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Anatomic approximation approach to correction of transverse facial clefts



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Abstract Transverse clefts of the oral cavity have significant impacts on both appearance and function. Many methods of repair have been described, but there is no consensus on optimal approach. In addition, dissatisfaction with scars, distortion of appearance, and recurrent deformity have led to complex surgical designs that are difficult to understand and reproduce. We describe a simple approach to repair that is based upon anatomic approximation of lip components and accurate repair of the muscle.

Twenty patients underwent repair by the senior author, who devised the approach, and the corresponding author, who adopted it. Eight (62%) patients had right-sided clefts, three (23%) patients had left-sided clefts, and two (15%) patients had bilateral clefts. One patient had an associated branchial cleft remnant, two patients had multiple branchial cleft remnants and tragus deformities, one patient had craniofacial microsomia with microtia, and one patient had a contralateral Tessier 1 cleft. Mean age of the patients at repair was 23 months. All patients achieved normal oral competence, have favorable scars and commissure appearance, and have had no recurrent deformity. None of the patients have required revision.

The described surgical approach is reproducible, easy to understand, and can produce favorable outcomes.

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Introduction

Macrostomia or transverse facial clefts involve a lateral opening of the oral commissure. Issues related to oral competence, especially with eating, drinking, and speech, produce significant functional burden. Aberrations in appearance may range from minor asymmetries with facial animation to marked lateral facial dysmorphology.

Transverse facial clefts are also known as Tessier number 7 clefts[1]. Although rare, they are the most common of all craniofacial clefts. Males are more frequently affected than females and approximately 10% of the cases are bilateral[2-4]. The anomaly is sporadic in nature and has an incidence of approximately 1:80,000 to 1:300,000 live births[5]. Unilateral isolated cleft anomalies often present with a left-sided predilection and rarely extend beyond the

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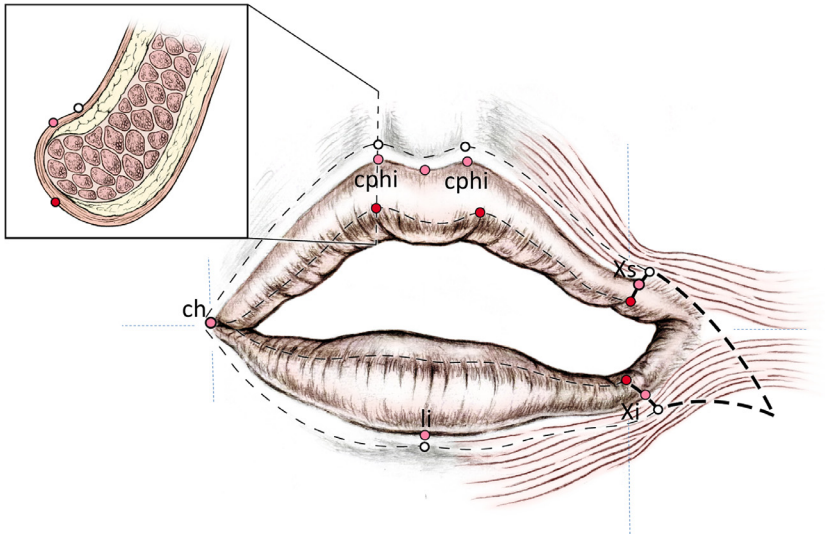


Figure 1 Anatomy and design. The superior and inferior points of lip closure (Xs and Xi) are identified as the point along the vermilion at which the vermilion-mucosal junction (red line) starts to converge with the vermilion border. The white roll becomes deficient beyond those points. The distances cphi-Xs and li-Xi should, respectively, approximate cphi-ch and li-ch on the noncleft side. Points Xs and Xi are along the vermilion border (pink dots), and corresponding points above the white roll (white dots) and along the red line (red dots) are marked for approximation. The lateral excision is tapered to mimic a skin crease on the noncleft side. The orbicularis and risorius muscles need to be approximated. On sagittal section, the orbicularis muscle has a "J" shape, which can be accurately reapproximated along the repair site to produce the 3D form of a commissure.

anterior edge of the masseter muscle[6,7]. The etiopathology of the phenomenon, which occurs during the third to eighth embryological week, is poorly understood,[8] and van der Meulen et al. have tried to correlate clinical clefting features with specific embryological events that define facial development[5]. They describe macrostomia as the failure to fuse between the maxillary and mandibular processes of the first branchial arch[9]. Theoretical causes predicating the anomaly include failure to fuse[4,10], failure of mesodermal migration/penetration,[11] and amniotic band theory. Additional hypotheses related specifically to the Tessier number 7 cleft are that this clefting represents an interruption of the stapedial artery to a variable degree causing a spectrum of presentation related to the first and second branchial arches and their orotragal line of fusion[12]. Transverse facial clefts may be associated with a spectrum of other anomalies including craniofacial microsomia[13] and, at the most extreme end of the disruptive spectrum, Treacher Collins syndrome. While the spectrum of pathology may be wide and could involve as little as a small groove-like deformity of the cheek, there is always an underlying separation of the labial and cheek musculature[14].

