceed with surgical scar revision and to help the patient understand its goal, that being to improve specific scar defects. A bad-looking scar may have devastating social, emotional even functional implications for the patient. To deal with these issues, several scar or revision techniques have been developed to optimize scar appearance; the ideal is to achieve a thin flat scar, with a good colour match to the surrounding skin and with a guideline parallel to the RSTLs. It is important for the surgeon to inform the patient that it is impossible to eliminate a scar completely, restoring healthy tissue appearance and histological structure, however, a remarkable improvement is often possible with the most appropriate technique. There are some limitations imposed by scar shape and size, by adjacent anatomical landmarks or by healing variables, which narrow down both the range of therapies and their effects. During the pre-operative visit the surgeon should

***Address of the author***
*Plastic and Reconstructive Surgery Department, National Institute of Cancer Research (IST), University of Genoa , Italy*

***Send correspondence to**: Dr. Susanna Polotto, polotto.susanna@gmail.com*

***Received**: November 26th, 2011 — **Revised**: December 16th, 2011 — **Accepted**: December 30th, 2011.*

explain the procedure's main target to the patient; that being to trade a poor scar for a better one, and not to make the scar disappear completely. The aim of this article is to consider the principal scar revision techniques and to provide a critical analysis of their specific indications, advantages and limitations.

**Timing of scar revision**

The key to successful scar revision is timing. The natural scar maturation process leads to a progressive scar improvement, so scar revision is traditionally executed in the range of 6-to-12 months following injury, typically not before 3 months, even if the revision may be brought forward in some particular cases. One of the most important elements to wait for before proceeding with a surgical scar revision is the resolution of the acute inflammatory process in the tissues surrounding the neoformed scar; the scar should be soft, flexible, non-painful and with no residual erythema, edema or induration [4]. The 'plateau phenomenon' is a 2-to-3 month period during which no significant scar improvement appears, that should allow the surgeon to decide whether or not scar revision is indicated. Moreover, the physician should inform the patient fully about surgical and non-surgical options and also about the expected degree of improvement. In case of doubt over whether to proceed to scar revision or not, it is preferable to wait, as scars usually improve with time and the decision can be postponed to the following check-up.

**Principles of scar revision**

In scar revision, accurate pre-operative planning is fundamental: photographs of the scar area should be taken in order to compare the original scar to the neocreated one and an accurate analysis of the scar characteristics should be made. As there are several surgical revision techniques, the surgeon should base his decision about which technique to use on an analysis of their advantages and limitations. After this decision has been taken, the specific design of the chosen surgical technique is drawn on the patient' skin following RSTLs, in order to avoid possible complications which might occur in the post-operative period; such as tensioned neo-created scar, dog-ears or adjacent structure distortions. If these complications are foreseen, the surgeon can plan additional or alternative procedures. Next, the surgeon proceeds to surgical preparation, during which it is fundamental to first identify anatomical landmarks before local anesthesia is administered, this is because local anesthesia causes superficial distortion. Afterwards, depending on the extent of scar revision, the patient is given either general or local anesthesia. Local anesthesia is the most common typology of anesthesia applied; the procedure consists of the infiltration of anesthetic solution, mostly lidocaine with epinephrine, into the mid-dermis in order to create local vasoconstriction and tissue turgor enhancing. Then, the initial incision is made to the upper dermis along the entire revision design; afterwards, the scar and sometimes the adjacent healthy tissue are excised up to a subdermal level. Finally, the surrounding tissues are undermined at a subdermal level at 360° for a distance twice as great as the defect created with scar excision, as an adequate relaxation of adjacent tissues is essential for the creation of a non-tensioned scar. Then, the contralateral corresponding edges are sutured together with both subcutaneous and running or simple interrupted cutaneous sutures. Wound edge hypereversion should always be done, using simple interrupted or running suture after tissue undermining, in order to minimize wound tensions creating a bunched-up and overeverted surgical wound. In fact, intradermal running sutures do not usually achieve the ideal eversion for optimal healing; over some weeks the tension created by surrounding tissues pulls down the everted edges, thus creating a thin scar. The circumstances in which hypereversion is particularly indicated involve all scars that are predisposed to widen or even hypertrophic if closed without it [5]. Another significant aspect in scar revision is hemostasis, especially in the case of large flaps to be advanced; if this step is neglected, consequent hematoma formation could cause an additional tension on wound edges, as well as a predisposition to local infections and fibrous tissue formation. It is also important to manipulate wound edges with tissue forceps as little as possible, in order not to cause small flap necrosis. The post-operative care principally involves one week of accurate cleaning of the surgical wound with disinfecting solu-

