Basic Principles

General Remarks

Plastic surgery of the face has two main objectives: it should correct dysfunctions and restore or improve the aesthetics of the face. Apart from addressing malformations, plastic reconstructive procedures are required to revise scars, resurface skin and soft-tissue defects, or correct deformities after trauma or tumor surgery. Operations to maintain or improve function are not feasible without incisions and the subsequent formation of scars. Sometimes function and aesthetics contradict each another in reconstructive plastic surgery. It requires experience, detailed knowledge, and careful planning to achieve the intended improvement of function with a minimal loss of aesthetics. Obviously, aesthetics play an essential role, especially when the face is involved.

Before undertaking plastic surgery of the face, therefore, the following general rules should always be kept in mind:

**Rules, Tips, and Tricks**

- Before each operation: analyze the alteration exactly, document all findings, and undertake thorough planning.
- Provide the patient with comprehensive information; the use of photographs can be helpful.
- Avoid making any unduly optimistic statements about the planned procedure; carefully enquire about the patient’s expectations and weigh them up against what is technically possible.
- Never correct more than what has been stated in the informed consent.
- Take the patient’s age into consideration; given the increased rate of hypertrophic scar formation in children and adolescents, be cautious with operations that do not necessarily need to be undertaken at this age.
- Be patient when doing revision surgery: allow an adequate period of time to elapse after the previous operation, usually 9–12 months; do not yield to understandable pressure from the patient.
- Do not play down an aesthetically unsatisfactory result to the patient, given that an inadequate result is not necessarily the surgeon’s fault.
- Analyze residual deformities and discuss subsequent measures for improvement with the patient.

Adhering to these rules will help avoid many disappointments. Nevertheless, results that are not completely satisfactory are unavoidable in certain cases, even for experienced surgeons; the dynamic processes involved in wound healing and scar formation are only partially predictable and are subject to individual variation. Achieving results that are largely predictable requires a detailed knowledge of the basic principles of the procedures used in plastic surgery and of established operative techniques for the face.

Surgical Anatomy of the Skin

Plastic surgery of the face is, in the first instance, surgery of the skin. Figure 5.1 depicts the topographic architecture of the skin. The skin (cutis) is made up of two layers: the epidermis and the dermis (corium). The epidermis consists of a superficial keratinized layer and a deep nonkeratinized layer, which is responsible for the color of the skin as a result of its content of melanocytes. The dermis bears the vascular and nerve supply of the skin and is rich in elastic and collagen fibers. This fiber content is responsible for the elasticity of the skin and its ability to retract. Both types of fibers are reduced in advanced age, which is why aged skin is loose and prone to form wrinkles.

The superficial part of the dermis is interdigitated with the epidermis (papillary bodies), rendering horizontal movement of these two layers with respect to one another impossible. Any shifting of the skin, therefore, always takes place at the level of the subcutaneous fat layer (subdermis), which separates the skin from the underlying structures (muscle, bone). The subdermis is well developed in some areas of the face, thus giving shape to these areas (e.g., the cheek), but is completely lacking in others (e.g., the eyelids or the anterior surface of the ear).

Hairs, sebaceous glands, and sweat glands are found as skin appendages, partly in the subdermis and partly in the dermis. It is important in plastic surgery to bear in mind that the epithelial components of the dermal appendages run through both epidermis and dermis.

The hairs of the head and the eyebrows grow at an oblique angle to the skin surface. This should be kept in mind when directing the scalpel (the plane of incision should be parallel to the hair follicle). Wound healing may be influenced by, among other things, the content of sebaceous glands in the skin. Visible scars may develop around sutures in areas rich in sebaceous glands (above all on the nose, and in adolescents in general) as
Reconstructive Plastic Surgery of the Face

Knowledge of the vascular supply of the skin is of fundamental importance for reconstructive plastic surgery, especially in designing skin flaps for defect coverage.

The vascular plexus within the papillary body of the dermis may be supplied by two routes (Fig. 5.1):

- From the subdermal vascular plexus, which runs in the subdermis and is ubiquitous. Random pattern flaps are supplied by these vessels.
- From a specific artery (with accompanying vein). These arteries usually run over muscles, parallel to the surface of the skin, and give off vertical vessels (in addition to the vessels from the subdermal plexus) to the skin. It is possible to raise skin flaps on these arteries which are considerably longer than random pattern flaps. Owing to the special position of the artery along the axis of the flap’s pedicle, these flaps are known as axial pattern flaps or arterial flaps. Typical examples of such arteries are the superficial temporal artery (“temporal flap”) and the supratrochlear artery (“(para-)median forehead flap”, see Fig. 5.36).

Aesthetic Units and Relaxed Skin Tension Lines (RSTL)

Aesthetic units are defined regions of the face which should, whenever possible, be reconstructed in their entirety during reconstructive surgery. On the other hand, the restoration of a structure with the aid of adjacent tissue must not be undertaken at the expense of destroying the aesthetic unit of the donor site. The aesthetic units of the face are the frontal, supraorbital, orbital, infraorbital, nasal, zygomatic, buccal, labial, and mental units (Fig. 5.2a). Some regions, such as the nose, are further divided into subunits (see Fig. 5.35).

When making incisions or revising scars on the face, it is essential to respect the “relaxed skin tension lines” (RSTL, Fig. 5.2b) and the wrinkle lines of the skin. Whereas the RSTL correspond to the spontaneous course of wrinkles after relax-
ation of the skin, the wrinkle lines are oriented perpendicular to the direction of the fibers of the facial muscles. RSTL and wrinkles lines are more or less identical, although they run differently in some regions (glabella, lateral canthus, lateral nasal wall). Incisions on the face should correspond to the direction of the RSTL (less wound tension, rapid wound healing, minimal scar formation) or, when creases are present, follow the wrinkle lines ("hide the scar within the skin crease").

**Rules, Tips, and Tricks**

Always consider the RSTL when making skin incisions on the face. If the wounds are predetermined, orientate the subsequent scars in the direction of the RSTL by advancement of the skin.

**Instruments**

The instruments must be adapted to the special requirements of plastic surgery. This means that the tips of forceps or the jaws of needle holders should be suitably small, although the handles must be large enough to be manageable. The following instruments have been proven useful:

- **Needle holders**: Instruments with flat jaw surfaces for holding the needle or suture are preferable. With textured jaw surfaces, the very fine suture material that is often used can either pass through the grooves, making it impossible to grasp, or be crushed and thus lose its tensile strength.
- **Forceps**: Adson or Adson–Brown forceps for plastic surgery have fine tips to allow tissue to be grasped precisely and securely. Nevertheless, despite this reduced tissue traumatization, only the subcutaneous tissue should be grasped, whenever possible.
- **Scissors**: One rounded and one pointed, curved pair of scissors are usually adequate.
- **Hooks/retractors**: Fine single skin hooks are very useful and can be inserted through the skin without leaving scars. This allows the skin to be moved or held without the crushing action of forceps. Retractors with more prongs are used for extensive mobilization, but should then only grasp the subcutaneous tissue.
- **Scalpel blades**: Usually a small, curved blade (No. 15) is used. For mobilization of larger skin areas to cover defects, especially in the area of the neck and chest, a correspondingly larger curved blade (No. 10) is used. For fine, angulated skin incisions, e.g., for scar revisions, a pointed blade (No. 11) is used.
- **Bipolar coagulation forceps**: Targeted bipolar coagulation is an essential guarantee for good hemostasis with minimal tissue damage. It is indispensable for plastic surgery of the face.
- **Further aids**: A ruler and a pair of dividers, as well as templates made of sterile material, are suitable for preoperative and intraoperative planning. In special cases, e.g., for sutures in the area of the free alar margin, the use of loupes is helpful.

**Suture Material**

Only **atraumatic needle/suture combinations** are suitable for plastic surgery of the face. Absorbable braided suture materials based on polyglycolic and polylactic acid (e.g., Vicryl) are used for subcutaneous sutures. These have a half-life (time until reduction of the tensile strength to 50%) of 10–12 days. Polylactic acid is broken down into CO$_2$ and H$_2$O. Complete absorption, however, is only achieved after approximately 9 months. The absorption time of a thread is determined by its size, among other factors, so the times stated above are therefore average values. The required thickness of subcutaneous sutures depends primarily on the tension required to achieve approximation of the wound edges.

Skin sutures are placed using monofilament, nonabsorbable synthetic strands made out of polyamide (e.g., Ethilon, Supramid) or polypropylene (e.g., Prolene). These sutures have a high tensile strength, skin irritation is minimal, and they have no “wick effect” (infiltration of bacteria into deeper skin layers).

A suture size of 4/0 or 3/0 is usually chosen for subcutaneous sutures. Skin suturing for the face should be undertaken with a maximum suture size of 5/0, even better 6/0. The suture size is stated according to the American system (USP) or the European system (metric) (Table 5.1). Cutting **needles** of various lengths and forms are suitable. Needles in the form of an arc of a circle (e.g., ⅛ circle) are used for superficial sutures. Semicircular or even more strongly curved needles are used for deep sutures, especially for sites with restricted access. The various manufacturers use different terminology for the needle shapes, so there is no universally valid nomenclature.

**Wound Healing and General Wound Management**

- **Wound Healing**

Wound healing proceeds in several phases. The wound surface is initially covered with a fibrin net, and after 24 hours the epidermis begins to close over the wound. Wounds that are surgically closed have already achieved epithelial coverage, preventing the infiltration of pathogens. This epithelial layer does not yet provide the wound with any tensile strength, however. The necessary stability is only achieved with the production of collagen fibers, mainly by dermal fibroblasts. Scar maturity as a result of increased collagen turnover (collagen production and

<table>
<thead>
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<th>Average strand diameter (mm)</th>
<th>Size (metric)</th>
<th>Size (USP)</th>
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<tr>
<td>0.07</td>
<td>0.7</td>
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breakdown) takes several months and is not complete for more than 1 year. The visible sign of this is the paling of the previously red scar.

Given that only the production of collagen results in a visible scar, it must be contained within limits by correct wound management.

Wounds must
- not be under tension,
- not have any cavities.

If increased collagen production is induced by dehiscence of the wound edges, reduction of the wound surface by contraction will occur and the surface will be covered by a thin, functionally inferior, epithelial layer. This form of secondary healing results in considerable deformity of the surrounding tissue and should be avoided on the face.

