Journal of Plastic, Reconstructive & Aesthetic Surgery (2019) 72, 2041–2048

JPRAS
An International Journal of Surgical Reconstruction
www.JPRASurg.com

Transverse facial cleft (macrostomia) repair: Modification of a traditional technique

Lian Zhou[a,1,*], Hongping Zhu[b,1], Dianyin Shi[a], Dongni Ren[c], Yingqiu Cui[d], Jizhi Zhao[a], Yingzi Hou[a], Tao Xu[e,f]

[a] *Department of Stomatology, Peking Union Medical College Hospital, CAMS and PUMC, Beijing 100730, China*
[b] *Department of Oral and Maxillofacial Surgery, Peking University School of Stomatology, Beijing 100081, China*
[c] *Medprin Regenerative Medical Technologies Co., Ltd., Guangzhou, Guangdong 510663, China*
[d] *Guangzhou Women and Children's Medical Center, Guangzhou Medical University, Guangzhou, Guangdong 510120, China*
[e] *Department of Mechanical Engineering, Biomanufacturing Center, Tsinghua University, Beijing 100084, China*
[f] *Department of Precision Medicine and Healthcare, Tsinghua-Berkeley Shenzhen Institute, Shenzhen 518055, China*

Received 6 July 2018; accepted 18 August 2019

KEYWORDS
Transverse facial cleft;
Commissure;
Anatomy structure;
Extent of difference scale

Summary *Objective:* Outcomes from surgical repair of transverse facial cleft (macrostomia) may not be very satisfactory when conventional methods are used to position the oral commissure to be repaired. To improve patient outcomes, we developed a modified oral commissure positioning and reconstruction method for transverse facial cleft repair.
Method: In the modified positioning method, the oral commissure at the abnormal side was positioned precisely and reconstructed by a combination of two conventional methods, namely, the distance measurement method and the anatomical charateristics method. The function of the orbicularis oris muscle was preserved. Postoperative surgical scar score and oral commissure symmetry score were determined and compared between patients and healthy controls. The scores ranged from one to five, with one representing the best and five indicating the worst results.
Results: Nine patients aged 4–31 months (7 girls) underwent the modified transverse facial cleft repair surgery. All the patients had unilateral transverse facial cleft with or without microsomia

[1] These authors contributed equally to this work.
* Corresponding author.
E-mail address: zhoulian@pumch.cn (L. Zhou).

https://doi.org/10.1016/j.bjps.2019.08.003

and/or complete cleft lip. The patients were followed up for one to five years. Although average surgical scar scores of patients (close-mouth: 1.8 ± 0.8, range: 1.0-2.8; open-mouth: 1.8 ± 0.9, range 1.0-3.6) remained significantly higher ($P < 0.05$) than those of the healthy controls ($N = 8$, close-mouth 1.1 ± 0.4, range: 1.0-1.4, open-mouth: 1.1 ± 0.3, range: 1.0-1.2) 6 months after the surgery, their average close-mouth oral commissure symmetry score (1.9 ± 0.7, range: 1.6-2.8) was similar ($P = 0.381$) to those of the healthy controls (1.8 ± 0.8, range: 1.0-2.6).
Conclusions: The modified procedure appears to lead to promising long-term benefit on restoring oral commissure symmetry.

Introduction

Transverse facial cleft, also called macrostomia, which is included in Tessier 7 facial cleft, is a typical feature of craniofacial microsomia.[1] The prevalence of transverse facial cleft is approximately 1:80,000 to 1:300,000 live births.[2,3] Transverse facial cleft can be either unilateral or bilateral. Severe transverse facial cleft often presents a cleft from the corner of the mouth to the ear and can involve the cheekbone or the temporal bone. The key factors for a successful transverse facial cleft repair include precisely positioning the oral commissure, restoring the symmetry of the lower 1/3 of the face, reconstructing the orbicularis oris muscle, and maximally reducing surgical scar.

