Triangular Flaps That Transpose, Advance and Interdigitate

9

Z-Plasty [2–7]

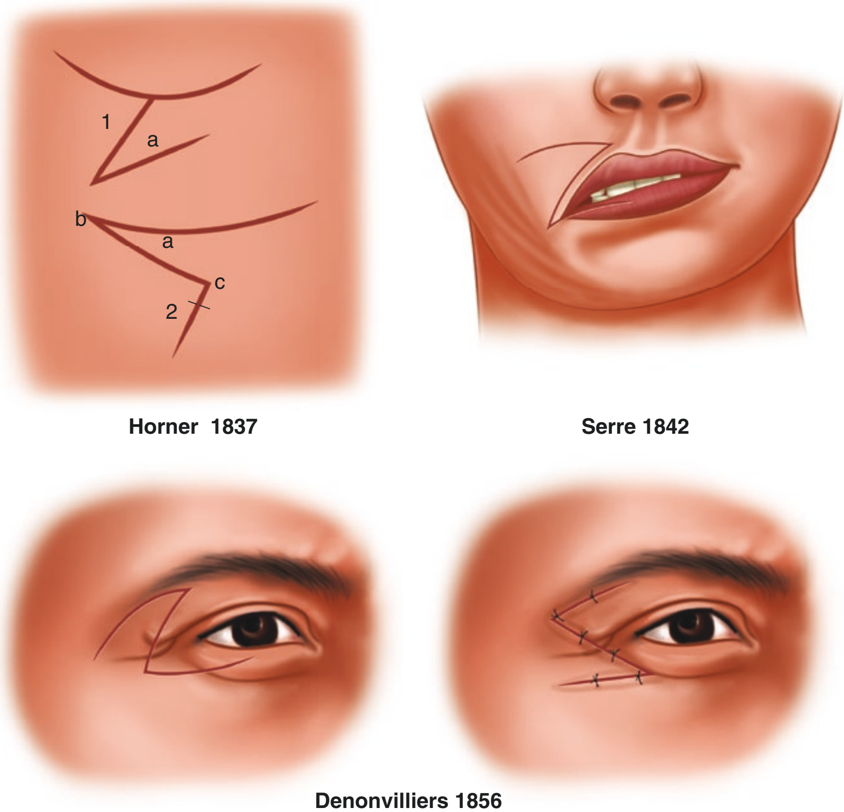

Fig. 9.1 Historical Z-plasties [1]

M.F. Klaassen et al., *Simply Local Flaps*,
https://doi.org/10.1007/978-3-319-59400-2_9

This procedure was described by Limberg [2] as the convergent transposition of two symmetrical triangular flaps. This is a surgical technique by which two triangular flaps are interchanged, one for the other. It consists of a central limb and two lateral limbs all of equal length, in the shape of a Z. In its classic form, the lateral limbs (or arms) extend outwards, at an angle of 60°.

The effect of transposing two equal triangular flaps is to increase the length along the direction of the central limb of the Z and to change the direction of the central limb [3].

In planning a Z-plasty, the basic Z (ABDC) Fig. 9.4 can be incorporated into a parallelogram, with a shorter diagonal (BD) in the line of the contracture and a longer transverse diagonal (AC) perpendicular to it. On transposing the flaps, the parallelogram changes shape so that the initial shorter diagonal lengthens to the size of the transverse diagonal and vice versa.

Whilst this is the classical Z-plasty, it is equally possible to have a mirror image, delineating a reverse Z.

There are two variables in a simple Z-plasty [3–5].

Angle size: Increasing the angle of the lateral limbs increases the percentage length gained. Smaller angles have a narrow base and smaller blood supply, whereas for angles greater than 60°, the flaps are difficult to transpose without producing cones and depressions. In practical terms the most common angles used are between 30 and 60°.

Length of central limb: The greater the length of the central limb of the Z, the greater the gain in length. The limb length controls the actual increase in length compared with the angle size that controls the percentage increase in length.

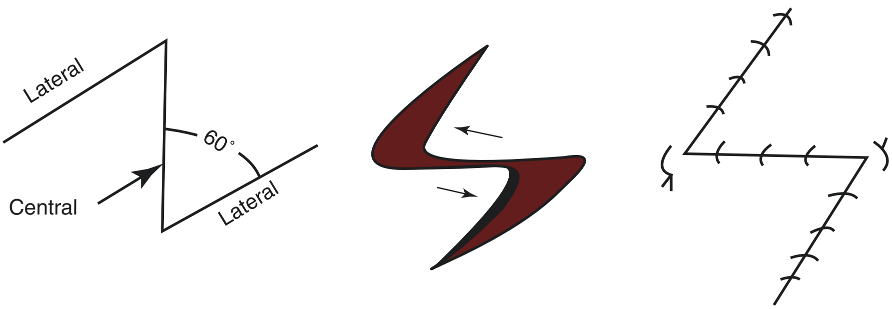

Fig. 9.2 Following transposition of the triangular flaps, the Z has rotated by 90°