tions followed, if necessary, by topical antibiotic ointment. The use of Mastisol and Steri-strips applied along the scar axis could also be suggested, as these are occlusive dressings which avoid any further wound care for the patient. They also provide an optimal and uniform compression to the small flaps created in the revision procedure. Steri-strips are removed 5-to-7 days after surgery, followed by permanent suture removal 5-to-7 days after surgery if the surgical wound is situated on the face, or 14 days after surgery if the wound is located on any other body site [4].

**Excisional techniques**

The most significant element to consider in excisional techniques is scar position; in fact, the ideal scars to be treated with excisional techniques are those situated parallel to RSTLs or within the hairline or other anatomical folds, in order to allow for an adequate scar camouflage.

*Fusiform or elliptical excision technique*

The fusiform excision technique is the most commonly applied procedure in small (<2 cm) and straight scars that lie on RSTLs; these scars may also be wide, bad-edged, raised or depressed. Scars perpendicular to RSTLs or excisions forming opposing angles greater than 60° are not suitable for this revision technique. This technique involves an extramarginal scar excision, which is ellipse-shaped, and ideally runs parallel to RSTLs, taking in a small edge of healthy skin (about 1 mm). This allows for a re-approximation of the wound edges with a good eversion and a non-tensioned neo-created scar. The pre-operative design consists of an ellipse drawn around the original scar, with two 30° angles situated at the ellipse ends in order to avoid dog-ears (Fig.1). The length-to-width ratio is 3:1 in order to allow a straight-line closure, and only the epidermal and dermal tissue should be excised as the subcutaneous fat tissue should be preserved to support the neo-created scar; so that its depression is prevented. Wound edges should be accurately undermined to create a minimal tension when re-approximated. When scars are particularly wide and not one-setting excisable, an intramarginal scar excision is indicated to reduce scar width; afterwards, the extramarginal technique could be performed. Additionally, the fusiform excision technique can be applied in serial excisions, executed with a time interval of at least six weeks between one excision and the next. The main indications for serial fusiform technique are anelastic skin or a scar too long or too large to perform a one-session excision, which may lead to an unsatisfying result [6]. The first surgical step is to cut an ellipse within the original scar, then the wound edges are undermined and sutured together; after a variable time lapse (8-to-12 weeks) the entire procedure is repeated. This procedure could be repeated a variable number of times depending on scar width. Finally, the residual scar tissue is excised using the extramarginal fusiform technique leaving healthy skin edges sutured together linearly or using an irregularization technique, such as W-plasty. Importantly, for scars larger than 1 cm, the surgeon should, at a later date, consider performing running W-plasty, Geometric Broken Line Closure (GBLC) or serial Z-plasty techniques, to improve the scar's appearance or even to lengthen it.

*Shave excision technique*

Shave excision technique is indicated in scars causing superficial skin irregularity, such as thin scars with raised or irregular edges, small enough to be tangentially shaved using a scalpel. The excision should not penetrate the deep dermis, as it should only seek to bring the scar level with the surrounding skin. After scar excision and coagulation with acusector, the wound should heal by secondary intention. Shaving could be used in association with other revision techniques applied to other scar parts [7].

*Scar repositioning technique*

Scar repositioning technique is indicated for small scars which lie close to RSTLs, to the hairline or to anatomical folds. These scars can be repositioned through excision of the healthy tissue which interposes itself

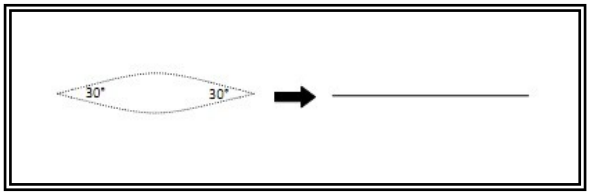



*Figure 1: Fusiform or elliptical excision technique: the scar is excised with an extramarginal and ellipse-shaped excision, with two 30° angles situated at each ellipse end; then the surgical wound edges are sutured together creating a linear scar.*

between the scar and the fold chosen by the surgeon to hide the scar. The result is a less noticeable scar, due to its new and more favourable location [7].