For unilateral transverse facial cleft, two methods are frequently used to position the oral commissure at the abnormal side: (1) measuring the distance from the normal oral commissure to the peak of Cupid's bow or the midpoint and using the distance as the reference to position the abnormal oral commissure (distance measurement method);[4-7] (2) using anatomical characteristics of oral commissure as the reference (anatomical characteristics method).[8,9] The two conventional methods for oral commissure positioning are simple and have been commonly used. However, each conventional method has some limitations. For the distance measurement method, the anatomical characteristics of oral commissure and the surrounding tissues are not taken into consideration when the commissure is rebuilt. For the anatomical characteristics method, the reference distance of the normal side is often not used. Therefore, the use of the conventional commissure positioning methods may lead to unsatisfactory surgical outcomes such as inaccurate commissure positioning and abnormal commissure shape. To the best of our knowledge, a combination of the two methods, which appears reasonable and may overcome the limitations of each method, has not yet been explored. The current study serves to fill this gap. We developed a modified oral commissure positioning and reconstruction method for unilateral transverse facial cleft repair. Herein, we present the modified oral commissure positioning method and the surgical outcomes from the modified procedure.

Patients and methods

Study design and patients

This was a retrospective observational study. Clinical records of consecutive patients ($N = 9$, 7 girls) undergoing transverse facial cleft repair between January 2012 and December 2016 in the Department of Stomatology of the Peking Union Medical College Hospital (PUMCH) were reviewed. The study protocol was approved by the Institutional Review Board (IRB) of the PUMCH (Approval No. S-K338). Patients undergoing the modified procedure for transverse facial cleft repair in PUMCH were included in the analysis. A total of 8 healthy controls (4 girls and 4 boys) were included. Written informed consent was obtained from the parent of every patient.

Modified oral commissure positioning procedure for unilateral transverse facial cleft repair

All the operations were performed by the senior surgeon Dr. Lian Zhou. The modified procedure was based on the anatomical characteristics of the normal commissure (Figure 1). We considered the commissure as a stretchable fossa structure but not a simple flat point (Figure 1(A)). We first used a marker pen to label the external contour line of the normal oral commissural fossa at close-mouth (Figure 1(B)). The outermost point of the fossa was considered as the outer oral commissure position (point B in Figure 1(B)). At the open-mouth position, the fossa structure was stretched so that the labeled area transformed into a curve starting from the upper vermilion border (point A in Figure 1(C)) to the lower vermilion border (point C in Figure 1(C)). When we examined the curve closely, it was surprisingly found that the upper and lower vermilion border lines did not intersect at point B; instead, the border lines extended to buccal mucosa and intersected at another point (point D in Figure 1(D)) several millimeters from point B. We considered point D as the inner oral commissure. In fact, the stretched fossa structure became a fan-shaped area (A→B→C→D, Figure 1(D)). This fan-shaped area was then used as the reference area to reconstruct the oral commissure at the abnormal side.

The diagram of the modified oral commissure positioning and surgical procedure is displayed in Figure 2. During unilateral transverse facial cleft repair surgery, the mouth was opened to the maximal position. We first labeled the normal commissural area A→B→C→D as shown in the illustration in Figure 1, and then we determined the corresponding A', B', C', and D' points on the abnormal side (the shaded area in Figure 2(A)). The positions of the A' and C' points were critical for determining the location of the anticipated new commissure, and both points were the vermilion-mucosal junctions of the abnormal side. The distance from point A to the peak of the Cupid's bow on the

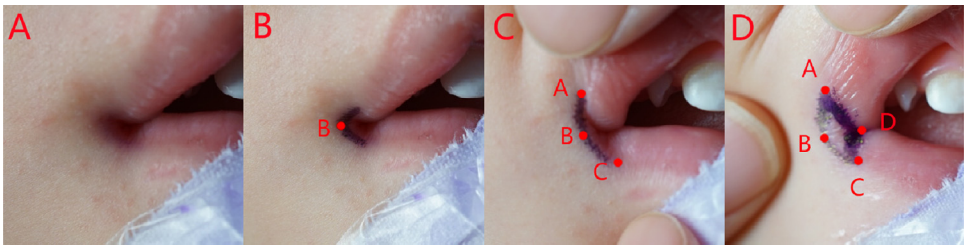

Figure 1 Normal Commissure. (A) Normal commissural fossa at close-mouse. (B) External contour line of a normal oral commissural fossa structure at close-mouth was labeled using a marker pen. Point B is the outermost point. (C) The labeled fossa structure was stretched into a curve at open-mouse. The curve is from point A on the upper vermilion border to point C on the lower vermilion border. (D) Point D is the inner commissure position. A→B→C→D is a fan-shaped commissural area.