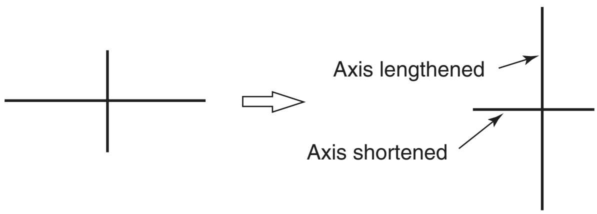

Fig. 9.3 Initial steps in planning a Z-plasty

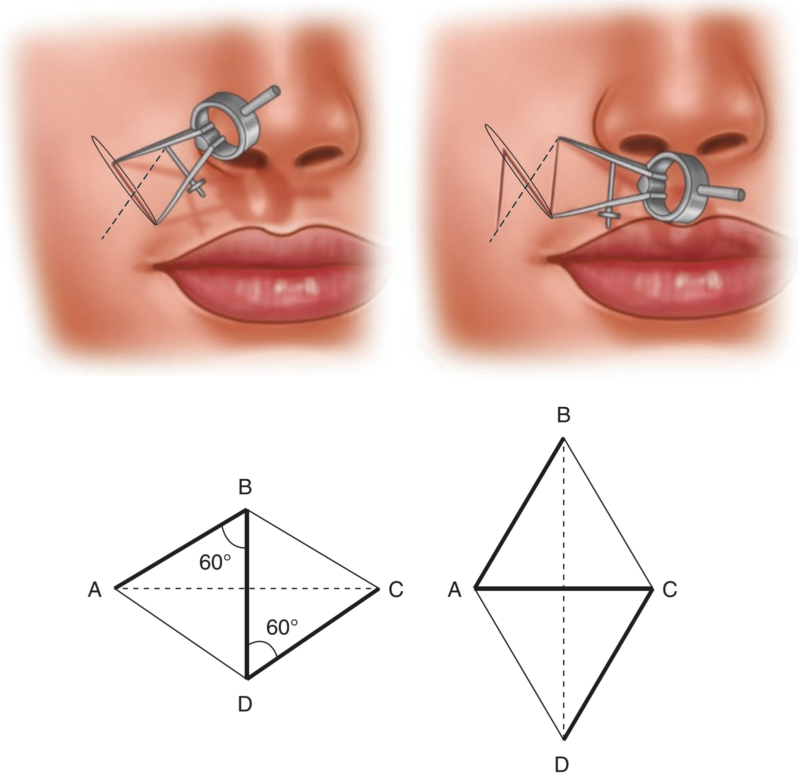

Fig. 9.4 Further planning

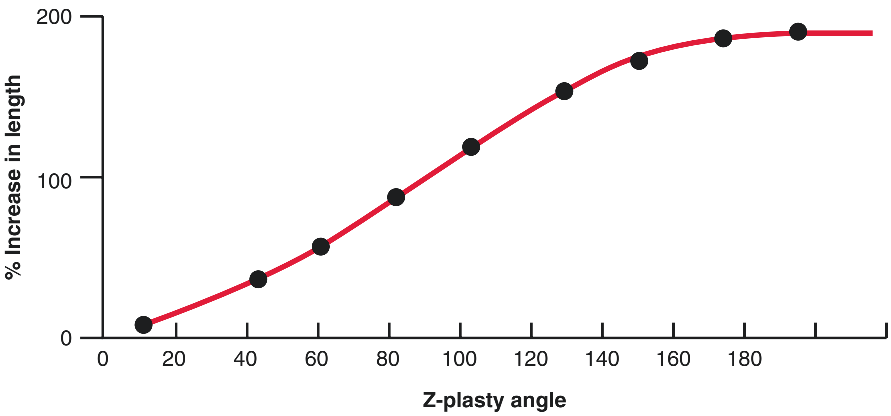

Fig. 9.5 Effect of Z-plasty angles on percentage increase in length

In order for the transposition of the triangular flaps to occur, there needs to be sufficient laxity in the skin on each side of the parallelogram to accommodate the shortening of the initial transverse diagonal (AC) to the final transverse diagonal. Where there is insufficient lateral tissue available for flap transposition, multiple Z-plasties can be designed. The central limb can be regarded as a series of segments, and a small Z is designed for each segment.

The final length of the central limb is a sum of all the segments, whereas the lateral shortening remains that of each smaller segment. Whilst this technique is appealing for regions where there is not a great deal of spare skin as in the fingers, Hudson has pointed out some limitations. The actual lengthening is less than the theoretical lengthening, because the field of tension exerted by each Z-plasty

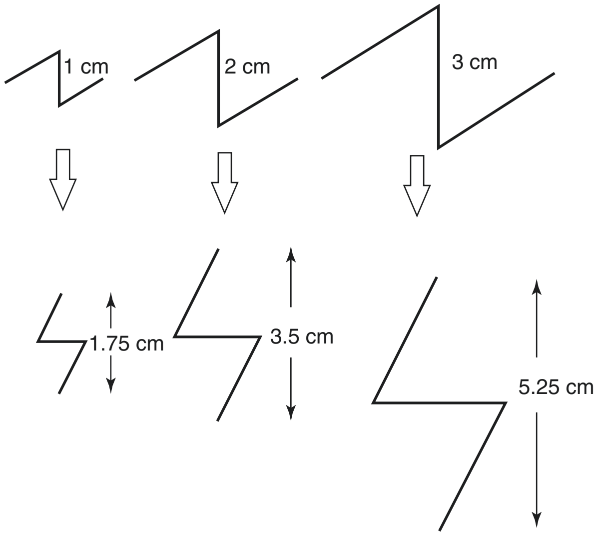

Fig. 9.6 Effect of length of central limb increasing the actual length

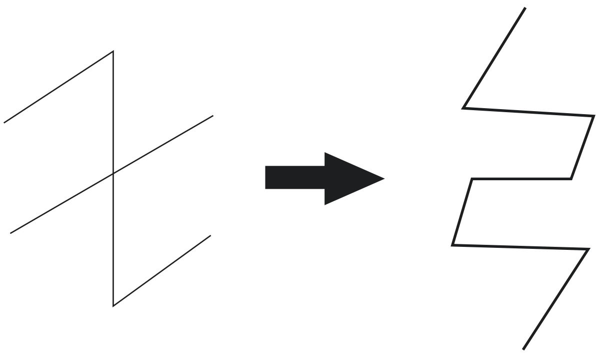

Fig. 9.7 The central flaps of multiple Z-plasties are almost square compared with the triangular flaps of a single Z-plasty

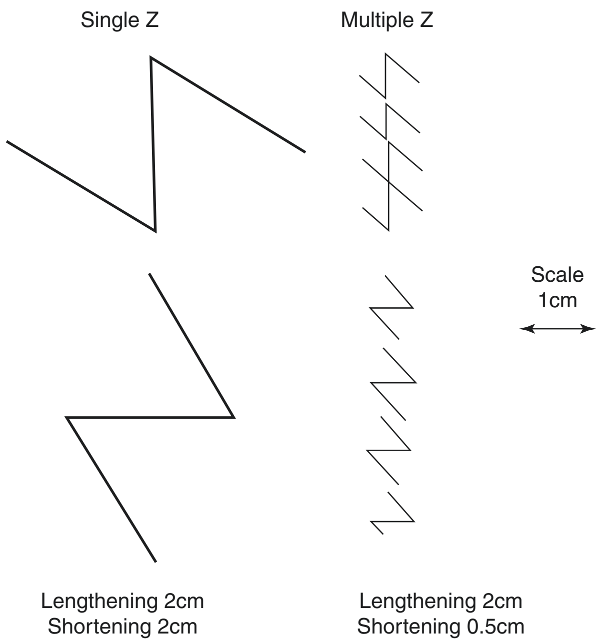

Fig. 9.8 Comparison of single and multiple Z-plasties

impinges on its neighbour and limits the overall gain in length. The central flaps of a multiple Z-plasty become square in shape and do not fit easily into the transposed position, leaving standing and depressed cones and an irregular surface. These tend to flatten out as the wound scar matures.

