Teaching Paradigm for Decision Making in Facial Skin Defect Reconstructions

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Objective: To present a decision paradigm for facial defect reconstruction, and test the ability of this paradigm to improve resident performance.

Design: A decision paradigm for reconstruction of facial skin defects is proposed and explained, with patient examples. The paradigm’s usefulness is then tested with residents.

Setting: Otolaryngology residency training program at a tertiary hospital.

Study Participants: Otolaryngology residents.

Interventions: Twelve residents took a pretest wherein they were presented with drawings of skin defects and asked to choose the “best” (most aesthetically pleasing) type of reconstruction from a closed set. This paradigm was presented to these residents, and their posttest consisted of choosing again with the same defects and closed set of choices.

Main Outcome Measures: Cosmetic outcomes of reconstructive decisions on the pretest and posttest were rated on a scale of 0 to 5 (with 0 indicating poor; 5, excellent).

Results: There was a significant improvement in reconstructive choices between the pretest and posttest ($P<.001$, Student $t$ test).

Conclusion: This paradigm can be easily modified to accommodate different surgical approaches preferred by individual surgeons and is thus useful in almost any reconstructive teaching situation.


Results

Compartment No. 1

Compartment No. 1 begins with the patient’s general health (Figure 1). There are many relative contraindications to further surgical treatment. These include unstable angina and anticoagulation therapy that cannot be interrupted. Patients with the most severe of these rarely seek surgical reconstruction. Second-intention healing is often a wise choice for the few such patients who do present for reconstruction.

The patient’s treatment desires are then considered. If a patient unequivocally does not desire any further surgical

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MATERIALS AND METHODS

Three otolaryngologists, 2 experienced reconstructive surgeons and the other holding an advanced degree in information and computer science, collaborated on this project. A sample of actual cases of facial skin defect reconstruction, representing a wide variety of anatomic locations and patient characteristics, was chosen from cases performed in the past 3 years. For each case, a decision flowchart was developed that diagrammed the actual decision making process used. These decision making diagrams were then merged to construct a composite decision making paradigm for use with most defect locations of the head and neck.

The decision-guidance system consists of 2 compartments. Compartment No. 1 includes a flowchart that is used to decide whether healing by second intention, a skin graft, primary closure, or the use of a local skin flap is the best choice for a patient. Compartment No. 2 details the process of choosing a specific local flap for the reconstruction of simple defects.

Each defect is first described by the anatomic (or aesthetic) unit or units it occupies. Those involving more than 1 unit are considered as 2 or more separate defects. Any defect in the nose, lip, ala, or eyelid area; those without available adjacent skin; or defects requiring bone or cartilage for reconstruction are complex defects and are not discussed in detail in this article.

intervention, an immediate decision is made for healing by second intention (node 2 of Figure 1). Relative contraindications for healing by second intention are defects of the nasal ala, eyelid, and lip because contracture in these areas can cause notching and possibly alar notching, ectropion, or oral incompetence. The use of a skin graft or flap is preferred in these areas unless the patient understands and accepts the likelihood of poor cosmetic and functional results (nodes 3 and 4 of Figure 1). The other firm indication for second-intention healing in our practice is a skin-only defect of less than 1 cm2 in the medial canthal area. Other facial areas where healing by second intention may produce a reasonable appearance are the temple, forehead, and periauricular areas. Second-intention healing in convex areas such as the lower nose and eyelids generally produces poorer results.

All defects not undergoing second-intention healing are considered for suitability for primary closure (node 6 of Figure 1). These defects should have a satisfactory shape, orientation, and laxity to allow such closure. A defect that can be made to be long and narrow with approximately a 3:1 length-to-width ratio (to avoid standing cones) and where the scar can be oriented in or near the relaxed-skintension line (RSTL) is suitable for primary closure (nodes 6, 7, and 8 of Figure 1). A defect that is long and narrow has its orientation already determined. If the defect is circular, a 3:1 ellipse can be created that is oriented to place the scar in an RSTL. Skin laxity varies with age, and the younger the patient, the more undermining is required for a low-tension closure. The closure of an ellipse generally requires undermining the equivalent of the width of the defect on the side at the center, tapering to a total of 1 width at each end of the ellipse. Neither the undermining nor the creation of the ellipse can distort a nondistortable structure (the distortion of which yields functionally [eyelid ectropion] or cosmetically [eyebrow, hairline] unacceptable results [Table 1]). If a long and narrow defect is oriented perpendicular to the RSTL or if creating a 3:1 ellipse oriented along the RSTL or 1-width-equivalent of

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**Table 1. Nondistortable Structures and Facial Anatomic Units That Often Provide Skin for Reconstruction**

