Cheek Reconstruction: Current Concepts in Managing Facial Soft Tissue Loss

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ABSTRACT

Significant defects of the cheek present a reconstructive challenge due to their extremely visible site, as well as limited local tissue supply. In addition, the cheek abuts several structures of expressive function, such as the eye, mouth, and local facial musculature. To achieve satisfactory functional and aesthetic results, reconstruction of such defects requires careful three-dimensional restoration of all missing components, adequate texture matching, as well as functional restoration. Aesthetic reconstruction of facial defects should adhere to the priority goals of first preserving function and second achieving cosmesis. According to the size of the defect, location on the cheek, relationship to adjacent structures, available donor tissue, and existing skin tension lines, a host of techniques is available for closure. As a well-established principle in facial reconstructive surgery, one should use local tissue whenever possible to provide the best tissue for color and contour restoration. However, thoughtful reliance upon the “reconstructive ladder,” including direct closure, skin grafting, local flap creation, regional flap placement, and free-flap repair, will invariably guide the surgeon in an optimal approach to cheek reconstruction.

KEYWORDS: Considerations for cheek reconstruction, free-tissue transfer, free-flap repair, skin grafting, flap placement

From an aesthetic point of view, the cheek may be divided into three overlapping units: (1) suborbital, (2) preauricular, and (3) buccomandibular (Fig. 1).¹ Zone 1, the suborbital zone, extends along the lateral border of the nose to the nasolabial fold, across the cheek below the gingival sulcus toward the sideburn, up the anterior sideburn to the lateral crow's-foot line, and then along the lower eyelid cheek junction.^{1,2} Underlying superficial tissues in this region are the lower orbital fibers of the orbicularis oculi muscle. More laterally, the masseter muscle arises from the outer surface of the maxillary buttress. The facial nerve branches lie on the masseter on the underside of the orbicularis oculi and quadratus muscles. In this location, wounds not ame-

nable to primary or skin graft closure may respond well to rhomboid, circular, or bilobed flaps. In addition, cervicofacial flap design or tissue expansion with rotation from a more lateral site is helpful for larger defects. Zone 2, or the preauricular area, extends from the helical junction with the cheek across to the sideburn to overlap with zone 1 at the malar prominence.^{1,2} This area includes the tissues over the parotid-masseteric fascia and extends inferiorly to the mandibular angle and lower mandibular border. In addition to the local flaps previously listed, regional flaps such as anteriorly based cervicofacial flap, deltopectoral flap, and pectoralis major flap may be advantageous for reconstruction at this location. The buccomandibular area (zone 3) extends

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Figure 1 The demarcation of the three overlapping, aesthetic zones of the cheek: (1) suborbital, (2) preauricular, and (3) buccomandibular.

from a vertical division at the middle cheek down to the mandibular margin and from the oral commissure back up to a horizontal division line half-way up the cheek.^{1,2} Not only does a majority of the orbicularis oris underlie this area, but also the parotid duct courses through this body of cheek tissue here as well. Reconstruction of this area must take into account important nearby structures, such as the oral commissure, ala, and nasolabial fold.^{1,2} Simple flaps, such as the transposition flap, W-plasty, or Z-plasty may be most useful here.

CONSIDERATIONS IN MALIGNANT TUMOR MANAGEMENT

The most common malignant tumors of the face are basal cell carcinoma (BCC), squamous cell carcinoma (SCC), and melanoma.³⁻⁵ An unfortunate reality of the

facial region is that indiscriminate margins cannot be resected without significantly affecting vital neighboring structures.^{3,4} Perhaps most critical in facial tumor management, oncologic principles must supersede reconstructive desires. Despite the urge to leave valuable facial structures intact, cancers of the head and neck must be optimally removed without priority concern for eventual aesthetics. In addition, malignant invasion of facial tissues may occur directly, via lymphatic flow, or along nerve pathways.^{4,5} These metastatic routes must be taken into account when managing tumors of the head and neck.