healthy side should be equal to the distance from point A' to the peak of the Cupid's bow on the abnormal side. A much bigger fan-shaped area A'→B'→C'→D' was observed on the abnormal side. Subsequently, we used the normal commissural area as the reference to develop the repair strategy on the abnormal side (Figure 2(B)). Briefly, we first determined the b point by measuring the same distance of A'→b on the curve A'→C' as the distance of A→B on the normal side (A'→b = A→B). Similarly, the b' point was determined by measuring the same distance of C'→b' as the distance from the C→B on the normal side (C'→b'= C→B). We then used the same strategy to determine the d and d' points on the abnormal side. The distance of d→A' is equal to the distance of D→A on the normal side (d→A' = D→A), and the distance of d'→C' is equal to the distance of D→C on the normal side (d'→C'=D→C). During the operation, the extra tissue on the abnormal side, which is the shaded area in Figure 2(B), was removed. After the orbicularis oris muscles on the cleft side were dissected, the mucosa margin D'-d and D'-d' was first aligned and sutured. Reconstruction of the mimetic muscles, including the orbicularis oris muscle at the cleft site, was the key to the success of the repair surgery. The detached muscle area, which was noticed frequently around the cleft side (Figure 2(C)), was rebuilt. The dissected orbicularis oris muscles on the cleft side were placed side by side from lateral to medial and sutured. The suturing of the muscle should be ended near the position of the anticipated commissure but never beyond that position. Finally, the cutaneous triangle of A'→d→b and that of C'→d'→b' were sutured. The combined area of the triangles surrounded by A'→d→b and C'→d'→b' was approximately equal to the area of the fan-shaped A→B→C→D on the normal side. Z-plasty with short arms was used only when the cleft was beyond the nasolabial fold, and linear suture was used for the cases with cleft not reaching the nasolabial fold. Figure 2(D) illustrates the result after the repair surgery.

Surgical outcome evaluation

Photos showing oral commissures, upper and lower lips, and the surrounding areas including the surgical scar were collected on the day when sutures were removed (T1), and the day of follow-up at postoperative 1-6 months (T2), and ≥ 6 months (T3). Photos at T3, which represent long-term postoperative recovery, were compared with photos of children with healthy oral commissures. Five resident surgeons, who were blinded to patient clinical and surgical data, reviewed the photos and graded the surgical scar and oral commissure symmetry following the grading criteria described in Table 1.

Statistical analysis

The scores of surgical scar and oral commissure symmetry of the modified technique group (T3) were compared with those of the healthy control using the Fisher's least significant difference (LSD) test. $P < 0.05$ was considered statistically significant.

Results

General clinical data

Nine patients underwent the modified unilateral transverse facial cleft repair procedure. Their age was 4-31 months, and the median age was 9 months (Table 2). The majority of them were girls (77.8%, 7/9). All the patients had unilateral transverse facial cleft; four were accompanied with microsomia; one was accompanied with ipsilateral complete cleft lip and palate. Of the 9 patients, 3 received Z-plasty cutaneous closure and 6 received linear cutaneous closure. The patients were followed up for one to five years, and the median follow-up time was 4 years (Table 2). Healthy control group included 8 children (4 boys and 4 girls) with an average age of 12.9 ± 6.6 months.