Although a myriad of techniques to correct transverse facial clefts have been described, there is a conspicuous lack of long-term aesthetic and functional outcomes in the literature. Unsatisfactory commissuroplasty has led to numerous descriptions of designs to address unfavorable scars and unnatural appearances. Many of these designs are complex and often nonanatomical, and consequently, they are difficult to reproduce (i.e., appropriate size and dimensions of squares, flaps, and Z-plasties). Given that cleft surgeons at high-volume centers will only encounter a few children with transverse facial clefts during their career, a technique of repair that incorporates a simple and reliable design would be of great utility.

The anatomic subunit approximation approach to unilateral cleft lip repair was introduced in 2005 and has begun to gain wide acceptance[15]. The Fisher technique has been accepted as one of the major standards of care,[16] and hybrid techniques are being utilized that teach surgeons trained in other techniques to transition to the subunit approach[17-19]. Principles of that repair include the following: (1) overt identification and consideration of all available anatomic landmarks; (2) excision of any abnormal tissues; (3) accurate approximation of normal muscular anatomy; and (4) repair using normal tissues along borders of anatomic subunits. The same principles may be applied to repair of transverse facial clefts as a simple yet effective way to produce favorable results. We present a measured and landmark-based repair to correct transverse facial clefts.

Surgical technique

Analysis and planning

Active animation, especially lower lip depression, can reveal discontinuity of musculature that extends laterally, well beyond the overt cleft. Preoperative examination is important given that the dynamic nature of the deformity is less apparent under general anesthesia, while in repose.

All available relevant anatomic landmarks are identified and marked (Figure 1), working systematically from "known" normal landmarks (midline or noncleft side) to "unknown" landmarks (cleft side):

- Upper lip midline (labialis superioris, ls) and Cupid's bow peaks (crista philtri inferioris, cphi)

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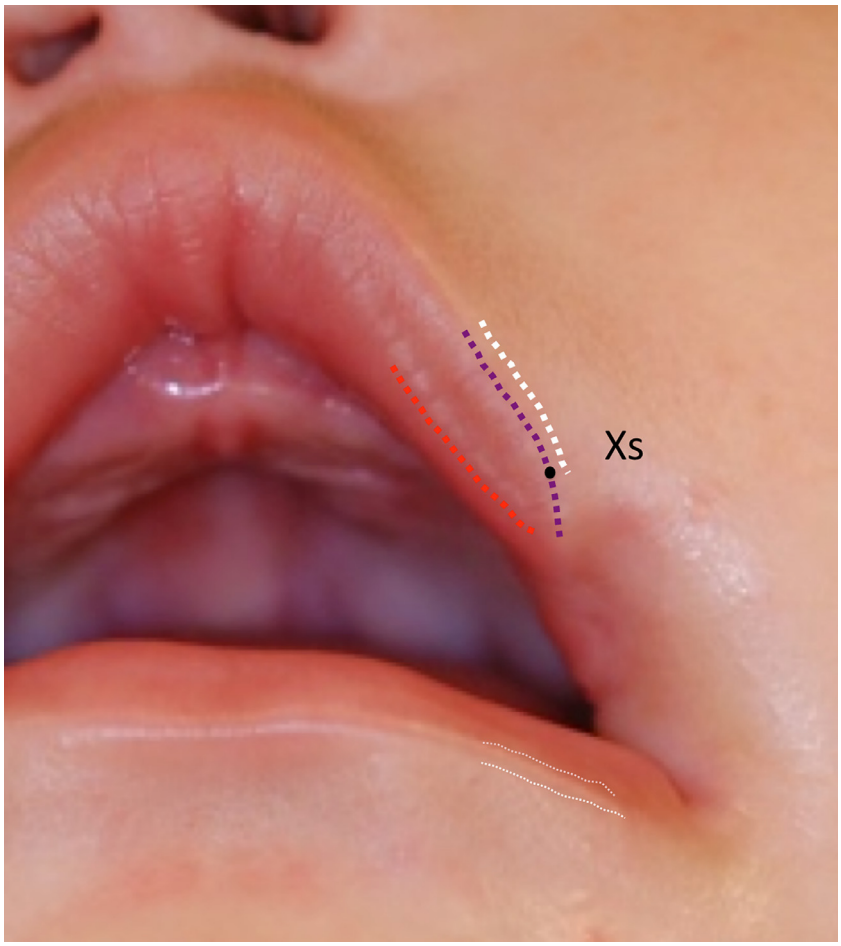