The functional achievements of a Z-plasty:

- Increase or decrease the length of a scar.
- Break up or change the direction of a straight-line scar.
- Shift anatomical landmarks and features.
- Create or efface a web or cleft.

Clinical applications of Z-plasty:

- Correction of linear scar contractures
- Correction of webbing, bridle scars and constriction bands especially in the neck, popliteal fossa, axilla and digits
- Release of circular contractures around body orifices, e.g. nostril, ear and mouth.
- As a planned procedure to avoid scar contractures or change the direction of scars (as in release of Dupuytren's contracture)
- As an adjunct to closing surgical wounds

Classification: Double-opposing transposition/single stage/flaps that move about a pivot point

Clinical case scenario: Unsightly tracheostomy scar with vertical orientation

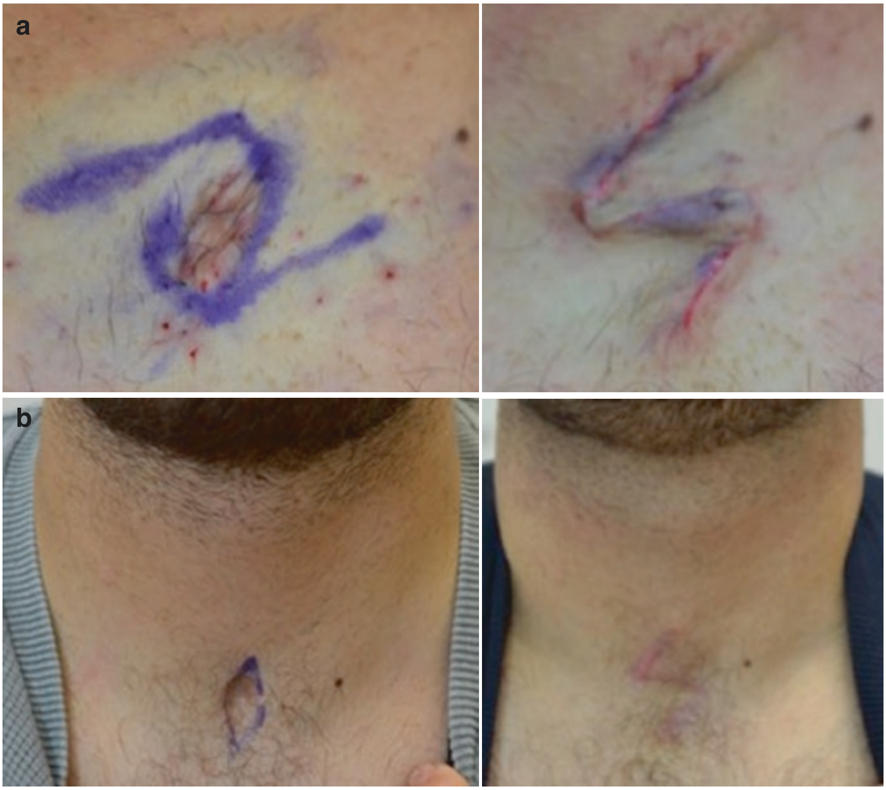

Fig. 9.9 Revision of a vertical tracheostomy scar with a Z-plasty revision in a 30-year-old man after major trauma (**a**). Result at 4 months (**b**)

Surgical method: A Z-plasty was planned to incorporate the vertical scar as the central limb. After excising the scar and transposing the triangular flaps, the central limb of the Z was oriented horizontally in the relaxed skin tension line.

Notes

Unless in an extreme emergency, vertical tracheostomy incisions should be avoided. They always leave unsightly scars that are difficult to disguise.

Fig. 9.10 Multiple Z-plasties to correct a contracture of the right little finger

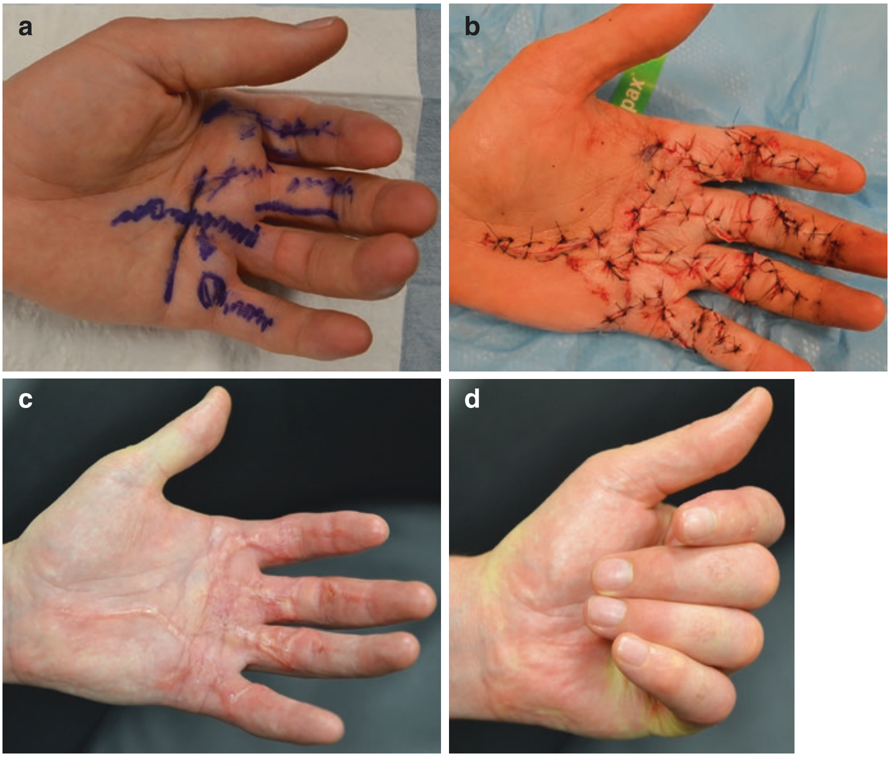

Fig. 9.11 Multiple single Z-plasties as commonly used in Dupuytren's contracture release at the bases of index, middle, ring and little fingers. Recurrent severe Dupuytren's fibromatosis in a left-hand dominant 48-year-old man (**a**). First post-operative day (**b**) and result at 10 weeks (**c**, **d**)

