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Keloids, hypertrophic scars and scar revision

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SEARCH STRATEGY

The data in this chapter are supported by a Medline search using the key words keloid, hypertrophic scar, scar revision, silastic, steroid, laser, dermabrasion and focussing on the aetiology, management and outcomes of the reviewed treatment options.

INTRODUCTION

The head and neck is a prominent part of the human body and can frequently be injured as a result of trauma, burns or surgery. With superficial injuries, most facial wounds will heal with little to no scar formation. However, once the reticular dermis has been violated, some amount of residual scarring is bound to occur. Several factors that are beyond the surgeon's control can affect the final appearance of the scar including the mechanism of injury, position of the wound, health status of the patient, patient's skin type and tendency to form robust scars. Factors that are under the surgeon's control include proper realignment of wound edges, conservative debridement of injured tissues, meticulous handling of tissues during primary repair and aesthetically favourable alignment of scars whenever possible.

After complete maturation and healing, an ideal scar should be flat and level with the surrounding skin, a good colour match with the surrounding skin, narrow, parallel to the relaxed skin tension lines (RSTL) or on the border of aesthetic facial subunits and without straight, unbroken lines that can be easily followed with the eye.[1] Scars with aesthetically unfavourable characteristics include those that are wide, misaligned with relaxed skin tension lines or aesthetic subunits, thickened, hypertrophied or keloids.[1] The facial plastic surgeon has many options to improve, but not eliminate, these aesthetically unfavourable scars. Successful application of various treatments requires an understanding of which techniques are best indicated when performing scar revision or treating hypertrophic and keloid scars.

CLASSIFICATION

Once the skin has been injured, normal healing involves the proliferation of fibrous ingrowth to repair the damaged tissues. When there is an excessive local tissue response to injury, a dysregulated deposition of extracellular matrix and collagen occurs resulting in either a hypertrophic scar or keloid. Both keloids and hypertrophic scars have a tendency to persist at the site of injury and recur after surgical excision. The distinction of what differentiates a hypertrophic scar from a keloid has been debated. Blackburn and Cosman[2] correlated the histologic features of hypertrophic scars and keloids with their clinical behaviour and found that mature keloids

almost invariably contain abnormally large collagen bundles that take on a pale glassy-pink appearance on haematoxylin and eosin staining. A more broadly accepted distinction in that only keloids grow beyond the boundaries of the original scar. Clinically, one may think in terms of a wound-healing spectrum with normal thin scars at one end, hypertrophied scars in the middle and keloids at the other end of the spectrum.

MOLECULAR BIOLOGY OF KELOID FORMATION

The molecular pathogenesis of keloids and hypertrophic scars has yet to be determined. However, there is an increasing amount of evidence that expression and activation of transforming growth factor-β (TGF-β) may play a role. Within the last decade, several studies have shown that overproduction of TGF-β has been associated with other fibrotic diseases, such as pulmonary fibrosis, glomerulonephritis and scleroderma.[3] Studies of keloids, hypertrophic scars and granulation tissue have demonstrated increased amounts of both TGF-β and TGF-β receptors in these tissues.[3,4] This excess of both TGF-β and its receptors is believed to create a persistent autocrine positive feedback loop resulting in the unchecked overproduction of downstream cellular components including collagen. [****]

Clinical genetics of keloid transmission

Keloid formation can occur sporadically in patients of all skin types, but patients with darker skin and positive family histories are at increased risk. Until recently, completely satisfactory epidemiological data on the genetics of familial keloids have been lacking. Recently, a comprehensive study of the pedigrees of 14 families of various ethnicities was undertaken to try and determine the mode of familial keloids expression. The study data represent the most comprehensive collection of keloid families to date and include the pedigrees of up to four generations, including 341 family members of whom 96 displayed keloids. The findings support the familial transmission of keloids occurring via an autosomal dominant mode of incomplete clinical penetrance and variable expression. Taken together, these data suggest that single gene mutations can predispose family members to keloids. As to which gene is responsible, more research is needed.[5] [***]

Treatment options

Despite the growing body of research as to the exact pathogenesis of keloids, the current 'best' clinical treatment of these lesions has yet to be determined. A review of the medical literature from 1965 to date reveals over 1000 articles describing the treatment of keloids with multiple modalities including cold excision, laser excision, intralesional steroids, radiation and combinations of these modalities.[6] The sheer extent of papers underscores the frustration in treating keloids in that no one preferred modality or combination of modalities has been clearly shown to be superior. Review of the literature is made more difficult by a lack of outcome standardizations. Most authors combine keloids from all body sites making the study of only head and neck keloids more difficult. Many papers also combine the treatment of both hypertrophic scars and keloids together, further making the elucidation of meaningful comparable results more difficult. Many groups report results in terms of resolution of the keloid, while others report in terms of 'significant improvement or response'. The complete resolution of a keloid provides a clear endpoint from which to compare various treatment regimens. However, the definitions of 'significant response' and 'significant improvement' vary widely. Short follow-up times are also problematic as previous studies have demonstrated that 90 percent of keloids will recur in the first 12 months and 100 percent will recur in the first 24 months.[7,8] For the purposes of this chapter, representative articles will be discussed. When possible, attempts have been made to reference only those articles with follow up beyond 12 months and those with a substantial number of head and neck keloids. Treatment options are presented from less to more aggressive.

