

# Reconstruction of midface defects using local flaps

## An algorithm for appropriate flap choice

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### Abstract

**Background:** Local flap surgery is commonly performed to cover defects with appropriate skin color and texture match. The purpose of this study was to present an algorithm for choosing an appropriate flap when reconstructing a midface defect using a local flap.

**Methods:** Between February 2013 and February 2019, 38 patients with midface defects underwent local flap surgery. All defects larger than 3 cm in diameter were reconstructed with perforator-based transposition flaps. Defects smaller than 3 cm in diameter were reconstructed differently depending on their location. Defects near the nasolabial fold (NLF) were reconstructed with perforator-based transposition flaps, whereas defects just on the NLF were reconstructed with VY advancement flaps. Defects distant from the NLF were also reconstructed with VY advancement flaps.

**Results:** Perforator-based transposition flaps were used in 22 cases and VY advancement flaps were used in 16 cases according to our new algorithm. All flaps survived without any complications. The aesthetic results were superior for VY advancement flaps, with higher patient satisfaction scores. The skin color match was similar for both flaps, but the contour was more natural in advancement flaps than in transposition flaps. However, transposition flaps had the benefits of being able to cover relatively large defects and allowing the donor scar to be hidden in a wrinkle line.

**Conclusion:** The most suitable local flap for coverage of a midface defect can be chosen based on the patient's condition. By following our algorithm, appropriate reconstructions can be performed, with satisfactory results.

**Abbreviations:** BCC = basal cell carcinoma, NLF = nasolabial fold, SCC = squamous cell carcinoma.

**Keywords:** advancement flap, algorithm, midface defect, transposition flap

## 1. Introduction

The midface is an area defined by borders composed of the infraorbital rim, nasolabial fold (NLF), mandible lower border, and preauricular crease.<sup>[1]</sup> Defects in this area result from various causes, such as neoplasm excision or trauma.<sup>[2,3]</sup> As midface is most prominent and perceptible part of face, reconstructing midface defect requires both functional and esthetic outcomes. To cover such defects, many reconstructive options, such as primary closure, skin grafts, and local or free flaps, have been used.<sup>[4-6]</sup> The options are usually chosen due to the size of defect. Free flap cannot be inevitable for large defect and primary closure

is a suitable option for small defect enough to be closed without tension. However, most of midface defect show moderate size which cannot be closed primarily. For this reason, local flap and skin graft are widely used options for covering midface defect.<sup>[7,8]</sup> Among these, local flaps show superior results in terms of color and contour match compared to skin grafts, which is why local flaps are generally preferred to cover midface defects.<sup>[9]</sup>

Local flaps can be divided into advancement flaps and transposition flaps according to the method of transfer.<sup>[10,11]</sup> For covering midface defects, the VY advancement flap and perforator-based transposition flap are popular options.<sup>[12,13]</sup> Both flaps are island flaps in terms of their shape, but the difference is the method of transfer. VY advancement flap is a method which advances V-shaped island flap to the defect resulting in Y shape as a final result. Otherwise, perforator-based transposition flap is a method which rotates an island flap to the defect with a pivot point of perforator pedicle. Both flaps provide advantages, but also have drawbacks. The choice of flap to use often depends on the surgeon's preference, which tends not to correspond to any systematic indication. An inappropriate choice of flap can result in an unacceptable outcome. The purpose of this study was to present an algorithm for choosing an appropriate flap when reconstructing a midface defect using a local flap.

## 2. Methods

This study was conducted in conformity with the World Medical Association Declaration of Helsinki, and the protocol was