Figure 2 Point of lip closure. Point X is selected along the lip where the vermilion-mucosal border (red line) starts to converge with the vermilion border (purple line). Medial to the point, the white roll (white line) appears normal, whereas lateral to the point the white roll becomes deficient.

- Lower lip midline at central bow (labialis inferioris, li). If it is not obvious, trace the course of mucosal frenulum from buccal surface to external.
- Commissure (ch) on the noncleft side

Despite the cleft side possessing no normal commissure, distinct landmarks can be found to determine the appropriate points of closure for the new commissure. Anatomical points much akin to "Noordhoff's point"[20], can be found on both upper (X superioris, Xs) and lower (X inferioris, Xi) lips where the tissues distinctly transition from normal to a progressive deficiency.

These points can be identified using several identifiable anatomical features (Figure 2):

(1) The vermilion-mucosal junction (or red line) parallels the vermilion border from medial to lateral and transitions to swoop and converge with the vermilion border. Despite the vermilion being widest in this area, it is at the transition of the lines converging that defines this point.
(2) Medial to the transition, the white roll is normal. Lateral to the transition, the white roll becomes deficient.
(3) The vermilion height at this transition point usually matches that at the commissure on the noncleft side.

When Xs and Xi are approximated, the new commissure should approximate the position of the chelion (ch) on the noncleft site. The distance of X to each of the upper (cphi) and lower (li) lip landmarks may not perfectly reflect those on the noncleft side (i.e., ch-cphi and ch-li, respectively) but should be within several millimeters. The distance and orientation of the new commissure relative to the tragus should also approximate that on the noncleft side (tr-ch).

Landmarks corresponding to Xs and Xi are identified both above the white roll (Figure 1- white circles) and along the red line (Figure 1- red circles). These three landmarks (red line, vermilion border, and superior white roll) are accurately approximated for final anatomic repair. Incisions are designed to pass through the three landmarks, perpendicular to the lip, and parallel to the lip creases.

The excision of tissues along the cleft margin is then tapered to an apex so that the cutaneous closure lies along an anticipated line of facial animation. Rhytides are not obvious in young children; therefore, manual pinching of the skin can demonstrate natural lines of election (Figure 3). If a branchial arch remnant is present, it can be incorporated into the excision. The two limbs along the cutaneous excision may not be of the same length. On the mucosal side, the excision is simply tapered to an apex with

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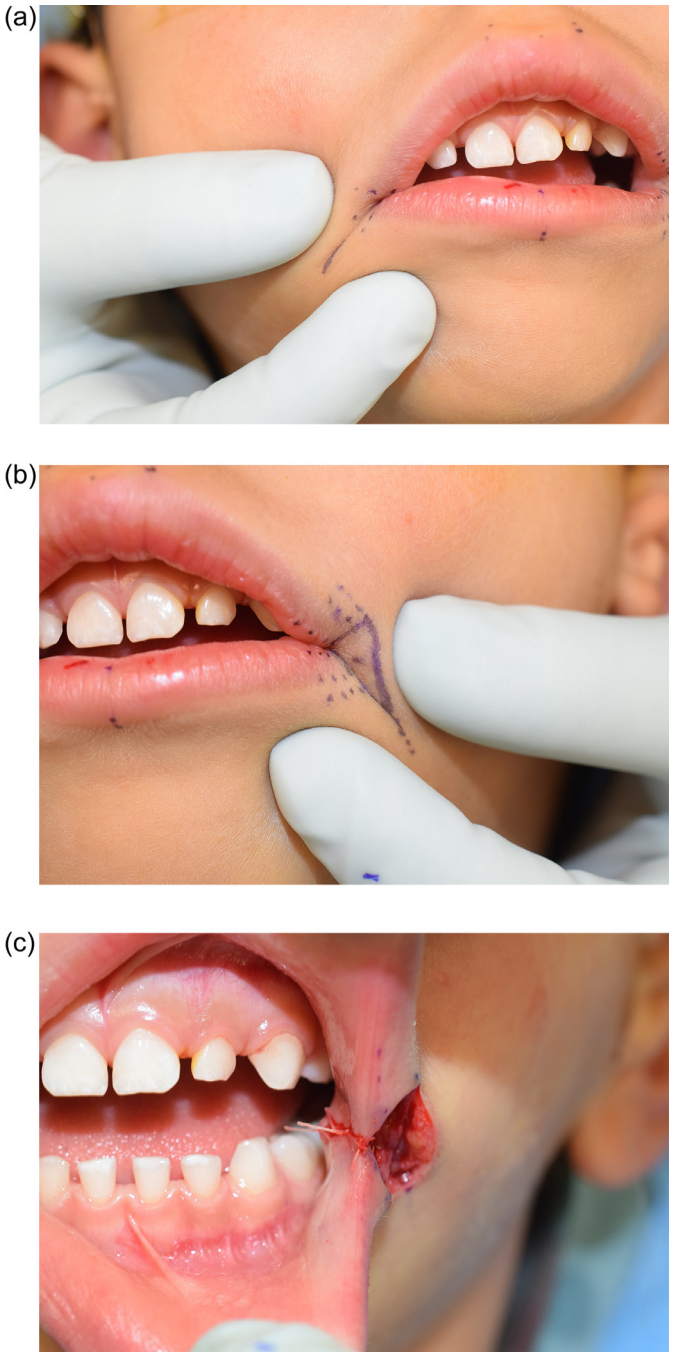


