Reconstruction of nasal ala with nasolabial perforator flap after cancer removal

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Abstract
Before the concept of perforator anatomy and perforasome was established, coverage of defects in nasal alar was performed with random local flaps from adjacent skin. This method was fairly successful, but restrictions in flap mobility were a major drawback. In an attempt to overcome this disadvantage, researchers have successfully reported the use of flap mobility and rotation using perforator flaps based on nasolabial perforators. Here, after removal of malignancy of the nose, eight patients received reconstruction with perforator flap based on nasolabial perforator of the facial artery, which was elevated as an island pattern. All flaps completely survived. Two cases which were extensively rotated in a propeller pattern temporarily experienced flap congestion, but later, this completely resolved. All donor sites were healed by direct closure. Versatility of this flap facilitates its further utilisation in reconstruction of other facial regions. Here, we report our novel methodology along with an update of the literature.

Introduction
Depending on the degree of soft tissue defect after excision of malignancy of the nose, reconstructive methods such as skin graft, local flap and free flap can be performed. Since the proposal of nasal subunit principle, local flap with adequate donor site has become extremely popular in the reconstruction of the nose.

The nasal alar region, which particularly is an independent aesthetic subunit, has been successfully reconstructed using nasolabial local flap. Before the concept of perforator anatomy and perforasome was established, restrictions in flap mobility were a major drawback as the flap had to be raised in a random or axial pattern. This brought some restriction in reconstruction of nasal alar defects, extending to the tip of the nose or dorsum. In an attempt to overcome this disadvantage, researchers have successfully reported the use of flap mobility and rotation using perforator flaps based on nasolabial perforators. This article attempts to share our experience and discuss the merits, demerits and pitfalls of this procedure along with an update of the literature.

Structure of the nasal skeleton
Nose is considered to be the most complex structure on a face, considering its three-dimensional topography. Reconstruction of its concave and convex contour is even more perplexed by its various tissue compositions with skin, mucosa, bone and cartilage.

Most of all, nasal ala is a critical anatomical landmark in terms of function and cosmesis. The crescent-shaped alar groove which connects to the alar-facial sulcus produces a convoluted contour and shadow; this contributes to the three-dimensional effect of the nose seen from any direction. Functionally, the ala serves as a structural framework comprising the lateral aspect of the external nasal valve. Distortion of this framework can bring discomfort in nasal breathing due to the absence of osseocartilaginous tissue. Alar tissue is relatively pliable in comparison with the nasal tip and dorsum. This quality makes the alar reconstruction prone to distortion after reconstruction. However, the ala maintains its structural support from a unique connection of muscles between the osseocartilaginous framework. On the midline of pyriform aperture, which consists of the nasal bone and maxilla, sits the nasal septum, which has a cartilaginous portion anteriorly. The upper lateral cartilage spans out from the septum and attaches to the deep portion of the nasal bone. The cephalic portion of the lower lateral cartilage is attached to the lower border of the upper lateral cartilage by intercartilaginous ligament. The lower lateral ligament gains additional stability by connecting with the pyriform ligament.

History of nasal alar reconstruction
Due to aforementioned functional and cosmetic reasons, the nasal ala is a very important aesthetic subunit. It is also very challenging for a surgeon to successfully reconstruct this area. In the early years of nasal alar reconstruction, a local random flap from the nearest skin was used. If the alar defect was part of a total or subtotal nasal defect, one-stage reconstruction with forehead or frontonasal flap was used; however, this gave suboptimal results in terms of an aesthetical appeal because of diminished three-dimensional contour of the nose.

To overcome this shortcoming, segmental reconstruction based on the nasal subunits was proposed by...
Defect in the alar area had been frequently covered with VY pattern nasolabial advancement flap or a rotation-advancement flap from the groove of the nasal sidewall. However, since reconstruction with such flaps produces a flat ala, this method is considered to be suboptimal. In contrast, some researchers have claimed that a different nasal subunit needs to be applied to Asians, because Asians have a relatively flat dorsum and ala. They proposed a new model combining the ala and soft triangle into a single subunit and subdividing the dorsum and glabella.

