

CHAPTER SIXTEEN

RELEASE OF CONTRACTURES

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Contractures are excessive scars that occur across joints or flexural surfaces of the body limiting the motion of the part of the body affected. These scars can be linear and narrow, they may be broad or the whole of the region may be diffusely scarred.



Aetiology

The causes of contractures include:

- Trauma – This may be thermal as in burns, or non-thermal as in lacerations, avulsions and other forms of injuries.
- Ischaemia
- Iatrogenic
- Infection
- Chronic wounds

Most contractures require release either because they impair function or because they cause symptoms of pain, tightness, and recurrent ulceration, among other problems.

Timing of reconstruction

Contracture release is usually done when the scar is mature and this may take 12 – 18 months to occur. It is however not in all situations that scar maturation must take place before contractures can be released because some contractures affect function so severely that they have to be released before the scar matures. Examples of these are scars that impair airway patency or the ability to gain access to the airway as may occur in cases of neck (mentosternal) contractures. Other situations where this rule of scar maturation may not be followed include cases of ectropion where there is a risk of exposure keratitis causing blindness, and in patients with microstomia.

Also, where the scar causing the contracture is small and can be totally excised, it does not have to wait for scar maturation. However when the scar is extensive and requires a staged repair, it is always expedient to consider awaiting scar maturation before revision surgery. When contractures involve multiple sites as it may be in burn patients, there is need to prioritize the sequence of the surgical procedures. After undertaking procedures that will enhance subsequent anaesthesia such as release of mentosternal contracture, correction of microstomia etc, reconstruction of active function e.g. release of severe contractures of the hand, elbow and axilla follows. Reconstruction of passive function such as alae nasi reconstruction and reconstruction of alopecia comes last on the priority list. Such multiple surgical undertakings can be grouped together in order to minimize the total number of theatre visits by the patient. However, procedures that require immediate postoperative mobilization, should not be grouped with procedures that require prolonged postoperative immobilization. When multiple joints are involved, the general principle is that proximal joints should be released before releasing the distal ones and the contractures of each joint should be fully released.

Methods of release

- **Incisional** – This method is often used when there is extensive scarring such that complete excision poses a great risk to the patient or in cases where the patient's condition cannot withstand extensive surgery the scar is incised perpendicular to its longitudinal axis while the area affected is placed under gentle stretch.
- **Excisional** - This method is suitable for contractures caused by small areas of scar but it can also be used for extensive scarring in which case the surgery may have to be staged. It is usually more rewarding to excise as much as the offending fibrous tissue preferable down to the level of the deep fascia. The whole of the scar is excised and the defect closed by one the method described below.
- **Combined** – This is a variation of the above methods. It involves excision of variable amounts of the scar tissue present after the initial incision. The whole scar tissue is however not excised. Most of the techniques for release of extensive scar contractures involve the use of this method.
- **Scar realignment** – This involves changing the direction of an inappropriately placed scar so that the main limb of the scar will be placed parallel to the lines of skin tension. This usually involves use of Z-plasty or any of its modifications.
- **Staged release** - The methods described above can either be done in a single stage or in multiple stages. The reasons for staging include extensive scarring involving multiple sites and/or multiple joints, poor patient's clinical condition and limited areas of donor tissue for wound coverage.

When it is necessary to release contractures in multiple stages, the sequence of release then becomes very important. Some of the principles to apply in such situations have been discussed above. Whichever method is chosen for the release, it is important to cut through all the fibrous tissue causing the contracture for it to be effective. The fascia, epimysium and indeed some muscle fibres may have to be incised in order to ensure full release of the contractures. In addition, the release incision should be carried into normal tissues beyond the margins of the contracture band. The associated joint may also need to be released if all the above prove unsatisfactory during surgery. In all, it is important to perform an adequate release at the time of surgery, as some percentage of the release accomplished intra-operatively will be lost postoperatively.

Methods of wound closure after release of contractures

- Direct closure
- Z-plasty
- Skin graft and skin substitutes
- Local/regional flaps
- Distant flaps
- Skin expansion

Direct closure – This has a very limited role in the release of contractures. It may however be used in situations where the contracture is caused by hypertrophic scar resulting from a complication such as infection during the healing phase. By excision of such a scar and correct re-approximation of the skin, the contracture may be released.

