



SURGERY

# Surgical scar management - an evaluation of surgical techniques

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## Abstract

The purpose of this narrative review is to analyze surgical techniques for removing scar tissue and minimizing them. A considerable proportion of the population have scars that are related to a traumatic event that they remember accurately, this being especially true for scars on the face, but also on the rest of the body if they are of significant size. The negative consequences of the esthetic damage are felt mainly in the family and at professional level, without losing sight of the fact that any person suffers as a result of the awareness of unsightly wounds or scars. To be successful, an aesthetic intervention must represent the optimal balance between science, the art of plastic surgery and the patient's expectations. Good communication between surgeon and patient is also needed. We must state that there is no method of total removal of scars; even in the case of complex surgical techniques, the scar cannot be completely excised, but a much more aesthetic appearance can be obtained. Scars cannot be completely removed from the skin, they can improve their appearance by fading or thinning, initially by conservative treatment, later, if necessary, by surgical scar reduction techniques. Improving the appearance of a scar depends on the type of scar, its severity, its surface and location, the causing factors, the time elapsed from production to the application of specialized treatment.

**Keywords:** scar, surgical techniques, removing scar, improving appearance

## Introduction

A considerable number of people have scars that are related to a traumatic event that they remember accurately, this being especially true for scars on the face, but also on the rest of the body if they are of significant size. In addition to the fact that the event that led to the formation of the scar is strongly fixed in the memory, relatives and loved ones can relate precisely when and how the traumatic event happened. In this way, scars can be used to identify people, both living and dead [1,2].

The negative consequences of the aesthetic damage are felt mainly in the family and at work, without losing sight of the fact that any person suffers as a result of the awareness of unsightly wounds or scars. Unsightly morphological changes can be produced

by various circumstances and can be represented by blows, bodily injuries, acts committed intentionally or by mistake [3,4].

Wound healing is the process by which the skin repairs itself after trauma. In uninjured skin, the epidermis and the dermis form a protective barrier against the external environment. When this barrier is damaged, a biochemical cascade of processes kicks in to repair the damage. This process is divided into the following phases: hemostasis, inflammation, tissue growth, proliferation and tissue remodeling [5].

Important factors that contribute to the formation of unsightly scars are: tension in the suture, infections, delayed epithelization, uneven alignment of the wound edges, insufficient blood flow to the healing scar, genetic factors, which

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cannot be controlled, etc. [6].

A fundamental principle of surgical scar reduction is to minimize as much as possible both the incorporation and deformation of normal tissue. Certain factors must be taken into account in order to achieve favorable results in scar remodeling. Excision is the therapeutic option for scars resulting from inadequate healing. Thus, the scar tissue will be removed with an incision and a suture. A fine suture line will replace the numerous pre-existing scars and will be more difficult to notice [7].

Another step is debridement which helps detach the skin from deep tissues and allows tension-free closure of the wound, followed by repairing the skin layers and suturing the deep dermal layer with deep knots. Suturing the deep dermal layer increases the strength of the repair, causes the exact opposition of the dermis, releases the tension from the superficial sutures, and allows the removal of the early, superficial suture to prevent cross-healing [8].

The smallest needles and sutures should be used. Atraumatic sutures from 5/0 to 10/0, and effective hemostasis can be given by the epinephrine contained in the local anesthetic, the application of local pressure, or the use of bipolar electrocautery [9]. Depending on the type of scar, several surgical techniques can be used: re-excision and direct suture, serial excisions, the use of various crossed flaps in the case of retractable scars, the use of expanders to obtain integumentary excess etc. [9].

The appearance of a scar depends to a large extent on the accuracy of the incisions, the type of suture, the type of threads used and the skill of the plastic surgeon, but it also depends on how the patient responds to the healing process. Moreover, the appearance of a scar depends on the path of the incisions. They must observe the lines of forces that are physiological at various levels of the skin. Any scar placed perpendicular to these lines of force will widen over time [10].

