NASAL RECONSTRUCTION

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INTRODUCTION

The management of nasal defects following tumour surgery is influenced by multiple factors. These include tumour histology, location, extent of disease and previous treatment regimens employed. These characteristics define the degree of tumour control and therefore the method of reconstruction. The size and location of the defect as well as the availability and condition of adjacent skin are further factors to consider. Nasal surface contours and skin covering varies in texture, colour and appearance and it are these unique characteristics that present the surgeon with reconstructive challenges. To add to these considerable variables, the patients' age, general fitness and aesthetic goals must be included in the decision making process. These multifactorial problems can, however, be approached with a variety of reconstructive options, ranging from *primary closure*, *healing by secondary intention* and *skin grafting* to *local or regional skin flaps.* This paper reviews various aspects of reconstructive rhinoplasty after tumour surgery including pertinent surface anatomy, type of nasal skin malignancies and the principles of nasal reconstruction.

ANATOMY

The otolaryngologist head and neck surgeon has intimate anatomic knowledge of the nasal bony and cartilaginous suprastructure. However, aesthetic reconstruction initially involves assessment of the surface anatomy of the nose, focusing on skin characteristics and contour. Nasal skin varies in texture, colour and appearance within different areas of the nose. The nasal dorsum, side walls, columella, alar margins and soft triangles are all covered with thin, smooth skin while the nasal tip and ala are covered with thick, pitted skin due to the presence of sebaceous glands[1]. Skin colour may vary from pale, with a matt texture on the side of the nose to a shade of red pink with a more shiny appearance over the nasal tip. Of course these patterns show large individual differences but detailed knowledge of nasal skin characteristics helps predict final scar outcome in a patient and is of consideration in choosing donor tissue (grafts or flaps) to improve the matching of nasal skin. Thick sebaceous skin is more difficult to handle because it is inelastic, bleeds more and cannot be easily everted[2] and this contrasts with thinner skin which often produces finer scars where small dog ear protrusions tend to resolve spontaneously. Furthermore, the skin of the upper two thirds of the nose is mobile, compared to the relatively fixed skin over the nasal tip and ala. This greater skin redundancy in the upper part of the nose may be mobilised and used effectively for reconstructing defects of the lower nasal third.

Fig 1. Relaxed skin tension lines are depicted. These lines are preperably used for incision placement.

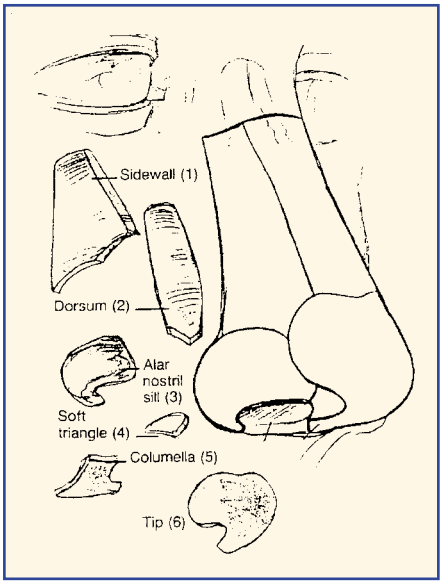

Fig 2. Aesthetic sub-units of the nose according to Burgett. Transition zones between the aesthetic units may be used to hide scars.

Incisions should preferably parallel the *relaxed skin tension lines* (RSTL) for optimal scar results. RSTL's of the nose are formed by the combined action of nasal muscles, gravity and the geometry of the underlying hard tissue. The format of the RSTL's is complicated as they are oriented transversely from the root to the tip, but change direction on the ala and columella where they are oriented perpendicular to the nostril orifice[3] (Fig. 1).

The *contour* of the nose varies directly from area to area. The surfaces of the nasal (hemi-) tip, ala, dorsum and columella are convex, while the nasal sidewalls and soft triangle are concave. These hills and valleys characterise the anatomic sub-units and create changes in light reflection and shadowing producing transition zones[1] (Fig. 2).

Relating the defect to subunit contour helps to determine the methods of reconstruction and optimal scar positioning. If subunits are violated in excess of 25-50% it is better to completely excise and resurface them with the intention of placing scars strategically in the transition zones[4,5].
Skin flaps tend to contract centripetally, tending to produce convex contours which can be used advantageously in reconstructing nasal tip, ala and dorsal defects. However, skin grafts are better able to adapt to concave contours making the lateral nasal wall a preferable graft recipient site.

The inner lining of the nose is formed by thin skin (vestibulum nasi) and mucosa. The single best criterion for gauging the complexity of the nasal reconstruction is not the size of the skin deficit, but the extent of the missing lining[6]. Proper replacement of the lining is imperative for the viability of the nasal skeleton, thus preventing alar retraction, vestibular stenosis and valve collapse[7].

An intact, healthy *nasal skeleton* in combination with a continuous skin covering forms the prerequisite for aesthetically pleasing contours of the nose. The nasal skeleton not only dictates surface aesthetics but is also important for nasal patency. More specifically, the alar cartilages and conjoint septum/upper lateral cartilages form the supporting structures of the nasal valve region, which is the narrowest part of the nasal airway.
Nasal cartilage anatomy is complex and difficult to reconstruct. However, modern rhinoplasty principles include a variety of restructuring techniques to augment or replace the bony and cartilaginous skeleton with autogenous cartilage grafts which may be useful in nasal defect reconstruction.

