

# Application of chimerical ALT perforator flap with vastus lateralis muscle mass in the reconstruction of oral and submandibular defects after radical resection of tongue carcinoma: a retrospective clinical study

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## Research article

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# Abstract

**Background:** Patients with tongue carcinoma who undergo combined tongue and neck radical resection often have the oral and submandibular defects simultaneously. Because of the high flexibility, the anterolateral thigh (ALT) perforator flap is gradually being adopted by the surgeons for the oral reconstruction. However, the tissue volume of a perforator flap is insufficient for the reconstruction of both oral and submandibular regions. In this retrospective study, we compared the postoperative effects and complications between two groups of patients. One group was reconstructed with the classical ALT perforator flap and the other was reconstructed with the chimeric ALT perforator flap with a mass of vastus lateralis muscle. **Methods:** From Aug 2017 to Aug 2019, 25 patients were reconstructed with classical ALT perforator flap (classical group), while 26 patients were reconstructed with the chimeric ALT perforator flap (chimeric group) after radical resection of tongue cancer in Xiangya Hospital, Central South University. The flap survival rate, incidence of submandibular infection, lateral appearance, lower extremity function, and quality of life were compared between two groups. **Results:** There were no differences in flap survival rate and postoperative lower extremity function between the two groups. The incidence of submandibular infection was 15.4% and 40% in the chimeric and classical group, respectively. The duration of recovery was  $12.20 \pm 2.69$  and  $15.67 \pm 4.09$  days in the chimeric and classical group, respectively. The submandibular region was fullness and satisfactory in chimeric group. The postoperative life quality in the chimeric group was better than that in the classical group ( $P < 0.05$ ). **Conclusions:** The chimerical ALT perforator flap with muscle mass can reconstruct the oral and submandibular defects accurately. It maintains the profile and fullness of the submandibular region and reduces the incidence of submandibular infection.

## Background

Oral squamous cell carcinoma (OSCC) is one of the most common malignant tumors in the whole body, and tongue cancer is the most frequent type. It is reported that the 5-year survival rate of tongue cancer is about 60%. The incidence rates of mortality and recurrence tends to be higher in recent years because of the local recurrence and submandibular cervical lymph node metastasis [1,2,3]. Therefore, it is a challenge for surgeons to develop reasonable surgical treatment strategies including therapeutic resection, postoperative defect reconstruction, and functional restoration.

Treatment of surgical resection and adjuvant radiotherapy and chemotherapy is the main therapy for the tongue carcinoma. The purpose of surgical treatment is to excise the primary tumor with a wide margin. The tongue is a complex organ which is composed of striated muscles. The tumor cells often migrate from the primary site, infiltrates into the muscle, and then develop into the mouth floor and submandibular region. Because of the special anatomical features, patients with tongue carcinoma often have early lymph node metastasis [4,5,6]. Therefore, the thoroughness of the resection is of particularly important. Recently, it has been suggested that the upper lingual muscle groups such as genioglossus muscle, hyoid muscle, geniohyoid muscle, mandibular hyoid muscle and / or anterior abdomen of digastric muscle should also be resect in the radical resection to reduce the possibility of recurrence [5, 7,

8]. However, the defect of mouth floor and submandibular region after operation leads to a large dead cavity, which causes the complications such as submandibular wound infection and oral fistula, prolongs the recovery period of the patients, and seriously affects the prognosis [7-9].

It is challenging to reconstruct the oral and submandibular defects simultaneously [10, 11]. In recent decades, free anterolateral thigh flap (ALT) has become one of the main choices for reconstruction because of its high reliability and versatility [11]. The traditional ALT always carries the redundant subcutaneous tissue, fascia lata, and muscle, and thus the tissue volume is far beyond the need. Then the perforator ALT flap was developed to overcome these defects. The vascular pedicle was naked to obtain the ideal length and to avoid carrying on the redundant tissues. Thus the accurate repair of the primary site defect was achieved [12,13,14,15]. However, the defect of submandibular region was left empty and may cause the submental or submandibular infection and the submandibular depression.