BCC constitutes more than three quarters of skin cancers, and the rest primarily consist of SCC.⁶ These two tumors share several features, including predilection for sun-exposed sites, increased incidence in fair-skinned patients, and higher frequency in those with

syndrome-related inability to repair UV-induced DNA damage.⁶ Full resection of nonaggressive BCC types requires 3- to 5-mm margins; however, morpheaform BCC should prompt 7-mm margins.⁷ SCC requires slightly increased margins, and 5- to 10-mm margins are considered sufficient. In cases of intraoral SCC, the resection may create a full-thickness cheek defect, requiring more complex methods of reconstruction such as locoregional or distal flaps.⁸ With an annual presentation incidence of 1 in 90 Caucasians, malignant melanoma has become increasingly survivable. Although mortality has dropped from 51% for all averaged stages in 1950 to 19% in 1990, the biological unpredictability of malignant melanoma warrants liberal resection.⁹ Although surgical margins are a topic of continued debate, most agree that in situ melanoma requires 0.5-cm margins, tumors less than 1 mm in depth necessitate 1-cm margins, 1- to 4-mm depth requires 2-cm margins, and depth of more than 4 mm should prompt 3-cm margins.²

In synchrony with surgical resection, radiation and chemotherapy may be required based on the scope of disease or histologic features of the tumor.^{7,8} SCC with high-risk factors, aggressive or deeply extended BCC, as well as advanced-stage melanoma all commonly prompt adjuvant therapy. The side effects of these adjuvant modalities on local soft tissue and wound healing can be significantly damaging. As a result, coverage provided by local tissue in the vicinity may become less dependable, particularly in the setting of radiation therapy. Therefore, healthy tissue in the form of distant pedicled flaps or free-tissue transfer from outside the irradiated field is frequently required.

CONSIDERATIONS IN CHEEK RECONSTRUCTION

In the past 20 years, evolving reconstructive techniques have greatly advanced the approach to cheek reconstruction; however, several factors continue to play a substantial role in reconstructive outcome. Potential tumor margins, radiotherapy, and lymph node dissection must all be taken into account when planning major cheek repair. Considerations in timing also play a large part in reconstructive planning. Whereas immediate repair may seem straightforward enough, closure attempts that must await final pathology evaluation or potential further resection may require a staged approach with a delayed closure of the defect. Often a skin graft or xenograft may suffice in the short term, followed subsequently by definitive closure. When a delayed reconstruction is employed, vigorous debridement of necrotic and ulcerated tissue is mandatory.¹⁰

After thorough evaluation and the patient has been identified as a candidate for reconstruction, a well-coordinated team approach is essential for optimal soft tissue repair. Preoperative communication between the

reconstructive and ablative teams is absolutely essential. Discussion and agreement on ablative strategy regarding likely residual defect, effects at potential tissue donor sites, as well as anticipated adjunctive therapy is imperative. When sentinel lymph node dissection is required, particular attention should be given to location of the incision so the blood supply to any future flap is not jeopardized.^{10,11}

PATIENT SELECTION

Careful patient selection is essential to successful outcome. Patient prognosis should impact reconstruction, as should several patient characteristics, such as skin laxity, tobacco use, sun exposure, and age. Other factors, including tumor site and spread, must shape surgical decision making as well. Ideally, one would like to maintain functional mouth opening, swallowing, articulation, and maintenance of oral hygiene.^{5,7} Any condition other than the index disease should be considered to have a potential impact on reconstructive outcome. Age greater than 70 years, moderate or severe comorbidity, through-and-through tumor involvement, and a history of recurrence are all associated with increased reconstructive risk; however, older patients may enjoy the advantage of increased skin laxity.³ The reconstructive surgeon should forego more exhaustive efforts in patients who are expected to have severely compromised postoperative function, substantial surgical risk due to medical comorbidity, and have an extremely poor expected life span. The surgeon should offer only primary or simple skin graft closure to these patients.

PRIMARY CLOSURE

With small cheek defects, primary closure after undermining of the soft tissue margins is optimal. In some areas, such as medial cheek, up to 4 cm of undermining beyond the borders of the defect can be done to allow tissue recruitment. However, distortion of anatomic structures such as the lower eyelid should be avoided.¹² Although some undermining of adjacent wound edges is often necessary to facilitate tension-free closure, maintenance of similar skin color, texture, and thickness optimizes functional and cosmetic outcomes. Particularly with preoperative anticipation of required margins, the surgeon can place the lines of excision along the relaxed facial tension lines to lessen postoperative scarring. In addition, increased skin laxity associated with aging often provides a surprising degree of laxity allowing for substantial tissue mobilization, transfer, and advancement. While a large defect often prompts preparation of a more elaborate surgical alternative, in patients with very poor survival based on tumor extension or comorbidity, primary closure may be the most optimal solution if at all possible.

