

# SCAR REVISION AND SKIN PLASTY TECHNIQUES

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## **General Characteristics**

The complexity of the wound repair phenomena is such that we still do not have an accurate way of predicting how an individual wound will respond. It has become clearer, however, that one of the interesting phenomena of wound healing involves a recapitulation of ontogeny during the collagen phase of wound repair. In particular, this involves an initial laying down of Type III collagen which is a more embryonic type of collagen. As the scar matures the Type III collagen is replaced by the Type I collagen which is the adult dermal collagen (1). It is also apparent that in hypertrophic scars the Type III collagen is never replaced by the normal Type I collagen.

For a variety of reasons that may include genetics, wound tension, and other wound signals, the patient with a hypertrophic scar never completes the normal ontogenetic process. Therefore, it is important to recognize that surgical revision of scars is limited by the patient's inherent characteristics.

Traumatic wounds and surgical incisions that are oriented opposed to relaxed skin tension lines are most likely to provide unsatisfactory scars. Clearly, the proper design of an elective surgical incision is the best way to avoid poor scarring (2).

## **Objectives and Indications**

According to Borges there are three main objectives in scar revision. These include:

1. Improving the scar's direction with reference to skin tension lines
2. Dividing the scar into smaller components to break up scar contracture
3. Achieving a leveling effect of the scar.

Several considerations should be reviewed prior to electing to perform a scar revision. The nature of the scar is particularly important. Wide scars that have resulted from the loss of tissue are not usually amenable to scar revision techniques. Surgical incisions placed within the relaxed skin tension lines that have healed primarily will generally not be improved by simple excision and resuture.

Surgical incisions that are opposed to the relaxed skin tension lines may be corrected by Z or W plasty depending upon the direction of the scar. Surgical incisions within skin tension lines that have healed from secondary intention may be improved by scar revision techniques utilizing fusiform scar revision (4).

Wide scars that have healed by primary intention may not respond to scar revision techniques if the wound is under tension secondary to loss of tissue or burns. Scars that are wide because of opposition to the relaxed skin tension lines may respond to scar revision.

The direction of the scar is quite critical. Once the decision has been made to revise a scar, there are three primary techniques which can be utilized. Fusiform scar revision is utilized when the scar follows the relaxed skin tension lines. The Z-plasty is utilized particularly when the scar is inclined less than 35 degrees from the relaxed skin tension lines. Scars inclined over 60 degrees from the relaxed skin tension lines can be corrected by utilizing W-plasties.

The timing of scar revision is somewhat controversial (1). Most literature indicates that the scar should be allowed to mature for a period of 9 to 12 months. Borges takes a contrary position and advocates revision some two months following the initial injury for revision of scars in adults and older children (3). This rationale is that in those situations where the scar can be reoriented to follow the relaxed skin tension lines, it is quite clear that the most desirable scar cannot be obtained without surgical scar revision. In his opinion it becomes more judicious to perform the scar revision early so that scar reorientation and maturation can occur more rapidly. In elective surgical incisions that follow the relaxed skin tension lines, a significant period of maturation should be utilized to determine the final scar result prior to performing scar revision.

## **Techniques**

As stated above, the three main objectives of the scar revision are to improve the scar's direction, divide the scar in smaller components, and level the scar. With respect to improving the scar's direction this can be accomplished by either the Z-plasty or the W-plasty.

Although it is desirable to have all of the scar follow the relaxed skin tension lines this is not always necessary and may not be practical in certain scar revisions. The objective here is to significantly improve the scar's overall direction with respect to the relaxed skin tension lines.

The division of a scar into smaller segments is done primarily to relieve the effect of a linear contracture (5). Frequently this can create a bow string effect with the scar. The longer a scar, the greater the force of the contracture. Multiple Z-plasties or a W-plasty can be used to divide scars into smaller components. Simple and double Z-plasties are less effective in creating this effect.

The third main objective of scar revision is the leveling of the scar. This can be accomplished best with the W-plasty (3). It can also be accomplished to some degree with Z-plasties (6). The fusiform scar revision does not significantly accomplish this.