**General Wound Management**

Wounds managed by suturing do not require any special covering, since— as stated above—the epithelial layer is closed after 24 hours. Exceptions are compression dressings required to avoid a subcutaneous hematoma after extensive undermining, or dressings to relieve tension. Larger epithelial defects, which are to be resurfaced at a later stage, may be managed temporarily with a synthetic or biological skin substitute. A compression dressing is often inadequate for hematoma prophylaxis of deep wounds. It is preferable in such cases to insert a soft drain or a suction drain.

Sutures on the face should be removed as early as possible, i.e., usually after 5–6 days. The timing depends on two factors:
- **Location of the suture**: In skin rich with sebaceous glands, such as the tip of the nose, epithelialization of the puncture hole occurs early from injured glands, resulting in unsightly scars. For this reason, sutures in this area should be removed by 5 days after surgery or even earlier.
- **Wound tension**: Skin sutures should never be placed under tension. The necessary relief of tension should always be achieved by subcutaneous sutures. In certain cases this may not be possible; if so, skin sutures should be left for a correspondingly longer time and possible cosmetically unfavorable scar formation must be accepted.

**Suture Techniques**

- **Standard Suture Technique**

Primary wound closure usually involves a subcutaneous suture and a skin suture (Fig. 5.3). The subcutaneous suture is placed in such a way that the knot is buried in the depths of the tissue (Fig. 5.3a). The skin margins are then re-approximated with an interrupted suture (Fig. 5.3b, c).

### Rules, Tips, and Tricks

The prerequisites for correct suturing are as follows.
- The wound edges must be of equal length at skin level. “Dog-ears” develop from incongruities and can be removed by the excision of Burrow’s triangles or by other techniques (Figs. 5.4 and 5.5).
- Wound edges with differing depths may be brought to the same level by skin excision and skin advancement (Fig. 5.6).
- Entry and exit holes in the skin should lie at the same distance from the wound edge (Fig. 5.3b).
- The depths of the entry and exit holes of the suture in the area of the wound must be equal (otherwise distortion of the wound edge will result) (Fig. 5.3b).

**Fig. 5.3a–c** Standard suture technique.
- a Subcutaneous suture with buried knot.
- b Suture in place
  
  Note: Needle entry and exit holes must be the same distance from the wound edge (a), the depths of the entry and exit bites are the same (b). To achieve the desired eversion of the wound edges, the suture bites must grasp more subcutaneous tissue in the depths than at the surface (c > a).
- c Wound closure completed.
The skin knots must not be pulled too tight, otherwise scar constriction will develop (postoperative swelling of the wound must be taken into consideration).

The ends of the sutures must be left long enough for their easy removal, but must be cut short enough to prevent them from interfering with the adjacent sutures.

When suturing is completed, the wound edges should be checked. The epithelium should not be rolled in, but should be everted outward (Fig. 5.3c).

Special Suture Techniques

Subcuticular Suture

Surgical Principle

The special advantage of this suture is that usually only one entry and one exit hole are required. This avoids epithelialization of the puncture holes, especially in areas where the skin is rich in sebaceous glands.

Surgical Technique (Fig. 5.7)

The needle first enters the skin near one extremity of the wound and exits in the wound intradermally. The suture is then passed in a horizontal dermal plane at exactly the same level on alternating sides of the wound to the far end. The needle then exits the skin at the far end of the wound. The approximation of the wound edges is achieved by mild traction on the suture ends, which are then secured with sterile surgical tape to avoid inadvertent removal.

Rules, Tips, and Tricks

This technique should only be used for wound surfaces which are well adapted at the subcutaneous level.
Good results are achieved above all in sites where the suture line lies in a natural skin line (e.g., a neck crease).

- With longer wounds, bring the suture out once though the skin after approximately 3–4 cm. If necessary, repeat after the same distance (removal of the suture is thus considerably facilitated).
- Longer suture lines with a potential risk of wound infection should be secured by transcutaneous interrupted sutures (the whole suture line will then not need to be opened up should fluid collection develop).
- This suture is less suitable for wounds with a significant curvilinear course, which would result in distortions.

**Vertical Mattress Suture (Donati Suture)**

**Surgical Principle**

The advantage of the mattress suture is its safer re-approximation of wound edges with different depths, e.g., at the alar base or the nasolabial region. This suture everts the wound edges and helps avoid “furrowlike” scar formation (e.g., on the lip, see Fig. 5.38b). It also gives the suture additional stability.

**Surgical Technique (Fig. 5.8)**

The suture is inserted perpendicularly approximately 4 mm from the wound edge, carried down to the subcutis and then brought out of the wound on the opposite side at the same distance from the cut edge. It is then reinserted as a mattress suture 1 mm from the wound edge and passed intradermally across to the opposite side, where it is again brought out at the same distance from the wound edge. The stitch is pulled just tight enough to evert the wound edges slightly.

**Rules, Tips, and Tricks**

Each one of these sutures can result in the production of four stitch marks. This technique should therefore only be used in the facial region when absolutely necessary. As an alternative, a modified half-buried (Allgöwer) mattress suture can be used (Fig. 5.9).

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**Fig. 5.7a–c** Subcuticular suture (e.g., horizontal neck wound).
- a Running subcuticular suture.
- b Approximation of the wound edges after pulling tight the ends of the suture.
- c Course of the suture within the level of the dermis.

**Fig. 5.8a, b** Vertical mattress suture (e.g., lower-lip wound).
- a Commence with entry and exit sites away from the wound (far-far technique) and continue with subcutaneous passage of the suture. The depths of the entry and exit holes must be equal.
- b Wound closure.
Continuous (Running) Suture

**Surgical Principle**

The area of usage of this suture corresponds to that of the interrupted suture, but it can be sewn faster with longer wounds. Good results can be expected above all in areas of thin and readily mobile skin with few sebaceous glands. The eyelids in particular, and the skin of older people in general, have these properties.

**Surgical Technique (Fig. 5.10)**

After an interrupted suture has been placed and tightened, the thread is not cut but continued diagonally to the direction of the wound. Entry and exit holes lie exactly opposite one another. In the subcutaneous tissue, entry and exit passage must be made at exactly the same distance from the skin surface. Finally a knot is tied, as with an interrupted suture.

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**Rules, Tips, and Tricks**

The end of the suture should be held under slight tension by an assistant. On completion, the wound edges should be checked and, if necessary, everted. Unlike the intracutaneous suture, this suture technique is also suitable for curvilinear wounds, in which case the stitches should be placed closer together.

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**Management of Soft-Tissue Injuries and Their Sequelae**

- **Primary Management**

  The primary management of soft-tissue injuries of the face is decisive for later results. Wounds that are not adequately treated at this stage can be corrected later only with much time and effort, and then only to a limited degree.

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**Fig. 5.9a, b**  Half-buried vertical mattress suture (Allgöwer stitch).

- a The entry point is away from the wound, the suture passes in the depths of the wound to make an intracutaneous exit on the opposite side of the wound. Crossing back to the original side, the entry site is at the same intracutaneous level with a near exit site.
- b Wound closure.

**Fig. 5.10a, b**  Simple continuous over-and-over or running suture (e.g., cheek wound along RSTL).

- a Passage of the suture after knotting at one end of the wound. Entry and exit sites are the same distance from the wound edge. The stitches are the same distance apart.
- b Wound closure after knotting with the formation of a suture loop. Three suture ends remain after cutting the thread.
Diagnostic investigations (radiography, any required assessment by surgeons, neurosurgeons, ophthalmologists, maxillofacial surgeons, and others) must have been completed before any surgical treatment is undertaken, to enable management priorities to be set. Local wound management is the initial treatment for nonurgent bony injuries of the skull; the treatment of the fracture itself is undertaken at a later stage after swelling has resolved.

**Primary Management of Facial Injuries**

- Ensure adequate tetanus immunization.
- Check wounds for foreign bodies, consider cleansing and irrigation with physiological saline or hydrogen peroxide; remove embedded foreign bodies (“dirt tattoos”) with a brush.
- Make conservative use of bipolar coagulation.
- Sparingly straighten any jagged wound edges, conservative skin excision (no formal wound excision).
- Re-approximate superficially avulsed epithelium with fibrin glue in a mosaic fashion.
- When faced with full-thickness defects, do not insert any sutures under tension (apply plastic reconstructive measures using transposition flaps from the adjacent area).
- Accurate suturing is essential in the region of the mucocutaneous junctions of skin and mucosa (free alar margin, lip, eyelid margin).

With dog-bite injuries there are usually full-thickness defects, commonly in the region of the tip of the nose. If it is only a gaping wound, then it may carefully cleaned and primarily closed in layers. Attempts should be made to reconstruct such defects early (within 24 hours after sterile dressing) with appropriate plastic reconstructive measures. Scar contracture after secondary healing requires generous excision and undermining of wound edges, which can enlarge the defect considerably.

**Scar Revision**

Scar revision may be indicated for functional reasons if severe contractures and distortions are present. In most cases, however, scar revision is indicated for cosmetically disturbing scars, which are not rendered invisible but may be made less conspicuous by surgical means.

**Questions to Ask in the Preoperative Assessment of Scars**

- Is it retracted, or thick and raised?
- Is it adherent to the undersurface, or mobile?
- What is the position of the scar relative to the RSTL?
- Is there distortion of adjacent tissue or functional impairment?
- How old is the patient? (There is a risk of hypertrophic scars or keloid formation in children and adolescents.)
- How “mature” is the scar? (Only a scar that has become pale is ready for revision.)

*Hypertrophic scars* develop as a result of increased skin tension. A scar that does not run along the RSTL, or the increased retraction of wounds in children and adolescents, can cause an increased production of collagen, resulting in reddish, lumpy scars that lie above skin level but do not extend beyond the boundaries of the original wound.

*Keloids*, on the other hand, are genuine neoplasms, which extend laterally beyond the boundaries of the original wound and into healthy tissue. They are more common in adolescents and dark-skinned individuals. The tendency to form keloids is often inherited. Areas of predilection are, among others, the posterior surface of the ear and the neck region. Since inconspicuous scars, hypertrophic scars, and keloids can coexist in the same patient, the existence of a “normal scar” (e.g., an appendectomy scar) in a patient is no sure indication for the absence of a disposition to keloid formation.

**Standard Operative Techniques for Scar Revision**

Small *retracted* scars, e.g., acne scars, are either excised or the affected area of skin is subjected to abrasion using a suitable laser procedure (CO₂, Er:YAG).