*Intramarginal scar excision technique*

The intramarginal scar excision technique is indicated for keloids and hypertrophic scars, and especially in post-burn scars; its aim is to decrease scar bulk and to flatten its contour. It involves a scar excision which leaves a small scar tissue margin on wound edges. There is some evidence in the literature [8, 9] that intramarginal hypertrophic scar excisions followed by reapproximation of the edges, lead to a lower hypertrophy incidence than extramarginal excision. The excision is made within the original scar, leaving a small scar tissue edge (2-3 mm) surrounding the surgical wound. Undermining of surrounding tissues should not be necessary and finally wound edges are closed both with subcutaneous and cutaneous sutures.

*Punch elevation or excision technique*

Punch elevation technique is indicated in depressed or pitted scars, as it may leave behind a smaller residual scar. It consists, at first, of cutting the tissue around the scar using a skin punch of appropriate size. Scar walls remain intact as only surrounding tissue is removed. Thus the scar base can be lifted up to the level of the surrounding skin by suturing it, helping in this way to reduce scar appearance. In time the skin heals over with the neo-elevated scar. An alternative method is to punch out the scar and to primarily close wound edges suturing them or using a skin graft, harvested with the same sized skin punch used for the excision. The main advantages of punch elevation technique are its simplicity, its painlessness and its option as a treatment for very deep scars not responsive to conventional scar removal treatments.

**Scar irregularization techniques**

Irregularization techniques are most often used on long and linear scars, on scars crossing adjacent anatomic subunits, on scars distorting anatomic relations or on webbed scars. These scar typologies draw attention to the scar itself; for this reason a wide variety of irregularization techniques capable of breaking up the scar line is necessary, in order to provide a satisfactory camouflage.

*Z-plasty technique*

Z-plasty is an irregularization technique used to re-orient contracted or poorly oriented scars, so that the neo-created scar is lengthened and de-contracted, or its linear component is interrupted and re-oriented bringing it parallel to RSTLs. The main indications for this technique include scars with a length of about 1 cm which deviate more than 30° from RSTLs, as well as contracted or web-forming scars. Indications and targets for Z-plasty are similar to those for the other irregularization techniques but its main prerogatives are achieving a significant lengthening and de-contracting of the scar. After accurate pre-operative planning, which assesses the relationship between the scar and the RSTLs and establishes the final scar reorientation, the surgeon proceeds to the flap design. The surgical procedure consists of a double-flap transposition technique, in which the original scar represents the "Z" central limb and forms a Z-shape when united to the two lateral limbs branching off from the central limb ends. The lateral limbs are equal in length to the central one

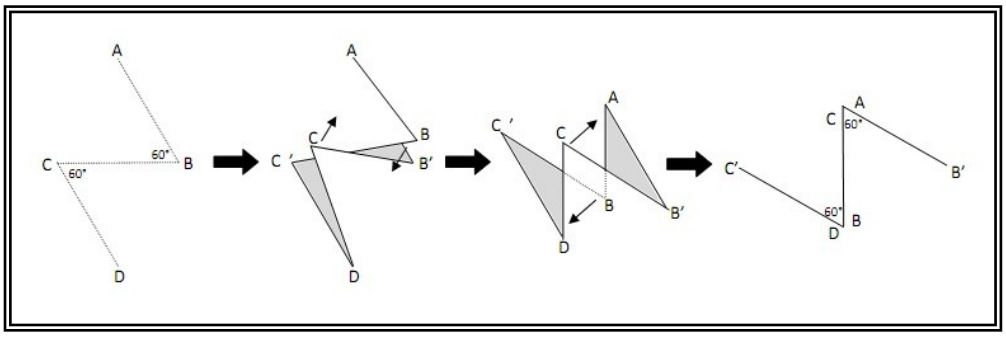



*Figure 2: Z-plasty technique: the scar represents the "Z" central limb, forming a Z-shape when united with the two lateral limbs branching off from its ends; each limb is equal in length and the degree of the two angles changes proportionally to the desired increase in the length of scar. After scar elliptical excision, two triangular flaps are created and transposed fitting together in order to create a Z-shaped scar.*

