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Cervicofacial Advancement-Rotation Flap in Midface Reconstruction: Forward or Reverse?

Jennings R. Boyette, MD¹, and Emre Vural, MD¹

Abstract

Objective. To present the authors’ experience and outcomes in the reconstruction of midfacial defects using cervicofacial advancement-rotation flaps (CARFs) based on a method of determining forward or reverse design in relation to the proportions of the defect.

Study Design. Case series with retrospective chart review.

Setting. Tertiary care academic medical center.

Subjects and Methods. Patients who underwent CARF reconstruction and the subset of patients with midfacial defects medial to the lateral canthus were included. CARF was designed in a forward fashion with an anteromedial movement for the defects with a larger vertical dimension and in a reverse fashion with a posterosuperior movement for the defects with a larger horizontal dimension.

Results. Thirteen of 45 patients who underwent CARF reconstruction qualified for the analysis as a subset based on defect location. CARF was used in a forward fashion in 7 patients and in a reverse fashion in 6 patients. The largest defect in this subset was measured as 9 × 6 cm, while the smallest defect was 3 × 2 cm. Average follow-up was 11.5 months. None of the patients developed partial or total flap loss. Six patients had mild ectropion, which was managed with conservative measures only. The outcome of the reconstruction was satisfactory in all cases.

Conclusion. Designing the CARF based on the proportion of the vertical and horizontal diameters of the selected midfacial defects as described allows for closure of the defects with minimal tension and minimizes the amount of discarded healthy skin overlapping at the suture lines.

Keywords

facial, reconstruction, cervicofacial, cheek, advancement, rotation, flap

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The management of midfacial cutaneous defects can be especially challenging, as the reconstruction of these defects can often be quite noticeable. The color and texture of the reconstructed skin must reproduce that of the surrounding skin while minimizing the appearance of scars. The adjacent lower eyelid also requires special attention to avoid or minimize ectropion. The cervicofacial advancement-rotation flap (CARF) has long been a widely used local flap for the reconstruction such defects.

The flap’s initial design has been attributed to Beare, who in 1969 described its use for reconstruction following orbital exenteration.¹ However, it was Mustardé who fully described and popularized the use of the CARF.² Utilization of the CARF has been subsequently expanded to the reconstruction of the cheek, eyelid, and preauricular region. Numerous modifications in the design of the flap have also been described to facilitate closure of a variety of regional defects and to better camouflage the reconstruction at the borders of the facial subunits.³

The primary modification of the CARF is the location of the base of the flap and thus the direction of flap rotation. An inferolaterally based flap with its pedicle located in the neck is the most commonly used, and its design is essentially that of Mustardé’s, with a preauricular incision that rotates the lateral cheek and neck skin in a forward direction toward the midline (Figure 1A). Conversely, a superolaterally based flap with its pedicle in the preauricular region rotates the skin of the lower face in a superior or reverse direction (Figure 1B).

Major drawbacks to the CARF in midface reconstruction include risks of distal tip necrosis, need for adjacent healthy tissue removal for correction of standing cone deformities, and the risk of ectropion. Blood supply to the flap is mostly a random pattern; therefore, mobilizing the flap to cover the

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Boyette and Vural created along the preauricular region extending down into the larger horizontal dimension. Reverse fashion with a superior movement for defects with a vertical dimension equal to, or larger than, the horizontal diameter and in an anteromedial movement for defects with a vertical dimension. CARF was designed in a forward fashion with an advancement or reverse was selected based on the proportions of the defect. The most widely known is Zide’s algorithm to flap reconstruction of the cheek defects based on a system of zones; however, the design of the flap and direction of rotation based on the defect are not adequately addressed.

We present a novel method for selecting forward or reverse design for CARF in reconstruction of midfacial defects located medial to the lateral canthus based on the dimensions of the defect. This report summarizes our technique for reconstruction and our results associated with these guidelines.

Methods

The Institutional Review Board at the University of Arkansas for Medical Sciences granted approval for this study. A retrospective review was performed on all patients who underwent CARF reconstruction by the senior author between January 2002 and August 2010. The defects located medial to the vertical line dropped from the lateral canthus comprised the subset for this analysis. Each defect was reconstructed according to subunit principles; therefore, cheek defects were reconstructed independently from adjacent subunit defect(s), if needed. Cheek defects were measured separately from the overall defect.

The design of the CARF for eventual flap movement (forward or reverse) was selected based on the proportions of the defect. CARF was designed in a forward fashion with an anteromedial movement for defects with a vertical dimension equal to, or larger than, the horizontal diameter and in a reverse fashion with a superior movement for defects with a larger horizontal dimension.