*Slightly raised* scars of less than 2 cm in length are planed down using a high-speed (up to 50,000 rpm) rotating brush or with a diamond fraise (dermabrasion). The operation is performed under local anesthesia and may be repeated at 4- to 6-week intervals.

*Hypertrophic scars* are excised, together with a margin of healthy tissue, if they do not regress spontaneously within 1 year. Wound tension, which is the cause of the increased production of collagen, must then be reduced. As a rule, the adjacent tissue must be widely undermined to make it possible to approximate the wound edges under minimal tension. The main tension must be taken up by absorbable subcutaneous sutures (see Figs. 5.11 and 5.12 for scar revision technique).

**Management of Keloids**

The management of keloids is problematic, given that they are neoplastic growths initiated by injury to the dermis. Any skin incision made for scar revision will therefore induce the formation of new keloid substance.

**Surgical Principle**

Excision and wound management without tension. Further measures are taken as prophylaxis against recurrence (see below).

**Surgical Technique**

Excision, if necessary leaving behind a fine keloid fringe, followed by wide subcutaneous undermining to approximate the wound edges without tension. Subcutaneous sutures are used to approximate the wound edges. Subcuticular skin sutures should be used, if possible.
Before any scar revision, hypertrophic scars and keloids must be strictly distinguished. Intralesional injection of the revised wound with a steroid crystal suspension, followed by weekly repeat injections, has proved effective for keloids. In addition, pressure dressings should be applied for as long as possible (depending on the affected region). Postoperative radiotherapy is not generally used nowadays for these mostly adolescent patients. Should the resulting defect after excision of the keloid be too large for primary suture closure, then it may also be resurfaced with a full-thickness skin graft. Retro-auricular keloids (e.g., after otoplasty) in particular may be treated with a skin graft harvested from the groin.

The indication for the revision of keloid scars should be made with extreme caution and the patient should not be encouraged to be too optimistic about the prospects of success.

**W-plasty**

**Surgical Principle**

Converting a linear scar into a zigzag shape distributes the tensile forces in the region of the scar so that the scar line is optically “broken up.” With scars running perpendicular to the RSTL (e.g., scars in the region of the cheek, see Fig. 5.11), part of the newly formed scar is redirected in a parallel fashion. At the same time retracted scars are corrected by resection and undermining.

**Indications**

Linear course of the scar perpendicular to the RSTL, step-offs (“trap-door deformity”).

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**Surgical Technique (Fig. 5.11)**

- Under local anesthetic, the zigzag skin incisions are marked with a pen, ensuring that the lines of either side interdigitate.
- The previously marked skin is scored with a pointed scalpel blade (No. 11). Blurring of the ink marks is then of no consequence.
- The scar is then excised with the scalpel, producing vertical incisional edges down to the subdermis.
- The area should be generously undermined and adapting subcutaneous sutures placed.
- The triangular skin flaps are repaired with fine sutures (6/0).
- A pressure dressing is applied for 1 week.

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**Rules, Tips, and Tricks**

The triangular skin flaps should not be cut too small and should be raised from unscarred skin. The area of undermining depends upon the resulting defect: it should at least equal the width of the defect on either side. This undermining of the skin is the simplest method for dealing with skin tension. A few skin sutures for approximation are helpful before placing the definitive skin suture, so as not to misjudge each corresponding flap and be left with a superfluous triangle of skin at the end.

**Alternatives**

Unlike the regular M- or W-shaped scar formation after W-plasties, the geometric broken-line technique results rather in a scar that is broken up and rendered less conspicuous. For this purpose the wound edges are excised in various geometric forms (triangles, squares, quadrangles) (Fig. 5.12).
Surgical Technique for Relieving Skin Tension

Z-plasty

Surgical Principle

A Z-plasty has three effects:
- Tension between the ends of the scar is relieved (a scar which is “too short” is lengthened).
- Two adjacent triangular skin flaps are exchanged.
- The original course of the scar is reorientated by up to 90°.

Indications

For any scar revision, it is above all the lengthening and transposition effect that is significant. The gain in length is achieved at the expense of the adjacent lateral tissue (see arrow in Fig. 5.13). Transposition is primarily desired when the original scar runs perpendicular to the RSTL (e.g., a vertical scar on the skin of the neck).

Surgical Technique (Fig. 5.13)

First, the existing scar is excised. Auxiliary incisions are placed to create lateral limbs at the end of the wounds and two triangles are elevated by undermining. The flaps are then transposed and inset by suturing in two layers.

Rules, Tips, and Tricks

- Maximal gain in length with reorientation of the scar by 90° is only achieved if the length of the lateral limbs corresponds to the length of the scar and they are at an angle of 60° to the scar (formation of equilateral triangles). If the course of the primary scar is different, preference should be given to a “multiple W-plasty”.

V–Y Plasty

Surgical Principle

The technique achieves lengthening of the scar (without transposition) by linear advancement (e.g., ectropion of the lower eyelid, Fig. 5.14). The nomenclature comes from the initial V-shaped auxiliary incision and the subsequent Y-shaped suture closure. As with the Z-plasty, lengthening is achieved at the expense of the adjacent lateral tissue (see arrows in Fig. 5.14a and c).

Surgical Technique (Fig. 5.14)

Excision of the scar is followed by a V-shaped incision at one end of the wound (Fig. 5.14a). The lateral skin is undermined and the opposite end of the wound is placed under tension with a skin hook (Fig. 5.14b). The V-shaped incised flap is sutured in its new position to the lateral wound edges, thus achieving “lengthening” (Fig. 5.14c).

Rules, Tips, and Tricks

- Undermining must be carried beyond the limits of the triangular flaps (shaded area in Fig. 5.13a) to allow suturing without tension.
- The mobility of the lateral skin should be taken into consideration when planning the operation (remember aesthetic units).
- The lateral limbs should lie more or less parallel to the prevailing RSTL.
Scar Revision Techniques for Extensive and Adherent Scars

The simple excision and primary closure of extensive scars or other skin lesions (e.g., naevi) are often not possible. The resulting defect must then be resurfaced either with a flap or a skin graft (see below). Alternatively, the so-called serial excision technique may be employed (Fig. 5.15). This involves removing only a part of the area, with dimensions such that a primary wound closure is just about possible. This allows the skin lesion to be excised gradually in several sessions. Attention should be paid here to the site of the resulting scar, any potential distortions of the adjacent regions (e.g., the lower eyelid), and ensuring a sufficient interval between the individual excision sessions (2–3 months). Use of a subcutaneously inserted tissue expander can reduce the number of operations required.

Scars adherent to the undersurface cannot usually be closed directly after excision because of the lack of mobility of the adjacent skin. Here too, plastic reconstructive procedures using skin flaps or free grafts will be necessary. Because of their thickness, preference should be given to skin flaps to cover deep-seated defects.

Management of Soft-Tissue Defects

- General Remarks

Soft-tissue defects can be managed with either pedicle flaps or free grafts. Pedicle flaps are attached to the adjacent tissue by a bridge of tissue, in which the feeding vessels run. They can also be freely transplanted when the vascular pedicle is connected to arteries and veins of the recipient site by microvascular anastomosis (vascular pedicle flaps). These flaps require a technically demanding procedure with a relatively long operating time, and are associated with an increased risk of flap necrosis. Usually other flap procedures are available to resurface defects of the head and neck region, which will achieve the desired result.
with the greatest degree of safety. Because indications for their use in the facial region are limited, vascular pedicle flaps are not dealt with any further here.

Another possibility for facilitating the creation of skin flaps is to produce excess tissue in the vicinity of the defects by skin expansion; the excess skin created in this way is then recruited for the actual closure of the wound. For this purpose, silicone balloons are used as tissue expanders; they are implanted subcutaneously and connected to a port that also lies subcutaneously (see Fig. 5.44a, b). This port is punctured percutaneously and the balloon gradually filled with a physiological saline solution. The procedure requires a certain amount of preparation time and is not as easily employed in the region of the face as in other areas of the body.

**Pedicle Flaps**

**Preliminary Remarks**

Pedicle flaps are named according to the type of flap movement (linear advancement, rotation, transposition) and their pedicle. With regard to the pedicle, two groups are distinguished:
- Flaps with a continuous epithelial surface (Fig. 5.16).
- Flaps without a continuous epithelial surface (see Figs. 5.22 and 5.23).

In the following, a distinction will also be made within these two groups according to the type of flap movement.

---

**Fig. 5.15a–d** Serial excision of an extensive skin lesion (e.g., naevus).
- a Elliptical partial excision of the skin lesion and primary wound closure after undermining.
- b Appearance of the residual lesion with a central scar. Elliptical incision is marked.
- c Rearrangement of the wound edges with a W-plasty.
- d Appearance after wound closure.

**Fig. 5.16a–f** Flaps with a continuous epithelial surface (see text).
- a Advancement flap
- b Rotation flap
- c Transposition flap
- d Hinged turnover flap
- e Bipedicled flap
- f Tubed flap
**Rules, Tips, and Tricks**

Aspects regarding the planning of flaps:
- Size of the defect vs. size of the required flap (contracture causes a mobilized skin flap to become smaller).
- Vascular supply.
- Aesthetic unit of the donor site.
- The resulting scar (oriented according to the RSTL).
- It is important to pay attention to the direction of the greatest gain in tissue length (line connecting the base of the flap and the furthest edge of the defect).

### Size, Blood Supply, and Viability of Pedicle Flaps

As described above (p. 10), the skin is nourished by two different arterial systems. All over the body, the subdermal plexus is supplied by arteries of the subcutaneous layer. These are distributed randomly and allow the elevation of skin flaps of limited size (random pattern flaps). Since this type of flap needs to be nourished by the vessels in the remaining pedicle of tissue, they are dependent on a flap length-to-width ratio of 1:1. Because skin of the face has a better blood supply than other regions of the body, facial flaps may, however, be twice as long as they are wide (a length-to-width ratio of 2:1). This ratio can, however, only serve as a rough guide. The actual blood flow to the periphery of the flap depends on whether the perfusion pressure can overcome vascular resistance. This resistance may be high in a scarred or previously irradiated area, for example, so that widening the flap pedicle may indeed increase the number offferent vessels, but not the perfusion pressure, because the feeding vessels belong to the same flow system.