and parallel to each other (Fig. 2). The overall orientation of the flap design is affected by the positioning of the lateral limbs and by the angle variation in relation to the central limb. The two lateral limbs can be designed according to two different options, always following the RSTLs in order to form non-tensioned neo-created scars. After the elliptical excision of the scar, which represents the central limb, the surgeon creates two triangular flaps equal in size to the central limb, with a 60° angle; these are then transposed and fit together after the surgeon have accurately undermined the surrounding tissue, in order to create a Z-shaped scar. The final position of the "Z" central limb can be predicted by imagining a line which connects the two free ends of the original "Z" design. The resulting scar will be at least three times longer than the original one [10]. The target of Z-plasty is the transfer of wound tension from the central scar axis to its lateral axis, by lengthening the original scar and transposing the two triangular flaps. The angle created is directly proportional to the desired scar length increase: i.e. 30° angles lead to a 25% length increase, 45° angles to a 50% increase and 60° angles to a 75% increase [11]. Obviously, the theoretical length increase is bigger than the real one, because of the adjacent tissue retraction forces. When Z-plasty technique is applied to contracted scars, as the flaps are released they show their natural tendency to lie in a relaxed state; this aptitude may produce a tensioned neo-created scar. To avoid this problem, the lateral limbs could be lengthened maintaining the original angularity, lengthening the flaps at the same time. In this way, the flaps are relaxed enough not to put a strain on the tips, in order to maintain an optimal dermal perfusion and to avoid tip necrosis. The main advantages of the Z-plasty technique are scar re-orientation, scar lengthening and longer scar discontinuation. Comparing Z-plasty to other irregularization techniques, its remarkable advantage is the minimal or absent skin excision. Instead, the limitations of Z-plasty are the creation of a scar three-times longer than the original one, with the addition of two lateral scars. It must also be considered that the characteristics of the Z-plasty meant that at least one third of the neo-created scar is not parallel to RSTLs. However, with accurate pre-operative planning, a single or serial Z-plasty may offer excellent results, highly improving scar orientation and dissipating the tensions which weighed on the original scar. Z-plasties can be applied both as single or serial techniques; in fact, if the scar is particularly long, it is possible to execute serial Z-plasty, either in an interrupted or in a continuous way, in order to irregolarize the scar and to re-orient it. In particular, in the case of scars situated on the face, it is better to perform a series of small Z-plasties rather than a single one with larger limbs, which would inevitably lead to worse-looking neo-created scar. The indications for serial Z-plasty technique are mainly trapdoor deformities, medial chantal webbing and any scar longer than 1 cm which requires lengthening. The serial Z-plasties technique design consists of a central limb, coinciding with the scar, with a variable number of lateral limbs, directly proportional to scar length, departing from the central limb with a 60° angle (Fig.3). The main difference between serial Z-plasty technique and the standard one is that the flap shape is a three-sided rhomboid, not a two-sided triangles. Moreover, the flaps may sometimes require trimming during the flap transposition

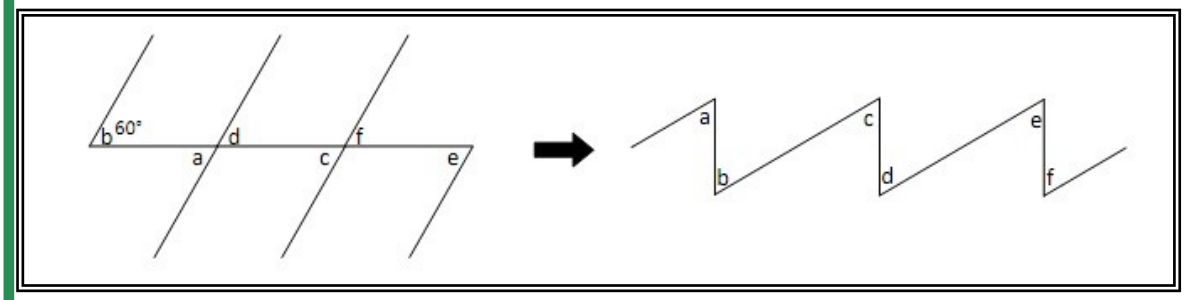



*Figure 3: Serial Z-plasty technique: the scar represents the central limb from which a variable number of lateral limbs depart with a 60° angle; after scar elliptical excision, a variable number of three-sided rhombic flaps are created and transposed fitting together in order to create a serial Z-shaped scar.*

process, due to their shape and their predisposition to becoming longer than at first. Indeed, the flaps situated between the peripheral pair become nearly twice as long as they were before; this adds length to the original scar axis and may also be used to elongate contracted scars.