In this retrospective study, the flap survival rate, the duration of harvesting flap, the incidence of submandibular infection and lateral appearance were compared between two groups with different reconstruction methods. The first group was reconstructed with classical perforator ALT flap, while the other group was reconstructed with the chimeric perforator ALT flap with the muscle mass at the end of the descending branch of the lateral circumflex femoral artery.

## Methods

### Study Population

Fifty one patients with primary tongue carcinoma who underwent extensive surgical resection in the Department of Oral and Maxillofacial Surgery, Xiangya Hospital of Central South University between August 2017 and August 2019 were enrolled in this retrospective study. All the 51 patients received the radical resection of tumor. The genioglossus muscle, geniohyoid muscle, mandibular hyoid muscle and anterior abdomen of digastric muscle were resected for all patients due to the aggressive tumor invasion. The Medical Ethics Committee of Xiangya Hospital, Central South University approved the study. The patient's identity was preserved.

The demographic information of patients, including age, sex, tumor stage, pathological T or N status, size of dead cavity and size of flap were collected and analyzed [16]. All the patients were proven as squamous cell carcinoma of tongue radio-logically and pathologically. The criteria of exclusion were as follows. The exclusion criteria include: (1) history of previous craniofacial surgery; (2) distant metastasis or contraindication for curative surgery; (3) the postoperative follow-up data were incomplete or lost contact; (4) patients who receive radiotherapy, chemotherapy and other treatment before operation.

Among these patients, 25 cases were reconstructed with the classical ALT perforator, and 26 cases was reconstructed with the chimerical ALT perforator flap with a mass of vastus lateralis muscle on the distal

runoff of the lateral femoral circumflex artery. All the cases underwent wound recovery assessment and management during the period between the date of surgery and the date of wound healing. The follow-up duration was 6 months to 24 months.

### **Methods of harvesting classical or chimerical ALT perforator flap**

The method of harvesting classical ALT perforator flap has been described previously [17]. Briefly, the doppler ultrasonography was used to map the perforator in the anterolateral thigh region before the surgery. After the radical resection, we dissected the pre-positioned perforator to the descending branch of the lateral circumflex femoral artery retrogradely without destroying the integrity of the fascia lata (Fig. 1a).

For the chimeric flap, the vastus lateralis muscle corresponding to the size of the dead cavity was cut at the distal end of the descending branch of the lateral circumflex femoral artery. The distance of the descending branch between the muscle mass and the perforator of the flap was determined by the distance between the defect of oral mucosa and the submandibular dead space (Fig. 1b). In the reconstruction, the flap was used to repair the defect of oral cavity, and the muscle mass was used to repair the submandibular dead space (Fig. 2).

### **Data collection and analyses**

Surgical parameters including the duration of harvesting flap, the survival rate of the flap, the incidence of submandibular infection and the duration of recovery were collected. The function of the donor area, submandibular appearance and the quality of life were recorded and analyzed after the recovery. Data were compared between two groups with the Fisher accurate test and unpaired *t* test (SPSS 22.0). *P* < 0.05 was considered statistically significant.

## **Results**

### **Patient demographics**

The mean age of the group of ALT chimeric flap was  $51.73 \pm 8.42$  years, and group of classical ALT flap was  $48.41 \pm 7.83$  years. The clinical stages and the metastasis of lymph nodes were compared between two groups, and no statistically significant difference was found (Table 1).

**Table 1** Characteristics of the patients reconstructed with ALT chimeric flap and ALT flap

Characteristic	Flap		<i>P</i>
	ALT chimeric flap (n=26)	ALT flap (n=25)	
Age, years (mean ±SD)	51.73±8.42	48.24±7.83	0.14
Sex, male: female, n: n	25:1	24:1	0.98
Tumor stage			0.42
T1	4	6	
T2	20	16	
T3	1	3	
T4	1	0	
Nodal stage			0.54
N0	16	13	
N1	6	4	
N2	2	5	
N3	2	3	
Clinical stage			0.78
I	4	3	
II	11	9	
III	6	5	
IV	5	8	
Size of flap(range)	8cm×4.5cm-14cm×6cm	7cm×4cm-14cm×7cm	0.60
Size of muscle(range)	3cm×3cm-5cm×4cm	—	
Size of dead cavity (range)	3cm×3cm-5cm×4cm	3cm×3cm-5cm×4cm	0.34

Date presented as mean ± SD or n, unless otherwise indicated. ALT, anterolateral thigh cutaneous; TNM, tumor, node, metastasis.