Z-plasty – Most of the contractures caused by linear scars occur as a result of unfavourable direction of the scar and will not be amenable to simple excision and direct closure. In these cases, the direction of the scar will have to be changed and/or the scar elongated. This can be achieved by using the Z-plasty technique. In this case, the central limb of the scar forms the main limb of letter Z while the lateral limbs are extensions that are created by new incisions; they are of equal length as the central limb. The angles between the central limb and the lateral limbs should be 60° for optimal scar elongation but this can be varied in order to achieve various reconstructive needs. The illustration shows the principle of Z-plasty and its various modifications.

Z plasties derives their effectiveness by changing the direction of scars and by recruiting tissue from adjacent to the contracture. Z plasties can be in series or in parallel (Figures 1a and b).

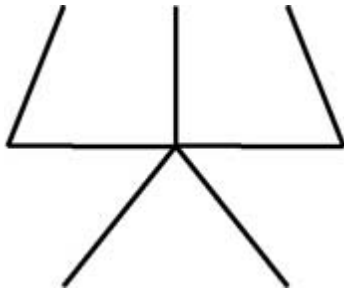


Figure 1: Z-plasty in series

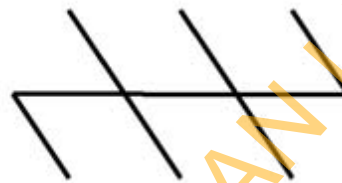


Figure 1b: Z-plasty in parallel

The Z-plasty-in-series recruits a relatively large amount of adjacent tissue and is best applied to a short band with normal pliable surrounding skin. An example is the five-flap Z-plasty. The bigger this design of Z-plasty the longer the length that is gained.

The Z-plasty-in-parallel recruits much less adjacent tissue compared with a Z-plasty-in-series, and thus the actual lengthening obtained is relatively less. Example of Z plasty-in-parallel are the multiple single Z-plasties.

As useful as Z plasties could be, they are only adequate in contractures where more than 50% of the range of motion of the related joint is preserved. In contractures that are more severe than this, other methods of release and closure will have to be used.

Skin Grafting and Skin Substitutes

When scar contracture is released, the edges of the wounds usually retract leaving a defect that is so wide that direct closure or Z-plasty cannot be sufficient to close. In the absence of pliable skin to cover such a wound in the immediate vicinity of the defect, the skin graft becomes the mainstay of management of the wound. This type of situation frequently arises when there is extensive contracture, and when excisional methods have been employed in the release of the contracture. Skin grafting is used very frequently after release of contracture and is probably the commonest method of closure employed in Nigeria.

The grafts may be split thickness or full thickness. Split thickness graft can be thin, moderate or thick depending on the amount of dermis taken with the skin. Split thickness grafts have the advantage of abundant donor site availability, good graft like and spontaneous healing of the donor site. The donor site of the thick split skin grafts can be grafted with meshed skin in order to reduce donor site complications. Grafts destined for use over joints or flexural surfaces are used as sheet

skin. Large sheets often produce better results as less number of sheets will have to be applied thereby reducing the scar complications arising from intervening spaces.

There may be an advantage in orientating the sheets such that the longitudinal axis of the grafts is laid transversely across the defect produced by the release. For better results, modest overlapping of the adjacent sheets of skin and overlapping of the sheet over the wound edge is allowed. The grafted area will usually require postoperative splinting until the grafts stabilize.

Some major disadvantages of split skin grafts include the tendency towards the recurrence of contracture. This tendency is greater when thinner grafts are used and this may call for prolonged periods of postoperative splinting programme. Other disadvantages include poor colour match, absence of hair growth and dryness of such grafts.

Full thickness skin grafts resemble the donor skin more closely than split thickness grafts. They also provide better padding, colour match and hair distribution. The tendency to recurrence with these grafts is less. However, they have the disadvantage of a poorer take particularly when placed on a bed of incompletely excised fibrous tissues. For this reason, they are used preferably on well-vascularized beds and in situations where complete scar excision has been achieved. There is a limit to the amount of a full thickness graft that can be harvested and since the donor sites do not heal spontaneously, this poses a great limitation to its use in patients with large defects following release of contracture.

Biotechnological advancements have now provided more options in the management of these difficult cases where tissue availability is a challenge. Dermal substitutes are particularly useful in cases of donor site deficiency, such as when the patient has sustained an extensive injury. Given the benefits of using thicker skin grafts with more dermis to minimize contraction and recurrent contracture, dermal substitutes offer a potential advantage when thick split-thickness donor sites are not available

Flaps

Flaps are masses of tissue transferred from one part of the body to the other with their blood supply intact. While defects resulting from release of contractures can be covered using other methods, e.g. skin grafting. Whenever possible, a flap should be used in the closure. This becomes essential when bones, cartilage, major nerves and vessels or tendons are exposed as a result of the release procedure or as a consequence of the need to elongate some of these structures. Flaps have the advantage that they have their own inherent blood supply and they do not contract postoperatively. This reduces the period of postoperative splinting required and also reduces the risk of recurrence in these patients. They may be designed in various forms and with varying constituents depending on the reconstruction needs.

