Comparing Rates of Distal Edge Necrosis in Deep-Plane vs Subcutaneous Cervicofacial Rotation-Advancement Flaps for Facial Cutaneous Mohs Defects

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OBJECTIVE To compare the untoward occurrence of DEN between 2 surgical dissection methods for reconstructive cervicofacial rotation-advancement flaps.

DESIGN, SETTING, PARTICIPANTS, AND EXPOSURE A review was conducted of 88 patients who underwent cervicofacial flap reconstruction for Mohs ablative surgery between January 1, 2003, and June 30, 2012, by the senior author (A.A.J.). All patients had periorbital, midfacial, cervical, and/or lateral temporal/forehead defects following Mohs surgical ablation. Patients were categorized into 1 of 2 groups on the basis of the surgical technique used: subcutaneous (SC) cervicofacial elevation or deep-plane (DP) cervicofacial elevation. Subcategories of smokers and nonsmokers within each group were further reviewed. Statistical analysis of DEN between categories and subcategories was performed.

RESULTS Sixty-nine patients were in the SC group and 19 were in the DP group. The mean defect size among both groups was 14.3 cm². The rate of active or recent smokers was 23% in the SC group and 11% in the DP group. The rate of DEN among nonsmokers in the SC group was 23% (n = 53) compared with 0% in the 17 DP nonsmokers (P = .03). The rate of smokers with DEN in the SC group was 75% and 0% in the DP group (P = .09). The mean area of DEN in the SC group was 0.8 cm².

CONCLUSIONS AND RELEVANCE Our statistically significant data indicate that DP dissection is a superior technique for avoiding DEN in nonsmokers. We found better outcomes in smokers as well. Thus, we strongly advocate the use of the DP approach as the criterion standard in cervicofacial flap elevation.

LEVEL OF EVIDENCE 3.

IMPORTANCE The cervicofacial rotation-advancement flap is commonly used for facial defects. Decreasing the rate of distal edge necrosis (DEN) encountered with this flap would help prevent complications in sensitive areas such as the eyelid, lip, and nose.

The midface, periorbital, and temporal/forehead zones can present very complex cutaneous defects after Mohs surgical ablation. The reconstruction of larger-sized defects is traditionally based on Mustardé’s description of a rotation-advancement flap elevated in the subcutaneous (SC) plane. This elegant reconstructive technique is useful and has withstood the test of time as a “workhorse” for facial defects. However, one of the major complications that occur with this reconstructive method is distal edge necrosis (DEN), especially in smokers and patients with a history of radiotherapy. This is a particularly troublesome complication in reconstruction of any facial subunit because distal edges can lie in aesthetically unforgiving areas. Distal edge necrosis is a result of inadequate blood flow from the random-pattern blood supply of the subdermal plexus of an SC flap. Even a small amount of DEN near important anatomic borders, such as the eyelids, nose, or lip, can result in ectropion, alar asymmetry, or commissure distortion, respectively. These problems require a secondary surgery.

In recent years, descriptions of cervicofacial rotation-advancement flaps with dissection in the subsuperficial muscularaponeurotic system (SMAS), or deep plane (DP), have been advocated with the skin and SMAS elevated as a composite flap. The advantage of this modification is its reliance on an...
Methods

Data
A review of the medical records of all patients requiring Mohs reconstruction was performed in the private practice of one of us (A.A.J.). Medical records with operative notes indicating that a cervicofacial rotation-advancement flap was performed between January 1, 2003, and June 30, 2012, were analyzed. Patients of all age ranges, sex, smoking status, general medical health, ambulatory or inpatient setting, and dissection method were included. An exclusion criterion was postoperative hematoma formation because this could serve as an independent cause of necrosis regardless of technique. Patients whose records showed no follow-up or were incomplete were excluded. All included patients had surgical treatment prior to this retrospective analysis. Because treatment decisions were not being made proactively, no institutional review board approval was necessary. However, informed consent was obtained from all patients.

Analysis of age, sex, defect size, and location was performed. Additionally, DEN and smoking status were reviewed and compared between the 2 groups. Distal edge necrosis was defined as grossly visible eschar formation of any size on any distal suture line area; DEN did not include failed skin graft sites when performed concurrently with a cervicofacial flap because it was considered an unrelated occurrence. Smoking status was based on a patient actively smoking within 1 week of reconstructive surgery. Independent statistical analysis of DEN between the 2 groups was performed using the Fisher exact 2-tailed test determined using a scientific calculator (GraphPad; GraphPad Software, Inc). Rates of facial nerve injury, ectropion, and need for further surgery were recorded and analyzed.

Surgical Technique
All surgical procedures were performed by one surgeon (A.A.J.). All defects were documented by photography. Preoperative skin markings were made following subunit principles. Both SC and DP reconstructive techniques require excising a triangle of skin adjacent to the defect within corresponding melolabial crease or relaxed skin tension lines to avoid a standing cutaneous deformity.