If a random pattern flap is not large enough to cover a defect, its size may be enlarged by flap delay. For this purpose, the flap is initially incised and only partially (e.g., half) elevated. The flap is then reset. After 2–3 weeks the definitive flap elevation and transfer may be completed. However, scar formation will have already begun and this will limit the degree of modeling of the flap—it can no longer be so easily “folded.” The delay phenomenon is not caused solely by an adjustment of the vessels in the flap pedicle to the interruption of the blood supply from the margins of the flap, or by an adaptation of the cells to oxygen deficiency; rather, it is due to a dilation of the shunt vessels caused by the autonomic nervous system. Flap delay is always recommended when the size of the flap exceeds a length-to-width ratio of 2:1, or if the skin is poorly vascularized.

**Axial pattern flaps** (arterial flaps) have a more extensive, defined arteriovenous system which allows a significant adjustment of the length-to-width ratio in favor of the length. These flaps are usually raised together with the subcutaneous fascia. The length of these flaps depends on the position of the feeding vessels, and the width depends on the dimensions of the defect to be resurfaced. In comparison with random pattern flaps, these flaps have the disadvantage of only being available in certain areas. Typical examples are the **paramedian forehead flap** (supratrochlear artery), the **cheek flap** (facial artery), the **temporal flap** (superficial temporal artery) and, as an important example of a pedicle flap from the chest region for covering defects in the region of the head and neck, the **deltopectoral flap** (branches of the internal mammary artery). Furthermore, these axial pattern flaps may be supplemented at their tip by a random pattern flap, resulting in flaps that receive their blood supply from two different systems.

The prerequisite for the successful coverage of a defect is the **viability** of the flap after its elevation. When the dimensions of the flap are borderline, as local conditions often dictate, additional risk factors, such as smoking, may put its viability at risk. This increased risk should be brought to the patient’s attention. Pinpoint bleeding at the cut edges of a flap can be regarded as a sure sign of an adequate blood supply. Normal conditions prevail when, after a brief application of pressure to the flap, the skin first appears livid and then regains its normal color within seconds. The general information given in **Table 5.2** can of course only serve as a rough guide. If flap necrosis is anticipated, the flap should be immediately returned to the donor site, before a renewed transposition is undertaken after 3 weeks, thus taking advantage of the delay phenomenon.

#### Flaps with an Intact Epithelial Surface

Flaps of this type are summarized in **Fig. 5.16**.

<table>
<thead>
<tr>
<th>Color of the distal end of the flap</th>
<th>Time of assessment</th>
<th>Physiological substrate</th>
<th>Prognosis</th>
<th>Consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>Immediately after mobilization of the flap</td>
<td>Reflex vasoconstriction</td>
<td>Viability not compromised</td>
<td>None</td>
</tr>
<tr>
<td>White</td>
<td>Ca. 30 min postoperatively</td>
<td>Capillaries empty of blood</td>
<td>Total or partial necrosis</td>
<td>Return flap to donor site</td>
</tr>
<tr>
<td>Livid</td>
<td>Up to approx. 24 h postoperatively</td>
<td>Low blood O(_2)</td>
<td>Limited viability</td>
<td>Re-assess after 24 h</td>
</tr>
<tr>
<td>Livid</td>
<td>&gt;24 h postoperatively</td>
<td>Venous congestion</td>
<td>Total or partial necrosis expected</td>
<td>Return flap to donor site</td>
</tr>
<tr>
<td>Pink</td>
<td>30 min to 24 h postoperatively</td>
<td>Normal perfusion</td>
<td>Flap viable</td>
<td>None</td>
</tr>
</tbody>
</table>
Reconstructive Plastic Surgery of the Face

**Advancement Flap (Figs. 5.16 and 5.17)**
The simplest type of linear skin advancement is the extensive undermining of the wound edges to close smaller, elliptical skin defects (Fig. 5.17). If there is a more significant degree of tension, then the contact area of the sutures may be enlarged by plastic disks or gauze pledgets (dental rolls) (Fig. 5.18). Advancement flaps which have been elevated on three sides (Fig. 5.16a) sometimes produce skin puckering or “dog-ears” at their base. These may be corrected by excising Burrow’s triangles (Fig. 5.5) or by Z-plasties. One special type is the V–Y plasty, which has already been discussed (Fig. 5.14).

**Rotation Flap (Figs. 5.16b and 5.19)**
This is the most commonly used type of flap. A prerequisite for its use is that the skin in the donor area must be sufficiently mobile to be able to cover the secondary defect primarily. Should the length of the flap be insufficient, then a limited extension can be achieved by a cutback. If the base of the flap becomes too narrow, however, there is a risk of flap necrosis.

**Special Forms**
Rhomboid flaps are based on the geometrical concepts of Dufourmontel and Limberg, from whom they take their respective names. The planning and raising of the flaps are shown in Fig. 5.20. The following aspects should be borne in mind:
- A rhombus-shaped incision should be planned for the excision of skin lesions; with existing defects, consider the option of transforming them into a rhombus-shaped defect.
- The skin should be generously undermined.
- The RSTL and the direction of the greatest skin advancement should be taken into consideration.
- Rhomboid flaps are particularly suitable for donor sites with readily mobile skin (e.g., the cheek region).

Bilobed flaps consist of two flaps with a common base, with the first designed as a rotation flap and the second as a transposition flap (see below) (Fig. 5.21).
- The defect is first resurfaced with a rotation flap from an adjacent region with only poorly mobile skin.
- The resulting donor defect is covered with a transposition flap from a region with readily mobile skin.
- The elasticity of the skin is used to advantage: the first flap is slightly smaller than the defect, with the second flap being smaller again than the first.

Multiply lobed flaps are theoretically possible, but the option can usually be restricted to only two flaps. A typical usage is the resurfacing of a defect on the dorsum of the nose, with the primary flap recruited from the immediate vicinity and the second flap coming from the glabellar region.

**Transposition Flap (Fig. 5.16c)**
Transposition flaps have a partial bridge of tissue between recipient and donor site. The flap is swung into the defect across
an intact surface of skin, so rotation of the pedicle by an angle of 90° or more is usually necessary. It should be kept in mind, however, that the more the flap is rotated the shorter it becomes. Because dog-ears may develop at the base of the flap, a second operation is often required for definitive management of the defect. The base of the flap may be contoured about 3 weeks after transposition by excision and thinning out. Transposition flaps are particularly suitable for resurfacing defects in the region of the nose (nasolabial flap, paramedian forehead flap, see Fig. 5.36).

The Z-plasty, a further example of a transposition flap, has already been mentioned (see Fig. 5.13).

Apart from these local transposition flaps, there are also regional flaps. The best known are Conley’s chest flap and
Bakamjian’s deltopectoral flap. Although their base is located in the thorax, they can be used as long axial flaps to cover defects in the head and neck region. The development of new techniques—especially the rediscovery of the pectoralis major myocutaneous island flap (see Fig. 5.23), and free microvascular flaps—means that these regional flaps have now become less important.

**Hinged Turnover Flap (Fig. 5.16d)**

Hinged turnover flaps are intended for the coverage of through-and-through defects, where transposition of the flap no longer takes place at skin surface level, but rather the flap is turned over 180° around an axis that lies level with the skin. This allows the reconstruction of the inner lining when closing a tracheostomy, for example (see Fig. 5.50).

**Bipedicled Flap (Fig. 5.16e)**

Bipedicled flaps are now rarely used and are mentioned here only for completeness. The bilateral blood supply means that relatively long flaps may be raised, which can consequently overcome longer distances. The disadvantages, however, are the need for several operative sessions and the unfavorable scars, particularly in the area of the donor site. The temporary formation of a bipedicled flap is used together with a dislocation technique for exposure of the alar cartilage or the mucosal flap repair to close septal perforations (see Chapter 6).

**Tubed Pedicle Flap (Fig. 5.16f)**

Tubed pedicle flaps are initially raised as bipedicled flaps, but are then epithelialized on their undersurface by rolling in and suturing the wound edges. They are mainly used as distant flaps, i.e., they transport epithelium from distant regions via several intermediate steps to the recipient site, when no suitable epithelium is available in the vicinity. The large number of operative stages required means that tubed pedicle flaps are very time-consuming and they have therefore been more or less displaced by myocutaneous island flaps (see below). They have not completely sunk into oblivion, however, because in special cases their reliability sometimes offers a way out of an otherwise hopeless situation.

**Flaps without a Continuous Epithelial Surface**

Various types of these flaps are illustrated in Fig. 5.22.

**Island Flaps (Fig. 5.22a)**

These consist of an area of skin (island) corresponding to the size of the defect to be covered, and have a defined vascular pedicle. It is usual to leave a layer of connective tissue around the arteries and veins when dissecting the pedicle, to prevent injury to the vessels. These flaps usually have a longer feeding artery (e.g., supratrochlear artery, temporal artery, facial artery, see Figs. 5.37 and 5.38), which allows the formation of a long-segment pedicle, and consequently a longer reach.

**Special Aspects of Island Flaps**

- **Advantages** include the possibility of a one-stage approach and the avoidance of larger scars.
- **One disadvantage** is the prominence of the skin caused by the flap pedicle.
Basic Principles

Excessive restriction of blood flow to the flap by rotation or twisting of its pedicle is a risk.
Dissection of the flap pedicle is demanding and laborious.

Special Form: Pectoralis Major Myocutaneous Island Flap

Surgical Principle

This flap consists of a skin island, the nutrient artery of which (the thoracoacromial artery) runs in or under a muscle pedicle (pectoralis major muscle). The flap pedicle therefore incorporates this muscle, and the size of the skin island can almost approach that of the palm of the hand. The donor site can be closed primarily.

Indications

The flap pedicle extends from the nipple to the clavicle and allows a large arc of action, reaching as far as the cheek region (Fig. 5.23e). Thus, for example, skin defects of the parotid region after radical parotidectomy can be treated, or defects of the floor of the mouth after tumor excision. The vascular supply of this flap is very good, allowing it also to be used for defects in irradiated areas. Because of its size, the flap is well suited for resurfacing larger defects, including full-thickness perforation defects of skin and mucosa, as well as for soft-tissue volume replacement (floor of the mouth, tongue). The very thick and muscular flap pedicle is a disadvantage and needs to be rotated at the clavicle at one level (when using the skin for an internal

Fig. 5.23a–e  Pectoralis major myocutaneous island flap.

a Concept of the flap and landmarks: acromion (A), xiphisternum (X), and midclavicular line (M) are marked. The skin island lies medial to the nipple. The thoracoacromial artery runs beneath the clavicle along the midclavicular line and then obliquely in a medial direction toward the xiphisternum.

b Skin incision commencing from the middle of the clavicle and extending around the skin island. Skin and fascia of the island are sutured together to avoid shearing movements. Pectoralis major has not yet been divided.

c Approximately 3 cm lateral to the assumed vascular pedicle, the pectoralis major muscle, together with its underlying fascia, is divided cranial to the skin island. The vascular pedicle can be dissected and palpated in the loose connective tissue.

d After identifying the vessels, the muscle is incised, together with the skin island by extending the medial muscle incision.

e The flap pedicle is mobilized as far as the clavicle. Pectoralis minor and the exposed ribs are visible. The arrow indicates the site of insertion for the skin island.
lining) or even at two levels (when used for external coverage of a defect).