For forward CARFs, a parotidectomy-type incision was created along the preauricular region extending down into the neck in a curvilinear fashion. A horizontal incision was also made in the subciliary region to form the superior border of the flap, and this was extended laterally into the temple to join the preauricular incision. The flap was then elevated in the subcutaneous plane. The extent of undermining was determined by the size of the defect and the amount of rotation needed. The defect was closed by advancing and rotating the flap in a forward fashion, and the donor site was closed primarily after adequate subcutaneous undermining in the neck and infra-auricular area. The standing cone deformity of this CARF is in an oblique orientation along the melolabial sulcus.

For reverse CARFs, an incision is made along the medial border of the defect into the melolabial sulcus with an occasional need for extension into the neck along an incision passing through the border of lower labial and chin subunits depending on the size of the defect and amount of rotation advancement necessary. The flap is elevated posteriorly in the subcutaneous plane and rotated superiorly to close the defect. The standing cone deformity of this CARF is in a horizontal orientation in the subciliary or temple region.

If the defect involved one or more of the nasal subunits, then an additional method of reconstruction was used for the repair of these components. The edge of the CARF adjacent to the lower eyelid was thinned adequately before closure, when appropriate. In occasional instances in which the horizontal and vertical diameters of the defects were essentially equal, the selection of a forward versus a reverse flap was made based on the quality, laxity, and amount of skin in the areas subject to be rotated/advanced, which in this series resulted in a forward CARF. When securing the flap in the lateral and medial canthal regions, additional suspension sutures were used to attach the flap to the underlying perioseal soft tissue. A Penrose drain was placed underneath the flap in all cases.

Results

Forty-five patients underwent a CARF procedure for cheek reconstruction. Thirteen of these 45 patients qualified for the analysis as a subset based on the location of the defects as described above (Table 1). Ages ranged from 38 to 82 years (mean, 59.8 years). CARF was used in a forward fashion in 7 patients (Figure 2) and in a reverse fashion in 6 patients (Figure 3). The largest defect in this subset was measured as 9 × 6 cm, while the smallest defect was measured as 3 × 2 cm. The mean defect size for forwardly rotated flaps was 4.14 × 4.14 cm and 6 × 4.9 cm for reversely rotated flaps. Ten patients had additional procedures in the form of paramedian forehead flap (8 patients), skin graft (1 patient), or lower eyelid reconstruction (3 patients), performed concurrently with CARF for repair of each defect according to subunit principles. Eight of 13 patients were current smokers, and 1 patient was diabetic. None of the patients underwent preoperative radiation therapy. Follow-up ranged from 1 to 64 months, with an average follow-up of 11.5 months.

None of the patients developed partial or total flap loss. One patient developed a small hematoma, which did not require surgical drainage and resolved with aspiration. Six patients had
mild ectropion, which was managed with massaging; none of these underwent any corrective eyelid surgery. Although surgery for ectropion was recommended in 1 of these patients, he elected not to undergo any further procedures. The outcome of the reconstruction was satisfactory in all cases.

**Discussion**

The reconstruction of midface defects can be accomplished through several methods; however, due to the high visibility of this area, many local flaps, such as rhomboid or bilobed flaps, may result in quite noticeable scars and may violate aesthetic subunit principles. The large surface area of the CARF is advantageous in that it allows for reconstruction of large defects and the ability to place incisions along the borders of the facial subunits. While there exists a variety of guidelines for nasal cutaneous defects, there have been few published guidelines to assist the surgeon in determining flap design for cheek defects.

Zide et al have advocated the reconstruction of cheek defects based on location. They divided the cheek into 3 overlapping zones and recommended different reconstructive options based on these zones, including primary closure, small rotational flaps, and forward and reverse CARFs. Zone 1 encompasses the suborbital and perioral medial cheek, zone 2 is the temporal and preauricular area, and zone 3 is the central, lower cheek near the mandible. Specifically for the midface, Zide et al recommend either forward or reverse CARFs for large defects in zones 1 and 2, but they do not distinguish which CARF option is more appropriate for any given defect.