SILICONE SHEETING

The topical application of silicone gel sheets to the surface of keloids has been shown to be beneficial in the management of these lesions. Ohmori studied the effects of silicone sheeting on 46 patients with 48 keloids in all areas of the body.[9] Using a study-defined grading scale, he reported excellent and good results in 60 percent of patients and fair to poor results in 40 percent. Use of sheeting was 8–12 hours per day for an average time of 6–12 months. Another study looking at the use of silicone sheeting in the treatment of keloids in different areas of the body demonstrated an overall 86 percent response rate to the sheeting, but interestingly no improvement was seen on the two study patients who had keloids of the ear lobule.[10] Katz investigated the use of silicone sheeting for both keloids and hypertrophic scars.[11] Fifty-six percent of keloids demonstrated measurable improvement. None of five patients with a history of hypertrophic scarring had recurrence of their hypertrophied scars following excision and postoperative silicone sheeting for six months. Like many of these types of studies, a control arm was lacking and responses were judged by a semi-objective grading scale. [**]

The biophysical properties of silicone sheeting have been studied, but the mechanism by which silicone sheeting may improve scar healing is still not well characterized.[12,13] Changes in pressure, temperature and oxygen tension have all been studied and found to be

negligible. Silicone sheeting has been shown to increase scar hydration by a more than 50 percent reduction in evaporation. This is postulated to cause a decrease in capillary activity and perhaps collagen deposition. It can be stated with reasonable confidence that silicone sheeting does not increase keloid recurrence, seems to have a favourable effect on wound healing and exposes the patient to little or no morbidity from the treatment. [***]

BUTTON/PRESSURE THERAPY

The use of pressure therapy has been shown to be an effective modality for the treatment of keloids. Like silicone sheeting, this can be used alone or as an adjunct to other therapies. Brent studied the effects of pressure on ear lobule keloids.[14] In five cases of bilateral ear keloids, pressure was used on only one side and no recurrence of keloids was seen. Two out of ten patients had to terminate the pressure therapy secondary to superficial necrosis. The mechanism by which pressure prevents keloid recurrence is unknown. Perhaps the pressure induces a state of tissue hypoxia that in turn leads to fibroblast degeneration and collagen degradation.[15] The best responses have been seen when these pressure appliances are worn for 18–24 hours per day for extended periods of time (four to six months).[16] [**]

INTRALESIONAL STEROIDS

Intralesional steroids are frequently involved in the treatment of keloids both alone and as an adjunctive modality. Studies on the use of steroids alone to treat keloids have shown 'response' rates of 30–100 percent.[6] In most studies, 'response' indicates an improvement in one or more measurable features of the keloid and is not synonymous with the resolution of the lesion. One of the earlier studies to report the use of intralesional steroids found that 88 percent of keloids demonstrated measurable improvement following treatment.[17] Parameters such as size and elevation were improved along with patients' subjective complaints of pruritus and discomfort. In a prospective trial of 52 patients treated with intralesional steroids alone or in conjunction with excision, recurrences were seen in over 50 percent of patients followed for at least five years.[18] [***]

SURGERY ALONE

Surgery alone has a recurrence rate in the range of 54–93 percent.[6, 19, 20] More commonly, recurrences of keloids occur in more than half of the patients treated. To treat a keloid solely with surgical excision with the expectation of a lasting cure would be a victory of hope over experience by the treating physician.

Several authors have also attempted treatment with lasers with overall results being mixed and poor. A prospective study by Strern and Lucente[21] compared the removal of earlobe keloids with either CO_2 laser ($n = 23$) or scalpel ($n = 4$). Despite the addition of post-treatment intralesional steroids at the first sign of recurrence, overall recurrence was at 70 percent. In another study where steroids were routinely given to all patients following CO_2 laser excision, no recurrences were seen at 17 months follow up.[22] Similar mixed results were seen with both argon and Nd-YAG lasers.[6] The 585-nm flashlamp-pumped pulsed dye laser (PDL) was studied in a controlled fashion on 16 keloid scars of the sternum.[23] In this study, one-half of midline sternotomy scars were treated with the PDL, while the untreated half served as a control. Improvements in scar height, erythema, texture and symptomatology were seen in those scars treated with the PDL. These results persisted for at least six months following treatment. [***]