Surgical outcomes

Surgical scar scores of both close-mouth and open-mouth at T1 (day of suture removal), T2 (day of short-term follow-up), and T3 (day of long-term follow-up) decreased progressively (Figure 3(A)), suggesting surgical scars alleviated continuously after the repair surgery. Nevertheless, the average surgical scar score of both close-mouth (1.8 ± 0.8, range: 1.0-2.8) and open-mouth (1.8 ± 0.9, range 1.0-3.6) at T3 remained significantly higher ($P < 0.05$) than those of the healthy controls ($N = 8$, close-mouth 1.1 ± 0.4, range: 1.0-1.4, open-mouth: 1.1 ± 0.3, range: 1.0-1.2, Figure 3(A)). Although the average symmetry score of open-mouth at T3 was significantly higher ($P < 0.05$) in patients (2.3 ± 1.0,

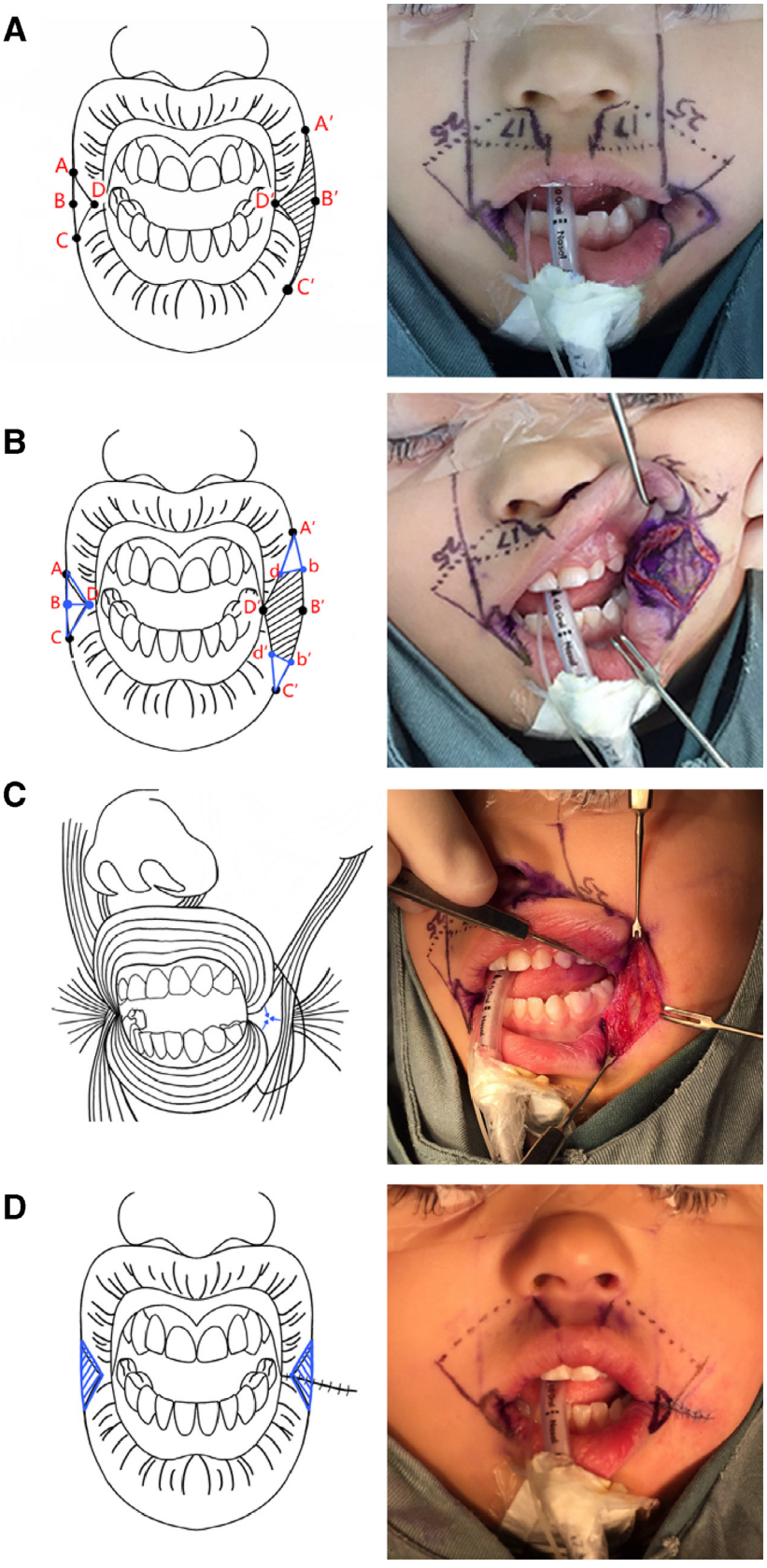

Figure 2 Modified surgical procedure for transverse facial cleft repair. (A) Diagram of the characterization of the 3D anatomical characteristics of oral commissure. (B) The shaded area was removed from the abnormal side. (C) The facial muscles at the abnormal side were reconstructed. (D) Result after the repair surgery.

Table 1 Grading criteria for surgical scar and oral commissure symmetry.[22]

Grade		Surgical scar	Oral commissure symmetry
1	Excellent	Barely visible scar	Complete symmetry