Figure 3 Line of closure. The orientation of the line of closure is selected based upon anatomic subunits. (a) The crease extending from commissure to cheek is identified on the noncleft side and (b) is transposed to the cleft side; (c) Direct closure of oral mucosa.

equal limbs given that the orientation of the intraoral scar is of no consequence.

Incision and dissection

Surgical incision and excision should remove marginal tissue and expose well-developed muscular structures. Adequate muscle dissection from the mucosa and skin is needed to allow accurate approximation of all anatomical structures along the line of excision. Excessive dissection should be avoided to prevent tissue trauma, edema, and scarring. The intricate architecture of orbicularis oris muscle must be preserved. The pars marginalis forms a "J" shape that contributes to subtle but important lip appearance (Figure 1 inset). On the cutaneous side, the muscle projects superficially under the white roll where the subcutaneous tissues are thin. On the buccal side, the muscle also becomes very superficial under the vermilion where the submucosa thins along the transition from mucosa to vermilion. Preservation of the "J" shape of the orbicularis contributes to the pout of the lip. It is important to note that very little or no dis-

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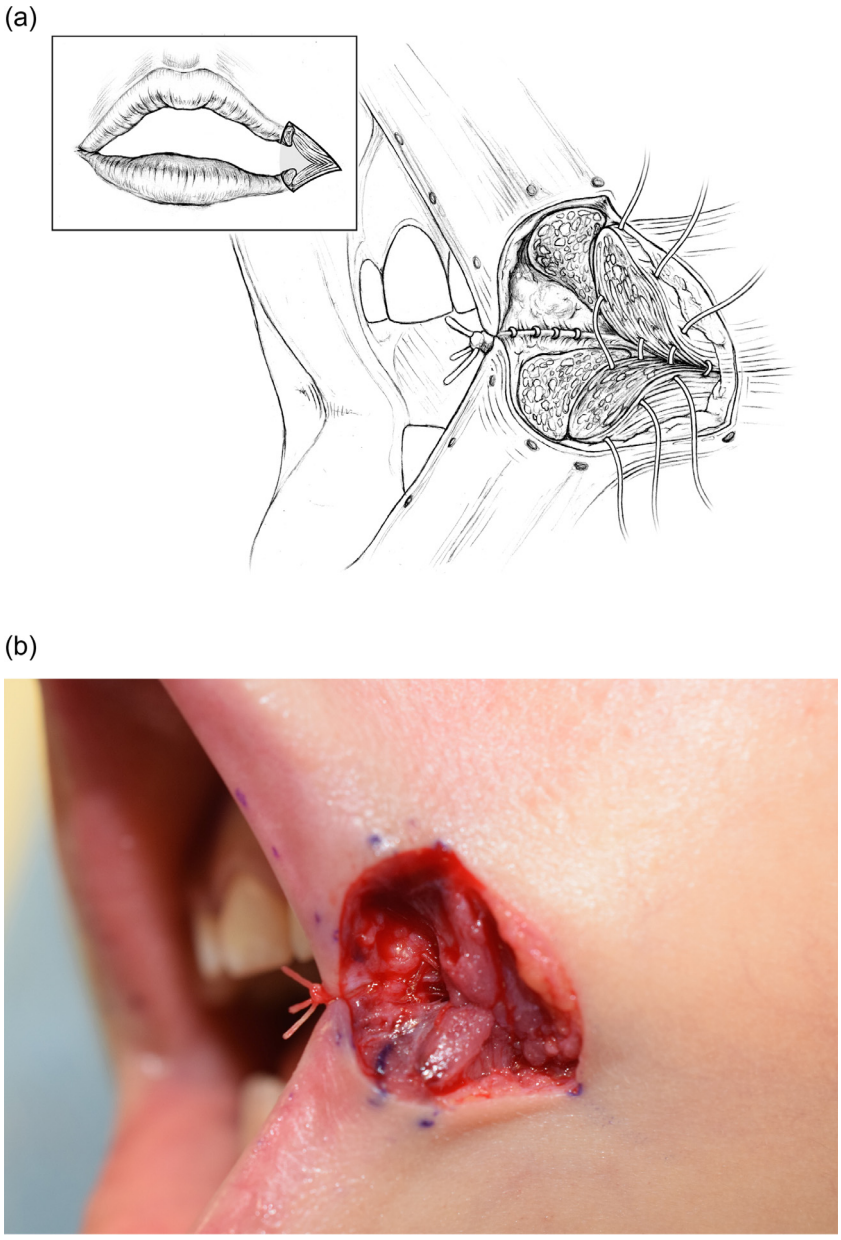