*Running W-plasty technique*

W-plasty is an irregularization technique which aims to break up an originally linear scar into smaller segments. The original scar should be longer than 2 cm, not lying on the RSTLs, contracted or U-shaped and associated with trap-door deformity. It should be situated over curved anatomical surfaces, especially on concave areas [12], even if the best results are obtained when this technique is applied on scars situated in lax skin areas. W-plasty technique aims to reorient the neo-created scar bringing it parallel to RSTLs and undermine the superficial layer separating it from the deeper one, in order to prevent contracture and to flatten the scar. Comparing W-plasty to single Z-plasty or serial Z-plasty technique, in which only the scar tissue is excised, in W-plasty technique an additional adjacent healthy skin ablation is indicated. The surgeon should think carefully about this further ablation and evaluate the overall wound tension to which the neo-created scar would be subjected. Moreover, in W-plasty technique the original scar is not lengthened if measured in a straight-line end to end of the new-created scar, even if the sum of the smaller segments is longer than the original scar. Another difference between W-plasty technique and Z-plasty is that W-plasty uses advancement flaps whereas Z-plasty uses transposition flaps; for this reason W-plasty should only be applied in sufficiently lapse tissue areas to allow bilateral flap advancement. Moreover, the triangular W-plasty flaps are smaller than Z-plasty ones, measuring about 5-8 mm [13]. The surgeon should choose when to use this irregularization technique; in fact, the regularity of the repeated W-plasty units is more easily noticed when applied on particularly long scars. In such a case, GBLC technique would offer a less noticeably irregular neo-created scar. The surgical procedure is based upon a pre-operative design consisting of a central limb, corresponding to the scar, and in a series of lateral limbs departing from the central one, measuring about 5-6 mm (Fig.4) [14]. After scar excision,

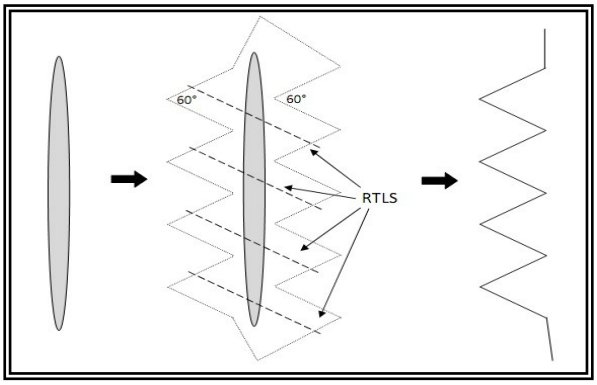



*Figure 4: Running W-plasty technique: after scar excision, a series of interlocking small triangular advancement flaps are created on both wound sides, parallel to RSTLs and with a 60° angle at each end; then the flaps are transposed fitting together in order to create a W-shaped scar.*

according to pre-operative design, a series of interlocking small triangular advancement flaps are created on both wound sides, parallel to RSTLs and with a 60° angle at each end, in order to avoid dog ears. Then adjacent tissues are undermined reaching out to the flap bases and the flap tips are approximated. Finally, the wound is sutured in an interdigitating pattern with a two-layer closure and edges eversion, in order to reduce wound tension. It is important to create scar excision endings with 30° angles, even if sometimes it is more advantageous to make a fusiform excision perpendicular to the W-plasty distal end. In 1998, Park [12] proposed an alternative W-plasty technique progressively reducing the flap limbs' length as they draw closer and closer to the ends of the surgical scar excision; in that way, a more fusiform defect is created and the neo-created scar healing is improved. The advantages to the W-plasty technique are mainly its easy planning and execution. Its principal limitation is the creation of a scar with a regular pattern, which is more easily detectable; thus, it is indicated for short scars but not for longer ones.