**Surgical Technique (Fig. 5.23)**

- The course of the thoracodorsal artery is marked out (connecting line between a point immediately medial to the acromion and the xiphisternum) (Fig. 5.23a).
- The skin island medial to the nipple is marked (Fig. 5.23a).
- An incision is made around the skin island and the skin is divided over the vascular pedicle (alternatively, the muscle is exposed after mobilization of a deltopectoral flap) (Fig. 5.23b).
- After incision of the pectoralis major muscle by blunt dissection, the vascular pedicle is identified beneath the fascia (by palpation) (Fig. 5.23c).
- An incision is made around the muscle at the distal circumference of the skin island (the thoracodorsal artery runs between the undersurface of the pectoralis muscle and the fascia; inclusion of the fascia in the pedicle provides additional protection to the vessels).
- The muscle fascia is sutured to the skin margin (this avoids vascular damage by shear movements) (Fig. 5.23c).
- The muscle pedicle is dissected with division from the main muscle (preferably using an electric knife) approximately 3 cm lateral and medial to the palpable and visible vascular bundle (Fig. 5.23d).
- The flap is mobilized up to the clavicle (Fig. 5.23e).
- The arc of rotation includes the ipsilateral side of the neck and face (Fig. 5.23e).

**Subcutaneous Pedicle Flaps (Fig. 5.22b)**

Unlike island flaps, these flaps do not have a defined vascular pedicle and are supplied only via the subcutaneous tissue, which is dissected in two planes. They slide over the underlying tissue (sliding flap) and can close smaller defects in this way. An example of their use is the resurfacing of a defect in the region of the cavum conchae after the harvesting of a composite graft (Chapter 15).

**De-epithelialized Flaps (Fig. 5.22c)**

These are essentially transposition flaps, which are drawn through and under a skin bridge. The area lying beneath the bridge is de-epithelialized to avoid an additional second operative procedure (see Chapter 15). Because parts of the dermis remain at the base of the flap, it is possible for epithelial inclusion cysts to develop from any remaining skin appendages.

**Free Skin Grafts**

**Preliminary Remarks**

Skin grafts are freely transplanted tissue, have no feeding vascular pedicle, and consist only of skin, mucosa, fatty tissue, cartilage, bone, or similar tissues. A “composite graft” may be made of several types of tissue, such as cartilage and skin. Whereas the term “graft” refers to living tissue, “implants” are nonviable tissue, synthetic material, or similar substances. In everyday language, the term “transplant” is used without a clear distinction.

With firm material in particular (cartilage, bone, synthetic material and similar substances), a further distinction is made according to origin:

- **Autograft** = from the same individual.
- **Allograft** = from another individual of the same species.
- **Xenograft** = from another species.
- **Alloplastic = inorganic.**

Because grafts do not have their own blood supply, they depend upon the conditions prevailing at the recipient site for their nutrition. For the first 2 days they receive nutrients by diffusion; only after this phase does revascularization begin. After approximately 10 days the graft is firmly adherent to the recipient bed.

Special attention must be paid to the recipient site when planning free grafts. The basic requirement for successful grafting is a well-perfused wound bed, completely free of any infection. Fresh wounds are usually unsuitable for primary grafting, because the wound surface is uneven. Secondary coverage, after the formation of a flat layer of granulation tissue, is more favorable. Given that split-skin grafts are unable to level out depression, and full-thickness grafts and chondrocutaneous grafts (composite grafts) can do so only to a limited extent, deeper defects need to await the development of a sufficiently thick layer of granulation tissue.

The various skin grafts have their own specific properties, which need to be taken into account when planning the operation (Table 5.3).

**Split-Thickness Skin Grafts (Fig. 5.24)**

Split-thickness grafts are divided according to their thickness into *thin* (0.2–0.3 mm) and *thick* (0.4–0.5 mm) split-skin grafts. The thinner a graft is, the less demand it places on the blood supply of the recipient site. These grafts are harvested with the aid of a dermatome. A precondition for graft survival is good contact with the underlying surface. For this reason, split-thickness grafts should be scored in several places (to allow wound exsudate to drain) and should be secured to the wound surface with an appropriate dressing for 10 days (Fig. 5.25). The use of fibrin glue is helpful in obtaining good adaptation. The disadvantage of split skin is its tendency to contract, especially in the region of highly mobile skin. When split skin is used to cover periosteum, however, this effect is scarcely relevant. The grafted area can be enlarged threefold if the split skin is converted into a “meshed graft.” For this purpose, the skin is passed over a foil through a cutting machine and transformed into a “skin net,” which can be spread out much more widely than the original skin.

**Donor sites** suitable for providing split skin harvested with an electric dermatome are the inner and outer aspects of the thigh, the inner aspect of the upper arm, and the buttock.

Split skin is only rarely and exceptionally harvested from the face because of the unfavorable aesthetic results and the availability of other techniques. Split-thickness skin grafts are most...
often used to epithelialize the auditory canal following the repair of stenoses.

**Full-thickness Skin Grafts (Fig. 5.24)**

Whereas split-thickness skin grafts include only sections of the epidermis and dermis, the *entire* dermis is used for full-thickness skin grafts. These grafts therefore have a thickness of around 1 mm. For its nutrition, the dermis must be in contact with the recipient site, so subcutaneous fat should not be left on the undersurface of the graft and must be carefully removed. This is best done by spreading the graft over a finger with the epidermis on the inside and cutting the fatty tissue away tangentially with curved scissors. Because of similarities in color and texture, the retroauricular, mastoid, and supraclavicular areas are particularly suitable as skin *donor sites* for the facial region. Smaller defects are often best managed with a strip of skin taken from the upper eyelid, especially in older patients. Regions that are more hidden (e.g., the retroauricular area) can be resurfaced with skin taken from the groin. Full-thickness skin grafts have only a slight tendency to contract and their thickness suits them for moderately deep-reaching defects. Because the donor site needs to be closed, the size of these grafts is limited above all by the possibility of mobilizing the skin to repair the donor site defect. The recipient area is managed in the same way as for split-thickness grafts (Fig. 5.25).

**Composite Graft**

A composite graft consists of different types of tissue. It is most often a *chondrocutaneous graft* (two- or three-layered) and less often a *chondromucosal graft* taken from the nasal septum. The cartilage component gives this graft its characteristic strength and form, making it particularly suitable for reconstructing

**Table 5.3** Aspects to be considered when planning skin grafts

<table>
<thead>
<tr>
<th></th>
<th>Split-thickness graft</th>
<th>Full-thickness graft</th>
<th>Chondrocutaneous (composite) graft</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recipient site</strong></td>
<td>• Heals even with poor</td>
<td>• Good blood supply required</td>
<td>• Good blood supply required</td>
</tr>
<tr>
<td></td>
<td>vascular supply</td>
<td>• Any defect size</td>
<td>• Max. diameter of defect ca. 1.5 cm</td>
</tr>
<tr>
<td><strong>Donor site</strong></td>
<td>• Heals spontaneously</td>
<td>• Wound closure required</td>
<td>• Wound closure required (flap)</td>
</tr>
<tr>
<td></td>
<td>• Possibly results in an</td>
<td>• Scar usually inconspicuous</td>
<td>• Scar usually inconspicuous</td>
</tr>
<tr>
<td></td>
<td>area of scarring and discoloration</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Properties of the graft</strong></td>
<td>• Easier take</td>
<td>• Takes well</td>
<td>• Takes in only ca. 80% of cases</td>
</tr>
<tr>
<td></td>
<td>• Contracts</td>
<td>• Hardly contracts</td>
<td>• Hardly contracts</td>
</tr>
<tr>
<td></td>
<td>• Cosmesis usually unsatisfactory</td>
<td></td>
<td>• Good cosmesis</td>
</tr>
</tbody>
</table>

Fig. 5.24 Free skin grafts.
complex structures. A composite graft, on the other hand, places special demands on the recipient site, because the attached cartilage prevents the skin or mucosa covering from having a broad contact with the underlying surface. The bradytrophic cartilaginous tissue tolerates this “deficient supply” well, whereas the epithelium is dependent on its nutrient supply coming from the wound edges. Since this contact surface is small, the size of a composite graft is limited to a maximum diameter of about 1.5 cm. Even when all precautions are taken, partial or total necrosis of the graft is not always avoidable (see Table 5.3).

The following aspects should be kept in mind:

- Maximum diameter of the graft approximately 1.5 cm.
- The skin or mucosa of the graft must not be crushed by forceps (this impairs nutrition by diffusion).
- The skin or mucosal component of the composite graft can contract (allow for this by forming overlapping skin/mucosa components).
- Even significant livid discoloration of the graft during the healing phase does not necessarily mean graft loss.

**Figure 5.26** shows the most common donor sites for composite chondrocutaneous grafts from the auricle, which have the following properties:

- A graft with a skin fold (**Fig. 5.26a**) can be harvested from the anterior helical margin, e.g., for reconstruction of the nostril. The donor site on the auricle is repaired with a retroauricular pedicled transposition flap. The donor defect usually remains conspicuous.
- A convex graft, e.g., for the free alar margin, is taken from the antihelical fold (**Fig. 5.26b**). The resulting defect can be closed by undermining the skin, which leaves a slight residual deformity.

- Most commonly, a large chondrocutaneous graft is harvested from the concha (**Fig. 5.26c**). Depending on the required concavity of the surface, the graft is taken from the retroauricular or anterior surface. Management of the donor site after posterior harvesting is by direct suture, whereas closure after anterior harvesting is accomplished by a subcutaneous pedicle island flap. The technique is described in Chapter 15.
Plastic Reconstructive Operations in Various Regions of the Face

Preliminary Remarks

The operations described here can only be taken as examples of certain clinical constellations and represent only one of many options available for solving surgical problems. Since every case has its own peculiarities, an optimal therapeutic result can only be achieved with the knowledge of a broad spectrum of various techniques, allowing the surgeon to select the most favorable procedure for any individual case.

