Surgical treatment of non-melanoma skin cancer of the head and neck: expanding reconstructive options
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Chapter 10

Summary and concluding remarks
Chapter 1
Skin cancer is the most common malignancy in the Caucasian population with basal cell carcinoma (BCC) representing 75% and squamous cell carcinoma (SCC) 20% of all skin cancer cases. Over the last decades, a significant rise in incidence of non-melanoma skin cancer (NMSC) has been observed. Several potentially curative options are available, but surgery is still the mainstay of treatment. In surgery as with other treatment modalities, the likelihood of curing an individual skin cancer strongly correlates with a number of well-determined prognostic factors (e.g. type of tumor, location, size, failure after previous therapy).

Aesthetically the face can be divided into specific areas or aesthetic units, which are covered by skin that has common characteristics such as color, texture, quantity of fat etc. Moreover, the face has a particularly rich vascular system, with a lot of collateral channels supplied by branches of the external carotid artery system, with the exception of a mask-like region in the center of the face; which is supplied by the internal carotid artery via the ophthalmic artery. Optimal reconstructive results rely on careful analysis of the defect and recipient site and a sound understanding of facial anatomy, skin flap physiology and wound healing. This must be supplemented by a scope of reconstructive options, and meticulous techniques. An ideal method of reconstruction leaves the patient with a closed defect after histologically complete resection, optimal function and good aesthetics. In view of these goals, this thesis evaluates Mohs’ micrographic resection as well as subsequent reconstruction aiming at different reconstructive approaches in the treatment of NMSC.

In Chapter 2 the efficacy of Mohs’ micrographic surgery (MMS) and conventional excision (CE) of non-melanoma skin cancers (NMSCs) are compared. Between 1990 and 2008, 795 patients were treated with MMS and 709 with CE. The median follow-up period for MMS was 24 months and for CE 16 months. Disease recurred in 6/795 (0.74%) of MMS patients and in 7/709 (0.98%) of CE patients. Analysis of the resection defects adjusted for localization and status of disease (primary tumor or recurrence) showed significantly smaller defects after MMS ($p= 0.008$). This may be due to the smaller resection margin applied in MMS, which was more often indicated for tumors on the nose, aggressive BCCs, recurrent skin cancer, females and younger patients. For pragmatical reasons, large (> 2 cm) tumors specifically on cheek and forehead were more frequently treated by CE.

Given the low recurrence rates, this study demonstrates that a single otolaryngologist or head and neck surgeon, in close collaboration with a group of pathologists, can adequately treat non-melanoma skin cancer in a private clinical setting. One advantage of MMS is the possible minimization of defect size in aesthetically and functionally important areas such as nose, eyelid and lip, thereby possibly enhancing reconstruction. Furthermore MMS allows for single-stage excision and reconstruction, which provides a great service to patients. Conventional excision with histology of paraffin embedded specimens remains a reliable treatment option for NMSC in less cosmetically critical areas of the face (forehead and cheek).

Chapter 3 evaluates the impact of wound characteristics and location on the final cosmetic
result of skin defects after skin cancer excision and wound healing by secondary intention. For analysis of cosmetic outcome three independent raters, using a categorical judgment scale, assessed photographs of the scars. 89 Patients with 95 skin defects were included. 43 Percent (41/95) of the wounds healed with ‘excellent’ outcome. In the univariable analysis, the rating “excellent” was given more often to scars derived from small \((p=0.0002)\) and superficial wounds \((p=0.017)\), and to healed wounds located in concave areas of the face, in particular near the medial canthus and medial cheek \((p<0.0001)\). Multivariable logistic regression revealed independent associations of cosmetic outcome with wound size \((p=0.0066)\) and contour of wound surface \((p=0.0026)\). This study presents statistical evidence that wounds in concave areas of the face, which are left to heal by secondary intention, have a high chance of healing with an excellent cosmetic outcome, especially if these wounds are small, superficial and located near the medial canthus and medial cheek. (nasofacial sulcus/supra-alar groove).

In chapter 4 we determine efficacy in terms of survival rate and cosmesis of “normal” full-thickness skin grafts (FTSGs) compared to perichondrial cutaneous grafts (PCCGs) in facial reconstruction. A chart review of all facial reconstructions using FTSGs and PCCGs between 1995 and 2005 was undertaken and a total of 121 skin grafts was included (70 FTSGs and 51 PCCGs). All patients were examined on day five and day ten to assess the viability of the graft. For aesthetic evaluation, 70 photographs were available with a minimum follow-up of six months (42 FTSGs: 59%; 28 PCCGs: 54%). The pictures were randomly shown to three independent raters, who had no previous knowledge about the type of grafting. The complete take rates of FTSGs (87%) and PCCGs (94%) were not statistically different \((p=0.1857)\). Although the cosmetic outcome of PCCGs scored better overall, no statistical difference was determined between PCCG and FTSG \((p=0.06)\). Both FTSGs and PCCGS are viable options in facial reconstruction, with no statistical difference in graft survival and cosmesis. Furthermore, the reconstructions are easy to perform in a one-stage surgical procedure.