### Flap harvesting time and survival rate

The flap harvesting time was 99.12±28.30 min in the group, and 96.71±20.64 min in the group of ALT flap. There was no significant difference between two groups (*P*=0.92). The success rate of the flap was

100 % in both two groups (Table 2).

### Postoperative complication and recovery time

Submandibular infection is the main postoperative complication and it is compared between two groups. Among the 26 patients in the experimental group, 4 cases were found with submandibular skin redness and finger pressure depression. Early interventions, including local drainage, compression bandage, and antibiotics treatment were performed to promote the rehabilitation. The other 22 patients healed on the first stage. The rate of the submandibular infection was 15.4%.

Among the 25 patients in the control group, 5 cases had submandibular skin redness with finger pressure depression. Three cases were found with fluctuation in the submandibular region. Two cases developed with sub oral fistula. Antibiotics treatment, local effective drainage, and compression bandage were used for all 10 cases. The two patients with sub oral fistula were treated with the second operation for intraoral and wound debridement and closure. Totally, 10 cases developed submandibular infection (40 %). There was a significant difference between control and experimental groups ( $P=0.025$ ).

The recovery time from the first surgery to the rehabilitation was  $12.20\pm 2.69$  days for the group of ALT chimeric flap and  $15.67\pm 4.09$  days for the group of ALT flap. The difference was statistically significant ( $P=0.0054$ ).

Therefore, the chimeric ALT flap can significantly reduce the incidence of submandibular wound infection, and shorten the duration of wound healing.

**Table 2** Comparison of indicators in the recovery period between the experimental group and the control group

Indicators	Experimental group (n=26)	Control group (n=25)	<i>P</i>
Submandibular wound infection (rate)	A 4/26	5/25	0.025*
	B 0	3/25	
	C 0	2/25	
Wound healing time (days)	$12.20\pm 2.69$	$15.67\pm 4.09$	0.0054*
Flap operation time (min)	$99.12\pm 28.30$	$96.71\pm 20.64$	0.92
Flap survival rate	100%	100%	1

A: submandibular wound skin redness and finger pressure depression; B: submandibular wound skin redness with fluctuating; C: sub oral fistula. Data presented as mean  $\pm$  SD or n/n, unless otherwise indicated. \*Statistically significant difference.

### **Submandibular appearance**

We evaluated the submandibular appearance after operation by measuring the angle between Sn-Pos and Mes-K in lateral profile photos (Fig. 3a). The results were statistically evaluated and compared between two groups. The angle of the experimental group was  $70.19 \pm 2.304$ , while that of the control group was  $72.00 \pm 3.072$ . There was a significant difference between the two groups ( $P=0.0236$ ) (Fig. 3b-c).

### **Donor site function and the quality of life after operation**

The Lower Extremity Functional Scale (LEFS) [18] were conducted for all 51 patients 6 months after the operation. The results were statistically evaluated. The LEFS score was  $68.28 \pm 2.95$  in the experimental group and  $68.89 \pm 2.30$  in the control group, and there was no statistical difference ( $P=0.483$ ). It showed that the function of donor site was not significantly affected in the group of chimeric ALT perforator flap (Fig. 4).

To evaluate the quality of life, the UW-QOL questionnaire was conducted for all 51 patients 6 months after the operation. The results showed that the values of mastication in the group of ALT chimeric flap were higher than that in the group of ALT flap. The other items were similar between two groups (Table 3).

**Table 3** Comparison of UW-QOL scores between the experimental group and the control group

Indicators	Experimental group	Control group	<i>P</i>
Pain	70.65±25.22	69.60±25.77	0.89
Activity	66.15±19.32	63.00±20.49	0.67
Recreation	64.42±23.18	61.80±24.85	0.70
Swallowing	63.65±22.26	54.40±23.04	0.16
Chewing	66.92±18.76	54.60±20.39	0.032*
Speech	55.77±18.33	55.00±19.90	0.88
Shoulder	67.88±21.67	69.80±17.63	0.74
Taste	62.12±22.37	57.60±21.73	0.48
Saliva	57.88±20.29	56.80±23.15	0.86
Mood	61.73±25.94	60.80±22.26	0.89
Anxiety	59.62±21.26	57.80±18.55	0.75

\*Statistically significant difference.