SKIN GRAFTING

Full-thickness skin grafting or split-thickness skin grafting for cheek defects is a relatively simple, effective method of providing external coverage. Full-thickness skin graft harvested from the postauricular, preauricular, and supraclavicular areas produce the best results in terms of color, character, and texture match.¹³ Skin originating in other areas may suffer from color mismatch, and mismatch in the skin thickness can cause lack of proper contour relative to neighboring tissue. Particular attention should be given when skin graft is considered for defect closure adjacent to eyelid, nasal margin, or oral commissure due to concern of skin graft contraction.

In patients with substantial medical comorbidity, skin grafting is an effective alternative to more complex methods requiring prolonged anesthesia. In addition, a temporary graft may prove useful while evaluating for adequate tumor margins, cancer recurrence, or resolution of infection.^{13,14} An example for such a situation is a patient with melanoma who may require wide surgical margins and prolonged surveillance. Later, the graft may be replaced with a permanent option for definitive repair. After graft placement at the cheek, donor tissue should be stabilized with a bolster for 5 to 7 days.¹⁵ Because of the mobility of native cheek tissues, the fresh graft retains mobility and frequently results in hematoma or seroma formation in the absence of bolster placement.

LOCAL FLAP PLACEMENT

Long an important part of the reconstructive armamentarium, local flaps such as the advancement, transposition, and rotational designs are versatile options in cheek reconstruction. Though too large for primary closure, small to moderate-sized cutaneous cheek defects can frequently be managed with the correct choice of local flap. Probably the local flaps provide the best result due to the good matching of the skin in terms of color, texture, and thickness and adhere to one of the basic principles in plastic surgery "Replace like with like". To camouflage the operative scars, the margins of the flap lines are designed to lie along an anatomic boundary such as the nasolabial fold or preauricular crease or parallel to relaxed skin tension lines.¹⁶

Advancement flap design is relatively simple and can be successfully applied to repair a wide variety of small or moderate-sized cheek defects (Fig. 2). This group of flaps is based on an incision that allows "sliding" movement of the tissue. In some cases, the advancement of the flap is associated with rotation of the flap. The advancement flaps can be unipedicle, bipedicle, V-Y flaps, or subcutaneous tissue pedicle island.¹⁷ By necessity, all advancement flaps must be designed so the advancing border of the flap also represents a margin of the cutaneous defect that it is designed to repair.

Because the distal end of the V-Y flap is surgically isolated from the donor site, soft tissue distortion associated with alternative advancement flaps is minimized.^{17,18} The advancing tissue can also be based on a neurovascular bundle. Useful in coverage of large cheek wounds, the V-Y advancement flap is equally effective for small defects or those approximating the lid or lateral cheek.¹⁸ For a cutaneous defect located near the medial lower eyelid or medial canthus, a unipedicle advancement flap is usually the preferred flap for repair. Advancement of tissue should be based laterally rather than inferior to help prevent the development of lower eyelid ectropion. Lateral cheek skin has less subcutaneous cheek fat and is more adherent to the underlying fascia than is medial cheek skin. For this reason, a rotational flap can be more suitable for this area than is a V-Y advancement flap.¹⁹ Large medial cheek cutaneous defects repair can be accomplished with local flaps that exhibit both pivotal and advancement movement to maximize the transfer of skin from the region of the posterior cheek and superior neck such as the cervicofacial flap (Fig. 2). A V-Y advancement flap is useful for the excision and repair of large cheek wounds.

The rotation-advancement flaps are an important tool in the armamentarium used for cheek reconstruction. These flaps may be designed as either single or double lobe; however, the rotation advancement flap is always designed to arc around a pivot point on which the flap is rotated. Of critical design importance, flap shortening with rotation must be compensated for during planning, and whereas most small defects may be primarily closed, large residual donor defects may require skin graft placement for closure. Rotational flaps work extremely well in repair of large cheek defects larger than 3 to 4 cm in the lower preauricular area where recruitment of the upper posterior auricular cervical skin is required for wound closure.²⁰ In the more medial part of the cheek, transposition flaps may achieve a more favorable result.