Figure 4 Anatomic muscle approximation. Following full-thickness incision, the mucosa is aligned and closed up to the vermilion-mucosal border. The risorius is then repaired up to its junction with the orbicularis. Accurate approximation of the corresponding "J" shape of the orbicularis produces a natural commissure contour.

section of muscle along the white roll and vermilion is performed to prevent distortion of these structures at closure.

Tissue alignment and approximation

Mucosa is repaired first to facilitate repair. Anatomical approximation of muscle is then critical to produce favorable appearance and function (Figure 4). Muscle is repaired as a continuous sheet. Fibers of the risorius can be seen coursing from lateral to medial, where they blend with deep fibers of the orbicularis oris. Simple approximation of risorius progresses from lateral to medial with care to ensure alignment of the orbicularis. The fibers of the orbicularis course in an orthogonal manner relative to the fibers of risorius. They arise underneath the latter and project into the free margin of the lip. The "J" shape of the upper and lower lip orbicularis muscles is carefully approximated ensuring alignment of the red line, vermilion border, and white roll for final surface closure (Figure 4). If the risorius and deep part of the orbicularis muscle are well aligned, the pars marginalis, immediately under the white roll, should project above the plane of the risorius (Figure 5).

Final closure of the deep dermis and superficial skin is performed with an emphasis on careful alignment of white roll and vermilion. No Z-plasty is performed during the initial procedure as the nasolabial crease is not always

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Figure 5 Alignment and approximation of the pars marginalis. With risorius and the pars peripheralis of the orbicularis repaired, the pars marginalis projects and has a natural "pout." Minimal dissection between the muscle and white roll/vermilion preserves lip form. Alignment and approximation of the muscle along the white roll and vermilion produces a natural contour of a commissure.

Table 1 Indirect anthropometric analysis using 3D stereophotogrammetry.

Case	Time	Oral aperture					
		Upper lip			Lower lip		
		Noncleft cphi-ch	Cleft cphi'-ch'	Ratio*	Noncleft li-ch	Cleft li-ch'	Ratio*
#1	Preoperation	28	36.5	0.77	21	30	0.70
	1 year	29	29	1.00	19	18	1.06
#2	Preoperation	18	29.5	0.61	15	22.5	0.67
	Postoperation	17	19	0.89	13	14	0.93
	1 year	20	20	1.00	16.5	17	0.97
	4 years	19.9	20	1.00	22	24	0.92
#3	Preoperation	30	35	0.86	29	31	0.94
	Postoperation	31	31	1.00	28	28	1.00

* Noncleft:cleft

apparent in younger children and must be determined with dynamic animation (which can change with initial repair).

