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Application of a new classification of chimeric anterolateral thigh free flaps

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ABSTRACT

Background: The anterolateral thigh free flap is one of the most commonly used flaps in reconstructive procedures. The purpose of this study was to assess this new classification of chimeric anterolateral thigh free flaps.
Methods: Sixty-five patients underwent free anterolateral thigh chimeric free flap reconstruction of defects in the head and neck region. We summarized the anatomic features of perforators, including the number and origin of the perforators.
Results: Sixty-five cases of femoral anterolateral double island flaps were divided into 3 types: trunk type (type I), 11 cases (16.9%), in which the perforators of two flaps originated in the descending branch and the transverse branch of the lateral femoral circumflex artery; branch type (type II), 45 cases (69.3%), in which both the perforators originated in the descending branch or the transverse branch of the lateral femoral circumflex artery; and bifurcation type (type III), 9 cases (13.8%), in which two perforators originated in the bifurcation of one perforator that originated in the descending branch or the transverse branch of the lateral femoral circumflex artery. All 65 flaps survived and none showed partial necrosis.
Conclusions: The anterolateral thigh chimeric flap can be divided into 3 types: trunk type (I type), branch type (II type) and bifurcation type (III type).

1. Introduction

The anterolateral thigh flap was first applied by Song et al. (1984).

Anterolateral thigh (ALT) flaps offer many features and can be prepared as perforating flaps, various chimeric flaps, fat flaps, fascia flaps, muscle flaps and others (Fang et al., 2013; Ren et al., 2014b; Gong et al., 2015). The donor site contains abundant soft tissues, and different types of myocutaneous flaps can be harvested and tailed, such as fasciocutaneous, musculocutaneous, perforator, adipofascial, pliable and thin perforator flap, de-epithelialized, folded, and chimeric flaps. Another advantage is that closure of the donor site could be performed possibly in the majority of the cases. Therefore, anterolateral thigh flap has become one of the most common flaps for the reconstruction of defects in the head and neck, limbs, torso and other body parts (Hong et al., 2010; Mao and Xu, 2015; Zhou et al., 2015; Wu et al., 2018).

As defects of the head and neck are varied and complex, the application of various chimeric flaps in the reconstruction of the head and neck region is increasing. Classifications of chimeric anterolateral thigh free flaps have been rare, and currently the classification standard is not unified. Recently, Ren et al. (2014a) developed a new classification of chimeric ALT free flaps and this new classification is purported to be very practical.

The purpose of this study was to validate the feasibility and practicability of a new classification of chimeric ALT free flaps. We summarized the anatomic features of perforators, including the number and origin of the perforators. According to the classification

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standard of Ren et al. (2014a), we classified the chimeric ALT free flaps and explored the practicality of this new classification in the reconstruction of buccal through-and-through defects.

2. Material and methods

2.1. Study population

To achieve the research purpose, we implemented a retrospective clinical study. This was an institutional review board-approved retrospective analysis of all patients who underwent reconstruction with chimeric ALT free flaps at Shanghai Ninth People's Hospital (Shanghai, China) between December 2014 and December 2016. To be included in study sample, patients had to be adults and have a general condition that permitted a lengthy operation. All 65 patients had through-and-through defects of the lip or buccal through-and-through defects caused by tumor resection and reconstruction with chimeric ALT free flaps. Among them, 54 patients were male and 11 were female. The youngest was 32 years old and the oldest was 78 years old. The mean age was 58.2 years (Table 1). The largest area among the single flaps was $10\times23 + 8\times12$ cm^2 and the smallest was $3.5\times4 + 4\times4$ cm^2 (Table 2). Postoperative follow-up was performed for all cases. Follow-up time varied from 5–14 months, and the mean follow-up time was 8.6 months. Basic information for all patients included flap size and type, donor complications and survival rate of the free flap.