NASAL MALIGNANCIES

Cancer occurs more often on the skin of the nose than on any other organ of the body[8]. Most cutaneous nasal malignancies are found on the more projecting lower 2/3 of the nose, possibly paralleling the amount of actinic damage. Although reports vary, the relative frequency of basal cell carcinoma (BCC), squamous cell carcinoma (SCC) and melanoma of the nose is approximately 85%, < 15% and < 1% respectively[9].
Most BCC are nodular, ulcerative or superficial. These tumours have a predominantly expansive type growth pattern accounting for a well-circumscribed border and relatively high cure rate with conventional treatment modalities. Other types of BCC including morphea type and infiltrating type as well as SCC are considerably more difficult to treat because of the indistinct clinical and surgical margins. Treatment of SCC of the nose always includes a full neck examination for neck nodes, particularly in the submental and submandibular region.
Fortunately, the mortality rate from BCC is negligible, but its morbidity can be significant when such tumours are not treated early and properly[10]. Previous studies show that the greatest percentage of *recurrent* BCC's are on the nose, illustrating the difficulty with nasal tumour control in this area[11]. In this aesthetically important area, there is a tendency towards narrow excision margins in an effort to simplify reconstruction and this may account for the high recurrence rate.
Application of Mohs micrographic surgery is particularly useful on the nose because this technique preserves more normal tissue than conventional surgery and enjoys higher cure rates[12]. Recurrent lesions have also been shown to have been more successfully treated with Mohs surgery[13,14]. As a result this microscopically controlled excision has to be organised with a multidisciplinary approach to ensure successful tumour excision. *Orientation* of the specimen is undertaken by the surgeon, *interpretation* of the slides by the pathologist with *communication* between the laboratory technician, pathologist and surgeon, are imperative for a good result. Although Mohs surgery requires time and expertise, it allows for same day reconstruction in most cases[15].

RECONSTRUCTION

The ideal reconstruction closes a cosmetic deformity with a good tissue match and no stenosis or distortion. Immediate closure decreases morbidity time, prevents the danger of secondary haemorrhage and minimises the chances of wound infection.
However, a delay up to 3 to 4 days has a very low risk of complication and does not compromise the final results[16].
Analysis of a series of the last 200 consecutive nasal reconstruction patients operated at our institution, demonstrates the frequency with which each reconstructive method was employed (see table 1).

TABLE 1: Frequency of use of nasal reconstruction modalities

Reconstruction modality	Number (%)
A Primary closure	2 (1%)
B Secondary intention	30 (15%)
C Skin grafts	46 (23%)
D Flaps Local	42 (21%)
Regional	
• Axial forehead transposition	32 (16%)
• Naso-labial transposition	20 (10%)
• Glabella rotation	20 (10%)
• Cheek advancement	8 (4%)
Total	200 (100%)

Primary closure

Because of the firm adherence of the skin to the lower portion of the nose very little mobilisation of tissue is possible in the primary closure of skin defects in this region. Horizontal closure of a supra-tip defect lies in the relaxed skin tension lines, but tension may produce elevation of the nasal tip. This, however, may be cosmetically acceptable in the elderly patient.
Although the scar in the primary *vertical* closure of a dorsal defect lies perpendicular to the relaxed skin tension lines, it may be the simplest solution available, accomplished by advancing lateral nasal wall and cheek tissues[17]. However, undue tension on the wound closure may thin the dorsal skin with subsequent unaesthetic profile changes. Moreover, a long straight scar of the nasal dorsum may be more visible than a broken line that results from the use of a local flap.

Healing by secondary intention

The basis for healing by secondary intention is epithelialisation and scar contraction. The indications for healing by secondary intention are dictated by tumour control factors, depth and size of the defect and anatomic site plus adjacent skin characteristics. From an aesthetic standpoint, a relatively small superficial wound in a concave anatomic area and in a fair skinned individual is considered an ideal indication[18].

Fig. 3a. A wound in the concave medial canthus/ lateral nasal wall region.

Fig. 3b. Healing by secondary intention with adequate wound dressing will lead to contraction and re-epithelialisation. Optimal results will be achieved in patients where the skin is pale and thin but also where the wound is superficial and situated in a concave area.

Zitelli characterised the most favourable sites of healing by secondary intention on the nose as being the medial canthal area and alar crease. (Fig. 3). The concavity of the lateral nasal wall is less pronounced, but may also produce a satisfactory result due to healing by secondary intention. Wounds on the nasal dorsum and nasal tip will invariably result in a flattening of the convex contour, while wounds along the alar and columellar margins risk retraction.

The advantages of healing by secondary intention are its simplicity and cost effectiveness[19]. It eliminates the need for an additional surgical procedure and avoids the creation of further scar tissue that must be excised if the tumour recurs. Moreover, healing by secondary intention improves the early detection of recurrent tumour by avoiding burying tumour under a flap or graft. This is particularly important in young patients[20]. Split thickness skin grafting also allows for close observation, but it is usually not a good aesthetic option and is probably inferior to healing by secondary intention in most cases[16]. Thus, excisional defects of tumours with a significant chance of recurrence are optimally managed by healing by secondary intention.
The primary disadvantage of this approach is the prolonged period required for healing but results are usually excellent with proper patient selection and wound care.

Skin grafts

Free skin grafts are pieces of skin that have been severed from their local blood supply and transferred to another location. They can be classified into three basic types: Full thickness skin grafts (FTSG), split thickness skin grafts (STSG) and composite grafts. Skin grafts have a definite indication where there is a regional, multifocal skin tumour and thus a local flap is undesirable.
Full thickness grafts include the dermis with overlying epidermis. These may be used for reconstructing small defects of the nasal tip and infra-tip lobule as well as the thinner skin covering the upper two-thirds of the nose. A prerequisite for skin grafting is a wound-bed that allows vascular ingrowth. Thus avascular tissues such as exposed

Fig. 4a. Patient with defect of lateral nasal wall.