<table>
<thead>
<tr>
<th>Nondistortable Structures</th>
<th>Good Lender Units</th>
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<tbody>
<tr>
<td>Nasal lip</td>
<td>Cheek</td>
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<tr>
<td>Nasal alae</td>
<td>Forehead</td>
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<tr>
<td>Central upper lip</td>
<td>Chin</td>
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<tr>
<td>Vermilion</td>
<td>Submentum</td>
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<tr>
<td>Oral and ocular commissures</td>
<td>Neck</td>
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<tr>
<td>Eyelids and canthi</td>
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<tr>
<td>Eyebrows</td>
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<tr>
<td>Hairline</td>
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<tr>
<td>Earlobe</td>
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Figure 2. Eight flap types to use during facial defect reconstruction. The shaded areas marked by broken lines indicate underscored skin; black areas, discarded skin; unbroken lines, the line of incision; 2-way arrows, the vector of force; and D, diameter. A, The note flap: For reconstructing a circular defect, an underminable arc of about 90° is required for a distance equal to about 2 diameters of the defect. With optimal orientation, at least 50% of the scar can be oriented in relaxed skin tension lines (RSTLs), and, for all 8 flap types, the vectors of closing tension are as shown. B, The rhomboid flap requires a 90° arc and 1.5 diameters. The scar can be at least 60% in the RSTLs. C, The bilobed flap requires a 90° arc and 2.5 diameters. The resulting scar can be at least 65% in the RSTLs. D, The O-to-Z flap requires 2 opposing 90° arcs and 1.5 diameters. The resulting scar can be at least 80% in the RSTLs. E, The subcutaneously pedicled flap requires 90° and 2 to 3 diameters. The scar can be at least 65% in the RSTLs. F, The triple rhomboid flap requires 360° and 1.5 diameters. The scar can be at least 50% in the RSTLs. G, The V-to-Y flap requires a 90° arc and 1.5 diameters. The resulting scar can be at least 65% in the RSTLs. H, The A-to-T flap requires a 180° arc and at least 2 diameters. The long limb of the resulting scar is ideally camouflaged in an anatomic boundary.
undermining along the long axis would impinge on a non-
distortable structure, this defect is probably not suitable
for primary closure.

Other factors can affect the likelihood of significant
perioperative problems (nodes 9 and 10 of Figure 1). Heavy smokers and patients with insulin-dependent
diabetes mellitus are at greater risk for small-vessel dis-
ease, and patients currently taking nonsteroidal anti-
inflammatory drugs have a greater risk of hematoma
formation, leading to flap necrosis. A full-thickness skin
graft may offer a better chance of a good result than a
local or regional flap in these patients. Skin grafts are
also offered to patients who prefer the quickest possible
surgery over the best cosmesis (node 11 of Figure 1). In
some anatomic areas such as the nasal sidewall (subunit
of the upper nose), skin grafting may offer the best cos-
mesis, but the remaining patients are candidates for
local flaps.

COMPARTMENT NO. 2

We use the following decision framework for the con-
sideration of relevant factors in choosing the best local
flap. Complex flaps involving bone or cartilage replace-
ment and reconstruction of the lip, nose, ala, or eyelids
are not considered. In this compartment, the surgeon first
describes the defect in detail, including size, shape, con-
tion, and location of surrounding structures. The char-
acteristics are then matched to flaps being considered,
and the best flap for reconstructing the defect is then
chosen.

For this study, we chose 8 flap types that are most
commonly used in our practice: the note, rhomboid,
bilobed, O-to-Z, V-to-Y, A-to-T, triple rhomboid, and
subcutaneously pedicled flaps. Five characteristics were
described for each: the arc of skin required, the diam-
eter of skin required, normal skin discarded, scar orien-
tation with respect to RSTLs, and the vector of maximal tension after closure (Figure 2, A through H). Other flap types can be similarly described.

The amount and location of skin required for the use of a particular flap is described by the arc and the number of diameters usually needed for elevating the flap and undermining for closure (eg, the note flap requires a 90° arc, the radius of which is 2 times the diameter of the defect). These flap diagrams also show the amount of normal skin that is discarded in transferring this flap and the shape of the scar resulting after flap transfer. When the scar is optimally oriented with respect to RSTLs, some of the scar will parallel (or nearly so) the RSTLs, and some of the scar will be perpendicular (or nearly so). An ellipse, eg, when oriented in the RSTL, will be 100% parallel. The use of the note flap

Figure 4. A circular defect of the left temple: (A) the defect, (B) an analysis of the defect, and (C) the result of the reconstruction. See the legend to Figure 2 for an explanation of the diagram.
flap results in a scar that is about 50% oriented with the RSTLs and about 50% against. In Figure 2, the numbers following the word “scar” describe this characteristic, as “100/0” for the ellipse (or 0/100 for an ellipse oriented perpendicular to RSTLs) or as 50/50 for the note flap. The final flap characteristic noted is the vector of the tension of flap closure, indicated by the vector-of-force arrows in Figure 2. It is undesirable to orient a flap so that the primary tension of closure pulls on (is perpendicular to) a nondistortable structure such as the lip or the eyelid.