A clear advantage of laser excision over cold scalpel has yet to be proven in the medical literature. Benefits of lasers include a more bloodless dissection and the ability to vaporize tissue. However, the effect of laser thermal injury on keloid cure or recurrence has yet to be defined. It appears that both laser and scalpel excision, when used as a sole modality, will yield poor results. [*]

COMBINED SURGERY AND STEROIDS

The combination of surgery followed by regularly scheduled postoperative intralesional steroid injections is regarded by many as the current standard of care for the majority of keloids seen in clinical practice.[24, 25] [Grade C] The best results were seen in those cases where steroids were administered at the time of excision and at repeated postoperative visits (**Figure 208.1**). In a study of 31 earlobe keloids treated with postoperative triamcinolone over a two-month period, only one recurrence and one case of hypopigmentation were seen by 35-month follow up.[26] Various doses have been reported, but in the treatment of most head and neck keloids, dosage in the range of 5–15 mg, repeated at regularly scheduled intervals (every 14–90 days) is customary. [***]

Intralesional steroids are not without risk or complication. With repeated injections come the risks of hypopigmentation, wound atrophy, telangiectasias and skin necrosis. Judicious use, conservative clinical judgement and close patient follow up should all help to minimize these complications.

RADIATION THERAPY ALONE

The use of radiation therapy should be considered in those patients whose keloids are causing gross disfigurement, functional impairment and have not responded to less aggressive therapies. Daland[27] first reported the use of radiation alone as a treatment for keloids in 1923 with an objective response rate of 79 percent. Since 1960, response rates have been reported to vary from 15 to 94 percent using various doses of radiation from 200 to 4500 rads.[6]