Application of the perforasome concept: nasolabial perforator flap

The perforasome concept was proposed only recently. The idea suggests that there is a geographical supply of perforator vessels that exclusively nourishes a certain limited area of the skin. The perforasomes partially overlap each other, being connected through multiple direct or indirect vessels. There has lately been a cadaveric study that identified perforators of the facial artery and mapped its perforasome with a special dye. According to this article, perforasome of the facial artery is divided into seven areas: anterior and posterior territory of mandibular area, inferior labial, jugular, nasolabial, commissural and subpalpebral area. These perforators are the major perforators, having a vessel diameter of over 0.5 mm. Smaller perforators indeed exist, but they are usually too small to supply an independent perforasome. The aforementioned perforators of the facial artery each supply their own skin area and tend to be fairly constant among individuals.

Therefore, nasolabial perforators can be identified in a fairly uniform manner, and flap elevation based on this perforasome could provide sufficient flap mobility without sacrificing the main source artery. Moreover, skilful skeletonisation of the perforator enables this flap to be rotated by 180° as a propeller flap. Much care should be taken to skeletonise such a small perforator.

Further, some researchers have claimed that nasolabial flaps for Asians can give superior result in comparison with those for Caucasians. One merit of a nasolabial flap is that a trapdoor-shaped donor site scar can be made with a teardrop-shaped flap design. These researchers have also suggested that a trapdoor-shaped scar can make a prominent depression of the ala-facial sulcus, thus contributing to the three-dimensional perspective of the ala.

As described above, nasolabial flap is the current first choice for alar reconstruction. Small cutaneous defect can be covered without special concern. However, a defect that involves multiple units, which usually extends to the tip of the nose or soft triangle, requires a larger flap size; this restricts flap mobility. A larger flap size not only restricts mobility but also has disadvantages in flap circulation, which could bring total or partial necrosis of the flap. To this extent, the authors located the nasolabial perforators originating from the facial artery and elevated a perforator-based nasolabial island flap. Having a longer vascular pedicle, the flap could be advanced further enough to the nasal tip. Also, a full thickness defect in the soft triangle was possible to cover by transposing the flap as a propeller pattern. Using this method, we were able to successfully reconstruct various types of alar defects. We are attempting to share our experience through this article.

Surgical technique

After general anaesthesia, the patient underwent resection for skin cancer of the nasal ala, including adequate safety margin. A nasolabial perforator flap based on nasolabial artery perforasome was used to cover this defect. To minimise the arc of rotation, the flap was designed adjacent to the defect site and its skin paddle was defined by mapping the perforators with an acoustic Doppler probe. The skin paddle was designed slightly larger than the exact defect size in order to minimise tension yet to permit primary closure of the donor site. Under loupe magnification, the design was incised and dissected meticulously to locate the nasolabial artery. Perforators were identified on the course following the nasolabial sulcus, and more than two perforators could be identified. A perforator that is more reliable in calibre and size for transposition was chosen for the pedicle. The artery was skeletonised down to locate the corresponding perforator of our design. Then, the remaining part of the flap was elevated with caution. If the flap had to be rotated in a propeller fashion, the pedicle needed more extensive skeletonisation to prevent kinking. If advancement was sufficient, conservative dissection was performed to minimise manipulation of the source vessels. If a propeller rotation is needed, a venous branch can be sacrificed to gain more extensive rotation. After coverage, light dressing was applied to prevent physical pressure to the flap.

Case presentation

A total of eight consecutive patients between 2008 and 2011 who required reconstruction of nasal ala after removal of a malignant tumour were included in this study. Perforator flap based on nasolabial perforator of the facial artery was elevated as an island pattern. Defect was covered by flap advancement or transposition by propeller rotation.
Case 1
A 68-year-old woman had undergone wide excision of squamous cell carcinoma on her left nasal ala. The mass was completely excised with 3 mm safety margin. Defect size was $3.0 \times 2.5$ cm$^2$. To cover the defect, a nasolabial perforator flap was planned, with skin paddle width 5 mm wider than the actual defect (Figure 1a). Pedicle dissection was performed with caution under loupe magnification. Nasolabial perforator was safely identified and the remaining flap was elevated (Figure 1b). Her defect was sufficiently covered with flap advancement (Figure 1c).

Case 2
A 48-year-old male was transferred to our department with basal cell carcinoma of the right nasal ala. After complete excision, the defect size was measured to be $2.0 \times 1.5$ cm$^2$. The long axis of defect was lying horizontally and the soft tissue triangle was involved in full thickness, requiring an extensive arc of rotation. A propeller flap was designed accordingly, the flap size being $2.5 \times 2.0$ cm$^2$ (Figure 2a). Nasolabial perforator was located and skeletonised to gain sufficient mobility (Figure 2b). The flap was clockwise rotated and inset (Figure 2c). At an acute post-operative stage, the flap colour was congested (Figure 3), but it completely healed without any complications. At 20-month follow-up, the flap showed good cosmetic result (Figure 4a–c).