For further details about flaps – see chapter 7.

RELEASE OF NECK CONTRACTURE

This section will discuss the methods that can be employed in the release of some common contractures. It highlights the difficulties that may be encountered and the methods used to overcome such difficulties. The principles discussed in this section can be applied to other types of contractures not specifically mentioned here.

Contractures of the neck can be classified as central, lateral or complete¹ depending on the location and disposition of the scar tissue. Rarely, there may be contractures affecting only the posterior aspect of the neck. Notwithstanding the position of the scars, anterior neck contractures have been classified according to their severity into mild, moderate, severe and extensive². This classification has been useful in planning the management of these patients.

- Mild: Scar band involving less than $\frac{1}{3}$ of the anterior surface of the neck.
- Moderate: Scar involving greater than $\frac{1}{3}$ but less than $\frac{2}{3}$ of the anterior surface of the neck.
- Extensive: this refers to the mentosternal adhesion in which the chin is brought down and is adherent to the sternum. The scarring in this case is usually extensive, often involving the whole of the anterior surface of the neck. The scarring in this case may also involve other parts of the neck.

Onah in 2005 classified mentosternal contractures into 4 major groups based on the location of the contracting band(s) and extent of flexion or extension away from the anatomical position of the neck and jaws. He further subclassified each group on the basis of width of the contracting segment(s) and availability of surrounding supple skin. A major consideration in the release of neck contractures is the difficulty that may be associated with the intubation of these patients for anaesthesia as a result of limitation in extending the neck. There may also be difficulties with mouth opening as a result of the net effect of the neck contracture.

These obstacles pose a major challenge which can be overcome by commencing release of the contracture with intravenous anaesthesia or a laryngeal mask airway until this emergency neck release allows for proper neck extension and intubation. Nasotracheal intubation can be done in cases complicated by trismus. The use of fiberoptic laryngoscopes has however minimized the need for initial emergency release.

The release:

After induction of anaesthesia, the patient is positioned supine, with sand bags between the shoulder blades to extend neck. A head ring is used to stabilize the head. The release can be incisional, excisional a combination of these. In mild cases, the release can be accomplished with the use of Z-plasty, figures 2a and b, in its various designs.



Figures 2a and b: Release of Mentosternal contracture with Z - Plasty

In other situations, the scar is divided transversely to accomplish the release and excess scar tissue removed. Two laterally placed V-shaped flaps (see figure) can also be designed, raised and the underlying fibrous tissue excised thereby achieving release.

In all these methods of release, it is desirable to incise or excise the scar tissue as the case may be to the level of platysma or deeper if necessary i.e. down to the strap muscles for better results and to enhance skin graft take if that method of closure is chosen. It is also important to divide all bands causing the contracture. The lateral extent of release incision should be the mid-lateral line or lateral to this.

Closure

Linear contractures usually lend themselves to release/closure with Z-plasty. However when the contracture is greater than 20% of the surface of the neck, Z-plasty alone may not provide an adequate closure and have to be complemented with a local flap skin graft or skin expansion.

Bi-lobed flaps have been extensively used in the release and closure of neck contractures¹. This flap is used when there is supple skin available in the neck adjacent to the area of contracture. It is designed in such a way that the major lobe (a) which will cover the primary defect is at right angle to a smaller flap (b) raised and transposed to cover the secondary defect (figures 3 and 4). The main flap is designed immediately adjacent to the scar, its size depending on the amount of skin available in the supraclavicular area, the amount of skin needed to cover the defect and the safe length-breath requirements. The smaller (minor) lobe is designed at right angles to the main lobe and its design is such that its size will cover the primary defect while its own donor site is closed directly. It is necessary to make the posterior edge of the smaller flap longer than its anterior and fishtail it in order to enhance its transposition.



Figure 3: Bilobed flap in the release of mentosternal contractures Note that the angle between the larger and smaller flaps is 90°



Figure 4: Bilobed flap in the release of mentosternal contractures

Donor site of the secondary flap is closed

Single based transposition flaps may also be used after release of neck contracture and the donor defect closed directly. However, a vertical suture line should be avoided after release of neck contractures and if there is a tendency toward this a Z-plasty should be employed to change the direction of the scar.