Chapter 5 reviews the literature on skin grafting with a particular view to investigate whether the paradigm of fat removal still complies with reality. Literature data showed that 19 out of 26 authors advocate fat removal. Additionally we report on a series of 43 nasal reconstructions with composite skin-fat grafts. In our series, five grafts were necrotic (12%) while six (14%) showed superficial epidermiolysis. The use of rim cartilage grafts was associated with necrosis \((p=0.03)\) but we did not find difference in rate of necrosis between bare and not bare cartilage \((p=0.34)\). In fifteen patients (35%) the outcome was scored as excellent and in 28 (65%) as mediocre by three independent professionals. There were no poor outcomes. Forty patients (93%) were themselves satisfied with the cosmetic outcome, one patient was not satisfied and the experiences of two patients remain unknown. When considering edge and graft contour, 27 patients (67%) had no contour abnormalities while 15 patients (35%) only a slight contour edge difference. Minor hypopigmentation of the graft was noted in 17 patients (40%)
We conclude that composite skin-fat grafts are a valuable asset in nasal reconstruction with a very satisfactory aesthetic outcome demonstrated by the blending in with the surrounding tissue and absence of significant depression of the grafted site. The survival rates are largely comparable to FTSG. In other words, defatting of skin grafts may not always be necessary. Given the additional subcutaneous fat layer, a composite skin fat graft largely avoids the problem of a depressed appearance of the reconstructed region. Composite skin-fat grafting is technically less demanding than flap repair.

In chapter 6 the concept of secondary intention healing is further explored. We questioned if a cartilage batten in the alar sidewall region left partially bare and kept moist, still heals by secondary intention. In 13 patients free cartilage grafts -harvested from the auricle - were used in combination with secondary intention healing for the reconstruction of alar subunits and lateral nasal wall defects following Mohs’ surgery. The aim of the cartilage batten is to control wound-healing contraction force by buttressing the alar free rim and maintain stiffness in the lateral nasal wall. All skin defects healed completely. None of the free cartilage transplants failed, probably due to the fact that 80% of the cartilage is covered by healthy surrounding tissue. In nine patients results were gauged as satisfactory by both patients and surgeon. In three patients minor aesthetic faults were evident: one prominence of the underlying cartilage and hypertrophic scarring, one alar notching and one hypertrophic scarring. Another patient developed a nasal blockage at the operated side. Our results demonstrate that this easy alternative reconstructive method can serve as a viable option for small and deep defects of the alar subunit and sidewall of the nose without significant donor-site morbidity. Furthermore, coverage of a free cartilage graft by a vascularized skin flap or subcutaneous soft tissue flap does not seem indicated in smaller defects located more than 5 mm from the free alar border.

In Chapter 7 we describe the experience of using non-covered subcutaneous hinge flaps in combination with secondary intention healing. Sixteen patients undergoing Mohs’ surgery for NMSC of the alar subunit with one or more adjacent facial subunits were included. The subcutaneous hinge flaps were harvested from the medial cheek and a cartilage batten graft was placed in the alar sidewall region in all cases. All subcutaneous hinge flaps healed well by secondary intention within 4-6 weeks and all reconstructions were assessed as either good or satisfactory by patient and doctor. In four patients there were minor aesthetic dissatisfactions. These included one prominent underlying cartilage graft, which needed a minor surgical revision, one effacement of the nasofacial sulcus, one hypertrophic scar and a combination of both in one other patient. Uncovered subcutaneous hinge flaps in combination with cartilage battens and secondary intention healing can be used as an alternative, straightforward, one-stage reconstruction method for small but deep defects involving the lateral lower nose and medial cheek area with satisfying cosmetic results.

In Chapter 8 we tested whether subcutaneous tissue flaps (either muscle or fat) filling up large nasal defects or defects with an unfavorable re-
recipient site, are still amendable to skin grafting. In the upper nasal third and lower dorsum the procerus and nasalis muscle were mobilized and transferred into the defect. On the lower lateral nasal wall, subcutaneous tissue of the cheek was used. Both full-thickness skin grafts and perichondrial cutaneous grafts were placed on the pedicled subcutaneous soft tissue flaps. The overall free-graft survival was 79% (Perichondrial cutaneous grafts 89% and full-thickness skin grafts 74%). The procerus and nasalis muscle flaps were found to yield higher graft survival than cheek flaps, which consist mainly of fat. The combination of subcutaneous soft tissue flap and skin graft coverage, offers a valuable alternative mobilization of adjacent skin.