Bilobed flaps can also be used to rotate adjacent tissue into cheek defects, and it is useful for medium-sized defects (3 to 6 cm) (Fig. 3). After advancement of the primary flap, the secondary flap can be rotated in to fill the primary donor defect. Taking advantage of jawline camouflage, bilobed flaps for cheek reconstruction are most effective in lateral defect repair when the donor site can be placed in the cervical area as well as in the buccal area where they can allow recruitment of a larger adjacent flap and closure of the donor defect with a more distant flap. In every case, a balance must be met between allowing adequate closure tension and preventing tension-related compromise in flap vasculature (Fig. 3). Bilobed flaps rotate adjacent tissue over the cheek defects for coverage.

Scar camouflage is also an important consideration, and the relatively short, angular lines of transposition flaps

Figure 2 (A) Transposition flaps take advantage of laxity of skin adjacent to the defect and provide skin flaps very similar to the skin that had been excised. (B) A particular condition of the transposition flap is the rhomboid flap which is designed to cover a defect that occasionally is converted to a rhomboid shape. When two angles of the defect are 60 degrees and two angles are 120 degrees the design of the flap is easier and the name of the flap is Limberg.

such as the rhomboid flap may be particularly advantageous in cheek reconstruction. The rhomboid flap must be designed with roughly 60- and 120-degree angles.²⁰ For best reconstructive effect, the flap should be planned on an area of loose skin to ensure closure of wound edges. Johnson et al described the use of bilateral rhombic flaps to facilitate closure of larger cutaneous defects. Using two rhombic flaps enables the surgeon to use redundant skin at two different locations for the same defect.²¹ Transposition flaps such as rhomboid or Limberg are particularly useful in the buccal cheek area. In some cases, additional skin excision may be required to accommodate the geo-

metric shape of the flap. When applied during cheek defect correction, such flaps are most commonly designed with an inferolateral base then rotated upwards and inwards to inset into a more medial wound.²⁰

REGIONAL FLAP OPTIONS

Large cheek defects require transfer of more distant soft tissue sources, such as the cervicopectoral, deltopectoral, or pectoralis major flap. The cervicofacial flap allows rotation of cutaneous submandibular and lateral facial tissues into the cheek area (Fig. 4). It is typically an excellent color and texture match, the flap can be raised

Figure 3 Bilobed flaps rotate adjacent tissue over the cheek defects for coverage.

quickly and the donor site directly closed without skin grafting.²² Of particular note with regional flap designs of the head and neck, such as the cervicofacial flap, reconstructive planning must take into account ablative requirements, particularly the need for neck incisions or lymph node dissection. The incision required for a sentinel lymph node may need to be located in the

territory of the cervicofacial flap. Therefore in such cases, it may make sense to elevate the flap and only then to proceed with the dissection of the sentinel lymph node without having to proceed with an incision in the skin (Fig. 4). The cervicofacial flap transposes cutaneous tissue from the submandibular and lateral facial planes with excellent color and texture matching results.

Figure 4 The cervicofacial flap transposes cutaneous tissue from the submandibular and lateral facial planes with excellent color and texture matching results.

Figure 5 The deltopectoral flap is beneficial for significant reconstruction of the cheek, offering up to 250 cm² of transferable cutaneous tissue.

The deltopectoral flap may provide up to 250 cm² of transferable cutaneous tissue to allow reconstruction of the entire cheek (Fig. 5).²³ In addition, cutaneous portions of the deltopectoral flap tolerate folding very well, and the potential arc of rotation allows movement in widely varying directions. Although this flap has been functionally replaced by pedicled myocutaneous or microvascular free-flap alternatives, the deltopectoral flap remains a viable alternative when faced with significant reconstruction of the cheek²³ (Fig. 5). The deltopectoral flap is beneficial for significant reconstruction of the cheek, offering up to 250 cm² of transferable cutaneous tissue.