Forehead and Temple

The skin of the forehead has only a moderate degree of mobility. Thus, only defects of up to 3 cm in width can still be closed primarily after generous undermining, and suturing of the skin is only possible under tension. Round defects must first be converted by appropriate excision into elliptical wounds (Fig. 5.27). A W-shaped excision at the ends of the wound will reduce the surface of the required skin excision.

Defects of the frontotemporal region are managed with rotation flaps, with rhomboid flaps as described by Limberg and Dufourmentel being particularly suitable (Fig. 5.28).

Rules, Tips, and Tricks

Attention should be paid to the possible distortion of the eyebrows and eyelids when designing flaps in the forehead–temple region.

Full-thickness skin grafts survive on the forehead only when used to cover smaller defects, because of the reduced vascular supply of the galea aponeurotica, and split-thickness grafts are used only in exceptional cases because of their unfavorable cosmetic appearance.

Eyelids

Upper Eyelid

Minor distortions of the upper eyelid due to scars may be revised using V–Y or Z-plasties. Partial reconstruction of the upper eyelid may be accomplished by a transposition flap from the supraciliary region (Fig. 5.29). The upper eyelid is immobilized by temporarily closing the palpebral fissure with a suture. If the inner surface of the eyelid also needs reconstruction, then a composite graft taken from the septum may be used for full-thickness tarsoconjunctival repair.

Lower Eyelid

Narrow defects in the region of the lower eyelid are reconstructed with a transposition flap from the upper eyelid skin crease. This procedure is indicated where the upper eyelid shows age-related redundancy and for more laterally located defects. It leaves scarcely visible scars (Fig. 5.30). Larger and more medi ally situated defects which encroach on the cheek will require a rotation flap from the cheek (after Imre, Fig. 5.31). The base of the flap is located laterally and the incision is placed in the nasolabial fold to avoid conspicuous scars.

The following points should be observed when designing this flap:
- The laterally based flap must be raised strictly in the plane of the subcutaneous fatty tissue as otherwise there is a danger of injury to branches of the facial nerve.
- After rotation, the flap must be well secured with sutures to the bony undersurface (infraorbital rim) to avoid traction on the lower eyelid (danger of a cicatricial ectropion).
- Excess skin resulting from incongruities of the wound edges is compensated for either with a Z-plasty or by the excision of Burrow’s triangles.

As with the upper eyelid, full-thickness defects of the lower eyelid can also be reconstructed with chondromucosal grafts in the form of a full-thickness tarsoconjunctival repair. The lacrimal ducts must be kept in mind when dealing with defects of the medial canthal area.

Eyelid Surgery in Facial Paralysis

Paralysis of the orbicularis oculi muscle results in incomplete closure of the eyelid (lagophthalmus) and a loss of lower lid tone, with lower punctal ectropion and the danger of exposure keratitis from insufficient moisture to the corneal epithelium. Surgical management of this eyelid disorder is symptomatic: narrowing of the distance between upper and lower eyelid, i.e., narrowing the palpebral fissure, by tightening the lower eyelid and thus elevating the punctum after eyelid shortening.

Tarsorrhaphy (Fig. 5.32)

Upper and lower eyelids are incised vertically at their lateral margins and divided into a tarsoconjunctival and a musculocutaneous layer. After mobilization of the tarsoconjunctival layer of the upper eyelid using a vertical incision and excision of a corresponding part of the lower eyelid, the tarsus of the upper lid can be attached to the lower lid by a mattress suture. Additional tightening of the lower lid can be achieved by the excision of a lateral triangle. The skin edges are then re-approximated with sutures after adaptation of the wound surfaces.

Other plastic surgery procedures, such as a temporalis sling procedure, are also available to correct the sequelae of a facial palsy that is not merely transient. A simple method is the implantation of a metal weight into the upper eyelid, which closes the palpebral fissure passively; active opening is possible with the levator palpebrae (third cranial nerve, oculomotor nerve). Suitable shaped gold or platinum implants are secured onto the
Reconstructive Plastic Surgery of the Face

Cheek

Because the skin of the cheek is highly mobile, smaller defects may be closed primarily after undermining the wound edges. The RSTL should be taken into consideration when planning incisions. Rhomboid flaps are also suitable in this region. For larger defects, particularly those situated medially at the junction with the nasal pyramid, an Esser cheek rotation flap is an option (Fig. 5.33). This flap is supplied by a broad caudal base. The incision line allows scars to be placed in a cosmetically favorable way in the infraorbital and pre-auricular regions. Here too, dissection must proceed strictly in the subcutaneous plane in order not to endanger branches of the facial nerve.

Nose

The aesthetic unit of the external nose is divided into several subunits, each requiring individual reconstruction (Fig. 5.35). This means that for defects involving several subunits, different management techniques should be planned for each individual subunit. In any one case, however, management will depend on the local conditions and above all on the aesthetic demands placed on the final outcome. Elderly people in particular tend to want a quick and less technically demanding reconstruction, in which case a free full-thickness skin graft could be perfectly adequate for defects that are not too large. Even healing by secondary intention is an alternative option in cases where distortions by scar formation are not to be expected. This danger arises more often on the alae and less over the dorsum of the nose.

The most important axial-pattern transposition flaps for partial reconstruction of the nose are the (para-)median or oblique forehead flap (supratrochlear artery) and the cranially or caudally based nasolabial flap (facial artery) (Fig. 5.36). The transposed skin of these flaps corresponds best in color and texture to the external skin of the nose. For full-thickness defects the best option is first to plan the reconstruction of the inner lining using tissue from the adjacent regions, and then to consider the options for the resulting larger skin defect. Using a...
Fig. 5.29a, b  Resurfacing a defect of the upper eyelid with a supraciliary transposition flap.
\( a \) Raising the flap after excising the area of skin to be replaced.
\( b \) Appearance after transposing and setting the flap.

Fig. 5.30a, b  Resurfacing a defect of the lateral lower lid with a transposition flap from the upper eyelid.
\( a \) Marking the lateral pedicle flap in the area of the upper-eyelid skin crease.
\( b \) Appearance after transposing and setting the flap.

Fig. 5.31a, b  Resurfacing an extensive defect of the lower eyelid with a rotation flap from the cheek.
\( a \) Raising the flap along the nasolabial fold with a relaxing incision at the level of the medial canthus. Wide undermining. Subcutaneous fixation of the flap to the bony undersurface (infraorbital rim) through a drill hole.
\( b \) Appearance after transposing and setting the flap.

Fig. 5.32a, b  Lateral tarsorrhaphy for lagophthalmos.
\( a \) Lateral separation of the upper and lower eyelids into their musculocutaneous and tarsocconjunctival layers. A vertical relaxing incision is made to transpose the tarsocconjunctival layer of the upper eyelid to the appropriately prepared defect of the lower eyelid.
\( b \) Fixation of the tarsocconjunctival component of the upper lid with mattress sutures. Skin sutures.
A template to measure the size of the defect is considerably more precise than relying on mere visual judgement (remember to calculate for skin contracture after excision at the donor site). Adequate flap length should also be considered: the greater the rotation of the pedicle of the transposition flap, the shorter the flap will become. Transposition under tension not only distorts the donor site bed but also endangers the vascular supply of the flap and its peripheral margins.

**Management of Defects of the Nasal Dorsum and Lateral Sidewalls**

Full-thickness skin grafts are effective in covering smaller defects, especially when the recipient site has a good blood supply. Island flaps from the forehead and cheek are also well suited, although their pedicles tend to elevate the skin tunnel (Figs. 5.37 and 5.38).

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**Fig. 5.33a, b** Esser’s cheek rotation flap to close a skin defect of the cheek.
- a The flap is elevated with removal of a triangular area of skin at the base over the neck (Burrow’s triangle) to facilitate rotation. Care must be taken to extend the incision up to and behind the attachment of the ear. This diverts the traction to a cranial direction, thus avoiding ectropion of the lower eyelid.
- b Appearance after rotation.

**Fig. 5.34a, b** Closure of a skin defect of the pre-auricular cheek with a bilobed flap.
- a Circumferential incision of the tumor, elevation of the two flaps: a retro-auricular flap and one in the region of the neck. Extensive undermining (area marked).
- b Appearance after insetting the flap.

**Fig. 5.35** Aesthetic subunits of the nose. These subunits should be respected both during excision as well as during reconstruction. The unit formed by the tip of the nose and the columella is of particular importance for cosmesis.
Skin defects in the region of the bony nasal pyramid and over the lateral side wall of the nose toward the medial canthus can be treated with a transposition-rotation flap from the glabellar region (Fig. 5.39).

Larger defects situated more caudally require the use of a (para-)median forehead flap (Fig. 5.40). If the lateral sidewall of the nose is also involved, it may be reconstructed independently as an aesthetic subunit using a cranially based nasolabial flap.

**Midline Forehead Flap**

**Surgical Principle**

This flap is supplied by the supratrochlear artery and can therefore be raised from the glabella to the hairline with a width of 3 cm. These unusually large dimensions are possible on account of its axial vascular supply.

**Indications**

Defects of the dorsum of the nose, the lateral sidewall of the nose and, as an oblique forehead flap, for reconstruction of the tip of the nose and the columella in particular.

**Operative Planning**

This applies to all types of flaps and is best approached systematically. The size and form of the donor site should be defined, as well as the required length and position of the “transport pedicle” to allow tension-free transposition:

**Fig. 5.36** Transposition flaps for reconstruction of the nose. The paramedian (oblique) forehead flap is based on the supratrochlear artery and is particularly suited for the dorsum of the nose, the tip and the columella. The nasolabial flap is based on the facial artery and is suited for the nostril and the inner lining of the nasal vestibule.

**Fig. 5.37a, b** Closure of a skin defect over the root of the nose with an island pedicle flap from the forehead. 
- **a** The skin island is elevated, the subcutaneous pedicle of the flap is dissected together with the supratrochlear artery. A tunnel is formed to allow transposition of the skin island.
- **b** Appearance after transposition of the flap and wound closure.

**Fig. 5.38a, b** Resurfacing a defect of the nostril with an island pedicle flap.
- **a** The skin island is incised in the region of the nasolabial fold and the flap pedicle and subcutaneous tunnel between the defect and the skin island are dissected.
- **b** Appearance after transposition of the flap and wound closure.
The size and form of the defect are defined with the aid of a template (e.g., one made from the foil of a suture pack). The skin incision line should be kept approximately 2 mm away from the template to allow for contraction of the mobilized skin. The donor site should not cross the hairline. To be sure of recognizing the hairline, do not shave the hair but cut it short, if necessary.