*Geometric broken line closure technique*

The GBLC is an irregularization technique which aims to excise the original scar creating a randomly irregular new scar, in order to create a pattern the lines of which mostly follow the RSTLs. This technique is indicated for long scars, oriented more than 30° off RSTLs or contracted scars. It is an alternative to W-plasty technique when

the repeated-"W" pattern could be easily detected. This technique, like W-plasty, uses advancement flaps which are sutured together after the interdigitation of the corresponding edges. The GBLC technique involves the following steps: first, the scar edges are highlighted with a dotted circular line in a pre-operative design; secondly, another concentric circle is drawn at a 5 mm distance from the inner one. Then thirdly, a horizontal series of lines, measuring about 5-6 mm (as in W-plasty technique) is drawn between the two circles, each line situated at a 5 mm distance from the others. At this point, opposing interdigitating geometric figures are drawn in square, rectangular, trapezoid, semicircle and triangular shapes. The scar is then excised following the geometrical design, thus creating on both wound sides a flap series with acute angles measuring less than 30°, in order not to create dog-ears; for the same reason, at each end of the scar excision is situated a 30° angle, too. Finally, the defect is closed, resulting in a neo-created irregular and geometrical scar (Fig.5) [15]. The main advantage of the GBLC technique is the conversion of a long and visible scar into multiple short segments which lie on RSTLs. Moreover, the neo-created scar is less visible if compared to the scar obtained with serial Z-plasty and W-plasty techniques. The breaking down of the scar into multiple parts, which mainly follow the RSTLs, and its random irregularization are the main factors that improve original scar appearance. The limitations of this technique are the complexity of its planning, design and execution, the need for more operating time and the necessity of having enough adjacent skin, in order to create a non-tensioned scar. Indeed, GBLC technique, like W-plasty, necessitates an additional healthy skin excision, and this feature should be evaluated during pre-operative planning. It is for this reason that GBLC technique should only be indicated in sufficiently relaxed and elastic skin areas, in order to create a non-tensioned scar.

**V-to-Y advancement flap technique**

V-to-Y advancement flap technique is indicated in contracted, webbed, curvilinear, adjacent structures tethering, full-thickness or trapdoor deformity associated scars, all of them moderate in size (1-2 cm). It is also particularly useful when applied to small scars situated on free margins, such as the eyelids and mouth where scars may cause an ectropion or eclabion, respectively. This technique aims to provide scar lengthening, to raise an anatomic area or to bulk up an area slightly widened, due to a triangular single flap linear advancement without transposition. Indeed, a "V"-shaped auxiliary excision is transformed into a "Y"-shaped scar, as the "V" neo-created flap recedes away from the defect. As in Z-plasty technique, also in V-to-Y advancement flap technique adjacent healthy tissue is excised. This technique involves a pre-operative design in which the "V"-shaped flap design is indicated, which is situated along the contracted scar length. Then the surgeon makes the surgical incision and undermines the surrounding tissues widely in order to loosen the scar. Then, the "V"-shaped flap is pushed away form the incision, relieving the scar tension and, at the same time, lengthening the scar. Consequently, the scar tension is released through the open part of the "V". Finally

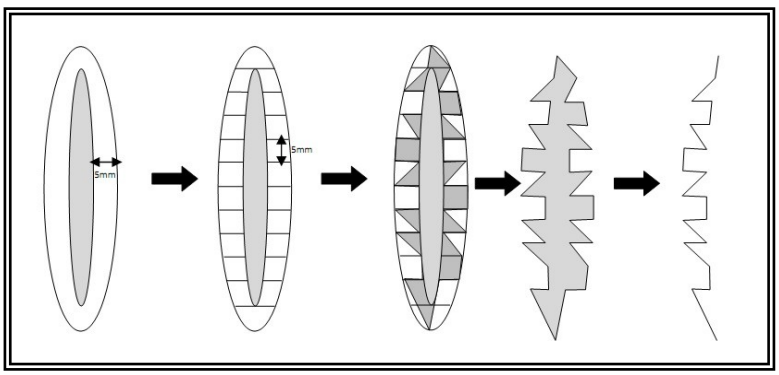
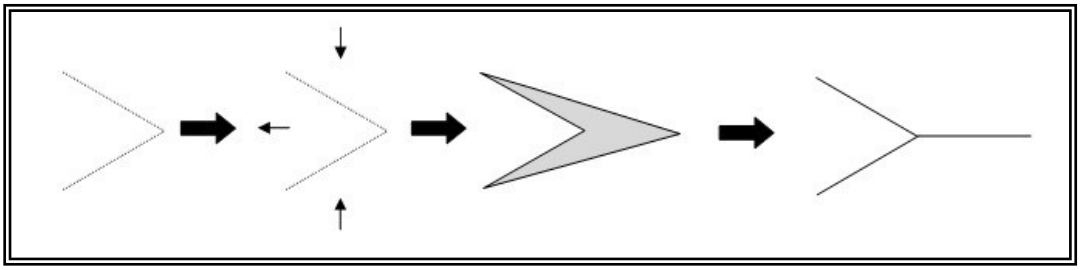