2	Good	Tiny scar that does not affect facial appearance	Good symmetry, but one side looks a little unnatural
3	Fair	Visible scar that barely affects facial appearance	Acceptable asymmetry, and the repaired commissure can be identified easily
4	Poor	Obvious scar that affects facial appearance	Asymmetry, and the position of the repaired commissure is obviously shifted
5	Very poor	Very obvious scar that adversely affects facial appearance	Extremely asymmetry, and the position of the repaired commissure is completely shifted

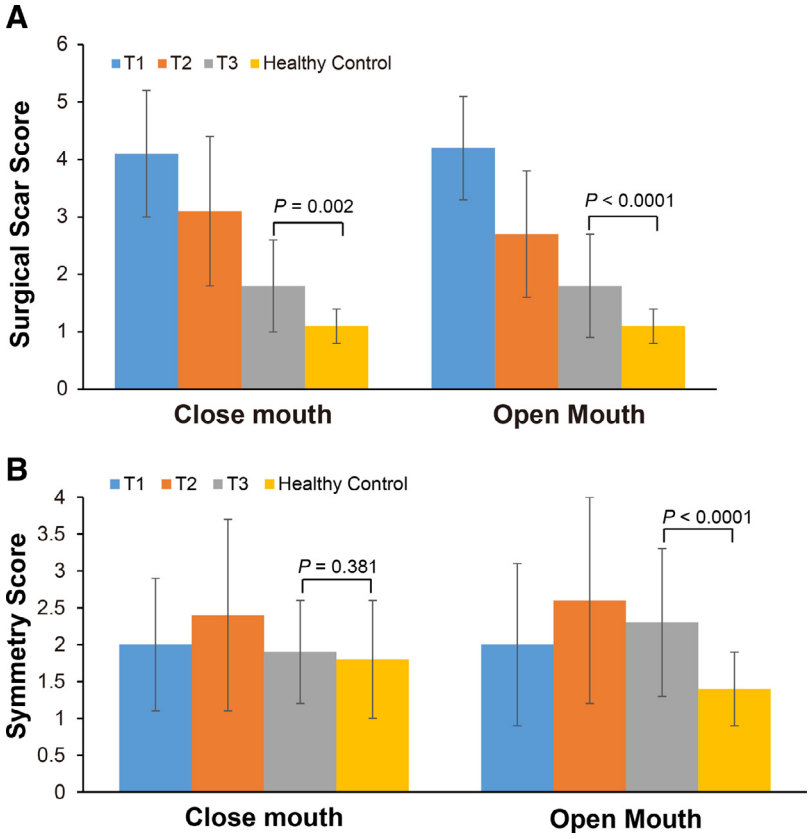

Figure 3 Surgical scar score and symmetry grade. Fisher's least significant difference (LSD) test was used compare the T3 group versus the healthy control group.

range: 1.6-4.0) than in healthy controls (1.4 ± 0.5, range: 1.0-2.0, Figure 3(B)), the average close-mouth oral commissure symmetry score at T3 was similar ($P = 0.381$) in patients (1.9 ± 0.7, range: 1.6-2.8) and the healthy controls (1.8 ± 0.8, range: 1.0-2.6, Figure 3(B)). Representative photos before and after the surgery of a patient with right transverse facial cleft are illustrated in Figure 4. Photos of the patients with the highest scores of linear scar or Z-plasty scar are displayed in Figure 5.