2.2. Operative technique

The incision line was parallel to the iliac patellar connection line at 2 cm to the inside of the iliac patellar connection line. Retrograde anatomy was performed to obtain appropriate vessel and vascular pedicles, as well as the concomitant vastus lateralis and motor nerves. All tissues were appropriately restored. To repair complicated defects, we took advantage of the lateral femoral circumflex artery that is characterized by multiple perforating branches. The donor wound was closed by direct suture after the preparation of complete flaps. When the donor wound was too wide to suture directly, the flap was prepared in a region above or below the anterolateral area by cutting full-thickness skin without expanding the donor site.

Table 1
Characteristics of the cases enrolled in this study (n = 65).

Characteristics	Value
Age	58.2 (32–78)
Sex	
Male	54 (83.1)
Female	11 (16.9)
Site	
Buccal	56 (86.1)
Lower lip	4 (6.2)
Lower gingival	5 (7.7)
T stage	
T1	0 (0)
T2	15 (23.1)
T3	40 (61.5)
T4	10 (15.4)
Clinical stage	
I	0 (0)
II	0 (0)
III	52 (80)
IV	13 (20)
Differentiation	
Well differentiated	28 (43.1)
Moderate differentiated	32 (49.2)
Poorly differentiated	5 (7.7)
Metastasis lymph nodes	
Positive	47 (72.3)
Negative	18 (27.7)

Table 2
Characteristics of the flaps enrolled in this study (n = 65).

Number	Type	Area (cm×cm)		Perforator		Reception
		Flap 1	Flap 2	Flap 1	Flap 2	
1	Trunk	6×8	6×11	2	1	Buccal
2	Trunk	8×12	10×23	1	3	Oral and Chin
3	Trunk	7×9	6×9	1	1	Buccal
4	Trunk	6×11	7×12	2	1	Buccal
5	Trunk	6×9	7×11	2	1	Tempus and cheek
6	Trunk	6×12	6×21	1	2	Oral and Chin
7	Trunk	7×8	6×10	1	1	Buccal
8	Trunk	7×13	6×12	1	2	Buccal
9	Trunk	7×10	6×14	1	1	Buccal
10	Trunk	6×8	7×12	2	1	Tempus and cheek
11	Trunk	6×12	7×10	1	1	Buccal
12	Branch	6×8	6×7	1	1	Buccal
13	Branch	4.5×5	4.5×5.5	2	1	Buccal
14	Branch	4×5	5×7	1	1	Buccal
15	Branch	5×5.5	5.5×7	1	1	Buccal
16	Branch	5×6	5.5×7	1	2	Buccal
17	Branch	5×6	5.5×8	1	1	Buccal
18	Branch	4.5×5.5	6×8	1	1	Buccal
19	Branch	4×6	5.5×8	1	1	Buccal
20	Branch	6×12	6×11	3	1	Buccal
21	Branch	6×9	6×7	1	1	Buccal
22	Branch	8×12	6×6	4	1	Buccal
23	Branch	4×7	5×6	1	1	Buccal
24	Branch	7×8	7×9	1	3	Buccal
25	Branch	4×5	5×7	1	1	Buccal
26	Branch	5×5.5	5.5×7	1	1	Buccal
27	Branch	4.5×5.5	6×8	1	1	Buccal
28	Branch	4×5	6×6	1	1	Buccal
29	Branch	7×8	5×7	1	1	Buccal
30	Branch	4×5.5	6×8	1	1	Buccal
31	Branch	4×8	5×6.5	1	2	Buccal
32	Branch	6×8	5×7	1	1	Buccal
33	Branch	5×8.5	6×8	1	1	Buccal
34	Branch	4×6	5×7.5	1	1	Buccal
35	Branch	5×7	5.5×6	2	1	Buccal
36	Branch	4.5×6.5	4×8	1	1	Buccal
37	Branch	4×7	5×8	1	1	Buccal
38	Branch	5×7.5	5×7.5	1	1	Buccal
39	Branch	6×8	4.5×6	1	1	Buccal
40	Branch	4×9	5.5×8	1	1	Buccal
41	Branch	6×8	4×7.5	1	1	Buccal
42	Branch	5.5×6	6×7	3	1	Buccal
43	Branch	5×9.5	4×8.5	1	1	Buccal
44	Branch	6×7.5	6.5×7.5	1	1	Buccal
45	Branch	6×7	5.5×8	2	1	Buccal
46	Branch	5×8.5	6×8	1	1	Buccal
47	Branch	6×6.5	6×9	1	1	Buccal
48	Branch	7×9	6×7.5	1	2	Buccal
49	Branch	6×9.5	5.5×8	1	1	Buccal
50	Branch	8×11	4.5×7	1	1	Buccal
51	Branch	5×8	5×6.4	1	1	Buccal
52	Branch	7×9.5	5×7	2	1	Buccal
53	Branch	6×8	6×7	1	1	Buccal
54	Branch	4.5×6	5×8	1	1	Buccal
55	Branch	6.5×7	6×8	1	1	Buccal
56	Branch	4.5×6.5	5×7.5	1	2	Buccal
57	Bifurcation	3×4	3.5×4	1	1	Buccal
58	Bifurcation	3.5×4	3.5×4.5	1	1	Buccal
59	Bifurcation	3×4.5	4×4.5	1	1	Buccal
60	Bifurcation	3.5×4	3×4.5	1	1	Buccal
61	Bifurcation	4×5	3.5×4	1	1	Buccal
62	Bifurcation	3×5	3.5×4.5	1	1	Buccal
63	Bifurcation	4×4	3×4	1	1	Buccal
64	Bifurcation	3×6	3.5×4.5	1	1	Buccal
65	Bifurcation	3.5×4	4×4	1	1	Buccal