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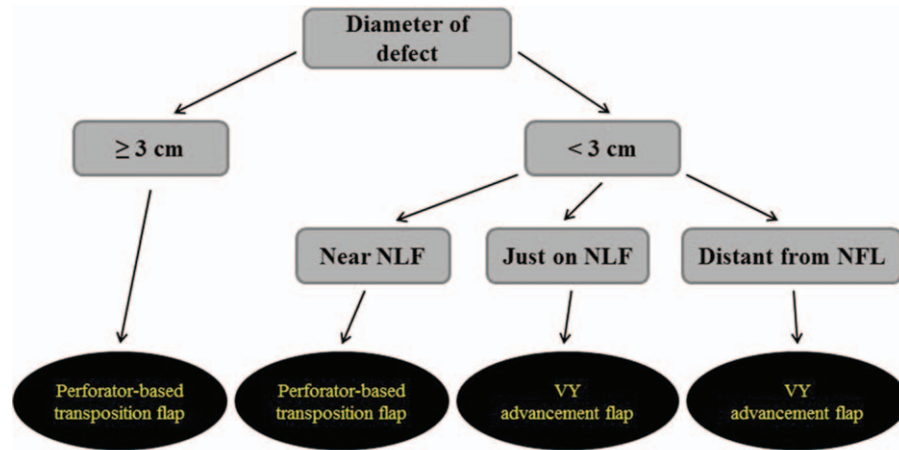
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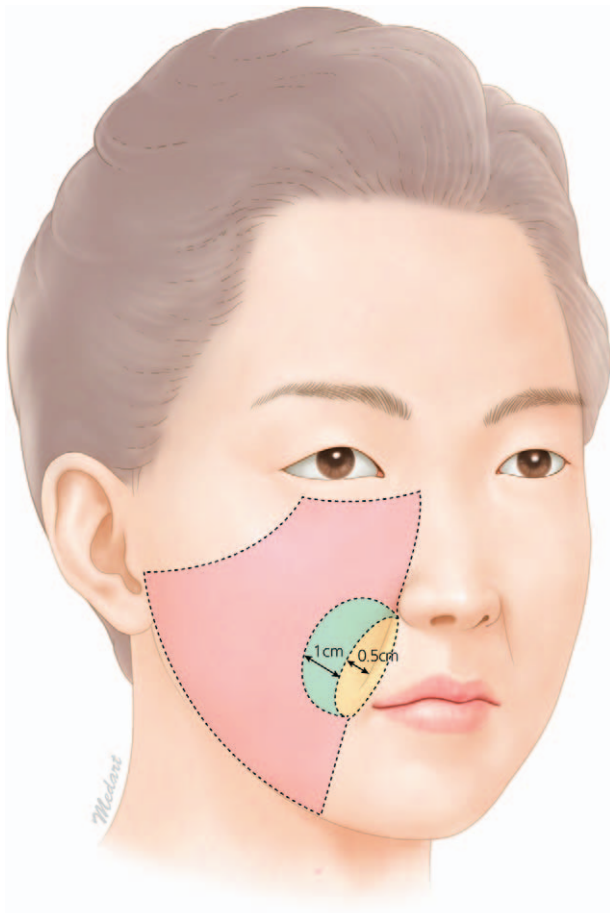
**Figure 1.** The new algorithm for flap choice when reconstructing a midface defect using a local flap. NLF = nasolabial fold.

approved by the Institutional Review Board of our institution (2018–07-023). From February 2013 to February 2019, 38 patients with a midface defect underwent local flap surgery. The choice between a VY advancement flap and a perforator-based

transposition flap as the local flap was made following a new algorithm used in our clinic (Fig. 1). The diameter of the defect was measured, and the location of the defect was identified. If the diameter of the defect was larger than 3 cm, a perforator-based transposition flap was chosen for reconstruction regardless of the location. If the diameter of the defect was smaller than 3 cm, then the flap selection depended on the location of the defect. If a small defect was located near the NLF (i.e., if the center of a circular defect was located between 0.5 cm and 1.5 cm laterally from the midline of the NLF), a perforator-based transposition flap was chosen. If a small defect was located just on the NLF (i.e., if the center of a circular defect was located not farther than 0.5 cm laterally from the midline of the NLF), a VY advancement flap was chosen. If a small defect was distant from the NLF (i.e., if the center of a circular defect was located farther than 1.5 cm from the midline of the NLF), then a VY advancement flap was also chosen (Fig. 2).

When performing perforator-based transposition flap surgery, a perforator was marked near the defect with using hand-held Doppler. The length of the flap was determined by measuring the length from the distal edge of the defect to the perforator marking, which became a pivot point. The flap was designed to hide the donor site scar within the relaxed skin tension line as much as possible. The flap was elevated as an island type in a fasciocutaneous fashion and rotated to the defect. Each VY advancement flap was designed as a V-shape flap with a length-to-width ratio of 2:1. The flap was designed beside the defect, and elevated in a fasciocutaneous fashion. The flap base was dissected until the advancement of the flap to the defect without tension became possible.