Once the paramedian position of the flap pedicle over the supratrochlear artery has been decided, the pivot point at the level of the eyebrows is then marked. Next, rotation of the flap is simulated using a strip of inelastic material (e.g., a roll of dressing gauze). It is important to ensure that the furthest wound edge of the donor site can reach the corresponding margin of the defect without tension. The greater this distance, the more obliquely the forehead flap must run in the direction of the lateral hairline of the forehead, and it must also be slightly curved (Fig. 5.41).

Surgical Technique (Fig. 5.40)

- Preparation of the recipient bed (trimming and undermining of the wound edges, cleaning of the wound bed).
- Planning and marking the flap.
- Incision around the flap (the incisions end at different levels at the glabella to facilitate rotation of the flap) (Fig. 5.40a).
- Elevation of the flap by developing the plane between the galea aponeurotica and the periosteum (pericranium).

- Care is needed when dissecting the flap pedicle: blunt dissection should be used to protect the vascular pedicle (the vessels lie immediately over the frontal muscle).
- The muscle should be more or less completely preserved (important for facial expression).
- The flap is rotation into the defect and fixed using two-layer sutures (Fig. 5.40b).
- The donor site is closed directly, after undermining the wound edges (Fig. 5.40b).

Fig. 5.39a, b Closure of a defect of the medial canthal region with a rotation–transposition flap from the forehead.

- Concept of the flap, which receives its blood supply from the supratrochlear artery of the ipsilateral side.
- Appearance after wound closure.

Fig. 5.40a–c Resurfacing of a defect on the dorsum of the nose and the tip of the nose with a midline forehead flap.

- The wound edges of the defect are trimmed and the planned incision line marked (the differing incision lengths facilitate rotation). The skin is undermined to allow closure of the donor defect.
- Transposition of the flap and primary wound closure. Temporary puckering of the flap pedicle.
- After the flap has healed in, the pedicle is revised and inset.
After the obligatory twisting of the flap pedicle, the viability of the flap should be checked.

The exposed undersurface of the flap is covered with a sterile dressing (ointment-impregnated mesh).

**Rules, Tips, and Tricks**

Closure of the donor site is not possible without tension, but wound healing usually proceeds normally if a careful surgical technique is used. Cosmetically, the midline scar is hardly conspicuous. Closure of the donor site brings the medial borders of the eyebrows closer together. This is unavoidable and may be reversed by returning the flap pedicle to its original position after approximately 3 weeks (Fig. 5.40c). At that time it is advisable to take the opportunity of thinning out the flap, which will by now have healed in, to give it a better shape.

**Management of Defects of the Nasal Tip and Columella**

The tip of the nose and the columella are a common aesthetic subunit, which also includes the so-called “soft triangles” on the upper nostril rim (Fig. 5.35). Reconstruction of the columella is particularly difficult. It is best reconstructed as a unit, together with the nasal tip, using an oblique forehead flap (Fig. 5.41).

Before transposing the flap, the framework must first be reconstructed. Here, attention should be paid to placing the inner lining of the nostril rims as far caudally as possible to avoid cranial retraction after the flap has healed. The suture between forehead flap and vestibular skin should come to lie exactly at the nostril rim and not be everted outward by scar contracture.

It is essential to incise exactly around the donor site at the lateral region of the forehead. The use of a template is strongly recommended, and it is highly convenient if the patient has a receding hairline. The columella should be wide enough to allow it to be folded to form the membranous septum. The distal part of the flap, however, should not be thinned out too much to make it easy to shape, because it is in effect a random pattern flap and its blood supply is via the general vascular system of the skin. It is better to initially transpose “too much” material, which can then be thinned out and adjusted later (after 3–6 weeks), than to achieve an acceptable immediate result at the risk of developing necrosis of the flap tip.

Since the donor site is often too large for primary closure, a full-thickness skin graft taken from the retroauricular area should be anticipated (Fig. 5.41b). Prior stretching of the skin with the aid of a tissue expander is also an option (see Fig. 5.44).

**Management of Defects of the Nasal Alae**

**Reconstruction of the Nasal Alar Margin with a Composite Graft**

**Surgical Principle**

Reconstruction of the skin defect with simultaneous contouring of the nostril rim using a three-layered chondrocutaneous graft taken from the auricle.

**Indications**

Wedge-shaped defects of the alar margin with a maximum width of 1.5 cm.

**Surgical Technique (Fig. 5.42)**

- Excise the skin in the region of the defect to form clean, well-vascularized wound surfaces (Fig. 5.42a, b).
- Harvest a wedge-shaped composite graft from the helical attachment (make it as large as possible to allow later forming of the rim) (Fig. 5.42c).
- Close the donor site with a direct suture (Fig. 5.42e) or use a retroauricular transposition flap.
- Inset the composite graft without any step-off (Fig. 5.42d).
The cartilage should overlap the skin island laterally and be inserted into prepared “pockets” of the wound edges of the defect. This makes it easier to avoid step-offs. The skin fixation sutures should not be placed too close together, because nutrition of the skin is via the wound edges and not via the wound base. As with all free grafts, the operative site should be immobilized for 10 days. This may be achieved by providing support from medial with a loosely placed ribbon gauze pack impregnated with ointment (antibiotic ointment because of the length of time it has to be left in place) and an external dressing. Alternatively, the nostril can be left without a dressing if the operative site is covered with a U-shaped synthetic foil (e.g., silicone), which is secured to the nostril with two mattress sutures placed through the full thickness of the wall. Since the chondrocutaneous graft will shrink, it should be excised slightly larger than required. Despite this, the scars may still form step-offs at the wound edges, so the final aesthetic result does not always meet expectations. Unlike the otherwise technically demanding pedicle flaps, the chondrocutaneous graft is a direct and relatively simple procedure.

**Complete Defects of the Nasal Alae**

**Surgical Principle**

Full-thickness defects require reconstruction both of the inner lining of the nasal vestibule and of the nasal alae, with contouring of the nostril rim. The inner lining is formed by a two-layered composite graft taken from the auricular concha, which is able to form and stabilize the nasal ala with its concavity. At the same time its free margin lends the nostril the necessary contour. The external skin defect is then resurfaced with a suitable transposition flap (e.g., a cranially based nasolabial flap).

**Indications**

Complete full-thickness defects of the nasal ala with loss of the alar margin and inner lining, as often occurs after excision of skin tumors or secondary to trauma.

**Surgical Technique (Fig. 5.43)**

- First of all, the wound edges are trimmed; they should be free of scar tissue. They are also undermined to allow the cartilaginous component of the composite graft to be inserted into this “pocket.”
- The composite graft is harvested from the anterior aspect of the auricular concha (ensuring concavity of the skin island) and the donor defect is closed with a retroauricular island flap (see Chapter 15).
- The chondrocutaneous graft is trimmed to slightly oversized dimensions and the overlapping cartilaginous edges are inserted into the prepared wound bed. The graft is secured with a few retention sutures, taking care to achieve exact symmetry with the contralateral side (Fig. 5.43a, b)
- The residual external skin defect may be reconstructed either with a cranially based nasolabial flap (one-stage procedure, Fig. 5.43b, c) or with an ipsilateral paramedian forehead flap (two-stage procedure), depending on its size.
- As with all free grafts, the operated site must remain untouched for 10 days.

**Rules, Tips, and Tricks**

- The position of the free margin of the composite graft must correspond exactly to the nostril rim of the contralateral side. This is best assessed by viewing from above.
When elevating the nasolabial transposition flap, one incision lies exactly within the nasolabial fold, while the parallel incision runs at the required distance down the skin of the cheek. If necessary, the flap may extend below the corner of the mouth. The skin of the cheek must be extensively undermined to achieve closure of the donor defect. This is done in the subcutaneous plane to protect the branches of the facial nerve. Excision of a distal triangle of skin will help closure (Fig. 5.43b). The final scar comes to lie exactly within the nasolabial fold (Fig. 5.43c).

Minor irregularities of the flap pedicle may be corrected after 3 weeks, together with any necessary thinning of the flap.

To achieve symmetry of the nostrils despite contracture of the composite graft, it is good practice to fit bilateral obturators for the vestibules, which should be worn at night for 6–9 months.

Total Nasal Reconstruction

Surgical Principle

Reconstructive surgery for total or subtotal loss of the nose can rely on a large number of procedures. Reconstructive flaps taken from forehead skin have generally proved reliable and effective. The procedure described here is based upon transposition of excess forehead skin gained from the implantation of a tissue expander. A sufficiently long flap for the simultaneous reconstruction of columella, nasal tip, and nasal alae is only obtainable by employing the principle of the oblique forehead flap. Male patients with a receding lateral hairline are therefore particularly suitable candidates.

Surgical Technique (Fig. 5.44)

- Incision above the hairline, dissection, and elevation of the skin (leaving the periosteum intact) and implantation of a 50-mL expander, e.g., with a remote valve (Fig. 5.44a).
- Adequate expansion of the skin (ca. 4–6 weeks); the recipient site is first prepared by reconstruction of the internal lining and the cartilaginous framework of the nose (Fig. 5.44b, c).
- As the central support column, the nasal septum can be reconstructed from residual septal cartilage or from costal cartilage (see Chapter 6). It is covered with the aid of nasolabial flaps, which also form the inner lining of the nasal vestibule. The inner lining is supplemented at the roof of the nose by a hinged turnover flap recruited from skin of the nasal dorsum. The supportive framework is supplemented by reconstruction of the alar cartilages using concave auricular cartilage.
- Incision and elevation of the trilobed oblique forehead flap (a broad base is important) and removal of the expander.
- Inset of the flap and primary closure of the donor site (Fig. 5.44d).
- After 3 weeks, division and relocation of the flap pedicle, and if necessary fine adjustments to the soft-tissue coverage.
Total nasal reconstruction with an oblique forehead flap after prior expansion of the donor skin with an expander (see text). 

a After insertion of the expander.

b Elevation of the forehead flap. Septal cartilage is harvested to reconstruct the caudal septum. Auricular cartilage is harvested from the cavum conchae to be used for alar-cartilage reconstruction. Lining for the nasal vestibule is formed by nasolabial turnover flaps.

c Appearance after reconstruction of the nasal framework. The inner lining is supplemented by the turnover flap from the roof of the nose.

d Appearance after transposition of the flap, wound closure and packing of the vestibule with “breathing tubes.”
To avoid furrowlike scars, the flap is best inset with evert ing sutures (see Fig. 5.8). As with alar reconstruction, it is advisable to fit bilateral obturators for the vestibules, to be worn at night for 6 months. The contours of the flap can be fine-tuned after 6 weeks by reopening the scar on one side at a time and thinning out the flap. Over-correction should be avoided, however, given that shrinkage of the soft-tissue coverage can be expected over the course of a year or more. This shrinkage may also produce a significant reduction in the length of the nose. When reconstructing the cartilaginous framework, care should therefore be taken to safeguard nasal length by inserting stable cartilaginous grafts, and to avoid small untreated defects of the inner lining before rotating the forehead flap into position.