For microscopic artery anastomosis, we performed Ren anastomosis (Ren et al., 2016). End-to-end anastomosis was used for microscopic venous anastomosis. The superior thyroid artery was most commonly used as the recipient artery. When the diameter of the flap artery was substantially greater than that of the superior thyroid artery, the facial or lingual artery was used as the second option for anastomosis. The most commonly used recipient veins were the branches of the internal or external jugular vein.

3. Results

According to the characteristics of vascular pedicles and perforators, the chimeric ALT free flap could be divided into the following three types: trunk type (type I), in which the perforators of two flaps originated in the descending branch and transverse branch of the lateral femoral circumflex artery (Fig. 1A); branch type (type II), in which both perforators originated in the descending branch or transverse branch of the lateral femoral circumflex artery (Fig. 1B); and bifurcation type (type III), in which two perforators originated in the bifurcation of one perforator that originated in the descending branch or the transverse branch of the lateral femoral circumflex artery (Fig. 1C).

The size of trunk type (type I) was very large. This type could carry much skin, fat and muscle tissue. Trunk type was often used for reconstruction of large through-and-through defects. Raising the transverse branch in the proximal part of the thigh leads to a large flap volume on the one side and, more importantly, to a significant reduction of the pedicle length in type I chimeric ALT free flaps on the other side (Fig. 2). The branch type (type II) was the most common type and has broad indications. Branch type carries appropriate skin, fat and muscle tissue. This type is suitable for medium or large through-and-through defects (Fig. 3). The bifurcation type (type III) was the least common, carrying little skin, fat and muscle tissue. This type is often used for reconstruction of the small through-and-through defects (Fig. 4).

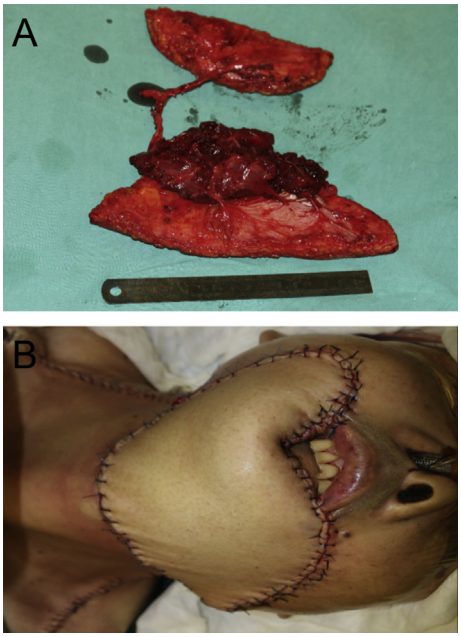

Fig. 1. Trunk type. A, in general, this type is very large. This type can carry much skin, fat and muscle tissue; B, this type is often used for reconstruction of large through-and- through defects.

