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Modified two-flaps palatoplasty with lateral mucus relaxing incision in cleft repair

A STROBE-compliant retrospective study

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Abstract

Study Design: clinical results of A STROBE-compliant retrospective study

Objective: To achieving adequate pharyngeal closure and improve the pharyngeal function by a modified two-flap palatoplasty.

Summary of Background: Excessive tension in soft palate is the main factor causing the dysphonia after cleft palate. The tension-free suture of the soft palate is the key to achieving adequate pharyngeal closure. In this paper, a modified two-flap palatoplasty improved the pharyngeal function

Methods: From August 2016 to December 2017, 20 patients with cleft palate were treated with a modified two-flap palatoplasty of the posterolateral symmetrical mucosal relaxation incision. The mucosal relaxation incision was performed on both posterolateral sides of the soft palate.

Results: All cases had good healing of mucosal flap and the palate. All patients underwent endoscopic examination at 6 months after operation. The postoperative results were satisfactory, with no complications. Twelve patients had bilateral exudative otitis media before operation, 4 patients returned to normal postoperatively, and 8 patients underwent bilateral tympanic membrane catheterization; 2 patients had abnormal function of bilateral eustachian tube before operation and returned to normal postoperatively; 3 patients had unilateral exudative otitis media before operation, and all of them returned to normal; the acoustic impedance test was normal in 3 children before operation. Most children begin to learn to speak, parents are satisfied with their pronunciation, and 3 children are in speech rehabilitation due to unclear pronunciation.

Conclusions: We propose a technique to improve the function of the velopharyngeal closure which effectively reduces the incidence of pharyngeal insufficiency and occurrence of operative correction of pharyngeal closure dysfunction. The modifed two-flap palatoplasty with posterior lateral symmetric mucosal relaxation incision is beneficial for better velopharyngeal closure.

Abbreviations: VPI = velopharyngeal insufficiency, V-W-K = Veau-Wardill-Kilner.

Keywords: cleft palate, velopharyngeal insufficiency (VPI), nasal endoscopy

1. Introduction

Cleft palate is a common type of birth defect. It is the result of tissues of the face not joining properly during development. The overall incidence of cleft palate in China is about 2.6 per 10,000 births.[1] Cleft Palate can occur as complete (soft and hard palate, possibly including a gap in the alveolus) or incomplete (a 'hole' in the roof of the mouth, usually as a cleft soft palate). It usually

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The project design was conducted in line with scientific and ethical principles. The institutional review board approved this project.

All participants in this study have provided informed written consent prior to enrollment.

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All data generated during the project will be made freely available via the Shanghai Jiaotong University's Research Data Repository. DOIs to these data will be provided (as part of the DataCite programme) and cited in any published articles using these data and any other data generated in the project There are no security, licensing, or ethical issues related to these data.

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results in difficulty with feeding, speech, hearing, and frequent mucotympanon, greatly affecting the psychologic status and living quality of the patients and parents'.

Cleft palate can be corrected by surgery. Palatoplasty is typically performed not only to close the soft and hard palate but also to produce a long and mobile soft palate, thus achieving physiologic velopharyngeal function. The functional goals of palatoplasty include normalizing voice resonance, improving feeding and oronasal hygiene, preventing nasal regurgitation, and improving eustachian tube function.

Restoring the levator muscle's function and increasing palate length are the most critical procedures used to achieve velopharyngeal competence. The direction of our efforts is to discern better technical methods which minimize trauma from surgery in the clinic. In this study, we performed the modified two-flaps palatoplasty by elongation of nasal myomucosal flap with lateral mucus relaxing incision.

2. Patients and method

2.1. Patient population

Between August 2016 and August 2017, this technique was performed on 20 patients (8 male and 12 female) with a median age of 18 months (range, 9–53months). With these patients, 14 cases were of incomplete cleft palate and 6 cases were of complete cleft palate. They were all treated with a modified two-flaps cleft palate repair of the posterolateral symmetrical mucosal relaxation incision of the soft palate. Nasopharyngoscopy was performed 6 months after surgery. The surgeon did regular follow-ups with all of the patients.

2.2. Ethical statement

This research did not increase the risk and economic burden of patients; the patients' rights were fully protected; the project design was conducted in line with scientific and ethical principles. The institutional review board approved this project.

2.3. Informed consent statement

All participants in this study have provided informed written consent prior to enrollment.