A retrospective review of the case notes was performed. Data were collected, including patients' demographics, defect size, postoperative complications, and aesthetic results. Postoperative complications and aesthetic results were evaluated at 1 week and 6 months postoperatively. Complications, such as wound problems or flap loss, were assessed by clinical signs. The aesthetic results were assessed by the patients' satisfaction using a questionnaire, on which a score of 10 points corresponded to the highest level of satisfaction (Fig. 3). Statistical analysis of the scores, with a comparison between the advancement flap group and the transposition flap group, was performed using SPSS version 20.0 (IBM Corp, Armonk, NY). *P* values  $\leq .05$  were considered to indicate statistical significance.



**Figure 2.** Illustration of the cheek area. The yellow color indicates the area just on the nasolabial fold (NLF) (<0.5 cm), the blue color indicates the area near the NLF (0.5–1.5 cm), and the pink color indicates the area distant from the NLF (>1.5 cm). NLF = nasolabial fold.

A questionnaire of the patients' satisfaction.

Category	Condition	Score	Check
Contour	Poor	1	<input type="checkbox"/>
	Fair	2	<input type="checkbox"/>
	Good	3	<input type="checkbox"/>
	Excellent	4	<input type="checkbox"/>
Color match	Distinguishable	1	<input type="checkbox"/>
	Acceptable	2	<input type="checkbox"/>
	Not distinguishable	3	<input type="checkbox"/>
Scar	Markedly visible	1	<input type="checkbox"/>
	Minimally visible	2	<input type="checkbox"/>
	Barely visible	3	<input type="checkbox"/>

**Figure 3.** A questionnaire of the patients' satisfaction score.

### 3. Results

The total population of 38 patients consisted of 11 males and 27 females. Their mean age was 70.5 years (range, 49–90 years). Two groups were divided according to flap type, group I of VY advancement flaps were used in 22 cases, whereas group II of perforator-based transposition flaps were used in 16 cases. There

is no difference for age between 2 groups but the defect size of group II is larger than that of group I ( $P \leq .05$ ) (Table 1).

Among the 38 cases, 7 involved a defect larger than 3 cm in diameter. These defects were all reconstructed with perforator-based transposition flaps. Thirty-one cases involved a defect smaller than 3 cm in diameter. Of those 31 cases, 9 cases with a defect near the NLF were reconstructed with perforator-based transposition flaps, 7 cases with a defect within the NLF were reconstructed with VY advancement flaps, and 15 cases with a defect distant from the NLF were reconstructed with VY advancement flaps.

There were no major complications, such as flap loss, in any cases. In 2 cases in which perforator-based transposition flaps were used, delayed wound healing was observed, but there was no necessity for a revisional procedure. The average of satisfaction score of a total of 38 patients increased during the follow-up period, from 6.9 at 1 week postoperatively to 8.1 at 6 months postoperatively. The patients who received a VY advancement flap consistently reported significantly higher scores than those who received a perforator-based transposition flap. The average scores of the 2 groups at 1 week postoperatively were 7.2 and 6.5 and the scores at 6 months were 8.4 and 7.8, respectively ( $P \leq .05$ ) (Table 2).

**Table 1**  
Demographic, diagnosis, and defect size and location by flap type.

Variable	Group I (VY advancement flap)	Group II (Perforator-based transposition flap)	P value
Sample size (number)	22	16	
Sex (number)			
Male	8	3	
Female	14	13	
Age (year)	72.8±9.4*	67.3±11.0*	.101 <sup>†</sup>
Diagnosis (number)			
SCC	7	6	
BCC	13	10	
Others	2	0	
Defect size (cm <sup>2</sup> )	2.2±1.3*	5.2±3.6*	.005 <sup>†</sup>
Location (number)			
Cheek	15	6	
Near NLF	0	9	
NLF	7	1	

BCC=basal cell carcinoma, NLF=nasolabial fold, SCC=squamous cell carcinoma.

\* mean±standard deviation.

<sup>†</sup> t test.

### 4. Case 1

A case with a defect larger than 3 cm in diameter on the cheek (Fig. 4). A 76-year-old female patient with squamous cell carcinoma (SCC) on her right cheek underwent wide excision. The size of the defect after wide excision was 3.5 × 3.0 cm, and

**Table 2**  
**Comparison of the satisfaction scores between Group I (VY advancement flap) and Group II (perforator-based transposition flap).**

Period	Satisfaction score		P value
	Group I	Group II	
1 wk	7.2	6.5	.008*
6 mo	8.4	7.8	.009*

\* Mann-Whitney test.

the defect was covered with a perforator-based transposition flap. The wound healed without any complications, but a mildly unnatural contour was seen in the early postoperative period. The patient's satisfaction score was 7 at 1 week postoperatively and increased to 9 at 6 months postoperatively.