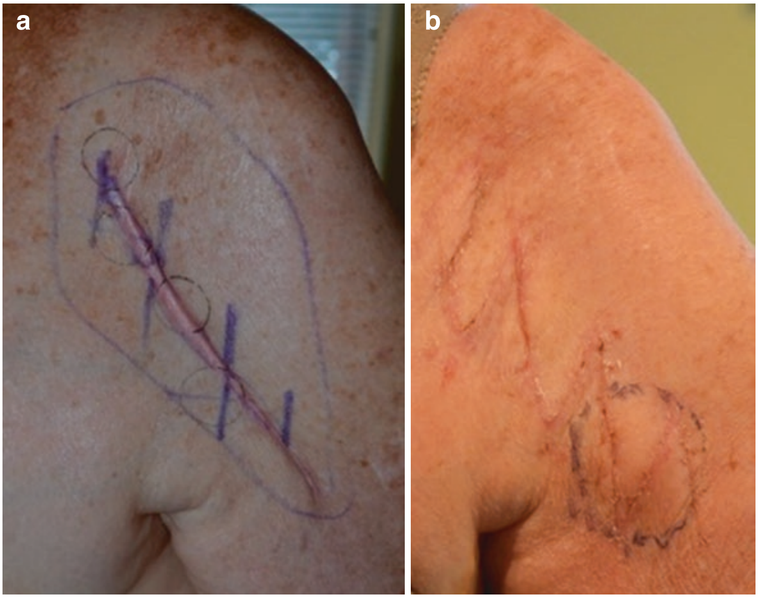

Fig. 9.12 A painful keloid scar on the left shoulder following arthroplasty in a 65-year-old woman (**a**). Released with multiple Z-plasties (**b**)

Z-plasties in this situation give an accordion like elasticity and insert additional skin along the longitudinal axis of the joint.

Planning a Scar Revision on the Face

The intended line of the transverse limb of the Z-plasty follows the resting skin tension line.

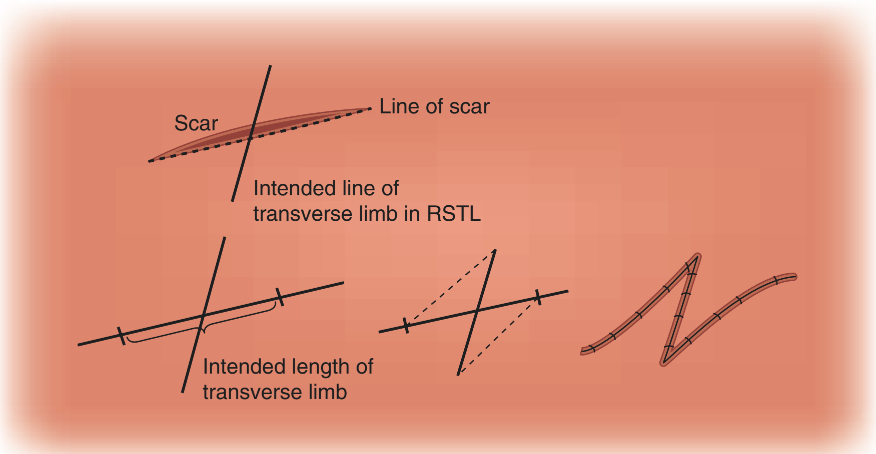

Fig. 9.13 Changing the direction of a scar. See Fig 9.4 The central limb of the transposed triangular flaps is now in the RSTL

Planning Z-Plasties in Three Dimensions

Planning is simplified by assessing the problem in two dimensions, one axis being too long and requiring reduction and the other axis too short and requiring lengthening.

Notching of the Lip

The axes to be considered are the line of the notch and the line of the lip margin. They are perpendicular to each other. The line of the notch can be considered too short and the line of the lip margin, too long. A Z-plasty will therefore shorten one axis and lengthen the other.

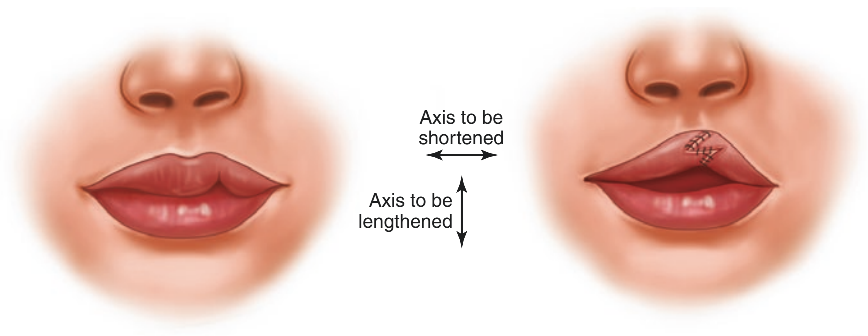

Fig. 9.14 Analysis of a notch in the upper lip

Bridle Scar

The axes to be considered are the line of the scar itself and a line drawn at right angles to it.