### Table 1. Patient Characteristics of Midface Cervicofacial Advancement-Rotation Flap Reconstruction

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age, y</th>
<th>Diagnosis</th>
<th>Horizontal Dimension, cm</th>
<th>Vertical Dimension, cm</th>
<th>Direction of Flap Rotation</th>
<th>Smoking, Diabetes</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50</td>
<td>Basal cell carcinoma</td>
<td>4.5</td>
<td>5</td>
<td>Forward</td>
<td>Smoker</td>
<td>None</td>
</tr>
<tr>
<td>2</td>
<td>73</td>
<td>Melanoma</td>
<td>8</td>
<td>8</td>
<td>Forward</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>3</td>
<td>38</td>
<td>Port wine stain</td>
<td>9</td>
<td>6</td>
<td>Reverse</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>4</td>
<td>48</td>
<td>Basal cell carcinoma</td>
<td>3</td>
<td>3</td>
<td>Forward</td>
<td>Smoker</td>
<td>Ectropion</td>
</tr>
<tr>
<td>5</td>
<td>63</td>
<td>Basal cell carcinoma</td>
<td>3</td>
<td>4.5</td>
<td>Forward</td>
<td>Smoker</td>
<td>Ectropion, hematoma</td>
</tr>
<tr>
<td>6</td>
<td>59</td>
<td>Basal cell carcinoma</td>
<td>6</td>
<td>6</td>
<td>Reverse</td>
<td>Smoker</td>
<td>Ectropion</td>
</tr>
<tr>
<td>7</td>
<td>53</td>
<td>Basal cell carcinoma</td>
<td>3</td>
<td>2</td>
<td>Reverse</td>
<td>Smoker, diabetic</td>
<td>None</td>
</tr>
<tr>
<td>8</td>
<td>68</td>
<td>Basal cell carcinoma</td>
<td>2</td>
<td>3</td>
<td>Forward</td>
<td>Smoker</td>
<td>None</td>
</tr>
<tr>
<td>9</td>
<td>69</td>
<td>Melanoma</td>
<td>3</td>
<td>4</td>
<td>Forward</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>10</td>
<td>48</td>
<td>Basal cell carcinoma</td>
<td>4</td>
<td>3</td>
<td>Reverse</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>11</td>
<td>82</td>
<td>Squamous cell carcinoma</td>
<td>8.5</td>
<td>7.5</td>
<td>Reverse</td>
<td>Smoker</td>
<td>Ectropion preop and postop</td>
</tr>
<tr>
<td>12</td>
<td>54</td>
<td>Squamous cell carcinoma</td>
<td>6</td>
<td>5</td>
<td>Reverse</td>
<td>Smoker</td>
<td>Ectropion</td>
</tr>
<tr>
<td>13</td>
<td>73</td>
<td>Basal cell carcinoma</td>
<td>3.5</td>
<td>3.5</td>
<td>Forward</td>
<td>No</td>
<td>Ectropion</td>
</tr>
</tbody>
</table>

**Figure 2.** Design of a forward cervicofacial advancement-rotation flap for a more vertically oriented defect in the midface (A) and the final closure (B). Nasal component of the defect was repaired with a paramedian forehead flap. Arrow indicates anteromedial movement of the flap.

**Figure 3.** Design of a reverse cervicofacial advancement-rotation flap for a more horizontally oriented defect in the midface (A) and the final closure (B). Arrow indicates superior movement of the flap.
Menick recommends that the base of the pedicle be determined by location of the defect and recommended a reverse CARF for small- to medium-sized defects of the anterior cheek and a forward CARF for posterior or large anterior defects. As with most local flap design options, that which has the best flap survival and the least associated complications often guides the best recommendations for repair.

The CARF has classically been associated with several drawbacks primarily related to its random-pattern blood supply and the extent of rotation advancement needed for closure. Blood supply to forward CARFs has been described as originating from distal branches of the submental and facial arteries in a more random pattern than reverse rotation flaps due to interruption of the superficial temporal arterial blood supply. Cadaver dissections have identified this contribution from perforators of the superficial temporal artery in reverse CARFs. Thus, it has often been suggested, although not necessarily shown, that reverse flaps have an improved survival due to this vascularization.

Recently, elevating the flap in the deep plane has been advocated as a method to improve flap survival. Popularized by Kroll, the flap is elevated below the plane of the superficial musculoaponeurotic system (SMAS) in an anteriorly based fashion toward the defect. Elevation in the neck is carried out either superficial or deep to the platysma. The major concern with sub-SMAS elevation is the potential for facial nerve injury. In a series of 5 patients, Becker and Langford had 1 distal flap tip necrosis, whereas Tan and McKinnon reported 18 deep-plane CARFs with only 1 distal flap tip necrosis. No facial nerve injuries were reported.