## Discussion

After the comparison between the classical and chimeric ALT perforator flap, we found that the incidence of submandibular infection was lower in the group of chimeric ALT flap than the classical ALT flap. The submandibular appearance and mastication efficiency of the group of chimeric ALT flap were better than those of the classical ALT flap.

Lymphatic drainage of tongue tissue is rich and complex [1]. The lymphatic reflux of the oral cavity needs to reach the upper cervical lymph nodes through the floor of the mouth [2]. The lymphatic drainage of invasive lesions located in the abdomen of the tongue is mainly concentrated in the floor of the mouth. The lymph nodes of the tongue or the root of the tongue artery are often small in size and thin in capsule. The metastasis into these lymph nodes is too occult to find out [4,5,6]. Also, the tumor cells can move longitudinally along the path with the least resistance [19]. As a result, some scholars have proposed that the radical dissection of tongue cancer should contain primary lesions and all possible pathways of metastasis, including suboral and partial suprahyoid muscle groups, lymphatic, neurovascular and glandular tissues [5, 7, 8]. However, this operation method could leave extensive dead cavity in the floor of the mouth and submandibular region, which may lead to submental and submandibular infection and fistula. The wound healing process was subsequently affected and the postoperative submandibular shape was depressed obviously [7,9].

How to repair and reconstruct the primary site and dead cavity of the floor of mouth and submandibular in tongue cancer patients is a challenge for surgeons. A free anterolateral thigh flap (ALT) has become

one of the most frequently used flap reconstruction methods in tongue cancer patients because of its high reliability, constant anatomy, and large amount of tissue [8,12,13]. The traditional ALT often carries too much subcutaneous tissue and muscle, which caused great damage to the donor site [20]. Then the perforating flap of the descending branch of the lateral circumflex femoral artery was developed. It was dissected through the muscle. Without carrying the redundant muscle and other tissues, it is more flexible for the reconstruction [13-14-15]. However, the large dead cavity in the floor of mouth and submandibular is left.

In this study, we find that the chimeric perforator ALT flap with vastus lateralis muscle mass is more suitable for reconstruction both in the primary site and submandibular region. The chimeric ALT perforator flap has the following advantages: 1) The damage of donor site is reduced as much as possible because the muscle flap is made precisely according to the size of submandibular defect, which obeys the principle of "caring for the donor site" [21,22]. 2) The distance between the perforator of the flap and the muscle mass was at least 3-5cm to make it more flexible in repair and reconstruction [23-24-25]. 3) Also, it can significantly reduce the incidence of wound infection, shorten the wound healing time and obtain better submandibular appearance.

## Conclusion

To sum up, the chimeric ALT perforator flap with vastus lateralis muscle mass has extensive application value. The appropriate filling of the defect of the mouth floor and submandibular region reduces the incidence of wound infection and shorten the length of the wound healing period. The post-operation submandibular profile is restored optimally.

## Abbreviations

ALT Anterolateral thigh cutaneous;

OSCC Oral squamous cell carcinoma;

LEFS The Lower Extremity Functional Scale;

UW-QOL The University of Washington quality of Life questionnaire;

TNM tumor, node, metastasis

## Declarations

### Acknowledgements

Not applicable.

## **Authors' contributions**

Guided the study: FG. Wrote the manuscript: RY, XSW, FG. Collected and analyzed the data: RY, XSW, PKA. Designed the study: YFX, CHJ, XCJ. All authors read and approved the final manuscript.

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## **Availability of data and materials**

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## **Ethics approval and consent to participate**

This retrospective study was approved by the Medical Ethics Committee of the Hospital and was done in accordance with the Declaration of Helsinki of 1964, and as amended in 2013.

## **Consent for publication**

The identifying images and other personal or clinical details of participants are presented without compromise anonymity. The patients signed the consent form for publication.

## **Competing interests**

The authors declare that they have no competing interests.