Because of its robust vascularity, the pectoralis major flap provides good quality, pliable chest skin for external coverage as well as cheek lining (Fig. 6). A proximal island can be used for intraoral lining, and the distal random portion is folded for the cutaneous portion. In using this double-island technique, the pectoralis major flap can provide excellent reconstruction of substantial full-thickness cheek defects (Fig. 6). Substantial full-thickness cheek defects may be repaired by a pectoralis major flap, which can provide both external skin coverage and cheek lining.

DISTAL FLAPS

Complex or very large cutaneous cheek defects require distal flaps. The surge in the development of

microvascular techniques in the past three decades has made the microsurgical transfer of distal flaps to the face a routine procedure. These include composite flaps, which allow reconstruction of defects involving all the layers of the cheek. With their inherent thinness, fascio-cutaneous flaps are highly pliable and most accurately recreate cheek contour.²⁴ Whereas a multitude of free flaps are available for use, the radial forearm, anterolateral thigh, scapular, and lateral arm flaps are particularly useful in cheek reconstruction.²⁴

Based on the long, reliable radial artery, the radial forearm free flap can restore superficial cheek defects or be sandwiched around more dense material to re-create the mandible, external, and oral lining (Fig. 7).²⁵ Based on the lateral antebrachial nerve, the radial forearm fasciocutaneous flap can also be innervated as well. Although sacrifice of radial artery and potential donor-site complications are the main disadvantages of this flap, good to excellent aesthetic results can be expected in a large majority of patients²⁵ (Fig. 7). The radial forearm free flap can either offer coverage of superficial cheek defects or provide density for re-creation of the mandible, external, and oral lining.

The anterior lateral thigh flap is based on the descending branch of the lateral circumflex femoral artery and based on the requirements the flap can be harvested as a thinned skin, fasciocutaneous or musculo-cutaneous flap.^{26,27}

Figure 6 Substantial full-thickness cheek defects may be repaired by a pectoralis major flap, which can provide both external skin coverage and cheek lining.

Figure 7 The radial forearm free flap can either offer coverage of superficial cheek defects or provide density for re-creation of the mandible, external, and oral lining.

FUTURE DIRECTIONS IN CHEEK RECONSTRUCTION

In addition to the current tools we have at our disposal, continued research is needed to develop better solutions for head and neck reconstruction. Stem cell research is a widely publicized topic that has multiple ethical hurdles to overcome before proceeding to major clinical trials.

CONCLUSION

With improvements in microsurgical technique and the increased availability of free-tissue transfer such as perforator flaps, reconstruction of total cheek defects has recently undergone a period of rapid evolution. However, today the local flaps are still the workhorse for closure of defects in the cheek area. When placed in the context of expected prognosis, the proposed classification system based on the location and volume of the associated soft tissue resection can help guide the reconstructive options for these decisions.

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Editor's Comments

Drs. Heller, Cole, and Kaufman from Baylor College of Medicine in Houston have written an excellent article on cheek reconstruction that illustrates extensive clinical experience.

I am happy to see their endorsement of skin grafting for reconstruction of selected cheek defects.

Quite frequently skin grafting of cheek defects is considered an inferior or “palliative” technique. However, in the appropriate patient, a color matched skin graft can provide very acceptable aesthetic results and should always be considered as a viable reconstruction option.

The next comment regarding local flaps is to remember the cheek often has, particularly in the elderly

Figure 1 Full-thickness color matched skin graft reconstruction of a large cheek defect in an elderly patient.

Figure 2 Linear closure of a large central cheek defect.

Figure 3 Spontaneous resolution of significant perioperative lip retraction.

Figure 3 (Continued)

patient, tremendous laxity. Even quite large defects can be closed by a simple linear vertical closure with meticulous dog-ear excision. This results in a scar that follows ideal aesthetic lines leaving a very acceptable aesthetic result.

Also, regarding lip retraction during repair; understand that the lip is surrounded by a dynamic muscular unit, the orbicularis oris, and even a moderate degree of lip retraction resulting from a closure of a cheek defect will resolve over a short period of time leaving no long-term defect.

Again, the authors are to be commended for writing a very thorough and well-illustrated clinical paper.

James F. Thornton, M.D.