In cases of moderate contractures and in the most severe forms of mild contracture, local flaps may not be adequate to close the release defect and skin expansion may have to be done prior to release

or skin grafts should be used to complement the flaps. In severe/extensive contractures, virgin tissue needs to be imported after the release of contractures, as there will not be enough normal native tissue to cover the resultant defect. The options in this case are either to use a skin graft or a distant flap. When skin grafts are used, they are either moderate or thick split thickness skin grafts. It is important to take large sheets so that the least number of sheets are used for cover. These sheets are oriented transversely and there is modest overlapping of the skin over the edge of the raw areas. A tie-over dressing or a stitched-in foam dressing can then be applied and the neck immobilized.

Where a distant flap needs to be used, it must be thin so as to approximate the quality of the neck skin. Example of a flap that can be used is the radial forearm flap.

RELEASE OF AXILLARY CONTRACTURE

Axillary contractures can be classified based on the anatomical location of the scar into 4 groups³.

Type I: This is characterized by a linear web involving the anterior or posterior axillary fold only. There is minimal or no adjacent scarring, and no involvement of hair bearing areas.

Type II: Typically there is involvement of either the anterior or posterior axillary folds with adjacent skin scarring but sparing the hair bearing areas.

Type III: Linear webs affecting both the anterior and posterior folds without involvement of adjacent skin or hair bearing areas.

Type IV: Is characterized by involvement of hair bearing areas.

The method of repair employed will depend on the type of contracture as depicted above and on the status of the surrounding skin i.e. of the chest, ipsilateral arm and the back of the patient.

For type I axillary contractures, the principle of Z-plasty can be used as in the figures 5 and 6.

In type II contractures, Z-plasty alone will not suffice and so these are best covered by using local flaps. Examples of these include: The lateral thoracic pedicled fasciocutaneous flap or the inner arm pedicled fasciocutaneous flap. These flaps are thin, pliable and conform to the shape of the axilla. The technical details of raising the flaps are described below.



Figure 5: use of multiple Z plasty in release of axillary contracture



Figure 6: use of multiple Z plasty in release of axillary contracture there is a gain in length along the line of contracture

The medial upper arm pedicled fasciocutaneous flap.

An incision is made to release the contracture. This incision will have to extend to the deltoid area i.e beyond the anterior or posterior axillary line as the case may be.

A proximally based fasciocutaneous flap is raised from the skin of the medial aspect of the arm. The base of this flap may be fishtailed both to completely the release of the contracture and to enhance the movement of the flap. The tip of the flap must extend beyond the appropriate axillary line as noted above. The donor site is closed directly over a drain and an abduction splint or a bulky dressing is applied until the wound heals.

The lateral thoracic pedicled fasciocutaneous flap

This proximally based fasciocutaneous flap is raised from the lateral aspect of the chest deep to the deep fascia. The axis of the flap may be vertical or oblique. One limb of the flap is made to be continuous with the band of contracture to achieve complete release. The flap is transposed to fill the defect created by a transverse cut into the main band of contracture. The donor site may be closed directly but if this is not possible, it is split skin grafted.

In the diffuse type IV contracture, the options will be either to release the contracture and apply a moderate – thick split skin graft or to import tissue from the scapular region in form of a scapular or parascapular flap if there is availability of normal skin in that area. The option of a free flap may also be useful.

HAND CONTRACTURES

Contractures involving the hand are commonly in the form of claw deformities, palmar contracture and web space deformities.

Claw Deformities

This type of deformity often results from contracture of the dorsum of the hand. The typical disposition of the hand is that of metacarpophalangeal joint extension, proximal interphalangeal joint and distal interphalangeal joint flexion. The wrist may be flexed or extended depending on the site of the scarring.

Release of this contracture is done skin cover obtained by using a pedicled groin flap or other local/regional flaps that may be available e.g. distally based fasciocutaneous flap from the forearm or distally based fascial flap. Free flaps e.g. the lateral arm flap and a free radial forearm flap may also be used in the reconstructions.

After resurfacing with these flaps, Kirschner wires will be required to keep the released hand in position of function during the healing phase after which intensive hand therapy will commence to regain the function of the hand. When skin grafts have been used to cover a wound following release of contractures, the hand will have to be splinted until the grafts are stable and intensive therapy commenced.