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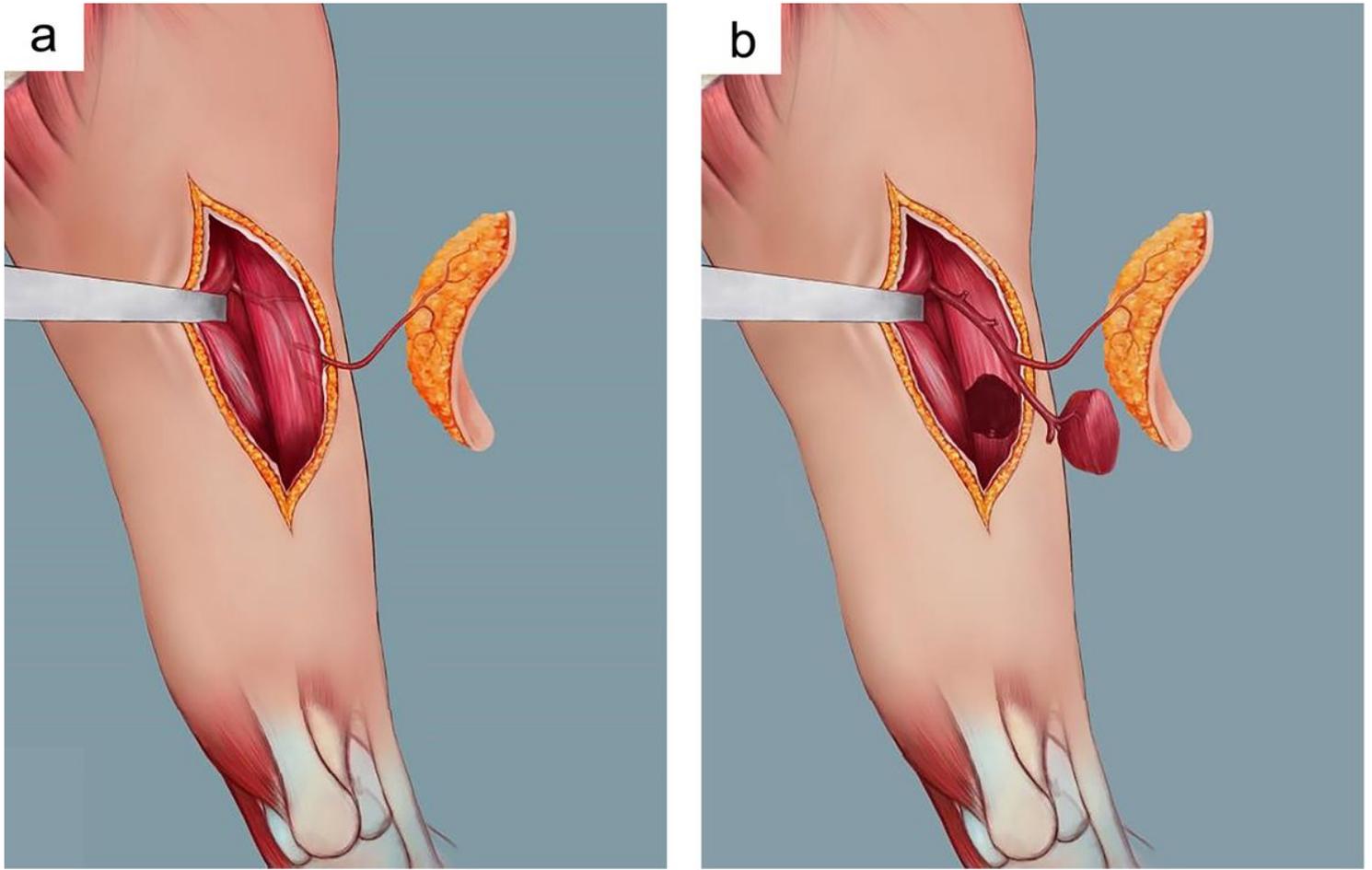
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