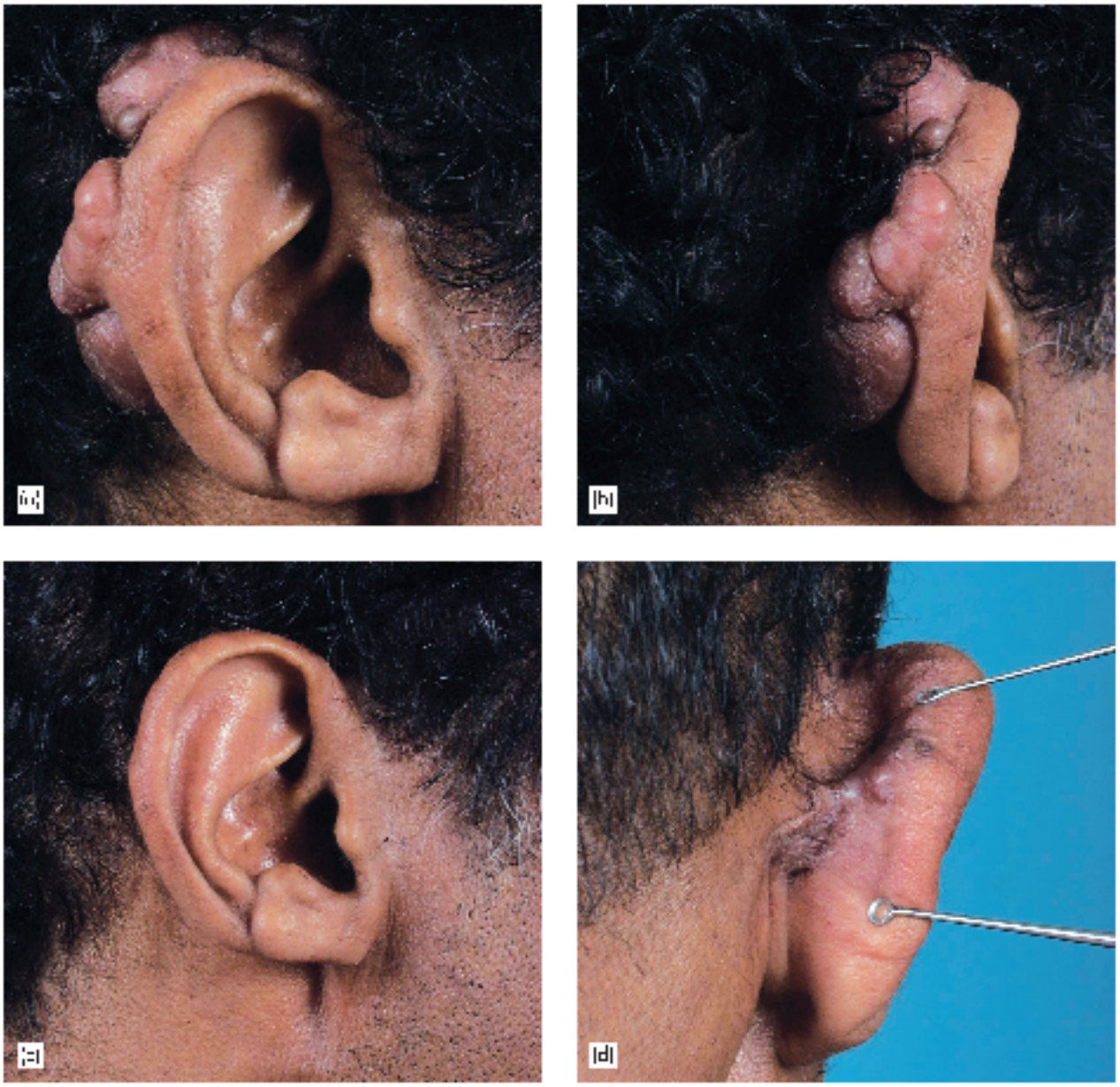


Figure 208.1 **(a,b)** Auricular keloid following sharp trauma to the helical rim (before treatment). **(c,d)** Resolution of auricular keloid following surgical excision and regularly scheduled triamcinolone injections (after treatment).

Currently, treatment with radiation alone is less common and its use as a postoperative adjunct therapy has been advocated by some.

COMBINED SURGERY AND RADIATION THERAPY

While there remains controversy in the use of radiation therapy in the treatment of a benign condition, the response of keloids to this modality can be noteworthy. When postoperative radiation is combined with surgical excision the response rates have been reported to be 33–100 percent.[6] When looking at those studies published since 1974, the response rates are further improved (64–98 percent), possibly reflecting an improved clinical outcome as practitioners refine treatment regimens for these lesions.[6] In a series of 501 patients with keloids treated at Johns Hopkins with postoperative radiation therapy of 400–2000 rads, only 23 percent recurrence was seen at a minimum of two years follow up.[28] [Grade B]

Still much controversy surrounds the use of radiation therapy for benign disease. Medicine has learned that patients who received radiation for acne in the 1940s and 1950s developed skin cancers 30–40 years after initial exposure to radiation. The dose delivered in the treatment of keloids is relatively low (usually less than 2000 rads) and shielding of surrounding tissues is possible when treating earlobe keloids. However, few data exist as to the

possible untoward long-term effects of this modality and it is probably best reserved for the most recalcitrant and disfiguring keloids of the head and neck. [*]

SCAR REVISION

Along with the problems of treating patients with keloids and hypertrophic scars, the facial plastic surgeon is often faced with the challenge of revising an existing scar. Successful scar revision begins with a precise analysis of both the scar, as well as the patient's expectations. Patients often have the false impression that plastic surgery can make an existing scar invisible. The surgeon should educate the patient on the more realistic goal of surgery, which is to modify the scar to a point of maximized camouflage within the natural shadows, lines and borders that exist within the head and neck.

Indications for revision

The surgeon should first begin with a detailed analysis of the scar. Experience has shown that many scars that are narrow, well positioned along aesthetic subunit borders or in parallel with relaxed skin tension lines will continue to mature, improve and become less noticeable over a period of 12–36 months (**Figure 208.2**).[29]

More commonly, patients will present with scars that are amenable to improved surgical camouflage. Indications for scar revision include scars that are: (1) widened; (2) perpendicular to RSTL; (3) webbed; (4) pin-cushioned; (5) long and linear and misaligned with RSTL; (6) hypertrophied; (7) interrupting an aesthetic unit of the face; (8) adjacent to, but not lying within, a favourable site; or (9) causing distortion of facial features or anatomic function.[29] Many of these scars should be considered for revision after the first 60–90 days of scar maturation has occurred. In fact, early revision with realignment of the scar may allow it to mature more rapidly. [*]

Available techniques

There are numerous techniques available when planning scar revision. This chapter organizes the available techniques into the following categories:

- excision;
- expansion with excision;
- irregularization;
- abrasion;
- steroids;
- adjunctive.

EXCISION

A cardinal principle of surgery is that the best treatment of any complication is primary prevention. For scar revision, this translates into the use of the proper technique when closing any wound primarily. When presented with wounds that were not closed properly, re-excision with meticulous closure may be all that is needed. Re-excision should be done using fusiform shape with 30° angled ends positioned within RSTL when possible (**Figure 208.3**). A slight vertical bevel outward from the original scar will prepare the wound edges for proper everted closure. Routine undermining of 1–2 cm around the periphery of the wound will allow re-approximation of the skin edges with minimal tension. The use of buried subcutaneous sutures will further decrease wound edge tension. Final eversion of the wound edges is achieved with properly placed monofilament interrupted sutures. Vertical mattress sutures can also prove helpful when wound edge eversion needs to be maximized. [*]

EXPANSION WITH EXCISION

Serial excision

Wide scars, birthmarks and skin grafts with poor match to surrounding tissues can all be candidates for serial