Chapter 9 describes the reliability and functional and aesthetic results of three types of forehead flap designs (classic paramedian, glabellar paramedian and hybrid midline forehead flap) in 300 patients. The reason for using the hybrid midline forehead flap was the need to have more effective length of the forehead flaps without transposition of hairs and a possibly more favorable midline donor site. A review of the anatomical literature on forehead flaps showed a robust vascular plexus to the forehead via the supraorbital, supratrochlear, and terminal branches of the angular and dorsal nasal vessels. This robust vascular plexus is the basis of success of the various flap designs including the angular artery based hybrid midline forehead flap. In our series, flap necrosis was reported in three patients (1%): two in the glabellar paramedian design and one in the classic paramedian design. Statistically, we found no difference in the rate of necrosis between the three flap designs (p=0.45). Only diabetes was associated with an increased risk of necrosis (p=0.01). Cosmetically most patients (297/300) are satisfied with their nasal appearance after forehead flap reconstruction. Photographs could be analyzed in 227 patients (76%). In 98% (78/80) the reconstructed ala was found to be slightly thicker than the contralateral (normal) side and in 16% the nostril ostium was smaller than the contralateral side. Brow position (98%) and color match (83%) were rated as good in the majority of patients. We found that the hybrid midline forehead flap design was as reliable as the paramedian (glabellar and classic) forehead flap, providing predictable, long-term results. If more effective length of the forehead flap is needed without hair transposition we prefer the hybrid midline flap for reconstruction of caudal defects of the nose. This design possibly gives a more favorable midline donor scar. For reconstruction of cephalic nasal defects (where the blood supply is endangered), a paramedian forehead flap design is preferred. The forehead flap still represents the preferred method for repair of extensive nasal defects, achieving near-normal functional and cosmetic results.

Concluding remarks
This thesis demonstrates that NMSC of the head and neck can effectively be treated surgically either by MMS or CE. MMS remains the preferred method for resection of NMSC with an aggressive growth pattern and for resection of recurrent disease originating in the aesthetically and functionally important H-zone (midface), especially the nose and eyelids. MMS offers the possibility of minimalization of surgical defect size in combination with an oncologically safe resection. These aspects are of particular impor-
tance in the above-mentioned locations. It has to be realized that MMS takes time and needs a specialized set-up of peroperative histopathological processing of tissue specimens. For less cosmetically critical areas of the face (forehead and cheek) conventional excision with histology of paraffin-embedded specimens or conventional frozen section control of resection margins is still a good alternative.

Secondary intention healing is the easiest surgical alternative for reconstruction of the face and this thesis presents the first statistical evidence for wound characteristics which give an excellent cosmetic outcome in almost half of the patients. Wounds in concave areas of the face have a high chance of healing with an excellent cosmetic outcome, especially if these wounds are small, superficial and located near the medial canthus and medial cheek.

In this thesis less complex innovative surgical techniques are described, which provide good functional and cosmetic results with minimal morbidity to the patient. These techniques include secondary intention healing in combination with subcutaneous hinge and/ or cartilage grafts, subcutaneous soft tissue flaps with skin grafts and composite skin-fat grafts. These techniques might serve as an alternative for more extensive reconstruction techniques in the face and represent an expansion of the surgeon’s armamentarium for facial defect reconstruction geared to the patient’s unique needs.

Reconstruction of nasal tip defects remains challenging because of the thicker sebaceous skin type. The use of local flaps may lead to additional scars, dog-ears and trapdoor deformities. In our series composite skin-fat grafts offer a reliable straightforward alternative with excellent cosmetic results. A subsequent prospective randomized study, comparing the aesthetic outcome of bilobed flaps and skin-fat grafts, is now ongoing.

For complex or large nasal defects (> 1.5 cm), especially located on the lower nasal third, multistage forehead flap reconstruction remains the treatment of choice. As we demonstrated the hybrid midline forehead flap as well as the paramedian (glabellar and classic) forehead flap are both equally reliable regarding the risk of necrosis. The choice of pedicle design is not only determined by location and size of the defect but also by the shape and level of the frontal hairline. The use of different pedicle designs also contributes to a further refinement of nasal reconstructive options.

Summarizing, a reconstructive plan of skin defects in the head and neck after complete excision of NMSC should be dictated by both the surgeon’s and patient’s preference, comfort, and ability. A careful preoperative assessment, with identification of individual surgical defect characteristics followed by appropriate surgical techniques is essential to achieve an optimal outcome. Given the alternative closure techniques described and evaluated in this thesis traditional relatively complex local flap reconstruction can now be weighed against less complex grafting techniques.

This thesis allowed us to reemphasize some facial plastic and reconstructive principles

1) A systematic defect analysis addressing mobile and immobile surrounding landmarks, vectors of tension, area of recruitment, and pre-existing lines and resultant scars (i.e. aesthetic lines) is essential before embarking on a reconstruction; 2) Liberal use of non-anatom-
cal cartilage grafting in functionally critical regions (e.g. nasal ala and side wall) predisposed to significant retraction enhances predictable functional and aesthetic outcome; (3) Counseling of the patient about the risk of a suboptimal outcome while continuing smoking and drawing the patient into a plastic reconstructive procedure; (4) There is no essential difference between nasal reconstruction and cosmetic rhinoplasty. Adjuvant rhinoplasty manoeuvres contribute to achieving the best possible functional and aesthetic outcome.