### 5. Case 2

A case with a defect smaller than 3 cm in diameter near the NLF (Fig. 5). A 62-year-old male patient with basal cell carcinoma (BCC) near the right NLF underwent wide excision. The size of the defect after wide excision was 1.0 × 1.0 cm, and a perforator-based

transposition flap was chosen for defect coverage. No complications were observed during the follow-up period. The donor scar was completely hidden within the NLF, but a trapdoor deformity on the flap margin was observed in the early postoperative period. The patient's satisfaction score was 6 at 1 week postoperatively and 8 at 6 months postoperatively.

### 6. Case 3

A case with a defect smaller than 3 cm in diameter just on the NLF (Fig. 6). An 82-year-old female patient with BCC on the left NLF underwent wide excision. The size of the defect after wide excision was 2.2 × 1.8 cm, and the defect was covered with a VY advancement flap. There were no complications, and the contour of the flap was quite natural. The patient's satisfaction score was 8 at 1 week postoperatively and 9 at 6 months postoperatively.

### 7. Case 4

A case with a defect smaller than 3 cm in diameter distant from the NLF (Fig. 7). A 70-year-old male patient with BCC on the left paranasal area underwent wide excision. The size of the defect after wide excision was 1.0 × 0.9 cm, and a VY advancement flap



**Figure 4.** A case with a defect larger than 3 cm in diameter. A 76-year-old female patient with squamous cell carcinoma on the right cheek. (Left) The size of the defect after wide excision was 3.5 × 3.0 cm. For designing perforator-based transposition flap, a perforator was marked (red dot) and the length of the flap (black arrow) was determined by measuring the length from the distal edge of the defect to the perforator marking (white arrow). (Center) The defect was covered with a perforator-based transposition flap. (Right) The wound healed without any complications, but a mildly unnatural contour was seen in the early postoperative period.



**Figure 5.** A case with a defect smaller than 3 cm in diameter near the NLF. A 62-year-old male patient with basal cell carcinoma near the right NLF. (Left) The size of the defect after wide excision was 1.0 × 1.0 cm. (Center) The defect was covered with a perforator-based transposition flap. (Right) The wound healed without any complications, but trapdoor deformity on the flap margin was observed in the early postoperative period. NLF = nasolabial fold.



**Figure 6.** A case with a defect smaller than 3 cm in diameter just on the NLF. An 82-year-old female patient with basal cell carcinoma on the left NLF. (Left) The size of the defect after wide excision was 2.2 × 1.8 cm. (Center) The defect was covered with a VY advancement flap. (Right) The wound healed without any complications, and the contour of the flap was quite natural. NLF = nasolabial fold.



**Figure 7.** A case with a defect smaller than 3 cm in diameter distant from the nasolabial fold. A 70-year-old male patient with basal cell carcinoma on the left paranasal area. (Left) The size of the defect after wide excision was 1.0 × 0.9 cm. (Center) The defect was covered with a VY advancement flap. (Right) The wound healed without any complications, and the flap showed a natural contour.

was used for defect coverage. The flap took without any complications, and showed a natural contour during the follow-up period. The patient's satisfaction score was 8 at 1 week postoperatively and increased to 9 at 6 months postoperatively.

## 8. Discussion

Perforator-based island flaps can be designed in various ways based on the numerous perforators in the midface.<sup>[14–16]</sup> As this flap covers a defect by rotation with a perforator as the pivot, a relatively large defect can be covered. In addition, low donor site morbidity is another advantage of this flap.<sup>[17–19]</sup> However, the unnatural contour of the flap after covering a defect is a weak point.<sup>[20–22]</sup> In this study, some patients treated with a perforator-based island flap showed unnatural contours, such as trapdoor deformity, as indicated by lower patient satisfaction scores. This contour problem may result from depth mismatch between the defect and the flap. After rotating a flap, the thick side of the flap is placed in contact with the shallow side of the defect, whereas the thin side of the flap is in contact with the deep side of the defect (Fig. 8). This mismatch provides an unnatural contour at the flap margin.