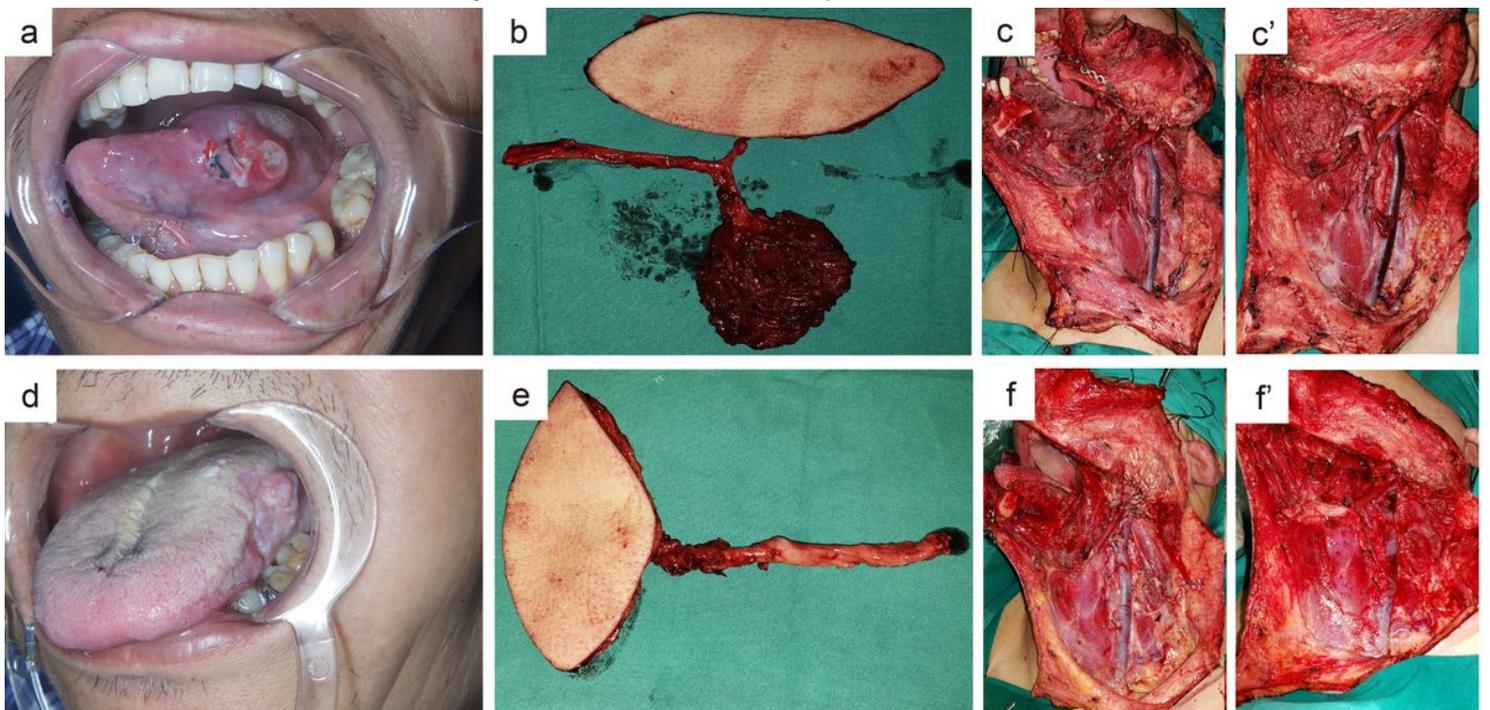
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## Figures