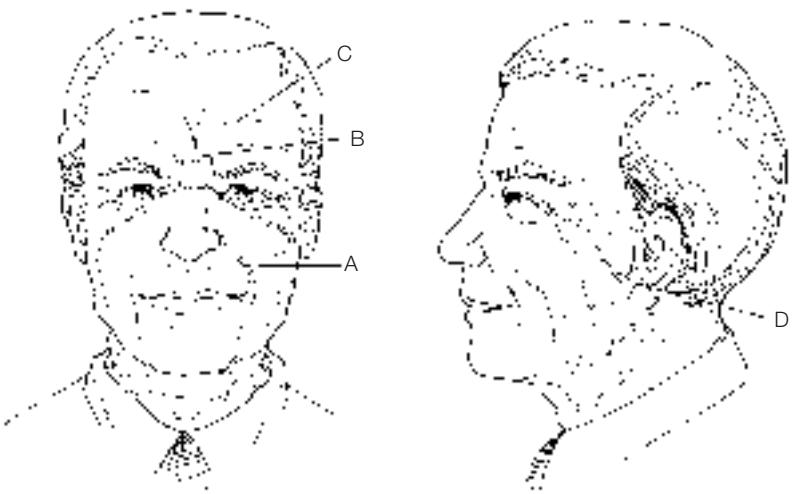


Figure 208.2 RSTL and creases that can aid in scar camouflage. A, nasolabial; B, glabellar furrows; C, horizontal forehead rhytids; D, subunit junctions (ear and cheek). Redrawn from Ref. 29, with permission. © Elsevier (1989).

Figure 208.3 Ideal placement of fusiform incisions with 30° angled ends aligned with RSTL and aesthetic unit boundaries. Redrawn from Ref. 29, with permission. © Elsevier (1989).

excisions. In some ways this is a variant of tissue expansion in that scarred skin is excised and adjacent normal skin brought into the defect area. Like tissue expansion, this technique relies on the skin's biological creep (ability to stretch over time) and is limited by the amount of stretch attainable during each excision. Typically, older patients and those with increased skin laxity will require fewer excisions than younger patients with increased skin tone. As with all techniques of scar revision, the patient must be well informed as to the proposed number of excisions and must understand that serial excision can require months to years to complete. [*]

Tissue expansion

When treating larger scars, the best camouflage is afforded when abundant amounts of similar-appearing tissue can be brought into the repair. Tissue expansion can be a powerful tool to help create excess amounts of surrounding tissue. Tissue expanders are available in a variety of shapes and sizes. Studies on the gain of surface area afforded by the three most commonly shaped expanders have determined that rectangular expanders provide the greatest expansion at 38 percent, crescent-shaped expanders provide 32 percent and round expanders provide only 25 percent.[30] As a general rule, the base of an expander should be approximately 2.5–3 times as large as the area to be reconstructed.[31] [***]

The effects of tissue expansion on skin have been debated. Is new skin actually produced or is the existing skin simply thinned and stretched? Currently accepted understandings on the fate of tissue layers during tissue expansion are: epidermis is thickened, melanin production increases, mitotic activity is increased, dermis is thinned (30–50 percent), collagen synthesis is enhanced, hair follicle number remains unchanged, hair density decreases, muscle thins and can atrophy, and blood vessels proliferate.[32] Interestingly, epidermal changes and increased melanin production seen during expansion resolves a few months following surgery.[32] [***]

Implantation of the expanders must take into account the neurovascular supply and final positioning of the skin to be transferred. A second pocket is created for the injection port, which should be several centimetres away from the expansion device and in an area that is easily accessed. Expander systems with external injection ports exist and may be indicated in certain patients. A 23-gauge or smaller needle is used to inject the expander. Expansion can proceed until the skin blanches or the patient complains of discomfort. Intervals between injections can be from 4 to 14 days, with once a week being favourable. By properly selecting the correct expander device and understanding the above principles of tissue expansion, reconstruction of larger and more complex scars can be successfully achieved. [*]

IRREGULARIZATION

The human eye is more likely to perceive scars that are long, linear and not in alignment with RSTLs and aesthetic subunits. To best camouflage these types of scars, the three most common techniques are Z-plasty, W-plasty and geometric broken line closure (GBLC). All three of these techniques convert linear scars to irregularized zigzagged scars that are less noticeable to the casual observer. When irregularization alone is needed, GBLC and W-plasty are the treatments of choice. However, when both irregularization and lengthening of the scar are needed, then a Z-plasty technique is the technique of choice.