The SC dissection technique continues by creating an incision with a No. 15 blade along subunit borders. In cases involving eyelid and midface defects, this follows along infraorbital rim and zygomatic arch skin and then inferiorly along the preauricular skin. The incision is then continued postauricularly, if necessary, for increased mobility and size. The rotation-advancement flap is then widely undermined in all directions in the SC supra-SMAS plane (Figure 1). This allows for movement in the inferolateral to anteromedial direction. Care is taken to maintain a large base to ensure adequate flap perfusion. Additionally, the remaining viable medial cheek skin is undermined widely and brought out laterally as far as possible. Two 4-0 nylon sutures are then used to tack the flap medially and superiorly to the periosteum along the superior edge of the zygomatic arch and the infraorbital rim, respectively. Care is taken to not overstretch the flap so as to limit tension that can reduce flap perfusion. Subsequently, 4-0 polyglactin 910 sutures are used to close the SC tissues, and 6-0 nylon sutures are used for skin closure as interrupted vertical mattress sutures.

The DP surgical technique is performed by marking the DP entry point by drawing a line connecting the lateral canthus and the angle of the mandible (Figure 2A). Incisions are made as described in the SC technique, and limited SC undermining is performed until the DP entry point. The DP is entered inferiorly at the level of the mandibular angle using a No. 10 blade and continued to the lateral canthus. Once the correct plane is identified, the tissue should separate with relative ease. At this point, face-lift scissors and a lighted retractor are used to continue the DP dissection inferiorly below the platysma with blunt separation of tissue to protect branches of the facial nerve (Figure 3). In the superior portion of the DP entry point, the orbicularis oculi and zygomaticus fibers are identified and the flap is elevated superior to the mimetic musculature. It is necessary to ensure that the muscle fibers are not incorporated into the flap. The zygomatico-cutaneous ligaments are released with blunt dissection to increase the flap’s mobility and arc of rotation. The skin and SMAS can now be
Elevated en bloc. The flap is rotated medially, and tacking sutures are placed in the same manner as in the SC technique. Closure is performed with 4-0 polyglactin 910 sutures for SMAS/muscle approximation, as well as SC closure. Final skin closure is via interrupted vertical mattress 6-0 nylon sutures. The dramatic movement can be seen by observing the starting and ending points of the skin markings for the DP entry point (Figure 4).

Full-thickness skin grafts may be required on the most medial aspects of wounds when the elevated flaps do not easily cover them without tension (Figure 4). Both techniques may require the incorporation of full-thickness skin grafts, which are harvested from the standing cutaneous deformity of the defect at the beginning of the operation.

Results

Ninety-five patients who had undergone a cervicofacial advancement flap were identified. Four were excluded because of postoperative hematoma formation (3 in the SC group and 1 in the DP group). One patient was excluded because of incomplete medical records and another because of inability to contact for follow-up.

A total of 88 patients met the inclusion criteria. Sixty-nine patients (78%) were identified as part of the SC group and 19 patients (22%) as part of the DP group. Forty-six were women (52%) and 42 were men (48%) (male to female ratios, 33:36 in the SC group and 11:8 in the DP group). The mean (SD) patient age at the time of the procedure was 65 (15) years. The mean patient age in the DP group was 70 years and in the SC group, 64 years. The mean defect size was 14.3 (8.1) cm². Notably, the SC group mean defect size was 12.9 cm² and the size in the DP group was 18.8 cm², but this difference was not statistically significant. Sites of the defects included the cheek, lower eyelid, lateral temporal forehead, and anterior cervico/mandibular regions. Eighteen smokers (20%) were identified: 16 in the SC group (23%) and 2 in the DP group (11%). Twenty-four cases (27%) of DEN were identified. The mean size of necrotic area was 0.8 cm² (range, 0.25-3.5 cm²).

There were 2 smokers in the DP group (11%), neither of whom had DEN, and 16 smokers (23%) in the SC group, 12 of whom had DEN (75%). Because of the disproportionate percentage of smokers in the SC group, subcategories of non-smokers between the 2 groups were compared. Among non-smokers in the SC group, the DEN rate was 23% (n = 12) compared with 0% in the DP group (P = .03). When comparing subcategories of smokers between the groups, 75% (n = 12) in the SC group had DEN compared with 0% in the DP group (P = .09) (Table). Direct comparison of DEN between the 2 groups, inclusive of all categories of smoking, showed a rate of DEN of 35% in the SC group vs 0% in the DP group (P = .001).
The rate of complications was small. There were no facial nerve injuries in any group. Five patients required a secondary surgical intervention because of DEN, all of whom were in the SC flap group. Two required scar revision surgery because of poor secondary healing and hypertrophic scar formation. Three developed ectropion because of secondary healing and contracture pulling the lower eyelid down, requiring a full-thickness skin graft.