2.4. Equipment, surgical procedures

The two-flaps cleft palate repair technique relieves sputum tension by combining of 2, mucoperiosteal flaps with incisions of the posterolateral symmetrical mucosal aspects of the soft palate. All patients required general anesthesia. (Fig. 1 A)

The palatal length was measured by a ruler during both acute pre-operation and acute post-operation. For local vasoconstriction and decreasing bleeding during surgery, a mixture of lidocaine and adrenaline (lidocaine 1% and epinephrine 1:100,000) was infiltrated under the oral mucosa in both the hard and soft palates until the pink, oral mucosa become pale. This helped to hydrodissect the palatal tissues and improved hemostasis. The medial incisions of the mucoperiosteal flaps were marked at 2 to 3 mm lateral to the medial margins of the cleft so as to transfer more oral mucosa to the nasal side, thusachieving tension-free closure of the nasal, periosteal flap. The lateral incision was located at the junction of the hard palate mucosa and the gingiva (Fig. 1B)

To lift the mucoperiosteal flap from the palatal bone, the lateral incision was joined at the anterior end of the hard palate, The periostal datacher was used to create a plane between the palatal bone and nasal mucosa. This helped the nasal mucosa to be fully free, which helped to fully close the nasal cavity. The tip of the suction cannula was used to lift the mucoperiosteal flap away from the hard palate during the dissection (Fig. 1C).

In order to fully remove the periosteal flap of the hard palate surface, it was necessary to fully release the palatine vascular and nerve bundle. The greater palatine vessels are located just anterolateral to the posterior end of the bony palate. The periosteal cuff could be dissected circumferentially to further release the vascular pedicle in wide cleft patients to achieve better mobilization of the palatal flaps. After releasing the vascular pedicle on both sides, the flaps were moved medially to check whether we could achieve tension-free suture. If further mobilization were needed, we further dissected and released the pedicle. With this, care should be taken to avoid undue traction and injury to the pedicle during the dissection. The next step was to separate the oral myomucosal flap of the soft palate. We used scissors to cut on medial side (just distal to the hard palate bone) between the oral part and nasal soft palate.

It is difficult to dissect and release the nasal myomucosal flap completely. Injury to the tensor aponeurosis should be avoided. In the cleft palate anomaly, tensor and levator muscles are closely related. The tensor aponeurosis attaches to the posterior border of the hard palate, and the levator inserts at the margin of the cleft in the anterior half of the velum. More time is usually spent to dissect and release the posterior border of the hard palate. While dissecting, it is important to protect the hamulus pterydoideus to restore normal tension of the velum after surgery. After dissociating the posterior and medial border of the hard palate, the nasal myomucosal flap is completely mobilized with the help of a periosteal detacher so that it can be sutured with the opposite nasal layer, or flap, over the vomer bone. As the nasal layer is completely mobilized in the region of the hard palate, a tension-free closure is achieved both in hard and soft palate areas. Once the nasal myomucosal flap is dissociated completely, the levator muscles move posteriorly, and return to the physiological anatomical site.

For better palatopharyngeal closure, we needed to lengthen the velum. Two incisions were made in the middle of the levator muscles of the nasal myomucosal flap, along the medial margins of the cleft bilaterally. The medial incision of the myomucosal flaps is usually 3 to 4 mm long and 5 to 6 mm wide so as to guarantee better palatopharyngeal occlusion (Fig. 1D). Then the nasal layer was repaired with polyglactin 5/0 suturing. After the nasal myomucosal flaps were stitched together, closure of the oral layer was started from the posterior to the anterior direction. In the end, we made two, lateral incisions at the inferior aspect of the soft palate to release the soft palate tension, and improve palatopharyngeal occlusion. The length of the incision depends on the tension of the soft palate. (Fig. 1E)

3. Results

The mean preoperative palatal length was 39.15 mm, and the mean post-operative palatal length was 43.75 mm. The mean range of palatal elongation was 4.6 mm (Table 1). Immediately after the operation, the mucosa of the palate was edematous for several days. All patients were fed through nasogastric tube for a week, oral care taken twice a day. Basic antibiotic medicine was