Fig. 4b. Free skin graft from the retroauricular area sutured in place.

Fig. 4c. Postoperative 4 months result.

bone and cartilage are generally unable to support a FTSG. Full thickness skin grafts are deceptively simple, but require gentle handling and meticulous surgical technique to prevent partial or complete necrosis. De-fatting of the graft is essential in skin grafting[21] leaving the white, glistening under-surface of the dermis which is a better medium for new vessel ingrowth. Perforating the graft in multiple lines parallel to the new relaxed skin tension lines permits the release of serosanguinous fluid also promoting graft take[22]. During the postoperative phase, the graft is immobilised using quilting sutures and a stent dressing. Stent fixation over a non-adherent contact dressing may also be achieved using skin adhesive and steri-strips alone[23]. Graft take may be significantly compromised in smokers, patients with diabetes mellitus and patients using any aspirin-type medication. Aesthetically, the most significant disadvantage of skin grafts is the difficulty in matching the texture, thickness and colour of the surrounding skin. Donor site selection is thus crucial.

Taking the sebaceous gland concentration into account, skin grafts from the melo-labial fold provide an excellent colour and texture match, for small sized defects of the nasal tip and infra-tip lobule[24] (Fig. 4), while pre-auricular skin can be utilised for grafting the upper two-thirds of the nose[1,26,27]. Because post-auricular skin is slightly red and supraclavicular skin relatively thick, they are considered poor secondary donor sites. It must be emphasised that a skin graft has limited thickness as it does not carry subcutaneous tissue and this may result in a flat or depressed contour if applied inappropriately.

Split thickness grafts are indicated in the elderly patient with very large defects and uncertain tumour margins[28]. The aesthetic results from split thickness grafting are usually less than ideal since they result in a shiny, whitish irregular surface with secondary contraction and distortion[29,30].

Composite grafts are useful for the one-stage reconstruction of small alar rim and superficial columellar defects. The term composite graft indicates that the graft contains at least two types of tissue, most often skin and cartilage and sometimes skin and perichondrium[31,32].

Fig. 5a. Defect of the left columella free border.

Fig. 5b. A composite skin-cartilage graft taken from the helical root replaces the skin and medial crus.

Fig. 5c. Two year postoperative result.

Fig. 5d. Helical root after reconstruction with an advancement flap of the preauricular area.

Composite grafts do not carry their own blood supply and are thicker than simple skin grafts so there is a greater risk of graft failure. The upper limit of a composite graft that will predictably survive relying solely on perfusion from only its peripheral edge is approximately 1 cm[33]. Composite grafts are preferably taken from the root of the helix where the donor defect can be closed with a cheek advancement flap, resulting in minimal deformity[34] (Fig. 5).

A second type of composite graft includes skin with attached perichondrium. The indication for these grafts is similar to that of simple skin grafts and they are extremely reliable. The advantage of these grafts is that they contract less than skin grafts, but they are of limited thickness and of limited use where strict tissue matching is required. The donor site of the cavum conchae[31] or retro-auricular area[35] is however reasonably well hidden.

LOCAL AND REGIONAL SKIN FLAPS

LOCAL FLAPS

A well-designed flap with a good vascular pedicle heals quickly, is highly resistant to infection, contracts minimally and can be formed in one stage[16]. As such a flaps are the only reliable way to transfer tissue bulk for reconstruction.
Skin flap design involves the assessment of a number of different factors. These include reservoirs of excess tissue, the tissue movement required plus its resultant effect and the various options for scar placement[36].

Over time, most reconstructive surgeons acquire preferences for certain flaps in various aesthetic units. These local flaps taken from within the aesthetic sub-units of the nose provide excellent aesthetic camouflage for small defects, largely because of skin match in terms of texture, colour and thickness.
The nasal dorsum and lateral nasal wall represent a tissue reservoir. Various types of small transposition flaps have been described which take advantage of the skin laxity in the upper two thirds of the nose. These include the *30° transposition flap*, *note flaps* and the *rhombic flap*[37,38,39]. The rhombic flap makes optimal use of tension redistribution by orienting the flap design according to the lines of maximum extensibility (perpendicular to relaxed skin tension lines). However, the geometric design of the rhombic flap (with 8 possible variations), onto the complicated RSTL pattern of the nose seldom fits to make optimal use of this concept[30]. The possible exception on this is on the lateral nasal side wall[36].
With transposition flaps excess tissue is moved into adjacent defects, usually in the upper third of the nose or into the superior half of the nasal tip. The same holds true for small rotation flaps designed in the same nasal area.
The alar region is less suited for single local transposition or rotation flaps taken from the upper two-thirds of the nose as the supra-alar crease is often lost. Moreover, closure of a primary or secondary defect may produce tension with resultant upward retraction/ rotation of the alar margin.

Fig. 6a. Defect of lateral supratip area. Because of the depth of the defect, a bilobed flap is prefered above a free skin graft.

Fig. 6b. Bilobed flap sutured in place after wide undermining around the defect and the dissected area to prevent pin cushioning and scar retraction.

Fig. 6c. Two year postoperative result with maintenance of contour without flattening.