Results

We conducted a review of all transverse facial cleft cases treated by a two surgeons at two separate high-volume centers in Canada and the United States (DMF and RWT). During a 16-year career (2000–2016), the most senior surgeon performed 705 primary cleft repairs, of which 534 were unilateral cleft lip, 155 were bilateral cleft lip, and 16 were facial clefts. Of the 16 facial clefts, 10 were Tessier number 7 clefts. During a 6-year career (2010–2016), the corresponding surgeon performed 176 unilateral cleft lip repairs, 46 bilateral cleft lip repairs, and 3 transverse facial clefts. One additional case of transverse facial cleft presented, but the family declined surgical correction thus far. The corresponding surgeon (RWT) reproduced the system of repair devised by the senior surgeon (DMF).

In this series, eight (62%) patients had right-sided clefts, three (23%) patients had left-sided clefts, and two (15%) patients had bilateral clefts. One patient had an associated branchial cleft remnant, two patients had multiple branchial cleft remnants and tragus deformities, one patient had craniofacial microsomia with microtia, and one patient had a contralateral Tessier 1 cleft. The mean age of the patient at repair was 23 months (range 5–58 months). All patients had favorable scars and commissure appearance with no recurrent deformity. All patients achieved normal oral competence. Example cases performed by the more junior surgeon (RWT), with and without associated branchial cleft remnants along the cleft, are presented in Figures 6 and 7. An example case by the senior surgeon (DMF), including 10-year follow-up, is presented in Figure 8. None of the patients in this series required any revision.

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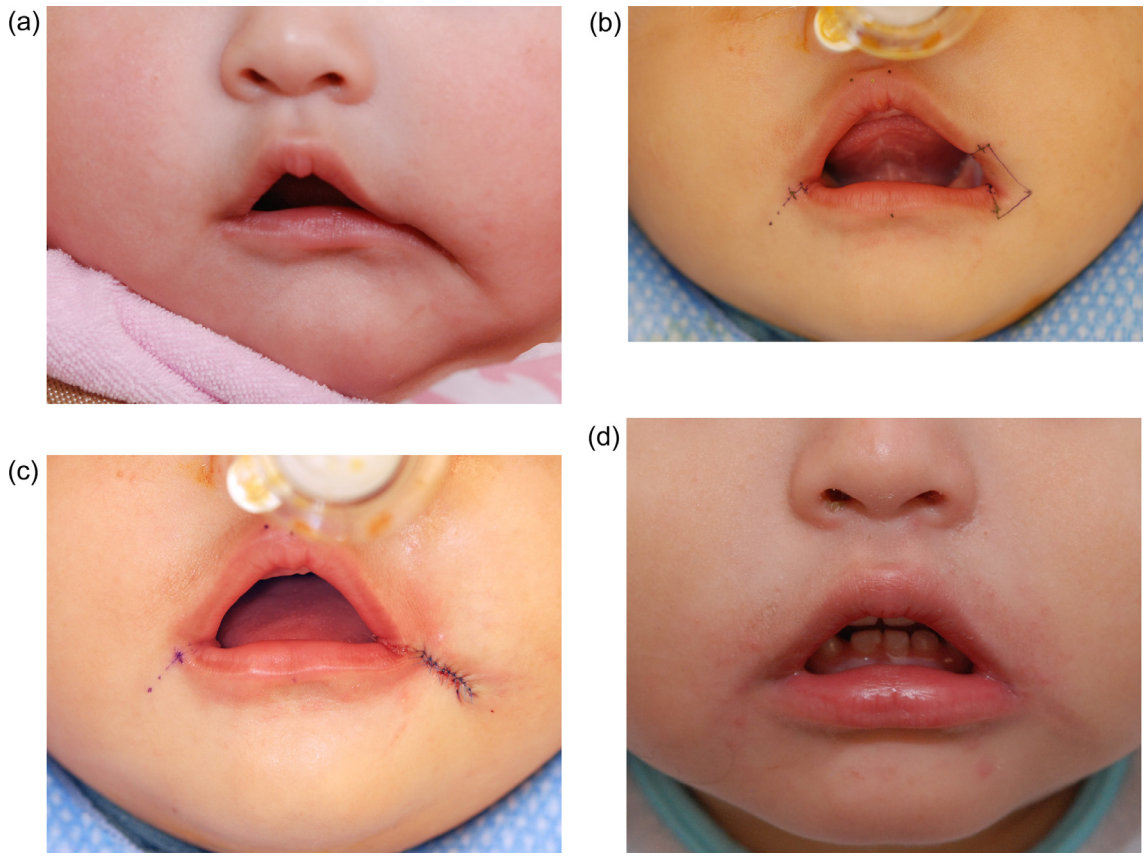


Figure 6 Case example. (a) Active lip depression preoperation; (b) Lip markings; (c) Immediate postoperation; (d) One year after surgery with active lip depression.