Z-plasty

The Z-plasty is one of the oldest and simplest techniques for scar irregularization. A 'classic' Z-plasty involves the transposition of equilateral 60° triangles (**Figure 208.4**). When these triangular flaps are transposed and closed, the original direction of the scar is rotated and the scar is lengthened by 75 percent. When lesser amounts of lengthening are required, a 30 or 45° Z-plasty can be utilized which will lengthen the scar by 25 and 50 percent, respectively. Longer scars may benefit from multiple Z-plasties. This can be particularly helpful when correcting scar contractures along anatomic concavities. Consecutive Z-plasties allow for the redistribution of forces more evenly along the entire length of the scar and also help to

camouflage the scar into the surrounding RSTLs. Another common indication for multiple Z-plasties is wounds or skin-flaps that have healed with a 'pin-cushioned' appearance. Placing several small Zs around the perimeter of the wound allows interdigitation of the flap with the surrounding skin (**Figure 208.5**). The resultant interdigitated skin edge provides excellent camouflage, especially if later treated with light dermabrasion. [*]

W-plasty

The most common application of W-plasty is when several Ws are employed in series in a technique originally described by Borge[33] as 'running W-plasty'. This is a useful irregularization technique that often uses shorter limbs as compared with Z-plasty and does not create lengthening of the scar.

The technique begins with the marking out of a series of consecutive triangles (Ws) along the wound or scar edge. The arms should be between 5 and 7 mm in length and one arm of the triangle should be drawn in parallel to the RSTL (**Figure 208.6**). Following excision of the triangles, superficial undermining of adjacent tissues is performed and the triangle-shaped flaps are then imbricated. Care should be taken to preserve the subcutaneous scar tissue as this can provide a stable bed for new scar healing. These wounds are also amenable to postoperative dermabrasion to further camouflage the wound. [*]

Geometric broken line closure

Geometric broken line closure (GBLC) is an excellent technique for scar revision that creates an 'irregularly irregular' scar without affecting its length. The geometry of the resultant scar is less predictable by the casual observer's eye and frequently goes unnoticed. This technique is particularly well suited to scars that traverse broad flat surfaces such as the cheek, malar and forehead regions.

The design of a GBLC is a series of random, irregular, geometric shapes cut from one side of a wound and interdigitated with the mirror image of this pattern on the opposite side (**Figure 208.7**). As in running W-plasty, the length of the geometric shapes are between 5 and 7 mm. Similar principles of undermining and leaving deeper scar tissue in the bed of the wound are adhered to as previously described. Two-layered closure is performed and the suture line is reinforced with adhesive medical strips. The patient is typically seen again after one week for suture removal with repeat taping of the wound edges for the next two weeks.

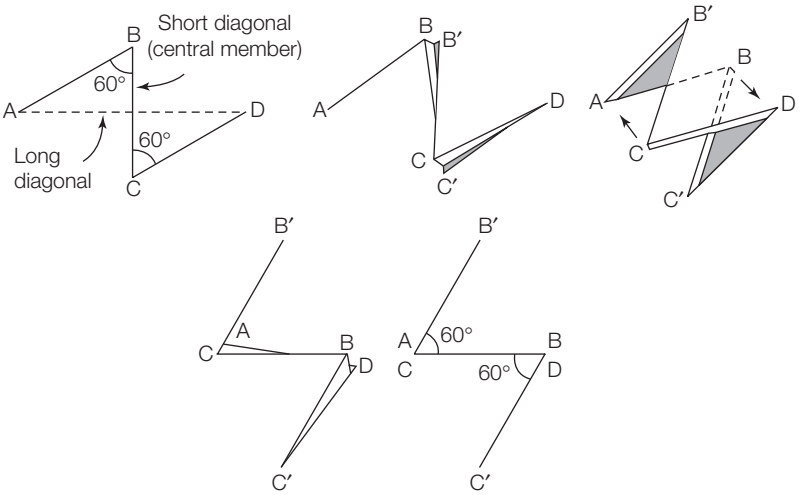
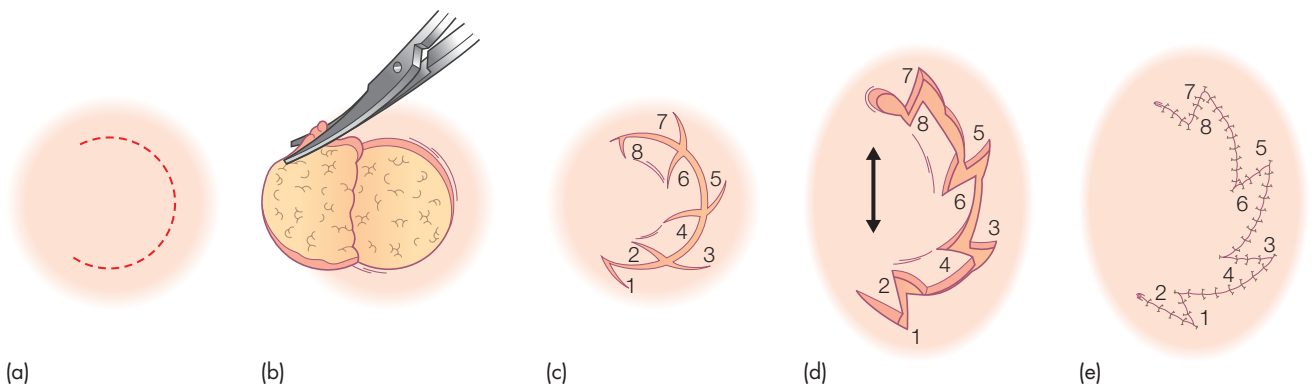


Figure 208.4 Classic equilateral triangle 60° Z-plasty. Redrawn from Ref. 29, with permission. © Elsevier (1989).