The *bilobed flap* is a variation of the standard single transposition flaps mentioned above[40,41,42,43]. It utilises two adjacent, incrementally smaller flaps of skin in series that are transposed over intervening skin (Fig. 6). Therefore, the bilobed flap allows tissue transfer from a donor site with greater skin laxity (upper and middle third of the nose) to the recipient site (defects on the lower third of the nose)[40,43].
To prevent excessive dog-ear deformity the skin should not be transposed over more than 90 degrees[40]. If a dog-ear deformity occurs, it is excised as a burrows triangle adjacent to the defect. Obviously a large number of variations in design are possible, enhancing the various applications of this flap[41]. The primary advantage of the bilobed flap is the use of adjacent, well-matched skin but the main disadvantage is the multiple secondary scar lines that are usually impossible to hide within the normal anatomic boundaries.
Subcutaneous pedicle flaps are rarely used because of the paucity of regional subcutaneous tissue on the nose[44,36]. The value of a subcutaneous island pedicled flap is the filling of the defect, but the pedicle is often bulky, obliterates natural concavities, and risks a suboptimal triangular scar[44,45].

REGIONAL FLAPS

These include the nasolabial flap, nasal dorsal glabellar flap and the forehead flap.

Nasolabial flap

Lateral to the nasolabial fold, an area of non-hair bearing tissue excess allows harvesting of a pedicled flap based on random terminal branches of the facial artery (Fig. 7). The donor site is closed by cheek advancement while hiding the scar in the border of the lip-cheek aesthetic units[46]. The main indication for this flap is for defects on the lower third of the nose less than 2.5 cm[47]. This includes defects of the ala, lateral sidewall, tip and sometimes vestibular/columellar defects. For full thickness alar defects the nasolabial flap may be used for outer coverage and internal lining, while adding structural cartilage support as a free graft in between both layers. Most of these flaps are superiorly based, except for certain vestibular or columellar defects.
The flap may be designed as a one or two staged procedure. In the one staged procedure, the flap is inset directly into the defect after excision of the tissue bridge adjacent to the defect[48]. This contrasts with the interpolation type flap that involves an intact skin bridge[1]. followed by a second stage release of the flap after three weeks. The advantage of interpolation is the maintenance of the cheek-nasal sulcus and the natural supra alar concavity[49]. Wide undermining of the entire surgical defect margins and thinning of the flap is important in order to prevent a trap door deformity[47]. In smokers or patients who have undergone previous radiotherapy, vascular complications and infections may be significant. In this scenario alternatives should be considered[50,51].

Nasal dorsal glabellar flap

By design a nasal dorsal glabellar flap is a rotation flap aiming to move skin from an area of relative excess (the glabella) to mid-nasal and lower nasal defects[52]. The ideal donor site in the glabella region contains loose skin with a lack of hair follicles in the interbrow region. The presence of hair follicles in this region, however, contraindicates its use[53]. The vascular pedicle is the nasal dorsal artery located on the contralateral

Fig. 7a. Through and through defect of the nasal ala.

Fig. 7b. Inner lining provided by vestibular transposition flaps. A nasal labial interpolated transposition flap subcutaneously pedicled is outlined.

Fig. 7c. Nasal labial flap transposed. The alar shape is provided by a batten type onlay autogenous cartilage graft. This graft is placed in a non-anatomic position to prevent scar retraction and dictates the shape of the ala.

Fig. 7d. Flap just before revision of the pedicle and excision of the remainder of the ala skin covering and inset of the flap.

Fig. 7e/f. One year postoperative result.

side of the dorsal defect, providing a sturdy blood supply. The arc of rotation is centred around this area in the medial canthus. A backcut in the glabella is used to increase rotation while the supple, mobile nature of the skin over the dorsum and medial cheek significantly aids in tissue transfer[54].

The flap is elevated in the supra-perichondrial plane as this contains loose alveolar tissue that dissects easily and limits bleeding. To maintain an even thickness of the flap a transition is made to the subcutaneous plane in the nasal frontal angle of the glabellar region (Fig. 8).

The advantage of this rotation flap is its versatile blood supply. Moreover it is a one-stage procedure and it provides excellent tissue match. Rotation involves closure of the primary defect at the cost of a secondary defect that is closed by cheek advancement and interbrow approximation. The closure of these secondary lateral nasal wall/cheek defects may be facilitated by concomitant reduction of the height of the bony cartilaginous nasal

Fig. 8a. Defect on the nasal dorsum and tip in an elderly patient with a cartilaginous bony hump and under-rotated and under-projected tip. Part of the under-projection is due to the resection of the skin of the nasal tip.

Fig. 8b. Nasal dorsum glabella flap with pedicle on the right side is outlined.

Fig. 8c. The skin flap is lifted off the osseo-cartilaginous framework in the same plane as in rhinoplasty.

Fig. 8d. Nasal dorsal hump reduction and tip reprojection and rotation will decrease the size of the defect and facilitates the tissue transfer.

Fig. 8e. After hump reduction the T-frame of the middle third of the nose is reconstructed by placing spreader grafts on both sides of the cartilage of the septum in order to maintain nasal function.

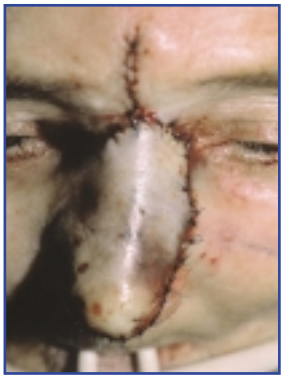

Fig. 8f. The flap is rotated and inset.