### Scar Revision Techniques

The fusiform scar revision technique involves the excision of a scar or part of a scar within a fusiform segment of tissue with primary closure by direct approximation of the skin. This technique is used for revising scars that are within or closely follow the relaxed skin tension lines but nonetheless need significant revision. The excision of the fusiform defect should be designed so that there is a taper to the point on either end with a spindle shape in the middle. This is somewhat narrower in character than a true ellipse. In addition the fusiform excision should be oriented so that its long axis follows the long axis of the relaxed skin tension lines. Ideally this should be performed such that regardless of the initial orientation of the surgical scars, the fusiform defect is oriented within the relaxed skin tension lines.

The technical execution of the Z-plasty is described in a following section, however, there are some additional considerations with respect to scar revision and the Z-plasty. Borges describes three basic principles of Z-plastic scar revision (3). They include:

1. The diagonals should fall over the scar
2. The limbs of each Z-plasty should always be of equal length
3. When performing multiple Z-plasties the segments should not be smaller than one centimeter. Careful planning is obviously critical in performing the multiple Z-plasty scar revision procedure.

The W-plasty scar revision is a very useful technique for antitension line linear scars. The technique can also

be described as a running W-plasty which more accurately describes its features (7). The concept behind this technique is to change a linear antitension line scar into a zig zag pattern without tissue rotation. This improves the scar by redirecting the forces of contracture on the scar. In addition it allows the scar to be less noticeable visually because the scar is broken up into smaller visual segments.

The W-plasty does involve the excision of some normal tissue and one of the areas of critical judgement involves excising the precise amount of tissue. Excising too large a segment of tissue creates excessive tension whereas forming segments that are too small results in a scar that has very little elasticity. The angles of the W vary between 45 and 90 degrees with 50 to 55 degrees being the angle most frequently used. As with the Z-plasty, the angle should be neither too small nor too large. The technique is most useful when revising a linear antitension line scar.

### Skin Plasties

Skin plasties consist of rearrangement or removal of skin in order to change position of a part. Skin plasties in the digits and forefoot are valuable adjuncts to osseous surgical procedures. Some of the general purposes for skin plasties include the following:

1. Skin lengthening (V-Y plasty, Z-plasty)
2. Reduction of redundant skin after bone removal
3. Redirecting scars (Z-plasty) and
4. Derotational skin plasties e.g. repair of curly fourth toes.

### Derotational Skin Plasties

Skin plasties can be particularly useful in digits where the deformity includes a rotational component. The two best examples of this situation are repair of congenital clinodactyly of the fourth toe (curly toe) and arthroplasty of the fifth toe when the toe is rotated in adductovarus. In rotated fifth toes one often sees lateral nail pathology caused by weightbearing pressure on the side of the toe.

The primary guiding principle in derotation skin plasties is that the skin wedge must be placed perpendicular to the axis of rotation of the toe. Therefore, the direction of the two semi-elliptical incisions must be carefully planned for each individual deformity. A skin scribe is essential for the successful placement of the incisions. The skin wedge for a toe where the deformity is primarily adductus will be quite different from a toe where the deformity is adductovarus.

The second principle in utilizing derotation skin plasties is that removal of the skin wedge is accomplished initially by dissection through epidermis and dermis only. The superficial fascia is left intact. The incision is deepened through superficial fascia only where critical for exposure. This enhances preservation of neurovascular structures, a critical requirement in digital surgery. An example of this is seen in clinodactyly repair. Two semi-elliptical incisions made dorsally from distal medial to proximal lateral. The wedge is placed over the portion of bone that is to be resected, the middle phalanx or the head of the proximal phalanx. The skin wedge is deepened by coaxial dissection through the dermis. A linear incision is then placed parallel to the neurovascular structures that are then reflected medially and laterally. The extensor digitorum longus is then sectioned transversely and the proximal interphalangeal joint is entered by incising the collateral ligaments. Bone is resected from either the proximal or middle phalanx, depending on the apex of the deformity.

## Z-plasty

The Z-plasty is a very useful technique which consists of the transposition of two triangular flaps. This creates a lengthening effect in one axis and a shortening effect in a perpendicular axis. The Z-plasty also creates a change in direction of the common limb of the "Z". These two properties make the Z-plasty particularly useful in treating linear scar contractures.