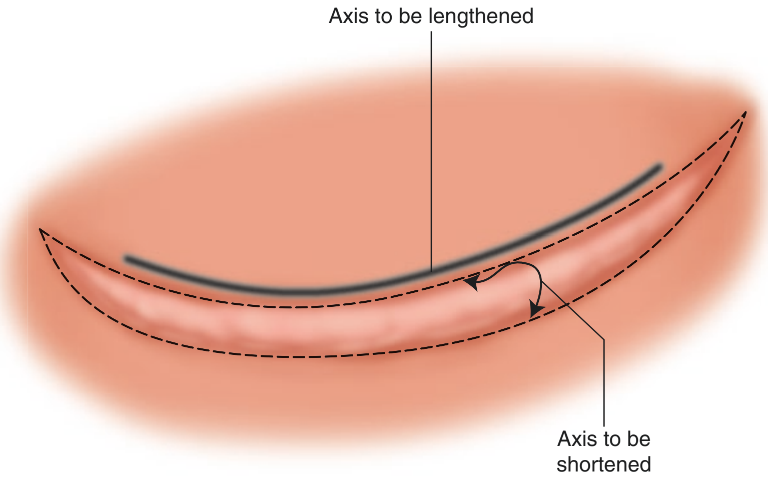

Fig. 9.15 Analysis of bridle scar

Fig. 9.16 A bridle scar contracture of the anterior neck resulting from previous cancer excision (**a**), released by a Z-plasty (**b**)

Congenital Ring Constriction

The circumference of the limb at the base of the constriction can be regarded as the short axis. The depression into the constriction, an axis at right angles to the former, is too long. Whilst this type of correction is frequently published in plastic surgery texts, in our experience the final results are disappointing.

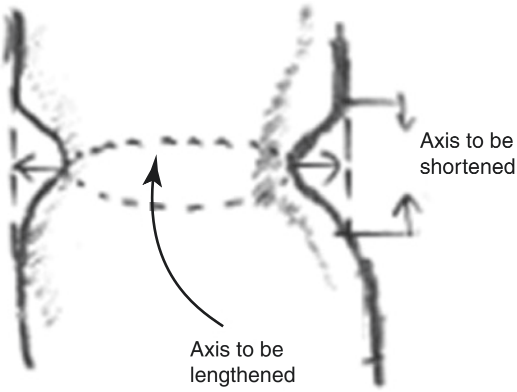

Fig. 9.17 Correcting a congenital ring constriction

Modifying the Z-Plasty Flaps

The tips of the flaps can be broadened to improve their vascularity. The transposed flaps, however, do not fit well into the adjacent defects.

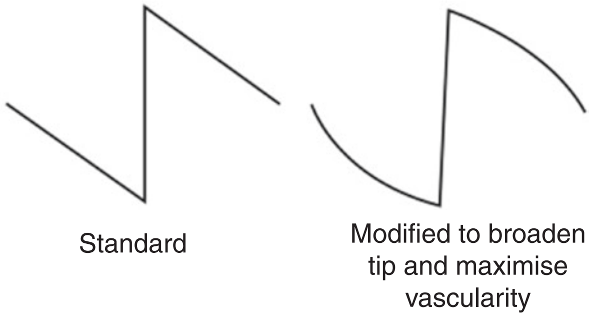

Fig. 9.18 Modifying the flap shape [3]

Tetrahedral Z-Plasty

In the creation or obliteration of a cleft or web by Z-plasty, four plane surfaces are involved. Two planes are occupied by two triangular flaps in their initial position, and two other planes are occupied by flaps in their transposed position. These four planes intersect to form a four-sided figure or tetrahedron.

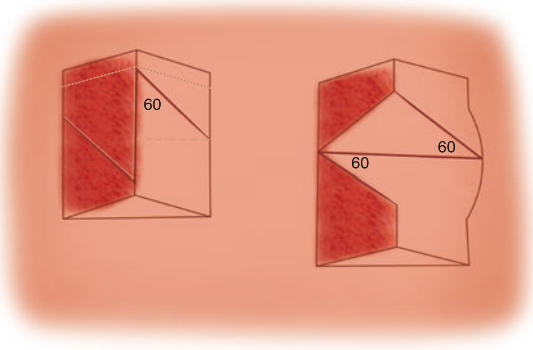

Fig. 9.19 Planning a tetrahedral Z-plasty

Finger Web

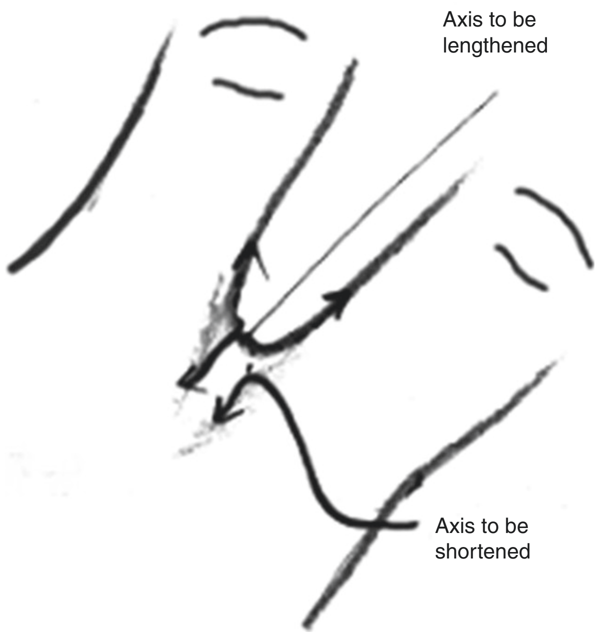

Fig. 9.20 The line of the web needs to be lengthened, and the line in the opposite axis needs to be shortened in order to deepen the web

Asymmetrical Z-Plasty

This procedure is useful when local features such as the scalp hairline, dense scar tissue or other anatomical features hinder the use of a symmetrical Z-plasty. It is planned with different angles, one of which can be 90° and the other considerably smaller. The flap with the narrowest angle is the most mobile, and with a narrower base, more transposition can be achieved. This narrower flap has a greater tendency towards a dog-ear since it moves through a greater arc and closes a larger angle. The increase in length and decrease in breadth of the procedure following transposition occur mainly around the base of the narrower flap. As the angle of the broader flap increases, its mobility decreases, and finally an end point is reached where it does not move.