Discussion

We used a modified oral commissure positioning and reconstruction method to repair a unilateral transverse facial cleft on 9 patients. Our results showed that the modified procedure resulted in significant long-term benefit in oral commissure symmetry. The close-mouth oral commissure symmetry 6 months after the surgery was similar between the patients and healthy controls, although the surgical scar remained relatively apparent. Our technique is different from the previously reported methods in terms of commissure positioning and reconstruction.

Some surgeons consider a commissure as a single point, and thus, they often use the distance between the normal commissure and the peak of Cupid's bow or the midpoint to determine the position of the anticipated commissure.[4-7] Some other surgeons take the anatomical characteristics of the surrounding tissues of commissures into consideration when positioning a new commissure. They

Figure 4 Photos of a representative patient. Photos of a representative patient underwent transverse facial cleft repair at different stages: (A) Before surgery; (B) T1 stage; (C) T2 stage; (D)–(H) T3 stage.

Figure 5 Photos of patients with the highest scores of linear scar or Z-plasty scar. The photo of the patient with the highest score for the linear scar was taken two years after the surgery, wherein the patient's complete unilateral cleft of the lip and palate was repaired. The photo of the patient with the highest score for the Z-plasty scar was taken 7 months after the surgery; Z-plasty technique was used because the cleft was beyond the nasolabial fold.

believe a commissure is the converging site of upper and lower vermilion-mucosal junction on the vermilion border.[8,9] Our method combined both concepts. We first determined the position of the new commissure on the upper and lower vermilion border using the anatomical characteristics method and then verified the position by using the distance from point A to the peak of Cupid's bow on the normal side as a reference. It is crucial to correctly position the anticipated commissure for satisfactory outcomes from transverse facial cleft repair.

On the basis of literature review, we summarized three oral commissure reconstruction methods: (1) using superiorly or inferiorly based vermilion flaps transpose to the opposite lip to form the neocommissure (triangle or rectangular shape),[4,5,10-14] (2) end-to-end anastomosis of the upper and lower vermilion,[3,7,8] and (3) placing other types of skin flaps between the upper and lower vermilion.[6,9,15-17] Our method belongs to the third category. Onizuka described the outermost edge of the upper and lower lip vermilion as two small opposing triangles that appear to be noncontiguous with the mouth closed.[15] In our clinical practice, we found that the upper and lower vermilion border line did not intersect at the external oral commissure, and they actually intersected at the internal oral commissure. The external and internal oral commissure was in a fan-shaped area when the mouth opened. This fan-shaped area may be "the triangular extension of skin" as Boo-Chai has mentioned.[3] On both normal and abnormal sides, we observed the fan-shaped area. On the normal side, the A, C, and D positions were the three apexes of the fan-shaped area; on the abnormal side, the A', C', and D' points defined the fan-shaped area. We then used the fan-shaped area on the normal side as the reference to measure the tissues to be removed from the abnormal side. The long-term outcomes, especially oral commissure symmetry, from our modified method were satisfactory.

Kajiwaka et al. used the end-to-end anastomosis method for oral commissure reconstruction.[7] However, both the

Table 2 General clinical and surgical data.

Characteristics	Modified repair $N = 9$
Age (months)	
Min-Max	4-31
Median	9
Mean (SD)	15.2 (11.7)
Sex (male/female)	2/7
Diagnosis	
Right macrostomia, *n* (%)	2 (22.2)
Right macrostomia + microsomia, *n* (%)	3 (33.3)
Left macrostomia, *n* (%)	2 (22.2)
Left macrostomia + microsomia, *n* (%)	1 (11.1)
Complete clefts in the lip, alveolar, and palate and left macrostomia + microsomia, *n* (%)	1 (11.1)
Surgical procedure	
Repair only, *n* (%)	4 (44.4)
Repair + Z-plasty, *n* (%)	2 (22.2)
Repair + Z-plasty + preauricular tag removal, *n* (%)	1 (11.1)
Repair + preauricular tag removal, *n* (%)	2 (22.2)
Follow-up (years)	
Min-Max	1-5
Median	4
Mean (SD)	3.1 (1.5)