Surgical strategies to minimize scars have an impact on the course of wound healing. To avoid the negative effects of scars, especially those located in visible areas, preoperative planning is necessary, including placing them parallel to the relaxed tension lines of the skin or hiding the incisions in natural anatomical landmarks. Surgical excision can be applied, which can be performed by many advanced scar repositioning techniques, such as Elliptical fusiform excision, Z plasty, W plasty, S plasty, geometric broken line closure (GBLC), the technique of advancement in V-Y and Y-V, dermabrasion and microdermabrasion or different types of flaps. Furthermore, the physician decides the most suitable post-excision management treatment to have the most aesthetic results [11,12].

The purpose of this narrative review, based on existing published literature, is to analyze surgical techniques for removing scar tissue and minimizing them.

### **Surgical techniques used to reduce scars**

In the first two weeks after surgery, local edema and discomfort are noted. Healing will continue for several weeks, and as the new scar heals, it improves in appearance. It is important that during healing there are no increased forces or movements at the level of the incision that alter the healing process. A study by Ulmer (1997) established a correlation between the size of the scar and the intensity of depression, therefore the importance of reducing scars increases both from a physical point of view, but also from the point of view of the patient's mental comfort [13].

The use of the tissue expansion method means the use of silicone implants (expansion) that are inserted under the healthy skin in the immediate vicinity of the scar area and wait for several weeks, up to 3 months. They will be filled weekly with physiological serum, thus obtaining "excess skin". When the specialist decides that there is enough skin to cover the scar area, the second intervention takes place in which the expander is removed, as well as the scar, and the excess skin is used to cover the postexcisional defect [14].

#### **1. Elliptical fusiform excision**

It is the most suitable technique to reduce a mature scar, uneven or arranged on a large surface that is located along Langer's lines and observes the anatomical structures of the face. In this technique, elliptical fusiform excision is done to excise the scar. The length-to-width ratio is 3:1, and the end of the incision must be angled at 30 degrees or less to prevent dog ears. The tip of the incision is placed parallel to Langer's lines to stimulate bleeding. Extramarginal scar excision involves excision of a small margin of normal tissue along with the scar so that normal tissue is found at the edges of the wound [15].

Intramarginal scar excision using serial excisions, done at an interval of 6-12 weeks, is used to reduce a wide or round scar (usually those from burns, ulcers or that cannot be excised in a single operation, surrounding scars of inextensible skin or after creating the ellipse if it forms a scar unfavorable for healing). This method is particularly useful for facial scars, where the aim is to preserve normal skin as much as possible [16].

To minimize the formation of scars in the folds, one edge of the scar is obliquely sectioned, and in the opposite direction, the other edge. In hair-covered regions, such as the scalp, serial excisions are recommended, using triangulation, which allows the edges of the wound to approach, while minimizing the excision of healthy scalp skin [17].

#### **2. Z-plasty**

This technique is based on geometric principles and is the most used technique for scar reduction. It has several advantages: it makes a linear scar irregular and thus less obvious, it changes the direction of a scar and aligns it with the Langer lines, it helps to lengthen or widen a contracted scar and to change the position of an anatomically modified

point by raising or lowering it [18]. Two components determine the performance and length of the Z-plasty, the size of the angle and the center length of the Z, also called the common diagonal. During Z-plasty, the original scar is used as a common diagonal [19].

#### **a. Classic Z-plasty**

In the classic Z-plasty, from each end of the common diagonal, two arms of the same length (to avoid folding) are extended in opposite directions. An angle of 60° is formed between the arm and the common diagonal. This angle determines the degree of elongation of the tissue, the greater the angle, the more length is gained. An angle of 60° in Z-plasty represents a 75% gain in tissue length and changes the direction of the scar by 90° [17]. An angle of 30° lengthens the scar by 25%, an angle of 45° by 50%, an angle of 75° by 100%, and an angle of 90°, lengthens by 125%. An angle less than 60°, although easier to transpose, results in a shorter scar length and less than 90° realignment. An angle greater than 60° is to be avoided as it increases the force required to transpose the tissue fragments, making approach difficult.