Two factors are particularly important to consider when planning a Z-plasty. One factor is that the desired gain in length is created at the expense of transverse shortening. In most areas of the body this does not present a problem. However, in the hand and foot the skin is less mobile (8). The digits in particular have less room for transverse shortening than other areas of the body. One modification that helps to circumvent these problems is the multiple Z-plasty. Instead of having one large Z-plasty multiple smaller Z-plasties are created. These may be continuous or separate. The multiple smaller Z-plasties summate to create a length increase equal to the large Z-plasty, with less total transverse shortening.

In addition to the problem of skin mobility the foot is marked by transverse skin creases brought about by the motion of underlying joints. If a Z-plasty is contemplated in such an area it should be planned so that the transverse scar lies in the skin fold line.

The Z-plasty should be drawn out on the skin prior to performing the procedure. The arms of the Z should be equal and the angle of the flap tips is usually 60 degrees. The flap tip angle must be at least 35 degrees and preferably 60 degrees to ensure a sufficient vascular base.

The angle of the flap is important because it determines the ratio of the increase in length. An angle of 30 degrees results in an increase in the length of 25%, whereas an angle of 60 degrees results in an increase in length of 75%. Increasing the angle beyond 60 degrees results in increased length but at the expense of increased transverse shortening. For this reason 60 degrees is generally considered to be the most efficient angle. In addition to angle size limb length is another critical factor. The length of the limbs of the Z-plasty controls the actual increase in length; a larger "Z" increases the real length gain.

Proper planning preoperatively can prevent most complications with the Z-plasty. However, necrosis of the tip can occur, particularly in thick scar tissue. Increasing the vascular supply and decreasing tension on the flaps can prevent tip necrosis. Vascular supply can be increased by keeping the flaps broad at the tip, by keeping the flaps thick, and by avoiding scar tissue at the base. Decreasing tension can be achieved by utilizing multiple Z-plasties and by bandaging the part in mid-position, not maximal tension. Meticulous hemostasis is critical.

The Z-plasty is not a difficult procedure but it does require meticulous planning. It is most useful where there is a thin linear scar contracture. It is also useful in other areas that require lengthening because it redistributes tension in the scar into different planes. This produces less chance of contracture or thick scarring (9).

## V-Y and Y-V Plasties

The V-Y plasty is a popular technique for skin lengthening. Its most desirable feature is that it allows some variability in the amount of length achieved. It is most appropriate in situations where previous scar contracture is not a factor. The procedure includes a "V" shaped incision. The wider the angle of the "V", the better blood supply there is to the flat tip. In the foot, the apex of the "V" should be distal in order to ensure an adequate blood supply to the flat tip. Distal skin is then advanced to the desired position, creating a "Y" incision. The entire "V" flap may be undermined beneath the superficial fascia for exposure purposes. When utilizing the V-Y plasty in conjunction with digital surgery we create an initial "Y" incision. The "V" portion is located over the metatarsophalangeal joint with the stem of the "Y" over the toe itself. This provides excellent exposure for the surgery and allows for the desired lengthening.

## Redundant Skin Plasties

Any time that bone is removed redundant skin is created. This redundant skin is cosmetically unappeal-

ing and is sometimes a functional disadvantage. Hallux and lesser digit fusions often result in excessive soft tissue, particularly when the fusion is performed to intentionally shorten the digit.

In the hallux two semi-elliptical incisions are placed over the joint. The width of the skin wedge is designed to accommodate for the shortening that will occur after resection of the joint surfaces.

In the lesser digits this approach alone is often not possible because access is required to the extensor tendon and hood and metatarsophalangeal joint capsule. In this case a linear incision is placed over the dorsum of the toe extending from the metatarsophalangeal joint to the proximal interphalangeal joint. Two transverse semi-elliptical incisions are then placed over the proximal interphalangeal joint and a skin wedge removed down to superficial fascia. The dorsal neurovascular structures are reflected medially and laterally. At closure there is no problem with skin redundancy and a superior cosmetic result is achieved.

### Summary

Skin plasty techniques can be very useful for redirecting tissue and reorienting scars. Scar revision techniques were emphasized in this paper. However, it should be stressed that careful judgement must be exercised prior to performing a scar revision so that there is reasonable hope of improvement in the scar. The most important means of achieving this is to have a clear understanding of why a scar became unsatisfactory after its original healing process.

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