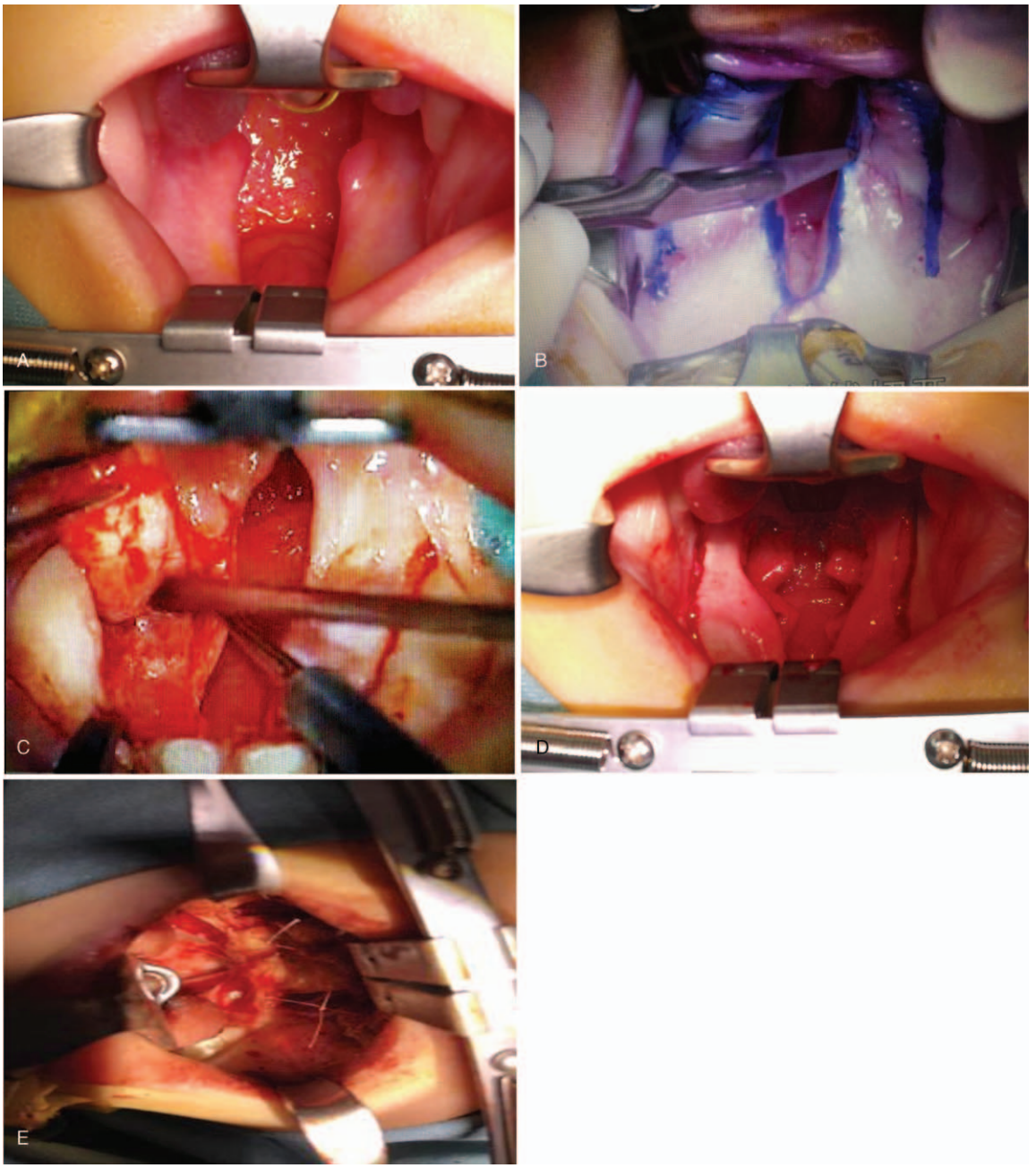

Figure 1. A: Preoperative photograph of a patient with cleft palate; B: Marking of the incisions; C: lift the mucoperiosteal flap; D: Make incisions in the middle of the levator muscles of the nasal myomucosal flap along the medial margins of the cleft bilaterally; E: Make two sideling incisions at the bottom of soft palate bilaterally to release the tension of the velum.

administered for a week. All study patients healed well. Postoperative outcomes were satisfactory, with no complications such as dehiscence, perforation, or palatal fistula. All patients underwent a 6-month nasoendoscopy examination after surgery, and they generally achieved velopharyngeal competence. A representative case is shown in Figure 2. The current average age of the children is 38 months. None of them has nasopharyngeal reflux.

Acoustic Impedance Tests: There were 12 patients with bilateral, exudative, otitis media before operation; 4 patients returned to normal after operation, and 8 patients underwent bilateral tympanic membrane catheterization; 2 patients had abnormal function of bilateral eustachian tube before operation; however, returned to normal after surgery. There were 3 unilateral, exudative, otitis media before operation, and all of them returned to normal after operation; the acoustic impedance test was normal in 3 children before operation. Speech Situation: Most children began to learn to speak, and their parents were generally satisfied with the pronunciation of the children; three children are in speech rehabilitation because their pronunciation is not satisfactory. These children are still in regular, postsurgery follow-ups.