Austen et al have questioned the need for deep-plane elevation and have demonstrated a low rate of tip necrosis (9%) in 32 CARFs. Our results of 0% tip necrosis with subcutaneous elevation support that flap blood supply can be sufficient with careful, tension-free design and placement. Furthermore, 62% of our patients were active smokers at the time of reconstruction. By reducing the amount of rotation needed and the subsequent tension needed for closure, selection of a forward or reverse CARF based on the dimensions of the defect allows for good vascular outcomes without the risk of facial nerve injury associated with sub-SMAS dissection.

Based on our experience, there are 3 major factors in determining the success of a CARF in reconstruction of the midfacial cutaneous defects located medial to the line drawn vertically from the lateral canthus. These are minimizing the amount of discarded skin along the final suture lines to correct standing cone deformities, minimizing the tension (hence the risk of distal flap loss) in the superomedial corner of the defect, and minimizing the risk of ectropion in the lower eyelid. The simple principle described in this article in selecting a forward versus reverse CARF may adequately address all these issues.

A standing cone deformity is formed along the anterior edge of the flap at the nasofacial/meloabial junction when a CARF is designed in a forward fashion. Therefore, the amount of discarded healthy skin is dictated by the horizontal diameter of the defect. If the horizontal diameter of a defect located medial to the lateral canthus is smaller than its vertical diameter, the amount of forward rotation will also be smaller to close the defect, which causes a smaller amount of skin overlapping at the melolabial sulcus (Figure 4A). Since the standing cone deformity is formed at the superior border of the flap in subcutaneous or temple regions in a reverse CARF, the vertical diameter of the defect dictates the amount of discarded skin. Therefore, a horizontally oriented defect may be best repaired by using a reverse CARF order to minimize the discarded skin at its superior border (Figure 4B).

Basic flap design principles stress the importance of a decreased arc of rotation to decrease flap tension and subsequent vascular compromise to the distal portion of the flap. If the horizontal diameter of a midfacial defect located medial to the lateral canthus is larger than its vertical diameter, this means that the width of the skin in the preauricular region—which will form the flap—will be narrower in the forward flap than in its reverse counterpart. In this scenario, using a forward CARF may result in closing a relatively wider defect with a relatively narrower flap, which may eventually cause more tension in the suture lines, especially at its superomedial corner where it is more dependent. The same is true for reverse flaps used for similarly located defects with a larger vertical diameter. Therefore, using the reverse CARF in more horizontally oriented midfacial defects and the forward CARF in more vertically oriented defects may minimize the amount of elevation, rotation/advancement, and eventual tension at the suture lines. This is also supported by our results since we did not encounter any flap loss in this series.

The benefit of covering large defects with the CARF may be offset by the risk of ectropion. In our series of 13 patients, we report on 6 cases of ectropion. These were distributed equally among forward and reverse flaps. One case was related to facial nerve sacrifice that occurred during the tumor resection prior to reconstruction. Two other cases were in defects encompassing the lower eyelid that were reconstructed concomitantly with a Hughes flap. All cases of ectropion were mild and did not require additional procedures, except for 1.
patient who had moderate ectropion but elected not to undergo any further surgery. Although ectropion can be encountered in reconstruction of midfacial defects with CARFs, this method of CARF selection seems to be providing acceptable results in terms of malposition of the lower eyelid.

We have found that the dimensions of the defect are a good determinate of CARF design. To improve flap survival and to decrease the amount of normal tissue resection for standing cutaneous deformities, we advocate the use of reverse CARFs for midface defects with a larger horizontal dimension. More vertically oriented defects allow for coverage with a forward CARF with minimization of the resection of healthy skin in order to correct standing cone deformity around the melolabial sulcus. While CARFs are often used for reconstruction of temple and inferior cheek defects, our guidelines are applicable only for midfacial cheek defects located medial to the lateral canthus. Furthermore, some defects may have relatively equal dimensions, and in these cases, a forward CARF is generally indicated.

For reconstruction of midface defects located medial to the lateral canthus, our approach using the height-to-width ratio to determine the base of the flap and direction of rotation appears to provide reliable outcomes. This study is limited by its retrospective design and small sample size. As with many procedures in plastic and reconstructive surgery, the basis for flap design of the CARF remains largely subjective, with few published guidelines to assist the surgeon. Furthermore, there are many published articles describing surgical technique but few regarding clinical outcomes. This report is intended to provide a simple method to determine flap design and to demonstrate reliable outcomes using this method.

Author Contributions

Emre Vural, conception, design, manuscript creation; Jennings R. Boyette, analysis, interpretation of data, manuscript creation.

Disclosures

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Funding source: None.

References