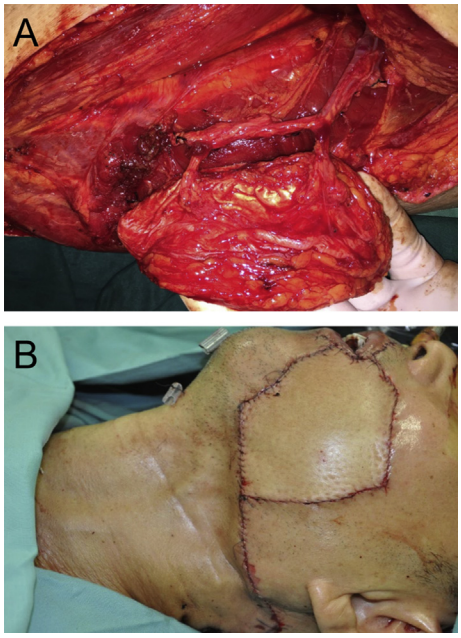

Fig. 2. Branch type. A, this type is the most common type and has broad indications. This type carries appropriate skin, fat and muscle tissue; B, this type is suitable for medium or large through-and-through defects.

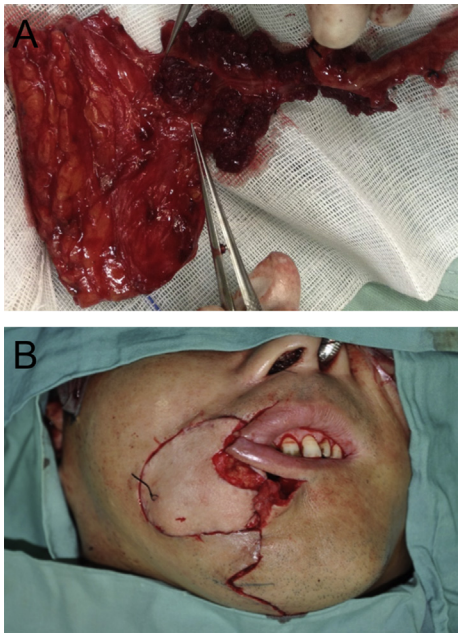

Fig. 3. Bifurcation type. A, this type is the most rare. It carries little skin, fat and muscle tissue. B, this type is often used for reconstruction of small through-and-through defects.

Among the 65 cases of chimeric ALT chimeric free flaps, there were 11 trunk types (16.9%), 45 branch types (69.3%) and 9 bifurcation types (13.8%). All 65 flaps survived (survival rate 100%).

4. Discussion

Although the advantages and application of ALT flaps in reconstruction of the head and neck have been widely reported, chimeric ALT free flaps have not been widely used (Wei et al., 2002; Wong

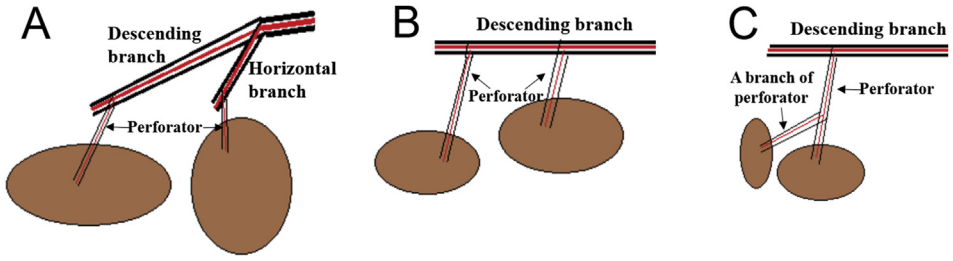

Fig. 4. Diagrammatic sketch of this new classification. A, Trunk type (I type): the perforators of two flaps originated in the descending branch and transverse branch of lateral femoral circumflex artery; B, Branch type (II type): both perforators originated in the descending branch or transverse branch of the lateral femoral circumflex artery; C, bifurcation type (III type): the two perforators originated in the bifurcation of one perforator that originated in the descending branch or transverse branch of the lateral femoral circumflex artery.