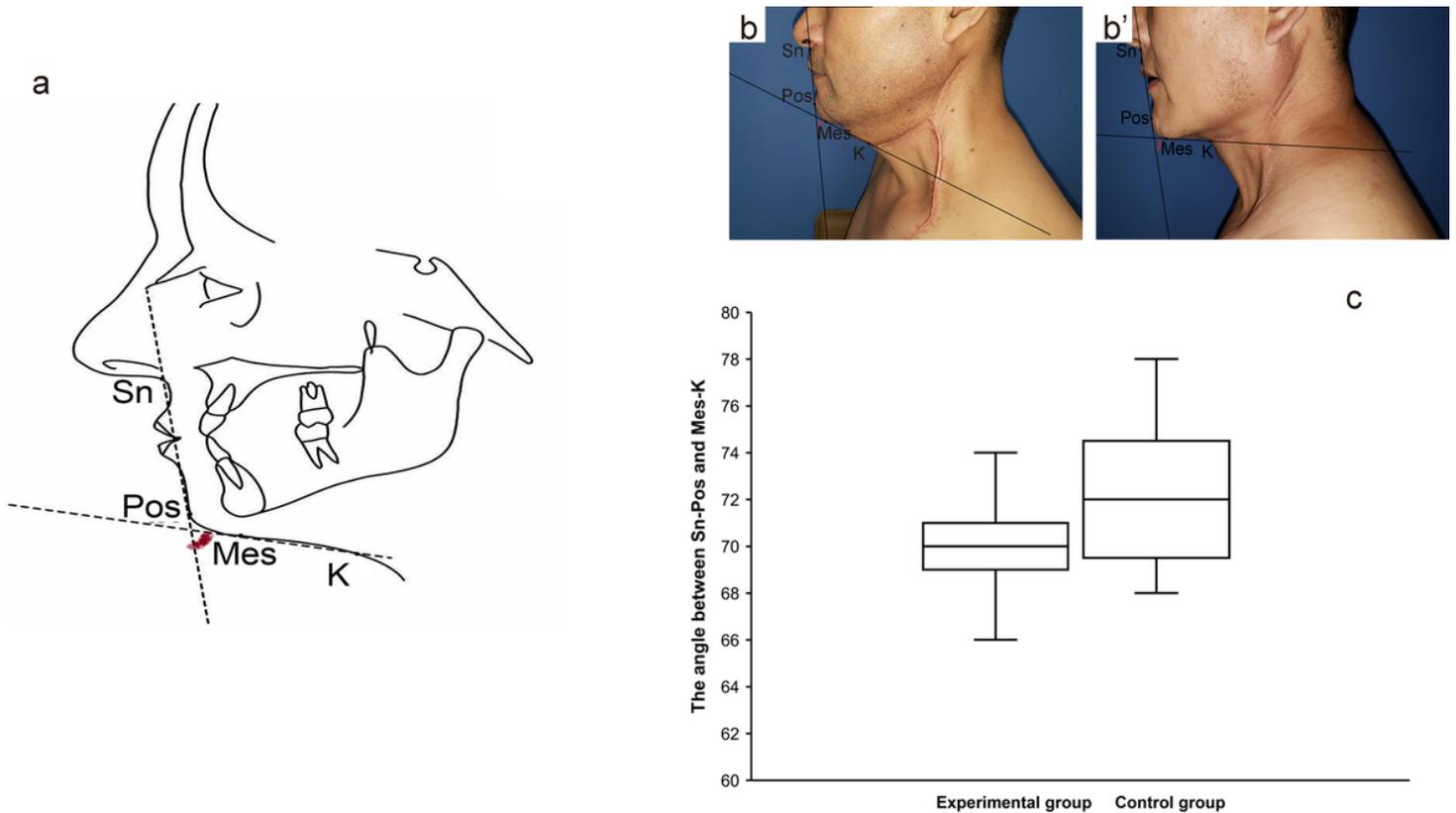
**Figure 1**

The schema of the chimeric and classical ALT flaps a. classical ALT perforator flap of descending branch of lateral circumflex femoral artery; b. The chimeric ALT flap with vastus lateralis muscle mass



## Figure 2

The schema of the chimeric and classical ALT flaps a. classical ALT perforator flap of descending branch of lateral circumflex femoral artery; b. The chimeric ALT flap with vastus lateralis muscle mass Fig. 2 Comparison of reconstruction of oral and submandibular defects with two kinds of flaps. a-c the reconstruction of oral and submandibular defects with chimeric ALT flap; a The size and location of primary tumor; b The chimeric ALT perforator flap; c, c' The oral and submandibular defects before and after the transplantation of chimeric ALT perforator flap; d-f the reconstruction of oral and submandibular defects with classical ALT flap; d The size and location of primary tumor. e The classical ALT perforator flap; f, f' The oral and submandibular defects before and after the transplantation of classical ALT perforator flap.