In performing the Z-plasty, the original scar as well as the main segment of the letter Z is excised, and two incisions are made at the extremities of the arm. The scar is widely sectioned at the level of subcutaneous fatty tissue to expand the scar. Then, the direction of the common diagonal is changed to “transverse diagonal” (the new scar formed is perpendicular to the original scar) by simultaneously lifting the two equal-sized triangular fragments and transposing them. For the correction of contracted or asymmetric anatomical landmarks, one triangle is the anatomical point to be moved, and the other triangle, the point to be moved to. By changing these points, the anatomical relief is either raised or lowered [20].

#### **b. Multiple Z-plasty**

Single Z-plasty is not suitable for scar correction on skin that is not elastic and for large scars because it creates increased tension on the transverse diagonals due to the longer length of the common diagonal and the arms. Also a larger Z makes the scar more prominent. In these cases, we resort to camouflaging the Z shape of the scar, using multiple Z plasty. In this, the long linear scar is divided into segments and each segment is separated into a Z-plasty that distributes the tension along several transverse diagonals [21].

Multiple Z-plasty gives the same zig-zag line as W-plasty, the difference being that it lengthens the scar. Correction of the contracture can be done using consecutive Z-plasties. For the correction of adhesion scars, Z-plasty placement around the periphery allows interdigitation to form and relieve contracture. Uneven triangles (oblique Z-plasty) represent areas of skin with varying elasticity such as scar edges that can be shaped using uneven triangular flaps by changing the angles. The segment of Z on the least elastic side is kept longer than the other [22].

#### **c. Halved Z-plasty**

It is used when the surrounding skin on one side of the scar is elastic and the other is inelastic. Here the inelastic side is incised to release the scar and a triangular flap from the normal side is transposed to fill the defect created. This is especially used to release the contracted scar at the interface between normal and burned skin [23].

#### **d. Limberg flap**

The angle of Z at both ends of the scar is kept at 90°, and then each flap is subdivided into a 45° flap. These 4 flaps of Z-plasty offer the advantage of a gain in length and are particularly helpful in releasing severely contracted scars that block or restrict normal flexion, such as web contracture and postburn axillary contractures [24].

#### **e. Planimetric Z-plasty**

In this surgery, the central incision of the Z-plasty is extended, being used for interrupted scars and stretching of the skin on a flat surface [25].

### **3. S-Plasty**

It is used for contracted oval scars (e.g. tracheostomy scar) when large triangular flaps are required to be transposed. Rounded flap ends ensure better flap survival [26].

### **4. W-Plasty**

The principle used in W-plasty is that the visibility of an irregular broken line is less due to insignificant light reflection and is easier for the eye to follow compared to a straight scar. The indications for this plasty are for linear scars that are longer than 2 cm and that are at an angle greater than 35° to the Langer lines. This makes them much more prominent and causes them to expand. Short scars present on prominent areas such as the forehead or cheek would be another indication of this plasticity. Another indication for W-plasty would be closure of petechial areas such as a pigmented fold or forehead flap, or closure over a curved surface such as the lower border of the mandible [27].

One of the disadvantages of using W-plasty is that it is not usable for long scars because the zig-zag regularity after W-plasty will make it much more pronounced, and the excision of normal tissue causes the wound to increase in size [28].

In the W-plasty, a series of triangles are made on one side of the scar and with a mirror image on the other side. The points at the apex of each triangle are placed 5-6 mm apart and 3-5 mm from the scar. The segment of each triangle should be 3-5 mm in length; if it is less than 3 mm it will not break up the scar adequately and if it is more than 5 mm it will make it more visible [29].

Ideally, the arms of the triangle should be parallel to the Langer lines. The angle of the apex of the triangle should be between 60° and 90° and be determined according to the angle that the scar makes with the Langer lines. To avoid dog ears or warp cones, the angles of the W-plasty ends must be less than 30°. To prevent extension of the

incision, an M-plasty can be made at the end of the incision. After excising the scars along these lines and undermining them, their re-approximation is done by interdigitating the triangles to form a single zigzag line [30].