Table 1

The basic data of the cleft palate patients.

Number	Sex	Surgery Age (month)	Width of the fissure (preoperation)	Length of the fissure (pre-operation)	Preoperative palatal length (mm)	Postoperative palatal length (mm)	The range of palatal elongation (mm)
1	male	13	8	23	45	48	3
2	male	13	4	14	35	40	5
3	female	11	15	25	35	45	10
4	female	20	10	25	40	45	5
5	female	11	15	35	40	45	5
6	female	10	11	20	38	43	5
7	female	12	5	8	42	45	3
8	female	23	8	20	43	47	4
9	female	23	12	28	38	43	5
10	male	12	8	14	40	43	3
11	male	11	3	7	40	43	3
12	female	17	6	7	45	50	5
13	female	23	12	35	42	45	3
14	female	12	6	15	30	33	3
15	male	11	15	28	40	45	5
16	male	9	11	14	35	40	5
17	female	11	15	25	35	40	5
18	male	20	15	25	35	40	5
19	male	53	10	15	40	45	5
20	male	55	13	25	45	50	5
mean		18.5	10.1	20.4	39.15	43.75	4.6

4. Discussion

Cleft palates arise because of the failure of fusion of the lateral palatine processes, the nasal septum, and/or the median palatine processes, and these are usually congenital defects. They can be reconstructed by combining existing tissue towards the "normal" anatomy, without compensation (exogenous grafts, biomaterials, etc). To elaborate, the basic principle of palatoplasty is to use local tissue flaps to close the cleft, extend the length of the soft palate, reset the dislocated muscular structures, and to increase the function of the soft palate. Normal palatopharyngeal occclusion is the most important factor to affect the post-operation speech function of these patients.[2]

Various surgical methods of palatoplasty for cleft palate have been described; these techniques include Von Langenbeck,[3] Veau–Wardill–Kilner[4] pushback, the 2- flap palatoplasty,[5,6] Sommerlad,[7] and the Furlow double opposing Z-plasty.[8] The assessment of surgical success is dependent on normal speech function and craniofacial growth. Von Langenbeck technique can be applied to cleft repair, but this technique does not lengthen the soft palate and often results in velopharyngeal insufficiency. Veau-Wardill-Kilner (V-W-K) [4] can retreat and extend the velum, and achieve palatopharyngeal closure, however a large denuded naked bone surface will be left in the front of the hard palate, which will affect maxillary growth.[9] The traditional 2-flap palatoplasty has clear surgical field and better mobility of the myomucosal flap. This technique is suited for all variations of cleft palate, but this technique cannot lengthen the velum. Therefore, with the standard two-flap method, there are a certain