(a) (b) (c) (d) (e)

Figure 208.5 Multiple small Z-plasties to improve the appearance of circumferential or pin-cushioned scars. Redrawn from Ref. 29, with permission. © Elsevier (1989).

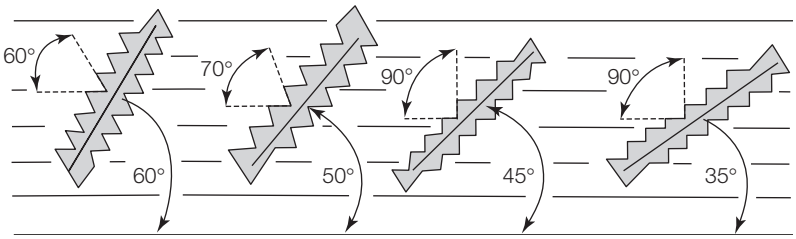


Figure 208.6 Running W-plasty with one area of triangle aligned in parallel with RSTL. As scar inclination decreases, the degree of the angles should be increased to keep one arm of the triangle aligned with RSTL. Redrawn from Ref. 29, with permission. © Elsevier (1989).

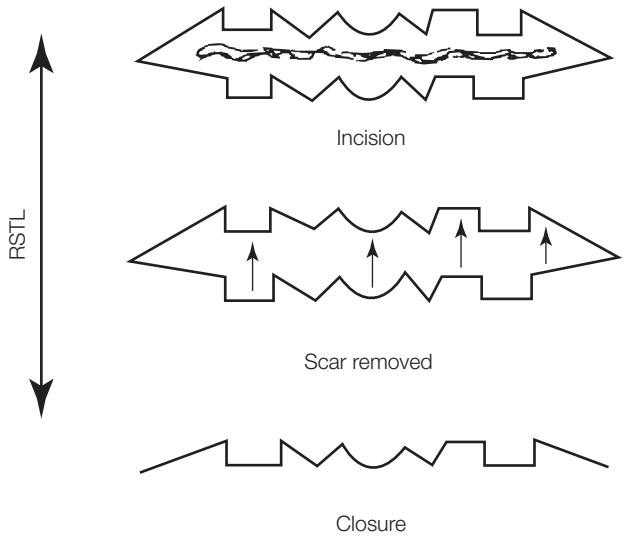


Figure 208.7 Geometric broken-line closure irregularizes the scar to a less predictable pattern further increasing camouflage. Note some of the geometric shapes are in parallel with RSTL. Redrawn from Ref. 29, with permission. © Elsevier (1989).

DERMABRASION

Dermabrasion is a method of controlled superficial skin ablation useful for smoothing out surface contour irregularities and softening the appearance of suture lines following primary closure or irregularization. We routinely employ dermabrasion as a preplanned adjunctive procedure to any irregularization scar revision procedure. Dermabrasion is best performed at the six- to eight-week interval. There is evidence to suggest that rewounding during fibrillogenesis (i.e. four to eight weeks after injury) may promote reaccumulation of hyaluronic acid in the wound matrix, thereby stimulating more epidermal cells to migrate and proliferate in the wound and improving the final appearance of the scar.[34] [***]

The best candidates for dermabrasion are those with lighter complexions, since the risk of post-abrasion dyspigmentation is lowest in these individuals. It is prudent to avoid dermabrasion in patients with human immunodeficiency virus (HIV) or hepatitis because of the risks to personnel from airborne pathogens. The use of 13 *cis*-retinoic acid and its effect on healing following dermabrasion has been debated in the literature. Conflicting reports exist and until the controversy is resolved, prudence would suggest waiting 6–12 months before performing dermabrasion on anyone with a prior history of 13 *cis*-retinoic acid use.[35, 36] Patients with a history of herpetic infection should be placed prophylactically on antiviral therapy, while others have advocated placing all patients on prophylactic antivirals.[32] [**]

Preparation of the patient for dermabrasion can be accomplished with local anaesthesia both for nerve block and infiltration. Infiltration not only provides anaesthesia but can also cause distention of the skin that aids in the technique. Diamond fraise bits are preferred as they are easier to control and remove the skin less aggressively than wire brush fraises. The handpiece is generally held 90° to the direction of wheel rotation and is advanced at right angles to the direction of wheel rotation (**Figure 208.8**). As the superficial papillary dermis is entered, small capillary loops are identified as pinpoint bleeding. As the papillary dermis is penetrated more deeply, small parallel strands of white-coloured collagen can be appreciated. Once this is seen, dermabrasion has been taken to the appropriate depth. Preservation of the reticular dermis with its adnexal structures will allow for the proliferation of undamaged epidermal cells across the abraded surface. The periphery of the treated area should be feathered with fine diamond fraises to allow for a smooth transition between treated and untreated areas. [*]