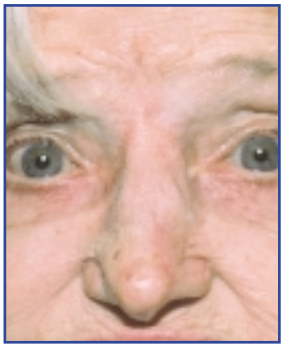

Fig. 8g/h. Two year postoperative result with closure of the defect in one stage after combining the flap transfer with rhinoplasty technique.

dorsum. The maximum size of the lower and mid-nasal defects to be closed by a nasal dorsal glabellar flap is less than 2 cm. If a larger flap is required a forehead flap may have to be considered. Two inherent problems associated with this rotation flap are its limited rotational movement and the introduction of differences in skin thickness along the wound margins[55]. Despite elaborate undermining, rotational movement is still limited, risking elevation and retraction of ala and/or the nasal tip[56]. Differences in skin thickness tend to occur when glabellar skin is moved down to lie adjacent to the thinner medial canthal skin. Thus dissection in different planes, careful suturing and long-term follow-up hides this visible ridge reasonably well. One of the other disadvantages of this flap is that the scars of this procedure are rarely optimally placed in RSTL or along borders of aesthetic sub-units and as such this one stage procedure with limited donor site visibility is a preferred reconstruction method in the elderly patient.

Forehead flap

The mid-forehead represents a maximum tissue reservoir for reconstructing large, full-thickness defects of the nose[1,57,58,59]. A forehead flap is the method of choice for closure of nasal defects which are not amenable to the more simple reconstructive methods described above (Fig. 9, 10). In general, nasal defects larger than 2.5 cm in length along the horizontal or transverse plane are best closed with a forehead flap.

Other indications are nasal defects with exposed bone and cartilage or cases where periosteum or perichondrium is deficient. There is also a strong case to be made for using this modality where the central face has been irradiated or where total nasal reconstruction is envisaged.

Median and paramedian vertically oriented forehead flaps are based upon the supra-trochlear artery, which crosses the supero-medial orbit approximately 1.7 to 2.2 cm lateral to the midline, and courses vertically in a paramedian position approximately 2 cm lateral to the midline[58]. Doppler location of the supratrochlear artery localising its exact position allows harvesting of a flap with a relatively narrow pedicle of less than 1.5 cm. This facilitates pivot rotation providing more effective flap length and preventing donor site deformity in the glabellar region.

The flap is lifted while dissecting in the sub-galeal plane. If the donor site defect is larger than 4.5 cm, primary closure may not be feasible and the remaining defect is left to heal by secondary intention[1]. Alternatively, intraoperative tissue expansion may be applied before further closure. The donor scar runs perpendicular to RSTL's but is relatively camouflaged by its midline position.

The excellent blood supply to this flap makes the vertical mid-forehead flap extremely reliable. Moreover, it allows thinning of the distal portion of the flap enhancing pliability and final contouring[60] with the incorporation of cartilage grafts to reconstruct the nasal skeleton[1]. The pedicle is divided at three weeks with appropriate debulking and contouring at the recipient site. At this time part of the pedicle base can be replaced, but never higher than the eyebrows. Alternatively, an intermediate stage before final pedicle division allows for more aggressive sculpting and contouring, making use of the enhanced blood supply at that stage[1]. This would occur at 3 weeks, the pedicle division being delayed until week 6.

Fig. 9a. Through and through defect of left ala lateral nasal wall. More than 50% of the right ala and hemitip is missing. Soft triangle is still intact. Consideration is given to removing the rest of the hemitip and alar subunit.

Fig. 9d. Using the exact shape of the template a forehead flap is designed on the ipsilateral side of the defect.

Fig. 9h. Supra-alar groove recreated after thinning using mattress type sutures.

Fig. 9b. Lining is provided with a composite skin perichondrial graft taken from the auricle conchal bowl.

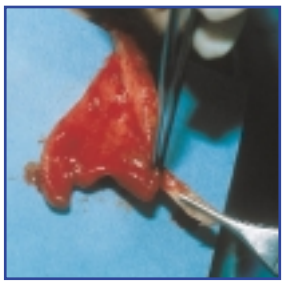

Fig. 9e. In this thin skinned patient a tunnel is made in between the skin and the thin musculus frontalis in order to insert a cartilage graft which will act as a batten to prevent scar contraction.

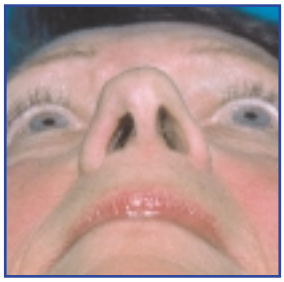

Fig. 9i/j. Two year final result. The skin perichondrial graft together with the cartilage mattress has prevented scar contraction. The final scar lines on the nose are hidden on the transition of the ala and cheek as well as in between the two nasal hemitip subunits.

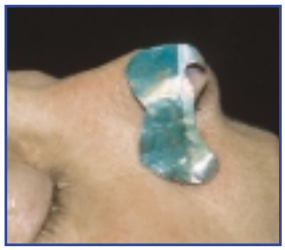

Fig. 9c. The other intact half of the nose is used to create a template of the missing tissues.

Fig. 9f. Forehead flap is inset. Complete hemitip and ala are reconstructed.

Fig. 9g. An intermediate stage after 3 weeks allows for thinning of the flap and recreating the supra-alar groove.

Fig. 10a. Defect of left nasal tip. More than 50% of the hemitip is missing.

Fig. 10b/c Remaining portion of the left hemitip is excised. A Peck autogenous cartilage onlay graft is used to recreate nasal tip position and tip defining point. A forehead flap is used for skin replacement.