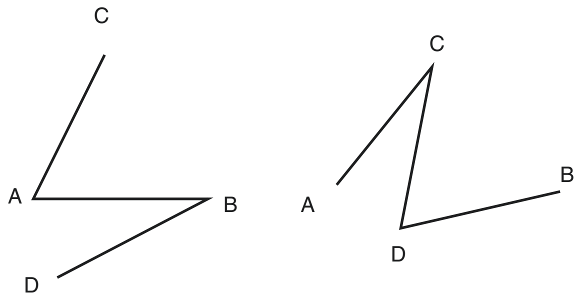

Fig. 9.21 The triangular flap, ABD, is transposed with the larger triangular flap, CAB

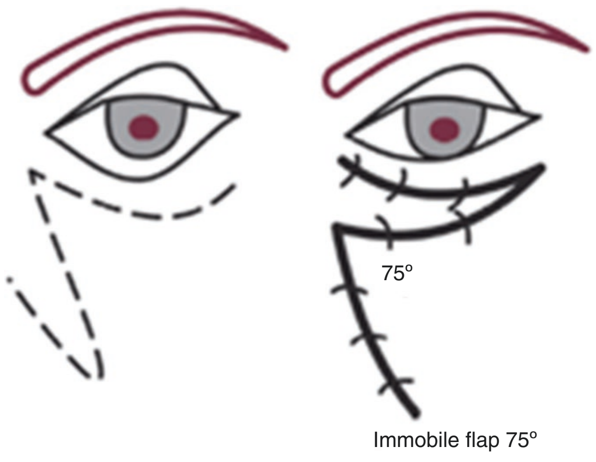

Fig. 9.22 Limberg's asymmetrical Z-plasty [1]

Altering Angle Size

As previously noted, the greater the angle size, the greater the percentage increase in length. Angles greater than 60° are more difficult to transpose. This problem can be overcome by splitting the wide-angle flaps. Further modifications to the Z-plasty technique can include the four, five and six-flap Z-plasty.

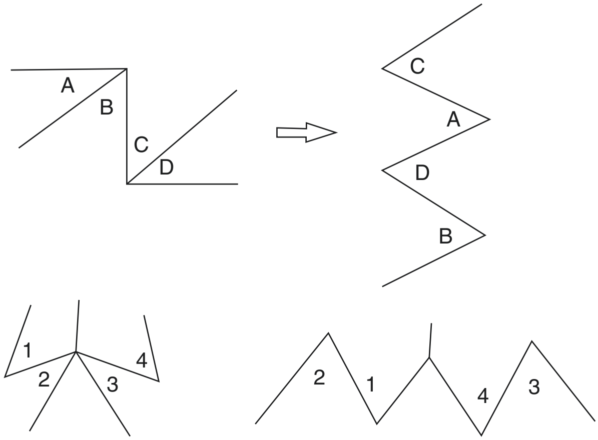

Fig. 9.23 Four and five-flap Z-plasties

Fig. 9.24 Planning for a five-flap Z-plasty to release burn scar contracture in the first web space of a child

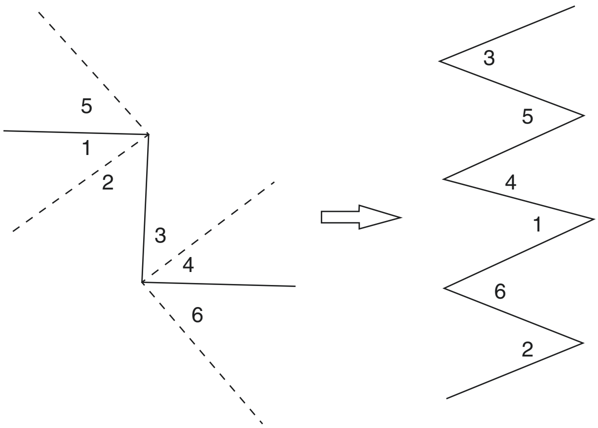

Fig. 9.25 Six-flap Z-plasty

The Jumping Man Flap

This is an extension of the five-flap Z-plasty. The V flap is made by incisions around the medial canthus and situated some distance from the baseline. It is used to correct epicanthal folds and telecanthus.

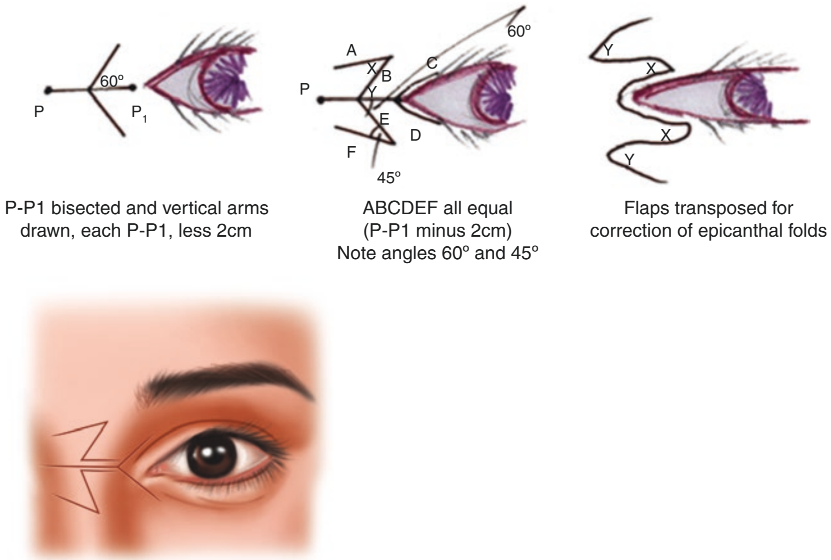

Fig. 9.26 Double-opposing Z-plasties are planned with a common apex at the new site of the medial canthus. The V flap including the medial canthus is the fifth flap of this Z-plasty

Use of Z-Plasty in Flap Repairs

Following the transfer of a flap to its recipient site, there may be some distortion of the skin at the flap base. This may be simply corrected with a Z-plasty.

Similar situations using a glabellar flap or a hatchet flap can be corrected by utilizing a back-cut and converting the base of the flap to a Z-plasty. This endorses the principle of preserving as much as possible of normal skin in local flap surgery.