Alternatives

The quality and vascular supply of the forehead flap as well as the stability of the cartilage grafts are decisive factors in the outcome of a total reconstruction of the external nose. If this cannot be guaranteed, or a multistage procedure is not acceptable to the patient, then a silicone nasal prosthesis should be considered. This can be attached using a skin adhesive, or anchored to spectacles or to bone screws/magnets.

Lips

Deformity of the Vermilion Caused by Scar Contracture

The conspicuous nature of the junction between vermilion lip and cutaneous lip (Cupid’s bow) allows even minor irregularities to become clearly noticeable. It is therefore recommended to use dividers and possibly also loupes when undertaking corrective surgery in this region. Visual judgement does not necessarily guarantee a good aesthetic result.

Deformities from scar contracture are commonly found in patients with vermilion notching following cleft-lip repair. Here, the vermilion is drawn up into the skin of the upper lip (Fig. 5.45). Reconstruction involves separating it from the skin with a pointed blade. Excess tissue is excised according to the height of Cupid’s bow and the wound repaired with fine skin sutures (6/0). A tension-free re-approximation of the wound edges will only be achieved if subcutaneous scar tissue is carefully excised before wound closure.

Minor Lip Defects

Minor lesions of the upper and lower lips up to a width of 1 cm may be treated by wedge excision followed by a three-layered closure. The slight shortening of the lip does not usually result in any functional impairment. A step-off can be avoided by a careful evert ing suture technique, possibly using a mattress stitch. Major lip defects, on the other hand, will require flap repair.

Central Defect of the Upper Lip

Surgical Principle

Medial advancement of the lip stumps resulting in a relative narrowing of the oral aperture.

Surgical Technique (Fig. 5.46)

- Resection of a central lesion of the upper lip, creating a full-thickness defect (Fig. 5.46a).
- Bilateral skin incision in the nasolabial folds up to the level of the piriform aperture.
Division of the mucosa in the labial sulcus.
Undermining of the cheek skin and excision of a strip of skin and subdermis on either side from the lateral base of the nose (Fig. 5.46b).
Three-layered suture repair of the lip stumps in the midline (mucosa–muscle–skin) (Fig. 5.46b, c).

Rules, Tips, and Tricks
An oral aperture which has been excessively narrowed may be widened at a further operation (see Fig. 5.48d–f).

Alternatives
A further option for closing central upper-lip defects is the Abbé flap (lip-switch flap, see also Fig. 5.48), with which a wedge-shaped upper-lip defect is replaced with a correspondingly sized segment of lower lip, pedicled on the labial artery. Unlike the technique described above, however, this procedure requires two sessions because the rotated vermilion connects both upper and lower lip in the midline. On the other hand, it avoids excessive narrowing the oral aperture and also offers the possibility of simultaneous reconstruction of the philtrum (e.g., with cleft lips).

Lateral Defect of the Upper Lip

Surgical Principle
Three-layered rotation flap recruited from the adjacent cheek region with secondary reconstruction of the vermilion.

Surgical Technique (Fig. 5.47)
- The flap is elevated in the region of the cheek, together with mucosa of the cheek (bearing in mind the duct of the parotid gland), parallel to the nasolabial fold (Fig. 5.47a, b).
- The width of the flap corresponds to the height of the defect (Fig. 5.47c).
- Reconstruction of the vermilion is undertaken after 6 weeks by a circumscribed de-epithelialization of the cheek flap with mobilization and advancement of the mucosa (Fig. 5.47d).

Lateral Defect of the Lower Lip

Surgical Principle
Three-layered rotation flap recruited from the upper lip, whereby the vermilion provides an adequate pedicle (labial artery). The vermilion is thus immediately reconstructed, with the oral aperture and oral commissure requiring secondary reconstruction.
Surgical Technique (Fig. 5.48)

- The triangular flap is based centrally on the vermilion (Fig. 5.48a, b). Elevation begins at the vermilion border of the upper lip, with the distance to the corner of the mouth being slightly shorter than the length of the defect of the lower lip. The incision is extended as far as the nasolabial fold, from where it follows the fold down to the edge of the defect.
- Deep down, the muscle and finally the mucosa are gradually divided. This results in a flap that is roughly triangular in shape and based on the vermilion. This narrow bridge allows the flap to be easily rotated through 180°, so that the vermilion of the upper lip becomes the vermilion of the lower lip (lip switch) (Fig. 5.48c).
- The flap must be sutured from the inside out in three layers (mucosa, muscle, skin). It is usually possible to close the donor defect directly without undermining (mucosa, subcutaneous layer, skin).
- After 6 weeks the oral commissure, which initially appears rounded off, is widened. For this purpose, the desired width of the oral aperture is marked out (Fig. 5.48d) and the oral commissure is divided laterally. After circumscribed de-epithelialization, the adjoining mucosa of the inner aspect is mobilized (Fig. 5.48e) and turned outwards (Fig. 5.48f).

- Reconstruction using this flap (also known as the Estlander flap, vs. the Abbé flap, with which central defects can be reconstructed employing the same principle but using a lower-lip flap) has the advantage of not only preserving the vermilion, but also reconstructing the oral sphincter.
- The same principle can also be employed for central lower-lip defects. In this case, the central defect is first converted into a lateral defect by an auxiliary incision, running from the corner of the mouth parallel to the defect margin. This results in a rhombic, three-layered skin flap with a pedicle directed toward the tip of the chin, which is rotated to repair the central defect, leaving a triangular lateral defect.

Unilateral Defect of the Lower Lip

Surgical Principle

The defect is repaired with a large rotation flap, pedicled in the submandibular region. The vermilion is reconstructed at a second-stage procedure.

Surgical Technique (Fig. 5.49)

- Loss of half of the lower lip secondary to tumor excision (Fig. 5.49a).
- The flap is elevated across the middle of the chin in a submandibular direction.
- The mucosa in the labial sulcus is divided (Fig. 5.49b).
- The skin is undermined and a triangular area of skin is excised in the lateral corner of the mouth (Fig. 5.49b).
- The flap is rotated medially and sutured in three layers.
The vermilion is reconstructed after approximately 6 weeks by advancement of the adjacent mucosa over the corresponding de-epithelialized area of the rotation flap.

Rules, Tips, and Tricks

Large parts of the lower lip can be reconstructed using this technique. The required incision also allows regional lymph-node dissection if this is indicated. Any secondary mucosal defects which remain as a result of the reconstruction are left untreated for healing by secondary intention.

Neck

The technique for closing an epithelialized tracheostoma is described here as an example of plastic reconstructive procedures of the neck.

Tracheostoma Closure

Surgical Principle

Reconstruction of the anterior wall of the trachea using a hinged turnover flap. Suture repair of the sternocleidomastoid muscle avoids retraction of the sternal notch. Primary skin suture line is parallel to the RSTL.

Indications

Epithelialized tracheostoma. Respiratory capacity with stoma occluded must be sufficient (even under exertion).

Contraindications

Skin infection in the vicinity of the tracheostoma. Height of the lateral walls of the trachea too low, resulting in insufficient respiration after closure (tracheal stenosis, tracheomalacia).
Surgical Technique (Fig. 5.50)

- The skin around the tracheostoma is incised asymmetrically in an elliptical curve (Fig. 5.50a).
- This leaves a rim of epithelium around the tracheostoma, which is elevated off the underlying tissue right up to the circular opening (Fig. 5.50b).
- The longer piece of skin is now flipped over 180°, hinged at the edge of the stoma as a turnover flap, and sutured to the adjacent margin of skin. These sutures are nonabsorbable and do not include the epithelium (Fig. 5.50c). This results in a reconstruction of the inner lining that is air- and watertight.
- To avoid too much skin retraction after a “deep tracheostoma,” the adjacent margins of the sternocleidomastoid muscles may be sutured together (Fig. 5.50d).
- The residual skin defect is closed primarily in two layers after extensive undermining. The resulting scar comes to lie in the RSTL (Fig. 5.50e).

Rules, Tips, and Tricks

- The turnover flap required to reconstruct the inner lining needs an adequate pedicle. At this stage, therefore, the flap must be separated from the underlying tissue only just enough to make a turnover easily possible. The flap must then be able to reach the opposite skin margin without any undue tension (it must not be cut too short). The sutures should be inserted as close together as possible, or immediately adjacent to the lateral tracheostoma edge.
- The turnover flap should fit as exactly as possible into the defect of the anterior wall. If it is too long, it may be drawn in during inspiration. Additional stabilization can be achieved by the suturing of an onlay cartilage graft taken from the auricle, but this is not usually necessary.
- Adhesions of the skin to the anterior wall of the trachea secondary to scarring should be avoided, as they will result in distraction during swallowing. Apart from the muscle interposition, particular care should be taken to achieve an adequate subcutaneous gliding layer. The skin should therefore be mobilized immediately above muscle fascia level to leave as thick a layer of fat on the skin as possible.
Fig. 5.50a–e Plastic-reconstructive closure of an epithelialized tracheostoma (frontal view with corresponding cross-section).

a Elliptical asymmetrical incision of the skin around the tracheostoma.
b Formation of a turnover flap which is hinged on the skin margin of the contralateral side. This brings the suture to lie laterally at the lumen of the trachea.
c Insetting the turnover flap. Mattress suture of the subcutaneous tissue to bury the epithelium in the trachea.
d Mobilization of the medial margins of the sternocleidomastoid muscles on either side and approximation over the previous tracheostoma (for a deep tracheostoma).
e Appearance after skin suture. The suture line lies along the RSTL. Care should be taken to gain as thick a subdermis of the mobilized skin as possible to allow shifting between skin and trachea during swallowing.