*Figure 5: Geometric broken line closure technique: a pre-operative circular design highlights scar edges and another concentric circle is drawn at a 5 mm distance from the inner one; then a horizontal series of lines is drawn between the two circles, each line situated at a 5 mm distance from the others. At this point, opposing interdigitating geometric figures are drawn; the scar is excised following the geometrical design, thus creating a flap series on both wound sides. Finally, the flaps are transposed fitting together in order to create an irregular and geometrical scar.*

the surgical wound is closed so that the two edges situated along the original scar line are sutured to form the straight line of the "Y"; the "V"-shaped flap is united with one end of the straight line by its "pointed" part, finally forming an "Y"-shaped scar (Fig.6). The immediate post-operative result could make the scar tension seem over -corrected but with the passing of time natural wound healing brings local tissue contraction.

*Figure 6: V-to-Y advancement flap technique: a pre-operative "V"-shaped flap design is drawn along the scar length; then the "V"-shaped flap is created and pushed away from the surgical incision. Finally, the wound is closed so that the two edges situated along the original scar line are sutured to form the "Y" straight line and the "V"-shaped flap is united at the bottom with the end of the line, in order to create an "Y"-shaped scar.*



## Conclusion

Scar revision techniques aim to improve both the functional capability and the cosmetic acceptability of a scar. Several techniques have been developed in order to fit every patient and scar typology in the best possible way. Indeed, depending on the characteristics of the scar a choice should be made between an excisional technique, an irregularization one or an advancement flap one. For this reason, an accurate pre-operative assessment of both patients and scars is fundamental for an optimal result. All revision techniques replace one scar for another neo-created one, so it should be always explained to the patient the impossibility of restoring healthy tissue appearance completely. Thus, the patient's more realistic expectations lead to satisfying results both for patients and for the surgeon [13].

## References

1. Ferguson MW, Whitby DJ, Shah M, Armstrong J,. Siebert JW, Longaker MT: Scar formation: the spectral nature of fetal and adult wound repair. Plast Reconstr Surg 1996; 97 (4): 854-860.
2. Kokoska MS, Thomas JR: Scar revision. In: Papel ID, editor. Facial plastic and reconstructive surgery. 3rd edition. New York: Thieme 2009; 59-65.
3. Borges AF: Relaxed skin tension lines (RSTL) versus other skin lines. Plast Reconstr Surg 1984; 73: 144-150.
4. Shockley WW: Scar revision techniques: Z-plasty, W-plasty, and geometric broken line closure. Facial Plast Surg Clin N Am 2011; 19: 455-463.
5. Zide MF: Scar revision with hypereversion. J Oral Maxillofac Surg 1996; 54: 1061 -1067.
6. Lee KK, Mehrany K, Swanson NA: Surgical revision. Dermatol Clin 2005; 23: 141-150.
7. Thomas RJ, Prendiville S: Update in scar revision. Facial Plast Surg N Am 2002; 10 (1): 103-111.
8. Engrav LH: Intrascar excision for persistent perioral hypertrophic scar (discussion). Plast Reconstr Surg 1996; 98:1206.
9. Engrav LH, Gottlieb JR, Millard SP: A comparison of intramarginal and extramarginal excision of hypertrophic burn scars. Plast Reconstr Surg 1988; 81:40.
10. Santi PL: Principi di chirurgia plastica. Prima Edizione; Genova; ECIG 1996.
11. Frodel JL: Creative uses of the Z-plasty technique. Operative Techniques in Otolaryngology 2011; 22: 30-34.
12. Park SS: Scar revision through W-plasty. Facial Plast Surg N Am 1998; 6 (2): 157-161.
13. McGillis TS, Lucas AR: Scar revision. Dermatology Clinics 1998; 16 (1): 165-180.
14. Westine JG, Lopez MA, Thomas JR: Scar revision. Facial Plast Surg N Am 2005; 13: 325-331.
15. Cupp CL, Johnson MB, Larrabee WF: Scar revision. Facial Plast Surg Clin N Am 1998; 6 (2): 195-201.