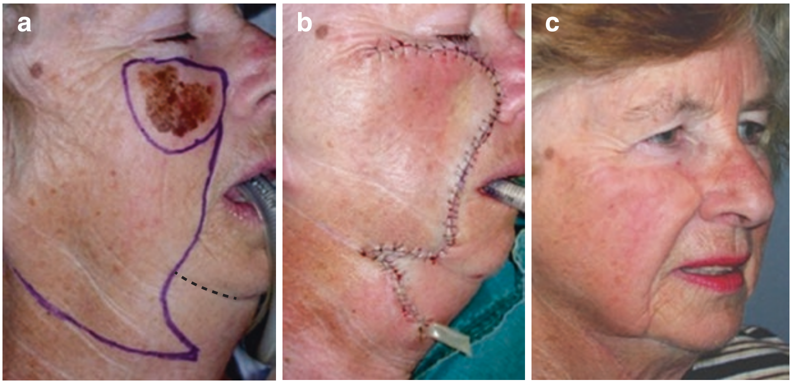

Fig. 9.27 A melanoma in-situ on the medial cheek of a 76-year-old woman (**a**), excised and repaired with a large cervico-facial rotation flap, incorpororating a Z-plasty to close the donor site (**b**). Result at 14 months (**c**) (Courtesy of Dr. Swee Tan) [8]

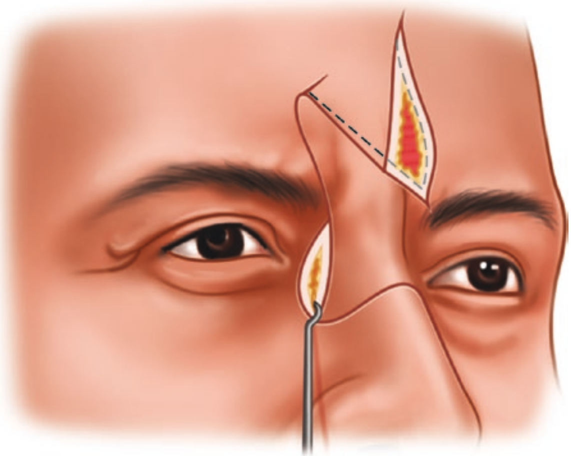

Fig. 9.28 Incorporating a Z-plasty to close the wound produced by a glabellar flap. The upper triangular part of the flap is inserted into the back-cut

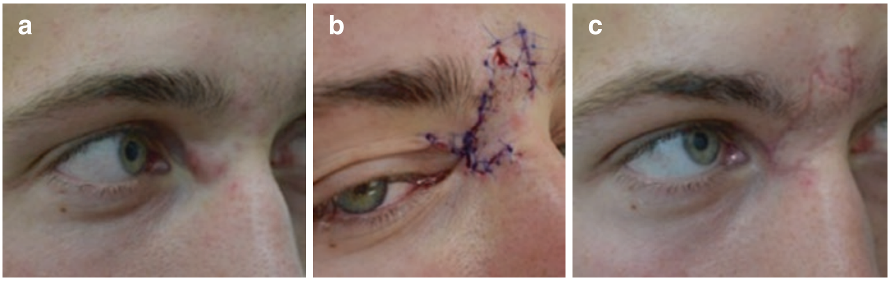

Fig. 9.29 Defect in the inner canthus following excision of a ruptured epidermoid cyst (**a**), repaired with a glabellar transposition flap incorporating a Z-plasty (**b**, **c**)

The Double Z to Rhomboid Plasty [9]

Following excision of the lesion, creating a 120°/60° rhombus, 60° Z-plasties are planned in opposite directions from the sides of the 120° angle, each limb being equal in length to the sides of the rhombus.

Four Z-plasty flaps are created, and these are transposed. The effect is to obtain half the area of required tissue from opposite sides of the defect. This procedure is versatile in that mirror image flaps can be used depending on the position and availability of lax skin.

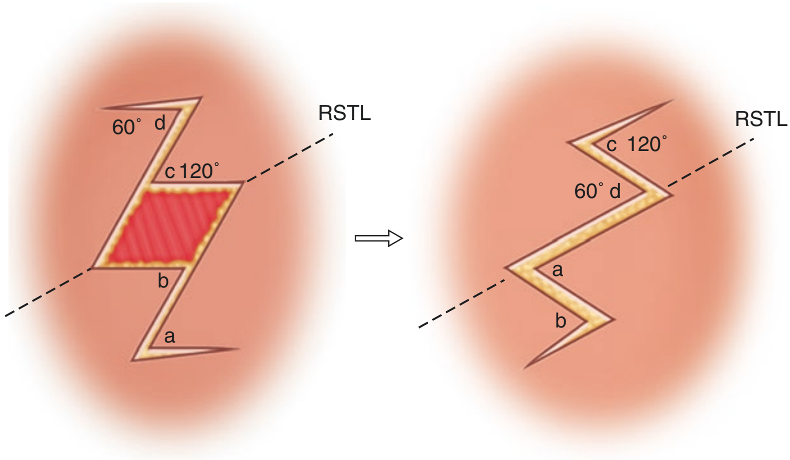

Fig. 9.30 Double-Z rhomboid plasty

Rhomboid to W-Plasty [10]

This is very similar to a double Z-plasty repair of a rhomboid defect. Opposing triangular flaps are planned and raised so that the axis of the resulting W will be in the RSTL. The triangular flaps are then transposed and advanced into the opposing triangular defect.

In general, the angle of the flap should equal that of the rhomboid and the length similar to the sidewall of the rhomboid. Both of these can be altered. With a longer flap opposite the apex of the rhomboid, the wound can be repaired as for a Z-plasty. Shorter flaps will require a V-Y advancement to complete the repair. Tissue is shared from the upper and lower parts of the triangular flaps. It is also borrowed from each side when a V-Y repair is required.

This procedure is suitable in areas where there is little spare skin for an elliptical excision and repair.

We have used this technique successfully in that area of hairless skin between the outer eyebrow and the temporal hairline.

Notes

This technique is suitable only for small skin defects. The tissue required to close the defect is provided by borrowing half the quantity from each of the two opposite sides of the defect. It is unwise to do the procedure in areas of extensive solar skin damage as the W scar may preclude further local flap surgery in that area.