vermilion flap method and the end-to-end anastomosis method fail to consider the fan-shaped area between the upper and lower vermilion, which represents the unique natural physiological and anatomical characteristics of the oral commissure area. In previous studies that demonstrated the placement of other types of skin flaps between the upper and lower vermilion to reconstruct oral commissure, the surgeons did not measure the size of the triangle skin flaps; instead, they determined by using their experience to determine the size. We used the size of the fan-shaped area of the normal side as a reference to determine the size of the skin flap on the reconstruction side.

Orbicularis oris muscle reconstruction is critical for restoring commissure function and improving appearance. When the modiolus is disrupted, there is unopposed action of the risorius, depressor anguli oris, and depressor labii inferioris muscles on the lower cleft margin. May and colleagues have suggested that closing the orbicularis oris muscle could restore muscular balance and prevent inferior displacement of the commissure.[18] Rogers believed the medially directed force produced by the orbicularis oris muscle at the commissure may directly oppose the lateral contractile force of the scar.[4] Previous reports recommended establishing a natural overhang by suturing the muscle bundle of the upper lip over that of the lower lip.[5,7,19] Although we did not find it necessary in our practice, we strongly recommended that the end point of orbicularis oris muscle closure should not go beyond the position of the anticipated oral commissure.

Linear cutaneous closure is a simple way to repair transverse facial cleft. However, it may cause lateral migration of the oral commissure with hypertrophic scarring and contracture.[7,8,13] Several nonlinear closure methods have been used, such as Z-plasty, W-plasty, and double Z-plasty.[3,7,20-22] However, some studies indicated that the nonlinear closure methods might result in more obvious scar than linear closure.[6,15,17] We performed linear closure on 6 patients and Z-plasty closure on 3 patients, and we did not find significant differences in scar score between linear and nonlinear closure. Although patients' scores of surgical scar were significantly higher than those of the healthy controls 6 months after the surgery, the scars were small and may not substantially affect facial appearance. In addition, we did not observe any scar contracture-associated commissure disposition.

Previous studies evaluated postoperative outcomes by comparing the distance from the commissure to the peak of Cupid's bow of cleft side versus the unaffected side.[4] Three-dimensional images were used for postoperative outcomes evaluation of macrostomia patients, which mainly focused on the distance measurement as well.[23] We think that overall oral commissure esthetics should also be evaluated. Thus, we adopted the extent of difference scale, which was often used to assess the facial characteristics of children with cleft lip, to evaluate the status of postoperative scar and symmetry at different time points.[24] Up to 60% of patients with hemifacial microsomia have transverse facial cleft.[25] Of the 9 children in the current study, 4 had combined hemifacial microsomia. We found that patients with combined hemifacial microsomia showed poorer facial symmetry than patients with isolated transverse facial cleft.

Conclusions

We developed a modified oral commissure positioning and reconstruction method for unilateral transverse facial cleft repair. The anatomical characteristics of oral commissure and measurement methods were combined to position the anticipated oral commissure. The modified procedure led to promising long-term benefit on restoring oral commissure symmetry.

Funding

There was no financial support for this study. The authors thank Sinocleft and Dr. Gui Su for editing and proofreading the manuscript.

Ethical approval

The Institutional Review Board (IRB) of Peking Union Medical College Hospital (PUMCH) approved the study protocol (Approval No. S-K338).

Patient consent

Written informed consent was obtained from parents of all the patients in this study.

Declaration of Competing Interest

We declare no known conflicts of interest associated with this publication.