### 5. Geometric broken-line closure

GBLC is the most sophisticated technique for the treatment of irregular scars; it provides maximum camouflage for long scars, better than W-plasty. The irregularity of the GBLC incision pattern is less predictable than the irregularity in W-plasty, due to twisting or accidental turn, the eye following it harder, but its surgical technique is more difficult than the W plasty [31].

The indications for GBLC are for the treatment of relatively long scars that are at an angle greater than 45° to Langers lines or those that involve a convex or concave surface. The perimeter of the scar is marked with a marker, a dotted line is drawn at a distance of 3-6 mm from the edge of the scar. Then, on one side of the excised scar the outline is made using a series of irregular geometric figures (such as semicircles, squares, rectangles and triangles), with the edges made on Langers lines. The mirror edge of this pattern is made with the same pattern on the opposite side, creating a sequence of interposed flaps. Each segment should be between 3 and 7 mm, and the angle at the end of the GBLC should be less than 30°, and an M-plasty can be made at the end of the incision. After wide undermining, re-approximation is done using mirror-matched dermal sutures, similar to W-plasty. Widening of the incision may be necessary to accommodate the geometric design [32].

### 6. Advancement technique in V-Y and Y-V

These techniques are indicated in elongating small, contracted scars, improving the “hatch” of the deformity, and raising or lowering a free edge such as the eyes and mouth, where a scar causes ectropion or eclabion. An anatomical point can be raised using the V-Y technique and lowered using the Y-V technique. In V-Y advancement, a V-shaped incision is made along the contracted scar, followed by wide undermining to release the scar and help even out the contracted scar base. The flap in the shape of the letter “V” is pulled in the “open” direction, as part of the V, and the defect is closed on both sides to form a “Y” [33].

In the Y-V repair, after a Y-shape is made, the incision is widely undermined and sutured to form a V. Another use of the V-Y surgical technique is for the closure of excisions with circular or oval defects, especially small defects in the skin hair (scalp, eyebrows). In these areas, the Y segment is camouflaged by the presence of hair [34].

### 7. Dermabrasion and microdermabrasion

Dermabrasion is used to smooth and level scar surface textural abnormalities and uneven edges to improve the appearance of raised flaps and grafts, to even out scars to surrounding tissues. This technique should be used 6-8 weeks postoperatively, to be able to interrupt and reorganize the last proliferative and early scar shaping phase in the

healing process to improve the appearance of the scar. It is important to apply abrasion on the entire cosmetic unit or subunit, not just the scar region to prevent pigmentation and textural demarcation [35].

Microdermabrasion is performed using either a pressure stream of aluminum oxide crystals (or other abrasive particles) or using reusable or disposable diamond tips. It causes superficial skin abrasions, improving epidermal turn over, stimulating and remodeling dermal collagen, and can also increase the absorption of topical drugs. It is used in scars caused by superficial acne [36].

### 8. Flaps

Flaps can be used to treat large scars or those located on critical areas where it is difficult to mobilize the adjacent tissue. The delto-pectoral flap is an outdated flap and should only be used in extreme circumstances, such as long, large-area, hypertrophic or atrophic scars [37].

To be successful, an aesthetic intervention must represent the optimal balance between science, the art of plastic surgery and the patient’s expectations. Good communication between surgeon and patient is also needed.

## Conclusions

We must state that there is no method of total removal of scars, even in the case of complex surgical techniques, the scar cannot be completely excised, but a much more aesthetic appearance can be obtained. Scars cannot be completely removed from the skin, their appearance may be improved by fading or thinning, initially by conservative treatment, later, if necessary, by surgical scar reduction techniques. Improving the appearance of a scar depends on the type of scar, its severity, its surface and location, the method of production, the time elapsed from onset to the application of specialized treatment.

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