Immediately after treatment, an occlusive dressing, such as polyethylene oxide hydrogel (Vigilon®), is applied. This is left in place for 48 hours and then the patient is instructed to keep the area moist at all times with bacitracin for the next 7–10 days. After that the patient can use a thick moisturizing lotion, such as Eucerin. Re-epithelization is usually accomplished after five to seven days, but post-treatment erythema can routinely persist for two to three months. This should be clearly communicated to the patient before the procedure. Women are usually less bothered by this as they can begin to cover the area with make-up once re-epithelization is complete. [*]

STEROIDS

As previously discussed, intralesional corticosteroids can be an effective adjunct in the treatment of hypertrophic scars and keloids. In addition, injection into areas of scar revision can be useful when persistent tissue oedema detracts from the wound's appearance. Small doses of triamcinolone (10 mg/cc) injected into the dermis or the dermis subcutaneous junction can provide the surgeon with an ability to 'sculpt' an otherwise normally healing

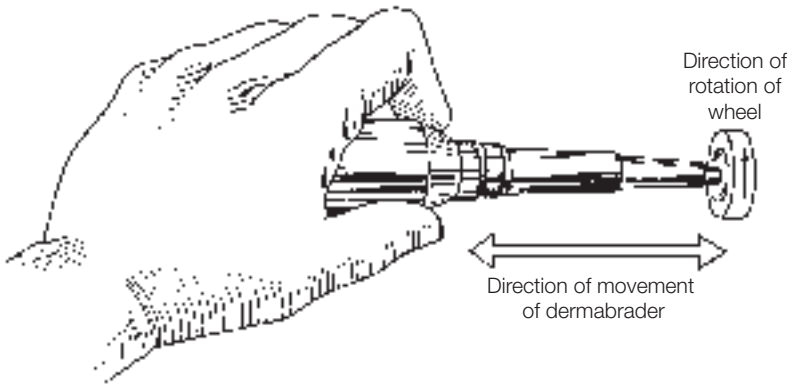


Figure 208.8 Dermabrader moved at right angles to direction of wheel rotation. Redrawn from Ref. 29, with permission. © Elsevier (1989).

wound and hasten the resolution of oedema. Steroids can cause hypopigmentation and telangiectasias when injected in higher concentrations into the dermis. Also, one should avoid the injection of steroids into the subcutaneous fat as this can lead to deformity from fat atrophy. Judicious use and conservative clinical judgement is usually all that is needed to prevent these untoward events. [*]

Topical steroids can also be used when trying to diminish minor wound erythema that can be a normal part of the healing process. This has an application in younger patients and those with more sebaceous skin who are prone to erythematous wounds. Also, following dermabrasion of other resurfacing procedures, short-term, low-dose topical steroids can be applied after re-epithelization is complete.

ADJUNCTIVE PROCEDURES

Cosmetics and hairstyling

Although not routinely thought of as part of the medical management of scar revision, cosmetics and hairstyling can play an important role in these patients. Surgeons who routinely perform scar revision are encouraged to seek out aesthetic professionals in their area that have an interest in helping with the care of these patients. The physician's familiarity with these adjunctive professional services is often met with considerable enthusiasm by the patient who is eager to look normal and regain confidence in his or her appearance. [*]

KEY POINTS

- An ideal scar should be flat and level with the surrounding skin, have a good colour match with the surrounding skin, be narrow, parallel to the RSTL or on the border of aesthetic facial subunits, and without straight, unbroken lines that can be easily followed with the eye.
- The use of pressure therapy has been shown to be an effective modality for the treatment of keloids.
- Surgery alone has a recurrence rate in the range of 54–93 percent. More commonly recurrence of keloids occurs in more than half of the patients treated.
- A clear advantage of laser excision over cold scalpel has yet to be proven in the medical literature.

Best clinical practice

- ✓ The combination of surgery followed by regularly scheduled postoperative intralesional steroid injections is regarded by many as the current standard of care for the majority of keloids seen in clinical practice.
- ✓ Dermabrasion is best performed at the six- to eight-week interval.

Deficiencies in current knowledge and areas for future research

- ➤ The use of 13 *cis*-retinoic acid and its affect on healing following dermabrasion has been debated in the literature. Conflicting reports exist and until the controversy is resolved, prudence would suggest waiting 6–12 months before performing dermabrasion on any patient with a prior history of 13 *cis*-retinoic acid use.
- ➤ The molecular pathogenesis of keloids and hypertrophic scars has yet to be determined.

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