References

1. Tessier P. Anatomical classification of facial, cranio-facial and latero-facial clefts. *J Maxillofac Surg* 1976;**4**:69–92.
2. Kobraei EM, Lentz AK, Eberlin KR, et al. Macrostomia: a practical guide for plastic and reconstructive surgeons. *J Craniofac Surg* 2016;**27**:118–23.
3. Boo-Chai K. The transverse facial cleft: its repair. *Brit J Plast Surg* 1969;**22**:119–24.
4. Rogers GF, Mulliken JB. Repair of transverse facial cleft in hemifacial microsomia: long-term anthropometric evaluation of commissural symmetry. *Plast Reconstr Surg* 2007;**120**:728–37.
5. Kaplan EN. Commissuroplasty and myoplasty for macrostomia. *Ann Plas Surg* 1981;**7**:136–44.
6. Kawai T, Kurita K, Echiverre NV, et al. Modified technique in surgical correction of macrostomia. *Int J Oral Max Surg* 1998;**27**:178–80.
7. Kajikawa A, Ueda K, Katsuragi Y, et al. Surgical repair of transverse facial cleft: oblique vermilion-mucosa incision. *J Plast Reconstr Aes* 2010;**63**:1269–74.
8. Raymond WT, Knight RJ, Fisher DM. Anatomic approximation approach to correction of transverse facial clefts. *J Plast Reconstr Aes* 2018;**71**:1600–8.
9. Hikosaka M, Nakajima T, Ogata H, et al. Refined simple line closure for macrostomia repair: designing a mucosal triangular flap on the commissure region. *J Cranio Maxill Surg* 2009;**37**:341–3.
10. Aketa J, Nodai T, Kuga Y, et al. A method for the repair of transverse facial clefts. *Cleft Palate J* 1980;**17**:245–8.
11. Chen K-T, Noordholff S. Congenital macrostomia–transverse facial cleft. *Changgeng Yi Xue Za Zhi* 1994;**17**:239–47.
12. Li J, Liu K, Sbi J, et al. Commissural symmetry in unilateral transverse facial cleft patients: an anthropometric study. *J Oral Maxil Surg* 2012;**70**:2184–90.
13. Eguchi T, Asato H, Takushima A, et al. Surgical repair for congenital macrostomia: vermilion square flap method. *Ann Plas Surg* 2001;**47**:629–35.
14. Franco D, Franco T, da Silva Freitas R, et al. Commissuroplasty for macrostomia. *J Craniofac Surg* 2007;**18**:691–4.
15. Onizuka T. Treatment of the deformities of the mouth corner. *Keisei Geka Plast Reconstr Surg* 1965;**8**:132–7.
16. Fukuda O, Takeda H. Advancement of oral commissure in correcting mild macrostomia. *Ann Plas Surg* 1985;**14**:205–12.
17. Ono I, Tateshita T. New surgical technique for macrostomia repair with two triangular flaps. *Plast Reconstr Surg* 2000;**105**:688–94.
18. May H. Transverse facial clefts and their repair. *Plast Reconstr Surg* 1962;**29**:240–9.
19. McCarthy JG. Oral commissure repair. *T*he artistry of reconstructive surgery: selected classic case studies. Mosby: St Louis; 1987. p. 267–71.
20. Bauer B, Wilkes G, Kernahan D. Incorporation of the W-Plasty in repair of macrostomia. *Plast Reconstr Surg* 1982;**70**:752–7.
21. Skoog TG. *Plastic surgery: new methods and refinements*. WB Saunders Company; 1974. p. 146–54.
22. Yu C-C, Goh RC, Lo L-J, et al. Surgical repair for macrostomia: significance of Z-plasty limb directions. *Ann Plas Surg* 2010;**64**:751–4.
23. Tuersunjiang M, Long X, Fu Y, et al. Reconstruction of the oral commissure in patients with unilateral transverse facial cleft. *Br J Oral Maxillofac Surg* 2018;**56**:621–5.
24. Broder HL, Flores RL, Clouston S, et al. Surgeon's and caregivers' appraisal of primary cleft lip treatment with and without nasoalveolar molding: a prospective multicenter pilot study. *Plast Reconstr Surg* 2016;**137**:938.
25. Vento AR, Labrie RA, Mulliken JB. The omens classification of hemifacial microsomia. *Cleft Palate-Craniofac J* 1991;**28**:68–77.