Fig. 10d/e One year nasal tip projection nicely maintained. Scars hidden in boundaries of aesthetic sub-units.

The Interface between Rhinoplasty and Nasal Reconstruction

This particular subsection clarifies how and why various techniques from both these disciplines can be used to complement one another, enhancing the overall end result. Rhinoplasty surgeons and reconstructive surgeons alike have always stressed the importance of robust osseo-cartilaginous support combined with an adequate internal and external lining and it is the individual reconstitution of each of these layers that determines the long term stability and function of the nose[7]. The external skin of the nose not only demonstrates a great inter-patient variability but also varies markedly within the delineated sub-units. These innate differences are appreciated particularly by rhinoplasty and reconstructive surgeons, as the skin covering over a remodelled cartilaginous scaffold is a major determinant of the eventual cosmetic result. As pertaining to both fields, the replaced skin soft tissue envelope must fit tight and tension free over a reconstructed cartilaginous skeleton. Thus an oversize or loose skin covering will not always shrink adequately over the osseo-cartilaginous framework, leading to loss of the natural anatomical details or even gross deformity. In order to minimise any potential long- term cosmetic problems with a loose skin covering, a nasal splint can be applied in order to prevent dead space formation thus ensuring better application of the skin to its modified skeleton.

The delineation of the nasal sub-units also serves to camouflage scars that may develop from nasal reconstruction using skin flaps. This is similar to external rhinoplasty where the columella incision is carried lateral to the skin role created by the medial crura. As a result the scar is hidden at the junction of the columella and vestibular skin.

One of the keys to rhinoplasty is the position and support of the nasal tip. The attachment of the skin to the alar cartilages lends strength to the nasal tip complex and it is now well established that in both the open and delivery approaches, tip projection is lost when this minor tip supporting mechanism is violated. Similarly, removal of nasal skin for tumour resection and the subsequent reconstruction of the defect also tends to decrease nasal tip projection in much the same way as mentioned above. In this scenario, the tip may be repositioned using standard rhinoplasty techniques such as inserting a columella strut, alar cartilage suturing techniques and grafts to align the nasal profile.
In a number of tumour surgery cases the nasal tip is under-projected or under-rotated before surgery has taken place. To diminish the size of the defect for reconstruction, it is often useful to re-project and rotate the tip, which also enhances the cosmetic outcome. Similarly, reduction of the bony/cartilaginous hump as in routine rhinoplasty may decrease the size of the defect for reconstruction, creating additional space to facilitate tissue transfer on to the lower part of the nose (Fig. 8).
The restructuring of the nasal framework in reconstruction is closely related to autogenous grafting of various areas of the nose as performed in modern rhinoplasty (Fig. 10)[61]. In alar reconstruction, batten type auricular cartilage grafts are placed in a similar fashion to those used in rhinoplasty for nasal valve insufficiency (Fig. 7). Even spreader grafts may be used to maintain nasal patency (Fig. 8). In essence, the cartilaginous lower 2/3 of the nose may be entirely recreated using technical insight gained from rhinoplasty surgery.
When narrowing of the alar base in rhinoplasty is required, care is taken to place the incisions not in, but just above the alar creases as this avoids unsightly scarring. This principle can also be applied to nasal reconstruction where excision and subsequent reconstruction of the alar sub-unit is confined by the same incision placement.

Nasal lining

Various alternatives can be considered to replace the internal nasal lining. This includes skin grafting, folding the distal aspect of the cutaneous flap on itself, intranasal pedicled mucosal flaps or epithelial turn-in flaps from around the defect.
Skin grafts may contract and do not allow major cartilage replacement at the first stage. Technical variations may be used to circumvent this problem (Fig. 9). Even after debulking of the folded-in forehead flap it is generally too thick to match the pre-existent thin internal lining and sometimes contains hair follicles. Small intranasal pedicled mucosal flaps may be harvested ensuring an excellent blood supply[62].
These include septal and bipedicled septal/vestibular flaps[4,62]. A composite septal flap may not reach down to the nostril without compromising midline support and significant secondary donor site morbidity may lead to septal perforation formation. The epithelial turn-in flaps using the remains of the aesthetic units involved are

hinged on the wound margin and may be considered as an alternative[4]. Excess bulk and subsequent nasal obstruction is rare with this technique[4] but it may be limited by vascular considerations, as it may not be long enough to reach the alar rim from the edge of a large defect[33]. Only in the case of total nasal reconstruction would a free forearm faslip flap combined with buccal mucosal graft be considered for reconstitution of the nasal lining.

CONCLUSION

The surgeon who treats malignant tumours of the nose must consider the functional and aesthetic qualities of the nose, yet appreciate that cure is the primary objective of treatment. Functional and aesthetic nasal reconstruction requires an inner lining, a supporting framework and external coverage. A variety of reconstructive methods have been reviewed in this article. The complexity of nasal reconstruction and the concomitantly high aesthetic standards expected, will hopefully have been clarified, although this unique area will always post a challenge in the search for the optimal result.

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RECONSTRUCTION OF LARGE 3-LAYER NASAL VESTIBULAR DEFECTS WITH THE COMPOSITE SEPTAL HINGE FLAP

G.J. Westerveld, Ch.R. Leemans and M.J. Middelweerd

We fully agree to the previous presentation of the essentials in reconstructive surgery of the nose. The experience which we have with these principles of providing support, lining and cover in planning a reconstructive operation of the nose fits well to the description of the previous authors. In our clinic, however, we are relatively frequently confronted with large defects of the lateral nasal wall, the nasal vestibule and tip. These large through and through defects of the nose may benefit from a reliable firm supportive composite flap from the cartilaginous nasal septum in a hinge fashion. Our experience with this specific supporting flap in cases of reconstruction extensive nasal defects will be presented in the following chapter.