The VY advancement flap is a classical flap that was used before the concept of perforators emerged. However, this flap provides a more natural postoperative contour than the perforator-based island flap.<sup>[23]</sup> After advancing a flap, the thick

side of the flap is placed in contact with the deep side of the defect, and the thin side of the flap is in contact with the shallow side of the defect (Fig. 8). This results in a similar contour between the flap and the adjacent tissue after defect coverage. Despite the superior results of the contour, the advancement flap has a limitation in the length that a flap can be advanced to a defect, meaning that a defect with a relatively large diameter cannot be covered with this flap.<sup>[24–27]</sup> Based on our experiences, we concluded that the maximal length of advancement for defect coverage without tension is 3 cm, and this cut-off was applied in the algorithm used in this study.

There is no difference in color match between the 2 flaps, because both local flaps are elevated near the defect. However, to maximize the advantages of both flaps, following our algorithm is beneficial. For covering a defect larger than 3 cm in diameter, using a perforator-based transposition flap is essential, as it can cover a large defect. Meanwhile, for covering a defect smaller than 3 cm in diameter, a VY advancement flap is suitable, as it results in a more natural contour. There is only one exceptional condition in covering a small defect. If a defect is located near the NLF, a perforator-based transposition flap is a better option regardless of defect size, because the donor site scar can be hidden within the NLF by designing a flap with 90° rotation.

## 9. Conclusion

For reconstructing a midface defect with a local flap, it is important to choose an appropriate flap for functional and aesthetic outcomes. Pursuing only a single option in every case is not suitable. The flap must be appropriately selected according to the defect size and location. By following our algorithm for reconstructing midface defects, satisfactory results can be obtained.

## Author contributions

**Conceptualization:** Jung Woo Chang, Jang Hyun Lee.

**Data curation:** Jung Han Lim.

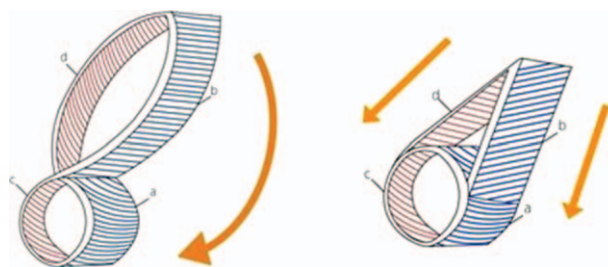
**Formal analysis:** Jung Han Lim.

**Methodology:** Jang Hyun Lee.

**Supervision:** Jang Hyun Lee.

**Writing – original draft:** Jung Woo Chang, Jang Hyun Lee.

**Writing – review & editing:** Jung Woo Chang, Jung Han Lim, Jang Hyun Lee.



**Figure 8.** Schematic images of the relationship between the defect depth and the flap thickness. (Left) Perforator-based transposition flap. After rotating a flap, the thick side of the flap (B) is in contact with the shallow side of the defect (C), whereas the thin side of the flap (D) is in contact with the deep side of the defect (A). (Right) VY advancement flap. After advancing a flap, the thick side of the flap (B) is in contact with the deep side of the defect (A), and the thin side of the flap (D) is in contact with the shallow side of the defect (C).