Post-operative follow-up
The average patient age was 64.9 years (47–73 years) and the average follow-up period was 13.3 months. The average defect size was 5.16 cm$^2$. Early flap congestion occurred in 2 cases, all of which were rotated in a propeller pattern. All donor sites completely healed with direct closure. There were no complaints regarding disfigurement after surgery.

Discussion
As described for Case 2, nasolabial perforator flap is valuable when there is a combined full thickness defect in the nasal ala and soft tissue triangle. The flap is elevated and transposed as a rotation-advancement manner. With adequate flap dimension, an excellent mobility provides extra skin on the distal part of the defect that could be folded inward to reconstruct the inward lining. If one pursue a smaller donor site scar, the inward

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**Figure 1:** (a) Basal cell carcinoma on left alar was excised with 3 mm free margin and a perforator flap was designed at the adjacent nasolabial region. (b) Nasolabial perforator marked with vessel loop. (c) Immediate post-operative state.

**Figure 2:** (a) A mass was excised completely and a nasolabial perforator was designed on the right alar-facial sulcus. (b) A nasolabial perforator marked with vessel loop. (c) Flap was rotated 180°; it covered the alar and soft triangle at once.
Original research study

Table 1 Patient demographics and flap specifications

<table>
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<tr>
<th>No.</th>
<th>Age/sex</th>
<th>Type</th>
<th>Mobilisation</th>
<th>Flap size (cm²)</th>
<th>Cx</th>
<th>F-U (Mo)</th>
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<tr>
<td>1</td>
<td>68/F</td>
<td>SCC</td>
<td>Advance</td>
<td>7.5 (3.0 × 2.5)</td>
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<td>2</td>
<td>47/M</td>
<td>BCC</td>
<td>Propeller</td>
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<tr>
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<tr>
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<td>12</td>
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<tr>
<td></td>
<td>Mean</td>
<td>64.9</td>
<td></td>
<td>5.16</td>
<td></td>
<td>13.3</td>
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BCC, basal cell carcinoma; SCC, squamous cell carcinoma; Cx, complication; F-U, follow-up; Mo, months

Figures:

Figure 3: Immediate post-operative flap state with mild congestion.

Figure 4: The flap completely healed with no serious complication at 20-month follow-up. (a) Frontal, (b) Three-quarter and (c) Worm’s eye view.

Lining can be replaced with a skin graft. As described in Table 1, early congestion ensued in all cases of flaps that were transposed as a propeller pattern. This may be due to kinking of the vessels by over-rotation or their spasm by skeletonisation. However, both cases recovered by itself, without any additional therapy such as leech application, and have completely survived. Post-operative administration of anti-spasm medication or intraoperative application of papaverine could be a helpful solution to this phenomenon. Doppler mapping is a very critical part in pre-operative planning, and flap dimension should be designed to be slightly larger than the actual defect size. This is to include a reliable nasolabial perforator. Due to these cautions, we believe that congested flaps that were transposed in a propeller manner eventually survived without secondary surgery.

Compared with conventional nasolabial local flap, our method is relatively tedious to perform as it takes more time and requires skillful dissection of perforator vessels. However, our method provides an excellent mobility and wide arc of rotation. Also, by having reliable vascularity, a sufficiently large flap could be elevated as long as it permits a donor site to be primarily closed.

In case of complex nasal reconstruction, such as a defect in the internal lining, this flap is also useful. If loss of the alar cartilage is not too extensive, defatting the flap and simply folding it inward could result in a successful reconstruction. A thorough understanding of the facial perforasomes and accurate perforator mapping could enable a surgeon to design a large flap and possibly cover a different subunit of the nose.

Conclusion

Propeller type nasolabial perforator flap requires more extensive skeletonisation around the pedicle for improved mobility, which makes it prone to early post-operative venous congestion. This can be minimised by a skilled surgeon who is familiar with this procedure. The flap design

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should always be slightly larger than the actual defect size. However, post-operative result is aesthetically superior to any other reconstructive method.

Therefore, nasolabial perforator flap makes a good choice for one-stage reconstruction of defects after removal of malignancies in the nasal ala area.

**Consent**

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

**References**