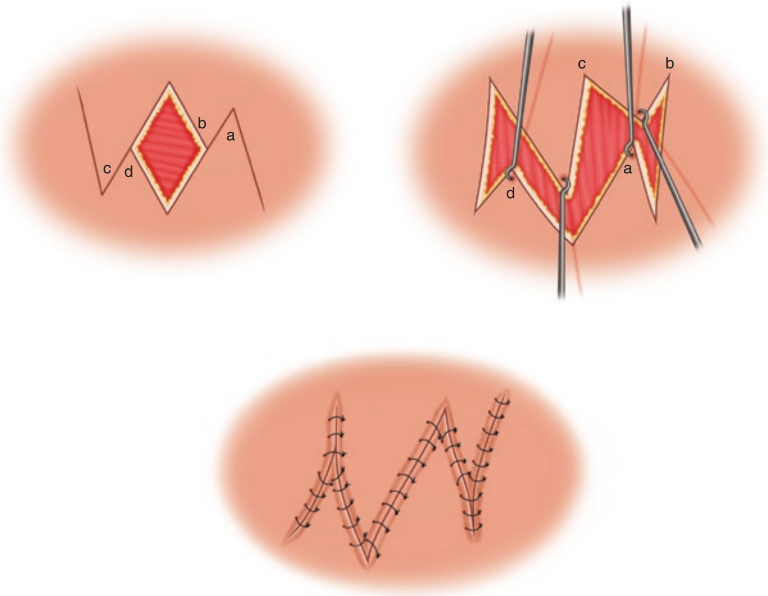

Fig. 9.31 Rhomboid to W-plasty

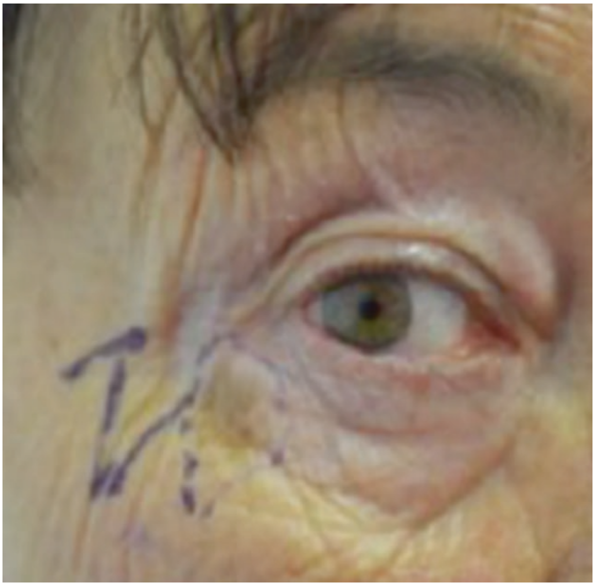

Fig. 9.32 This lesion was too big for the considered rhomboid to W-plasty in this case. See Chap. 6, Fig. 6.9 where small rotation flap chosen instead

Triangular Flaps that Advance and Interdigitate [11]

W-Plasty

This is a method of improving the appearance of scars.

Surgical method: A zigzag incision is made on each side of the scar to be treated. Small isosceles triangles are created. The flaps on each side are mobilised and advanced so that each flap interdigitates with a corresponding triangular defect.

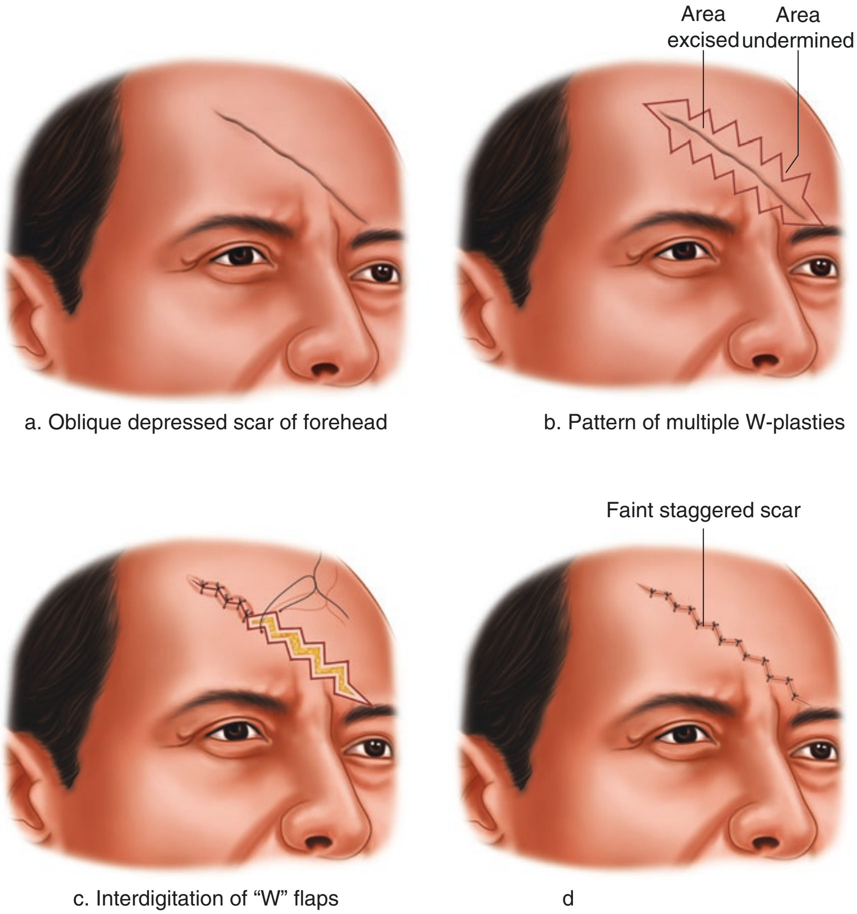

Fig. 9.33 W-plasties

Fig. 9.34 Scar on the right periorbital/malar region of a 54-year-old woman (**a**), excised and combined with W-plasties (**b**). Result at 7 months (**c**)

The Effects of a W-Plasty

It breaks a scar into smaller components, relieving the bowstring effect of longer scars. It produces a redirection of anti-tension line scars, so that they better follow the relaxed skin tension lines. It can accomplish, by the halving technique, a situation in which the subcutaneous scar does not coincide with the zigzag cutaneous scar. This helps camouflage scars by dividing them into small segments and intermingling these segments with normal unscarred skin.

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