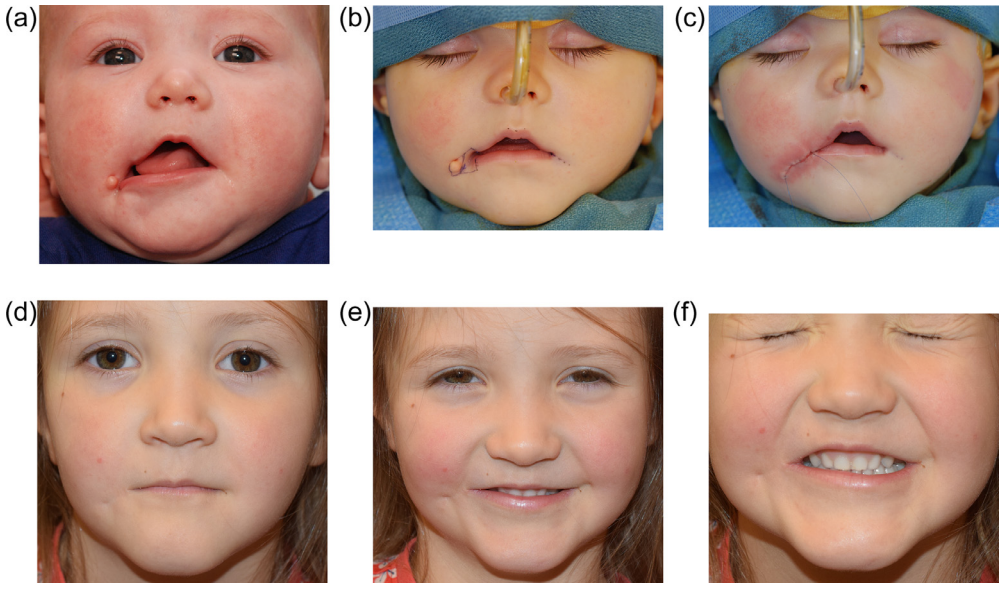


Figure 7 Case example with modified markings. (a) Active lip depression preoperation; (b) Lip markings including excision of branchial cleft remnant; (c) Immediate postoperation; (d) 4 years postoperation in repose; (e) 4 years postoperation animated; (f) 4 years postoperation with lip depression and grimace.

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The three patients repaired by the more junior surgeon (RWT) had preoperative and postoperative 3D images (3dMD Cranial System, 3dMD, Atlanta, GA) available. Table 1 summarizes preoperative and postoperative indirect anthropometric analyses using 3dMD Vultus (3dMD, Atlanta, GA) for each subject.

Discussion

Numerous techniques have been described to repair transverse facial clefts in an attempt to produce favorable aesthetic and functional results. Many of these repairs, however, involve complex designs that may be difficult to reproduce. Some of the repairs involved complex mucosal transpositions[14,21,22], muscle transpositions[23,24], cutaneous transpositions (Z-plasty[5,14,23,25,26,27,28,24,29,30], W-plasty[31,32], and square flaps[33]), and lip/vermilion transpositions[23,26,33,34]. Most of these are difficult to understand and reproduce, and none of these involve anatomic repair that follows anatomic subunits. Published results often display conspicuous nonanatomic scars[5,23,25,27,31,32,28,29,34,29,30] and distorted commissure appearance[29,28,34,29,30]. Considering that even a high-volume cleft surgeon will encounter very few of these cases during their career, a simple and reliable repair that produces favorable outcomes would be helpful. There have been no recent estimates of incidence, and we do not know of previous studies documenting the relative incidence compared to more common orofacial clefts. We found a consistent ratio of approximately 55:15:1 for unilateral: bilateral: transverse clefts at two different centers.

We describe a simple approach that is anatomical, easily reproducible, understandable, and clinically effective. It permits adequate but not excessive dissection. It is simplistic in its design and uses a system of land marking of perceived normal anatomical points (Xs and Xi), to achieve symmetry at the commissures. Transposition, Z-plasty, and W-plasty repairs that create extra scarring are generally not necessary. The described technique considers the intrinsic anatomy and orients scar along the lines of election that compliment functional animation of the face without iatrogenic distortion.