and Wei, 2010; Ren et al., 2014b). The organizational structure in the head and neck region is very complicated, and the thickness and volume of tissue required for reconstruction varies greatly. In addition, several anatomic units require reconstruction after resection of head and neck cancers (Ren et al., 2017). Because the defects of the head and neck are complex, the application of various chimeric flaps, especially chimeric ALT flaps in reconstruction of the head and neck region, is increasing (Ren et al., 2016). Nevertheless, the classification of chimeric ALT flaps is rare. The present study summarized the outcomes of the application of 65 chimeric ALT flaps for head and neck defects and their preparation process and provided useful information regarding the application of anterolateral flaps in head and neck reconstruction. We also validated the feasibility and practicability of the new classification of chimeric ALT free flaps.

In recent years, there has been improvement in surgical techniques and the subsequent requirement of high quality of life for head and neck cancer patients (Hidalgo et al., 1998; Zhang et al., 2015). The development of head and neck reconstruction technology has progressed by leaps and bounds. ALT free flaps are becoming increasingly frequent, as postoperative defects are complex after head and neck cancer radical surgery (Wang et al., 2012; Xu et al., 2015). In many cases, these defects require several flaps to reconstruct. Using several flaps simultaneously increases operation time and the significant damage to patients (Jiang et al., 2014; Stalder et al., 2015). Chimeric flaps are the best way to solve this problem (Jiang et al., 2014; Barreiro et al., 2017). Single pedicled double-island ALT free flaps are the most-frequently used chimeric flaps in the head and neck. However, there is no uniform classification standard for this type of free flap. In 2014, Ren et al. (2014a) reported a practical clinical classification for chimeric ALT free flaps. This study verified the Ren classification. The Ren classification guides the preparation of ALT free flaps and reconstruction of head and neck defects. In trunk type, the perforators of flaps are derived from the descending branch and transverse branch of the lateral femoral circumflex artery. The blood supply of the trunk type is adequate. The flap volume is large and carries a large amount of fat, muscle and other soft tissue. In the preparation of trunk type flaps, it is necessary to dissect to the lateral femoral circumflex artery, even to the deep femoral artery, and the trauma is substantial. The trunk type is the second-most common form of classification in this study and is easy to perform. Trunk type can appear in any area of the anterolateral thigh and has a very wide scope of application. In the branch type, the most common type in the present study, the perforators of flaps originate from the descending branch or transverse branch of the lateral femoral circumflex artery. This surgical technology can be easily mastered by a young surgeon. Several perforators of branch type appear simultaneously in the upper, middle and lower part of the ALT. The volume and thickness of this flap could be varied according to clinical demand. Due to these advantages of this type, it can be applied in most defects of the head and neck. The bifurcation type is the least common, always appearing in middle and lower part of the ALT. The bifurcation type flaps carry little skin, fat and muscle tissue and have the advantages of lesser trauma and hemorrhage, slight pain, rapid recovery and requirement of accurate surgical skill. The blood supply of the bifurcation type is less than that of other types. The distance between the two perforators is approximately 1.5–4.0 cm; therefore, it cannot supply enough blood for large flap volumes.

There are many methods for the reconstruction of through-and-through defects in the head and neck, including two different free flaps, one free flap and one local pedicled flap, a folding single flap, etc. Nevertheless, using several flaps simultaneously increases operation time and significantly damages patients (Hanasono, 2014; Cohen et al., 2016; Khadakban et al., 2016).

Every classification, including our own, has limitations. First and foremost, the proportion of the third type is low. Second, several complicated anterolateral thigh chimeric flaps could not be classified using this system. Finally, this classification has not been verified in large clinical samples. Further studies are required to substantiate our findings.

5. Conclusions

The anterolateral thigh chimeric flap can be divided into 3 types Ren classification: trunk type (I type), branch type (II type) and bifurcation type (III type).

The authors all have viewed and agreed to the submission.

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