## References

- [1] Pletcher SD, Kim DW. Current concepts in cheek reconstruction. *Facial Plast Surg Clin North Am* 2005;13:267–81. vi.
- [2] Eskander A, Kang SY, Teknos TN, et al. Advances in midface reconstruction: beyond the reconstructive ladder. *Curr Opin Otolaryngol Head Neck Surg* 2017;25:422–30.
- [3] Kawase-Koga Y, Mori Y, Saijo H, et al. Reconstruction of a complex midface defect from excision of a squamous cell carcinoma, according to regional aesthetic units. *Oral Surg Oral Med Oral Pathol Oral Radiol* 2014;117:e97–101.
- [4] Chang EI, Hanasono MM. State-of-the-art reconstruction of midface and facial deformities. *J Surg Oncol* 2016;113:962–70.
- [5] Cho K-H, Uthaman S, Pakr I-K, et al. Injectable biomaterial in plastic and reconstructive surgery: a review of the current status. *Tissue Eng Regen Med* 2018;15:559–74.
- [6] Shan X, Choi JH, Kim KJ, et al. Adipose stem cells with conditioned media for treatment of acne vulgaris scar. *Tissue Eng Regen Med* 2018;15:49–61.
- [7] Liu X, Liu Y, Chen K, et al. Reconstruction of skin defects in the medial cheek using lateral cheek rotation flap combined with Z-plasties. *J Plastic Reconstr Aesthet Surg* 2015;68:e183–8.
- [8] Ozkaya Mutlu O, Egemen O, Dilber A, et al. Aesthetic unit-based reconstruction of periorbital defects. *J Craniofac Surg* 2016;27:429–32.
- [9] Kim SW, Kim YH, Kim JT. Angular artery perforator-based transposition flap for the reconstruction of midface defect. *Int J Dermatol* 2012;51:1366–70.
- [10] Pepper JP, Baker SR. Local flaps: cheek and lip reconstruction. *JAMA Facial Plast Surg* 2013;15:374–82.
- [11] Starkman SJ, Williams CT, Sherris DA. Flap basics I: rotation and transposition flaps. *Facial Plast Surg Clin North Am* 2017;25:313–21.
- [12] Jayarajan R. A combination flap for nasal defect reconstruction. *Ann Plast Surg* 2018.
- [13] Rossi M, Milia A, Carmisciano M, et al. Advancement perforator cheek flap for aesthetic one-stage reconstruction of postoncological extended split-thickness defects of the nasal sidewall. *ScientificWorldJournal* 2013.
- [14] Iyer K, Chen Z, Ganapa T, et al. Keratinocyte migration in a three-dimensional in vitro wound healing model co-cultured with fibroblasts. *Tissue Eng Regen Med* 2018;15:721–33.
- [15] Qassemayr Q, Havet E, Sinna R. Vascular basis of the facial artery perforator flap: analysis of 101 perforator territories. *Plast Reconstr Surg* 2012;129:421–9.
- [16] Yoon TH, Yun IS, Rha DK, et al. Reconstruction of various perinasal defects using facial artery perforator-based nasolabial island flaps. *Arch Plast Surg* 2013;40:754–60.
- [17] D'Arpa S, Cordova A, Pirrello R, et al. Free style facial artery perforator flap for one stage reconstruction of the nasal ala. *J Plast Reconstr Aesthet Surg* 2009;62:36–42.
- [18] Mann R, Srinivasan B, Webb R, et al. An unusual complication of nasolabial flap reconstruction. *Ann R Coll Surg Engl* 2017;99:e60–1.
- [19] Zhao XP, Zhang H, Yu X, et al. Reverse facial artery flap to reconstruct the medium-sized defects in the middle facial region following cancer ablation. *J Craniofac Surg* 2013;24:2077–81.
- [20] Cho K-H, Singh B, Maharjan S, et al. Local delivery of CTGF siRNA with Poly(sorbital-co-REI) reduces scar contraction in cutaneous wound healing. *Tissue Eng Regen Med* 2017;14:211–20.
- [21] Bi H, Xing X, Li J. Nasolabial-alar crease: a natural line to facilitate transposition of the nasolabial flap for lower nasal reconstruction. *Ann Plast Surg* 2014;73:520–4.
- [22] El Habr C, Vinelli G, Tinklepaugh A, et al. Reconstruction of an alar defect with a fusiform nasolabial turnover flap with a proximal, superiorly tapered apex. *J Craniofac Surg* 2018;29:e20–1.
- [23] Motamedi MH, Behnia H. Experience with regional flaps in the comprehensive treatment of maxillofacial soft-tissue injuries in war victims. *J Craniofac Surg* 1999;27:256–65.
- [24] Ryu YH, Lee YJ, Kim K-J, et al. Epidermal growth factor (EGF)-like repeats and discoidin I-like domains 3 (EDIL3): a potential new therapeutic tool for the treatment of keloid scars. *Tissue Eng Regen Med* 2017;14:267–77.
- [25] Boyette JR, Vural E. Cervicofacial advancement-rotation flap in midface reconstruction: forward or reverse? *Otolaryngol Head Neck Surg* 2011;144:196–200.
- [26] Li JH, Xing X, Li P, et al. Transposition movement of V-Y flaps for facial reconstruction. *J Plast Reconstr Aesthet Surg* 2007;60:1244–7.
- [27] Yildirim S, Akoz T, Akan M, et al. Nasolabial V-Y advancement for closure of the midface defects. *Dermatol Surg* 2001;27:656–8.