## Figure 3

Comparison of submandibular appearance between two groups a Assessment of submandibular appearance by measuring the angle between Sn-Pos and K-Pos; b submandibular appearance of tongue cancer patients after chimeric ALT perforator flap reconstruction; b' submandibular appearance of tongue cancer patients after classical ALT perforator flap reconstruction; c the statistical result of the comparison between two groups.

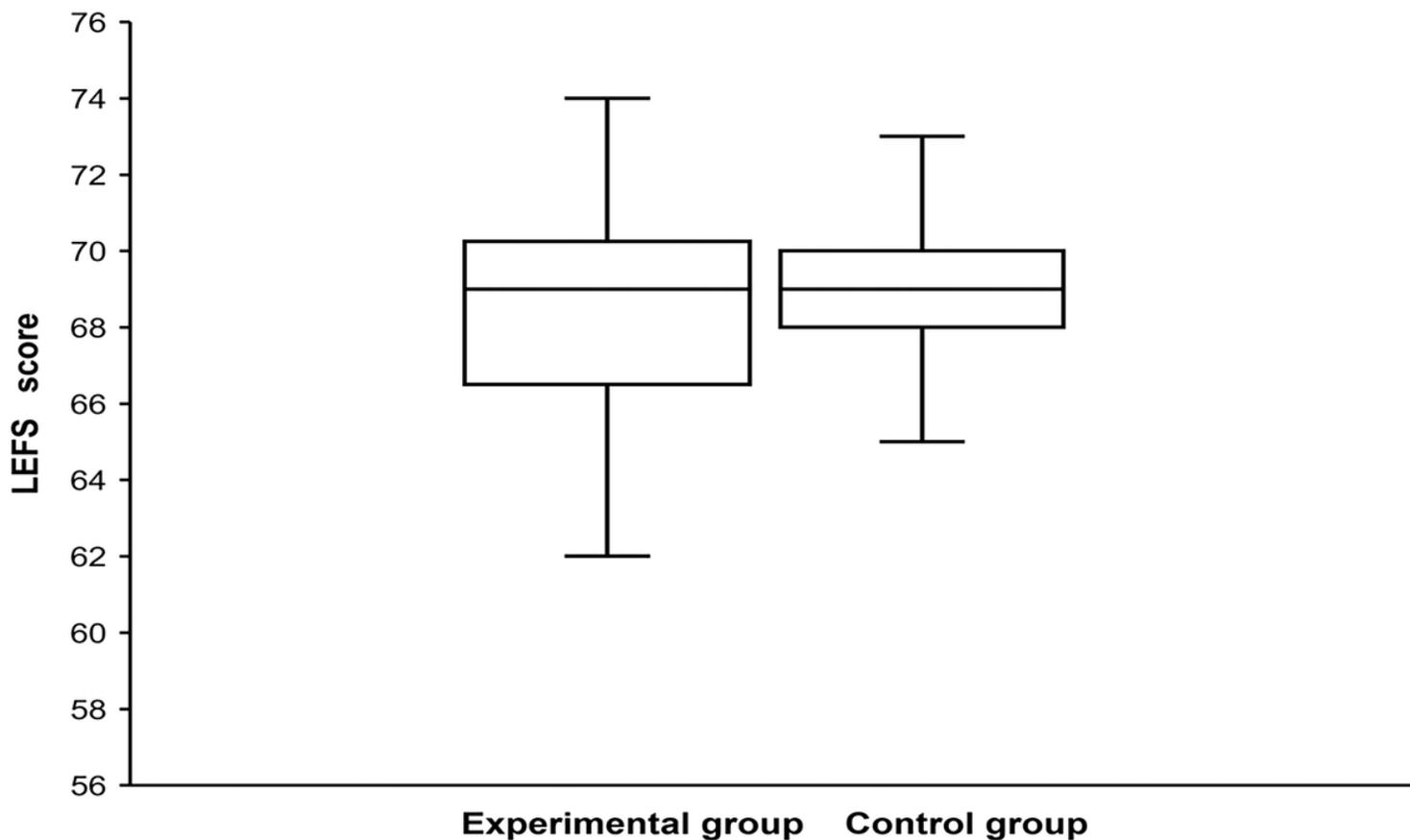


Figure 4

Bar graph illustrated the differences of LEFS between the experimental and the control groups

## Supplementary Files

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