INTRODUCTION

When surgery needs to be performed for squamous cell carcinoma of the nose or nasal vestibular skin, often extensive parts of the nose need to be resected to obtain radicality. The paramedian forehead flap is especially suitable for reconstruction of large defects of the nose, as the characteristics of the skin of the forehead, such as thickness, texture and color, match excellently to those of the skin of the nose. Moreover, forehead flaps do not transpose hair-bearing skin to the midface and have no effect on the mimetic musculature of the face[1,2]. Except for excellent skin characteristics, the paramedian forehead flap is highly vascular which makes it well suitable for the incorporation of cartilage or tissue grafts, which act as support or lining structures[3], which has been stipulated im the previous chapter on nasal reconstruction.

The goal of reconstruction is both a pleasing aesthetic and functional result. Many techniques have been described to reconstruct supporting tissue, i.e., cartilage and bone, and mucosal lining. One of the main problems of reconstruction after major oncologic resections in which the lateral nasal wall is involved is malfunction of the nasal valve. This functional disorder may be prevented when adequate support and lining are provided during reconstructive surgery[4]. When structural support of the lower two-thirds of the lateral nasal wall is needed, septal or conchal cartilage grafts are best used. Internal lining defects may best be resurfaced with pedicled skin or mucosal flaps of the nasal interior[5].

To achieve adequate skin replacement with both structural support and internal lining in nasal reconstruction, a composite hinged-door septal flap can well be combined with a paramedian forehead flap. We present our experience with this reconstruction procedure in 4 patients who underwent extensive nasal resection for carcinoma in the nasal vestibule.

MATERIAL AND METHODS

Subjects

Between 1995 and 1997, 4 patients with carcinoma in the nasal vestibule were surgically treated using a paramedian forehead flap in combination with a composite hinged-door septal flap for reconstruction of the defect. All patients were male. The age ranged from 63 to 78 years (mean age 72). Three patients had a primary squamous cell carcinoma of the nasal vestibule and were staged according to the Wang classification[6]. One of these patients (no. 1) who was staged as T1N0, developed a recurrence 6 months after initial irradiation (5250 cGy + 1600 cGy low dose rate endocavitary brachytherapy) and received salvage surgery. The two other patients underwent primary surgical treatment and were staged as T2N0 (no. 3) and T3N1 (no. 4) respectively. The remaining patient (no. 2) had a primary squamous cell carcinoma of the skin on the right side of the nose staged as T1N0. After initial irradiation of the lesion (5000 cGy) this patient developed a recurrence in his nasal vestibule 5 months later and was surgically salvaged. In all patients the surgery involved total resection of the lateral nasal wall including the alar region.

Fig. 1a. Intraoperative photograph of patient no. 1 showing the defect and the composite septal flap. On the forehead the paramedian forehead flap is outlined.

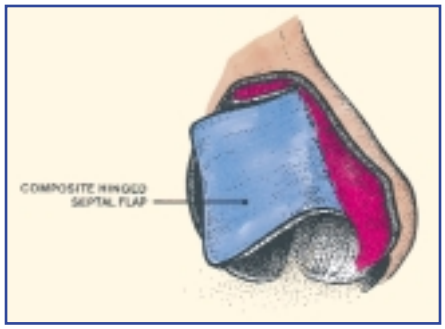

Fig. 1b. Drawing of the composite septal flap rotated laterally in a hinged-door fashion leaving its base attached to the nasal dorsum.

Surgical technique

Approximately two weeks after resection, when tumor free margins are reported, the reconstructive procedure is performed using a hinged-door composite septal flap (Fig. 1) which was laterally covered by an ipsilateral paramedian forehead flap. Before paramedian forehead flap inset, a hinged-door composite nasal septum flap is prepared. A through and through U-shaped incision is made in the nasal septum leaving the 3-layer mucosa-cartilage flap attached to the nasal dorsum. The size of the flap is adjusted to the amount of lateral support needed for the parmedian forehead flap. Care is taken that the caudal part of the septum is left intact to provide nasal tip support.The composite septal flap is transposed in a hinged door fashion, leaving its vascular supply intact at the nasal dorsum where it receives branches from the ethmoidal arteries. The ipsilateral mucosa is removed before suturing the septal flap into the defect (fig . 2).

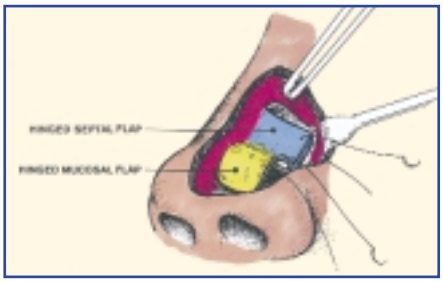

Fig. 2. The ipsilateral mucosa of the septal flap is removed before the flap is sutured in the defect. When needed this mucosal flap can also be used in hinged-door fashion to provide internal lining of the neo-nasal vestibule.