Based upon our experience, overlap of muscles to "create" a modiolus is not necessary given that the muscle elements are present and tend to be robust once the hypoplastic tissues along the borders of the cleft have been excised. We emphasize anatomic approximation of the muscles in which the buccinator can be seen as a different muscle than the orbicularis (Figure 4) to effectively produce a modiolus. Ultimately, we cannot reproduce the intricate decussation of individual fibers of the modiolus, and thus, we avoid the additional dissection and scar required when overlapping gross bundles of muscle.

Although final skin closure is in a straight line, orientation of closure along natural creases can make the eventual scar less obvious. In more severe cases, when closure necessitates crossing natural creases, contracture could make the eventual scar unfavorable. We prefer to address any such potential scar problems on a secondary basis given that straight-line scars can heal favorably with underlying muscle repair. To date, no patients have elected for revision.

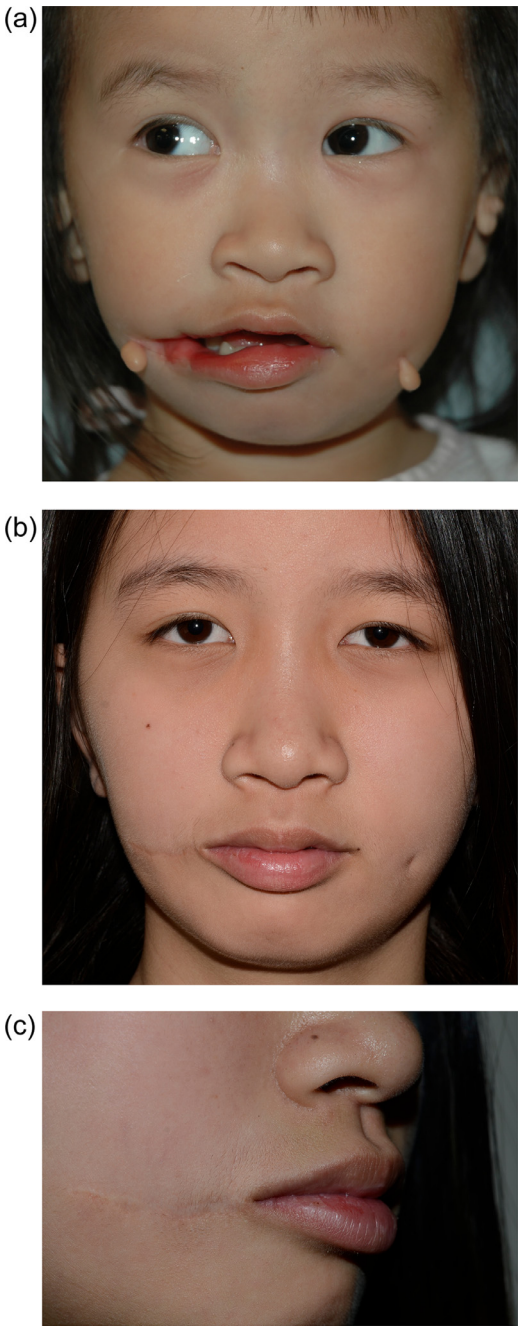


Figure 8 Long-term follow up. (a) Preoperation; (b) 10 years postoperation; (c) Maintenance of natural commissure appearance and function.

Our approach may seem similar to that described by Skoog[35]; however, there are several important differences. While Skoog uses freeform incisions, our markings follow anatomic landmarks (Xs and Xi, the equivalent of "Noordhoff's point" and their corresponding points above the white roll and along the red line), as well as the natural creases of the lip that define anatomic subunits. Skoog dissects the muscle layer widely and separates buccinator from orbicularis, whereas we dissect only enough to allow accurate placement of sutures and leave the intricate architecture at the convergence of these muscles intact. The limited dis-

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section, especially along the pars marginalis and white roll, preserves the 3D contours that form a pout and a natural commissure contour when corresponding elements are approximated. Finally, Skoog trims excess skin at final closure in a cut-as-you-go manner, whereas excision and closure is inherent in our design that follows anatomic subunits.

The most senior surgeon (DMF) has used it in 10 cases for a period of 16 years. The corresponding author (RWT) has reproduced the approach with favorable outcomes in the first three cases in practice. With anatomical repair of the muscle, the appearance of the commissure can essentially appear normal. The 3D anthropometric analysis provides additional objective evidence of anatomic alignment and improved facial symmetry. The explicit land marking allows more of a "measure twice, cut once" style of repair and potentially reduces any learning curve. This series is one of the largest reported.

Conclusions

Simple anatomic approximation can produce near-normal appearance and function following repair of transverse facial clefts.

Financial disclosure statement

The authors have no conflicts of interest to disclose.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.bjps.2018.05.020.

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