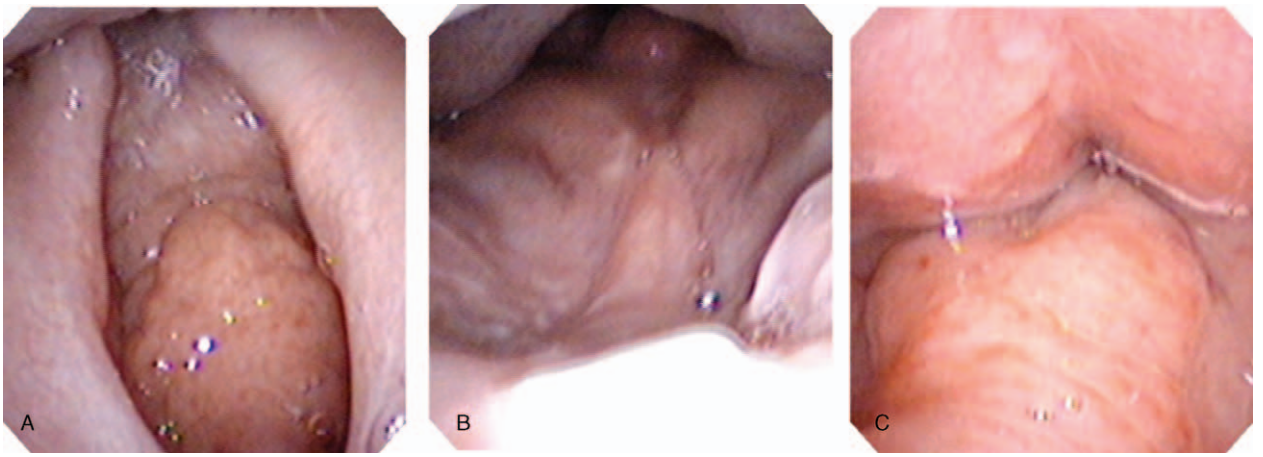

Figure 2. Representative case of a 12-month old with uncomplete cleft palate. A, Preoperative view. The cleft gap was 8 mm. B, Oral view after 6 months. C, Nasal view after 6 months (the photo was made during swallowing). The technique can achieve velopharyngeal competence basically.

proportion of cases of velopharyngeal insufficiency after surgery. The Sommerlad technique is suited for narrow cleft palate; however, in this technique it is easy to injure the levator muscles and nasal myomucosal flaps during the dissection.[5,6] The Furlow double opposing Z-plasty is popular for soft-palate prolongation and muscle repair[8]; however, the main disadvantage of this approach is that length is achieved at the expense of lateral tightening. The velum always has high tension after surgery, and that will affect palatopharyngeal closure.

Hakan[10] introduced the use of acellular, dermal matrix in cleft palate and palatal fistula repair in 2015. The technique is simple, safe, and convenient, and it is suited for wide clefts by decreasing the rate of fistula formation after surgery. But the implanted cellular dermal matrix does not always integrate well with adjacent tissues, with a high post-op fistula rate while failing to lengthen the velum. Percy Rossell-Perry[11] introduced the one-flap palatoplasty method to repair the cleft palate in 2015. This technique includes less surgical trauma and reduced bleeding, and it is suited for the repair of the unilateral cleft palate. It cannot lengthen the velum, thus it will affect velopharyngeal function. Muzaffer[12] reported using bilateral buccal mucosa flaps in cleft repair to lengthen the velum, but this technique results in significant surgical trauma, with more bleeding during the surgery.

Hisao Ogata[13] reported a palatoplasty method without using a lateral, relaxing incision. In the velum, a symmetrical intravelar veloplasty with mucosal Z-plasty was performed on both the nasal and oral sides. In the hard palate, instead of lateral relaxing incisions, a one-line mucoperiosteal incision, along the cleft margins, was designed with subperiosteal undermining in the entire palatine bone. The palatal mucoperiosteum was sutured together in the middle of the cleft, and the cleft was directly closed, without lateral relaxing incisions. This technique is suited for a cleft with a less than 5-mm gap, and the velum always has high tension after surgery, thus it is difficult to achieve velopharyngeal competence.

The advantage of elongation of the nasal mucous flap is that the surgical field is very clear, and the greater palatine vessels can be fully dissected, which can effectively increase the activity of the myomucosal flap. Once the posterior and medial borders of the hard palate are dissociated completely, the muscles attached to the posterior border of the hard palate can move downward and medially; this is helpful to achieve better functional reconstruction of the soft palate. Whereas, to achieve better palatopharyngeal function, it is critical to lengthen and relax the soft palate.

Therefore, we made 2, mucosal, lateral incisions on both sides of the soft palate to relieve the tension of the soft palate and to increase the mobility of the soft palate. When we take the loose incision, we only loosen the soft palate mucosa, and do not involve the soft palate muscle layer, so it does not affect the motor function of the muscle layer. In this technique, we protect the hamular groove while separating the caudal edge of the hard palate. This helps restore the tension of post-operative soft palate.

5. Conclusion

This elongation of nasal mucous flap with lateral mucosal relaxing incisions is more suitable for incomplete cleft palate. The palatal flaps have improved mobility, allowing the entire cleft to be closed in a single stage. The incidence of palatopharyngeal insufficiency was reduced effectively. It avoids the operation for correcting VPI, such as: pharyngeal flap, sphincter palatoplasty and posterior wall augmentation. Through this modified approach, we can achieve a lengthened and tension-free velum, to achieve a sufficient palatopharyngeal function.

In conclusion, our procedure for palatoplasty creates a physiologically-focused reconstruction method. Future studies will involve follow-ups for this procedure to assess speech and maxillary anatomical outcomes.

Author contributions

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Writing – original draft: Meizhen Gu, Xiuchang Huang, Xiaoyan Li.
Writing – review & editing: Meizhen Gu, Xiuchang Huang, Hongming Xu, Fang Chen, Yugang Jiang, Xiaoyan Li.

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