Palmar contractures

This occurs in patients, particularly children who grasp hot objects e.g. hot iron, heater etc. It is also seen in children with seizure disorders who have sustained burns. The contractures should be released, as much of the scar tissue removed and the defect covered with a skin graft. Full

thickness skin graft is better used to cover these defects as they contract less than the split thickness graft and so the risk of recurrence of the contracture is reduced. Kirschner wires are used to hold the involved fingers in extension until the grafts have consolidated. The cross finger flap is especially useful in these patients when tendons and other important structures are exposed or when tendon elongation has been done.

Web space deformities

They may be in the form of a scar band contracture (web space contracture), adduction contracture or syndactyly. The goal of surgery in these contractures is three folds:

- 1) To break the line and add length to a straight-line contracture.
- 2) To recreate the web space commissure by use of local flaps and
- 3) To add skin from outside the local area for severely scarred web spaces.

In case of the web space contracture, the main problem is in the skin and the contracture can be released using single Z-plasty or using multiple Z-plasty placed side by side, in tandem and varying the angles between the limbs of the Z plasty in order to achieve the optimal release particularly when the scar contracture involves a long distance e.g. in the thumb-index web space. Other methods include the V-M flap and the X-plasty.

Adduction contractures

Involve both the skin and structures that are deeper to the skin and as such there may be fascia or muscle fibrosis associated. In the release of these contractures, apart from excising the scar there in the skin, the muscle/fascia will also require to be released.

The resultant defect is then covered with a flap or a full thickness skin graft.

Post burn syndactyly

Post burn syndactyly of the fingers has been graded based on the distance or the distance the scar band extends along the length of the involved finger. Grade I extends up to $\frac{1}{4}$ th of the distance from the MP to the PIP joint, grade 2 up to $\frac{1}{2}$, grade 3 MP to $\frac{3}{4}$, grade 4 greater than $\frac{3}{4}$ th. These contractures can be released using the principle of Z-plasty or X-plasty and complementing the closure with the use of full thickness skin grafts where necessary. Another method is to cover the defect with a local flap⁶.

RELEASE OF LOWER LIMB CONTRACTURES

Popliteal contractures

Popliteal contractures may occur as a result of restriction of movement by medial or lateral scar bands, or as a diffuse posterior popliteal contracture.

Movement in the knee could be limited by longitudinal bands of scar tissue at the posteromedial or posterolateral aspects of the knee with normal skin at the posterior surface of the knee. In the very mild forms, Z-plasty or V-Y advancement flaps can be used in the release of these contractures. Where this is not adequate either because of the severity of the contracture or because of the width of the bands, local skin or fasciocutaneous flaps can be used to close the defect produced by the release or scar excision.

Occasionally, extensive injuries to the popliteal area may cause contracture of this region. The method of release/cover will depend on the severity of the contracture. If the contracture involves the central popliteal fossa, with normal skin on either side, local flaps may suffice in the release

and closure. When the entire popliteal fossa is involved, the release incision must extend to both the mid medial and the mid lateral axis of the knee in order to achieve complete releases. Options of cover of the resultant defect include split thickness skin graft followed by postoperative splitting or the use of a flap.

Release of foot contractures

Contractures of the feet could occur on the dorsum, or the plantar surface of the foot. The web spaces may also be contracted. Contracture of the dorsum of the feet usually causes the hammertoe deformity in which there is gross hyperextension and subluxation of the toes at the metatarsophalangeal joint. There may also be associated syndactyly.

Mild to moderate linear scar contracture of the foot can be corrected with single or multiple Z-plasty to lengthen the scar. In more extensive contractures with tissue deficiency however, the release will have to be carried out and split skin graft applied. In cases where release of the skin contracture is not sufficient to complete the release, tenolysis, tenotomies or release of the joint may have to be done and a flap complemented by a skin graft used in the closure. Kirschner wires passed from the tip of the toes to the metatarsals (figures 7 and 8) are used to maintain the release and immobilize the joints until the skin grafts have stabilized. Syndactyly of the toes is corrected, using the principles described for release of the hand web deformities.

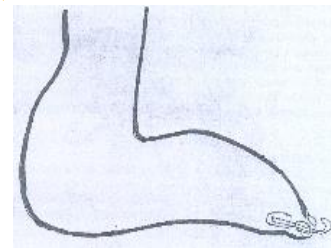


Figure 7: Inverted V-shaped flaps centred on the affected joint in the release of hallux flexus. Figure 8: Note the Kirschner wire inserted for post-operative immobilization.

Flexion contracture of the hallux and classified according to its severity⁷. Bilateral V-shaped flaps centered on the joint and complemented with skin grafts have been successfully used in the release of these contractures.

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