### Discussion

Mohs facial reconstructive surgery can be a difficult process for a patient to undergo. The stress and fear of a cancer diagnosis is compounded by the resultant facial defect. The goal of facial reconstruction is to restore contour and aesthetics while minimizing morbidity. The impact of DEN is more far-reaching than the simple wound care that it requires; it can create an unsatisfactory scar. Even a small amount of DEN near important anatomic borders, such as the eyelids, nose, or lip, can result in ectropion, alar asymmetry, or commissure distortion, respectively. These problems require a secondary surgery. Examples of DEN with an SC flap approach are seen in Figure 5 and Figure 6.

In our practice, we were not satisfied with the results of SC cervicofacial rotation-advancement flaps and decided to apply the same surgical principles that we have been practicing in our standard rhytidectomy. Our results show statistically significant distal flap survival rates with the DP approach compared with the SC approach; this significance was verified in independent analysis of nonsmokers. Although mean defect sizes were larger in the DP group, there were no episodes of DEN (Figures 2, 7, and 8). Because our cohort had a dispropor-

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**Table. Rates of Distal Edge Necrosis Among Subgroups and Resultant Area of Secondary Defect**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No. of Patients</th>
<th>Necrosis</th>
<th>Area, cm²</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Distal Edge, %</td>
<td></td>
</tr>
<tr>
<td>Nonsmokers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subcutaneous dissection</td>
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<td>23</td>
<td>0.4</td>
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<tr>
<td>Deep-plane dissection</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Smokers</td>
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<td></td>
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</tr>
<tr>
<td>Subcutaneous dissection</td>
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<td>1.2</td>
</tr>
<tr>
<td>Deep-plane dissection</td>
<td>2</td>
<td>0</td>
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</table>

**Figure 5. Depiction of Patient With Subcutaneous Flap**

A, Preoperative infraorbital and cheek defect on a 68-year-old man. B, Intraoperative elevation of a subcutaneous cervicofacial flap. C, One-month postoperative image showing secondary wound healing due to distal edge necrosis. This patient subsequently required a full-thickness skin graft for ectropion repair.

**Figure 6. Distal Edge Necrosis**

A, Preoperative infraorbital, temporal, and lateral cheek defect in a 79-year-old woman. B, One-month postoperative image showing secondary wound healing due to distal edge necrosis; further surgery was not required. C, Six-month postoperative image demonstrating slight hypertrophy of a scar in the area of prior distal edge necrosis.

**Figure 7. Another Depiction of a Patient With a Deep-Plane Flap**

A, Preoperative defect involving perioral and midcheek region in a 69-year-old man. B, Incision lines drawn before deep-plane cervicofacial flap. C, Six-month postoperative image; this patient had no distal edge necrosis.
Figure 8. Complex Defect Treated With Deep Plane Flap

A, Large, complicated defect in a 73-year-old man involving the nose, cheek, and perioral region. B, Postoperative results at 6 months after a deep-plane cervicofacial flap combined with a paramedian forehead flap; this patient had no distal edge necrosis.

Statistical analysis:

To our knowledge, this is the first published comparison of both techniques of cervicofacial rotation-advancement flaps and the largest published sample size of the DP technique. Kroll et al3 advocated the DP as the “level of choice” on the basis of their results with 7 patients. However, in a study of 32 patients undergoing SC flaps, Austen et al10 promoted the superiority of the SC approach. They concluded that the SC method had an acceptable tip necrosis rate of 9% and advocated its use because they postulated that it would “likely” have a lower ectropion rate. We did not find this to be the case. In our study cohort, none of the patients who had DP surgery developed ectropion, and 3 patients who had SC flaps developed small areas of DEN resulting in ectropion requiring a secondary full-thickness skin graft. As for the discrepancy between our higher rate of DEN of 23% among nonsmokers, we acknowledge a low threshold for documenting DEN because we included areas of epidermolysis as small as 0.25 cm². This gave us a higher rate of necrosis than that of Austen et al.10 As such, we concede that not every case of DEN leads to poor scarring and healing. Nonetheless, even small areas of epidermolysis and contracture can lead to problems, such as ectropion. The 5 patients who required a secondary procedure included 3 skin grafts for ectropion repair and 2 scar revisions for poor healing results. The rest of our DEN cases responded to conservative local debride-ment and wound care. The best-case scenario is one free of DEN, and our study indicates that this is most achievable via a DP approach.

The sample size of our DP group was smaller than that of our SC group on account of our relatively recent change in technique. Accordingly, there were fewer smokers in the DP group, and statistical significance was not achieved in comparing DEN among smokers. However, there was a strong correlation between DEN and smokers when approached via the SC technique, which was not seen with the DP approach. We therefore propose that smokers, in particular, should undergo DP dissection. In a study11 of rhytidectomies, a 0% rate of skin edge necrosis was found with DP procedures in 18 patients who were active smokers. These results were attributed to the thickness of the DP flap and the resultant lack of perforator disturbance.

The increase in operative time and technical difficulty make DP unappealing to a surgeon with limited experience. However, the merit of significantly less necrosis makes the DP technique an excellent choice for dissection of cervicofacial rotation-advancement flaps.

REFERENCES