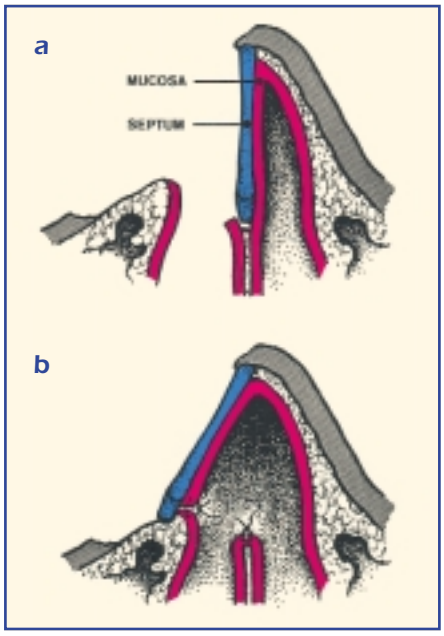

Fig. 3a,b. Drawing of the lateral rotation of the hinged-door septal flap in the nasal defect. The contralateral mucosa of the septal flap is sutured to the edge of the defect.

The contralateral mucosa of the flap is sutured to the mucosa of the defect (Fig. 3a,b). A three-dimensional template exactly mimicking the area of the defect is fashioned from a suture pack. This template is used to outline the flap design on the ipsilateral forehead skin. The lenght of the flap is determined, measuring the distance between a central point at the base of the flap pedicle and the most distal part of the nasal defect. This lenght including the template is outlined on the forehead. The base of the pedicle was traced approximately 1.5 cm wide to allow for maximal axial rotation without strangulation. The flap is elevated in a subfascial plane from superior to inferior, except for the most proximal part were flap is elevated in a subperiostal fashion to protect the vascular supply. After adequate flap mobilisation has been accomplished the flap is rotated about its pivot point in a coronal plane and then sculptured to fit the defect. Donor site closure is accomplished by extensive undermining of the forehead skin in the subfascial plane to both the anterior borders of the temporal muscle. When necessary bilateral galear releasing incisions are made.

Primary or near primary closure of the donor defect could be performed in all cases. In 3 of the 4 patients a sculptured free auricular cartilage graft was incorporated in a pocket made by folding the distal part of the flap to provide contour and inspiratory support of the neo nostril margin. After the procedure had been completed the nasal cavity was packed during 1 week with a parafin gauze. Pedicle separation and closure of the glabellar defect was performed 3 weeks after flap transfer since peripheral ingrowth of bloodvessels is considered sufficient at that moment, even in irradiated patients.

Fig. 4a,b,c. Frontal, lateral and, basal view of the nasal defect of patient no. 1, two weeks after resection and 2 years after surgery. The patient was pleased with the result in terms of functionality and cosmesis. Note the inconspicuously healed donorsite of the forehead flap.

RESULTS

All patients had a good functional result meaning that none of the patients had complaints of nasal obstruction or nasal discharge after wound healing. Moreover, all patients were content with the aesthetic result (fig. 4a,b,c). Despite the fact that all patients had a large septal perforation none complaint about nasal turbulence or crustae on the perforation edges. No revision surgery was needed in any patient. Patient characteristics are summarized in table 1 (table 1).

Discussion

Nasal reconstruction after oncologic resection should not only be focused on aesthetics but also on optimal nasal function. To obtain maximal aesthetic and functional result the subunit principle of nasal reconstruction combined with the concept that missing tissues have to be replaced should be used[3,7]. When multiple subunits of the nose are lost, i.e., the laterodorsal part and the alar region, the preferred skin replacement procedure is an ipsilateral paramedian forehead flap[8,9]. Except for skin coverage, structural support and adequate lining are equally important in nasal reconstruction. In the presented patients we used an composite nasal septum flap for lateral support and internal lining.

TABEL 1: Individual patient patient characteristics

Patient/ sex	Age (years)	Stage	Primary Rt* (cGy)	Primary surgery	Interval after RT before salvage surgery (months)	Auricular cartilage (yes/no)	Functional/ aesthetic result
1; male	76	T1N0	5250 (+1600)**	–	6	yes	good
2; male	78	T1N0	5200	–	5	no	good
3; male	70	T2N0	–	yes	–	yes	good
4; male	63	T3N1	–	yes	–	yes	good

* RT; radiotherapy

** patient 1 recieved additional brachytherpay of 1600 cGy

This hinged-door septal flap was first described by DeQuervain in 1902[10]. The inside lining tissue of the reconstructed lateral nasal wall is formed by the contralateral mucoperichondrium of the nasal septum. The ipsilateral mucosa of the septal flap is removed before suturing the septum flap to the paramedian forehead flap. It should be noted, that when needed, this mucoperichondrium can also be used as second hinged-door flap providing lining tissue for the lower nasal vestibule or nasal dome (fig. 2a). Ideally, lining should be thin, pliable and well vascularized to feed its underlying cartilage or bone grafts. Moreover it should not distort the external shape of the nose nor compromise the airway. When nasal reconstruction for full thickness defects of the lateral nasal wall has been performed various undesirable sequelae can occur. Functionally, nasal obstruction is the most frequent problem and may be due to alar notching , stenosis of the external nares, inadequate release of a mucosal lining flap, internal bulging of a mucosal lining flap or cartilage support flap and turbulent nasal airflow due to the iatrogenic septal perforation or reactive turbinate hypertrophy. Cosmetically, a flattened ala due to an undersized cover flap or inadequate support from the nasal interior, a malpositioned alar base due to unavailability of an alar remnant for reference, and unsatisfying scars are the most frequently encountered problems. Treatment of these problems has to be focused on the underlying problem.

Conclusion

In cases of nasal reconstruction after extensive oncological resection there is great need for reliable tissue transfer for internal lining and support. As is shown in the herein presented patients, the composite hinged-door nasal septal flap provides these qualities when applied in lateral nasal wall and nasal vestibular reconstruction. In addition, the paramedian forehead flap provides excellent skin coverage for these defects.

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