A description of the defect begins by noting the size, shape, average diameter of the defect, and the involved anatomic units. The adjacent nondistortable features, good facial lender units (from which skin can often be borrowed with minimal distortion) and nonlender facial units (from which skin can rarely be borrowed with a good result) are identified (Table 1). Then the arc and the number of diameters of skin potentially available for reconstruction are diagrammed and described.

The amount and location of skin available for the reconstruction is compared with the amount and location of skin required for each of the flaps being considered. Those that are obviously incompatible (eg, the use of an O-to-Z flap when the skin available is limited to a 90° arc) are discarded from consideration. Any flap that would place the vector-of-closure tension perpendicular to a nondistortable feature is similarly discarded from consideration.

The final step of a successful flap reconstruction is to choose from among the remaining flaps the one that will yield the least noticeable scars. The least visible scars are those hidden in an anatomic boundary, such as the hairline or the nasolabial crease. Scars that parallel RSTLs are also minimally noticeable, especially in older patients. The 2 subcutaneously pedicled flaps (V-to-Y and tunneled) have slightly more tenuous blood supply than the other 6 flaps and are used only if they offer substantial advantages over these other flaps. If necessary, several sketches can be made in which each of the remaining flaps is tried, thus leading to the choice of the best possible flap for the reconstruction of that defect.

Figure 3 shows a skin defect (Figure 3, A), with its finished working diagram (Figure 3, B). It is a roughly rectangular defect, 14×22 mm, with an average diameter of 18 mm. It occupies the lateral lower lip and chin, with the adjacent lower lip being a nondistortable area. The chin and cheek are possible lender units. There is an arc of about 225° available for reconstruction that covers the lower lateral cheek, jaw, and submental and chin areas. The diameters potentially available for reconstruction are about 1 diameter medially, 1 to 2 diameters inferiorly, and 3 to 4 diameters laterally. For a flap-to-defect match, an inadequate arc is available for the O-to-Z or triple rhomboid flaps. There is no good boundary for long-limb placement for an A-to-T flap. Note, rhomboid, and bilobed flaps are all possibilities. The use of the technically more complex V-to-Y
The cosmetic outcomes of the reconstructive decisions on the pretest and posttest facial defects were rated on a scale of 0 to 5 (with 0 indicating poor; 5, excellent) (Table 2). The tests were scored in accordance with this rating, with the best possible score being 42. The residents were also asked to rate the paradigm as not helpful, helpful, or very helpful at the end of the field testing. A paired t test was used to assess the data for statistical significance.

Three resident physicians from each of the 4 otolaryngology training years (n=12) were tested. The individual pretest and posttest scores are shown in Table 3. The average scores for each postgraduate training year are shown in Table 4. Reconstructive choices between pretest and posttest scores were significantly improved (P<.001). All the residents rated the reconstructive facial paradigm as helpful.

FIELD TESTING

The usefulness of this composite decision paradigm was field-tested on 12 resident physicians. The pretest consisted of each field tester taking 10 minutes to decide the 3 most suitable reconstructive options for 4 diagrammed facial defects (medial canthus, check, temple, and forehead) (Fig 5). A 15-minute talk was delivered explaining the facial reconstructive paradigm. The decision tree was illustrated with 2 example defects dissimilar to the defects under consideration. During the posttesting period, each resident was tested with the same defect diagrams and the same allotted time (10 minutes). Diagrams of compartment No. 1, a summary of compartment No. 2, RSTLs, facial subunits, and appropriate equipment (compass, protractor, ruler) were supplied.

COMMENT

The rapid and consistent improvement of the resident physicians’ reconstructive decisions indicates the usefulness of this paradigm for teaching novice surgeons. It is also of use to experienced surgeons because it can be adapted to reflect their practice preferences.

CONCLUSION

This paradigm provides a technique for teaching the complex decision making required for consistent and successful functional and aesthetic reconstruction of facial skin defects. It can be adapted to reflect individual surgeons’ practice preferences and is easily followed by novice surgeons. A standardized framework such as this for decision making enhances the training of neophyte reconstructive surgeons by providing them with a clear understanding of basic considerations in choosing a flap. Using this understanding as a base, beginning surgeons can devote energy to developing the technical facility and artistic nuances that distinguish skilled reconstructive surgeons.

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REFERENCES