

Square-root Palatoplasty: Comparing a Novel Modified-Furlow Double-opposing Z-palatoplasty Technique to Traditional Straight-line Repair

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Background: The purpose of this study was to introduce a modification of the Furlow double-opposing Z-plasty (DOZ)—the square-root palatoplasty (SRP)—and critically evaluate outcomes compared to children who underwent straight-line repair (SLR).

Methods: A retrospective review was performed of all nonsyndromic children undergoing primary cleft palate closure either by SRP or SLR at our institution between 2009 and 2017. Outcomes of interest included rates/location of oronasal fistula, secondary surgery, speech delay/deficits, resonance, nasal air emission (NAE), articulation errors, and velopharyngeal function. Logistic regression was used to assess for the effect of surgery type on outcomes while controlling for Veau cleft type, age, and gender.

Results: Seventy-eight patients were included; 46 (59%) underwent SRP, and 32 (41%) underwent SLR. The mean follow-up was 4.07 years. When compared to SLR, children who underwent SRP were less likely to have oronasal fistula [odds ratio (OR) 4.8, $P = 0.0159$], speech delay/deficits (OR 7.7, $P < 0.001$), NAE (OR 9.7, $P < 0.001$), articulation errors (OR 10.2, $P < 0.001$), or need for secondary speech surgery (OR 13.2, $P < 0.0002$). Patients who underwent SRP were also more likely to have normal resonance (78.26% versus 43.75%, respectively; $P = 0.0043$) and good VP function (84.78% versus 56.25%, respectively; $P = 0.0094$).

Conclusions: This study describes and evaluates outcomes following a modified-Furlow DOZ technique—the SRP. After adjusting for Veau classification, age, and gender in nonsyndromic children, SRP is associated with significantly less speech delay/deficits, NAE, articulation errors, and need for secondary speech surgery when compared to children who underwent SLR. (*Plast Reconstr Surg Glob Open* 2021;9:e3777; doi: 10.1097/GOX.0000000000003777; Published online 19 August 2021.)

INTRODUCTION

Double-opposing Z-plasty (DOZ) for cleft palate closure was initially reported by Furlow in 1986.¹ Since then, its popularity has increased greatly and it has become one of the most commonly used techniques for primary

palatoplasty in the United States.² DOZ has also been recommended in the primary treatment of submucous cleft palate and as a secondary speech operation for velopharyngeal insufficiency (VPI).

Many advantages of DOZ over straight-line repair (SLR) have been previously proposed: better repositioning of levator veli palatini muscle (and formation of a functional levator sling),³ palatal lengthening,⁴ tighter nasopharyngeal sphincter,⁵ decreased risk of longitudinal scar contracture from a linear incision, improved vascularity by limiting the dissection to only one mucosal layer, and favorable postoperative scarring.⁶ Furthermore, the risk of oronasal fistula formation is theoretically lower because of nonoverlapping incisions.^{6–8}

Previous studies have advocated several anatomical benefits of DOZ, including increased palatal length and

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thickness.^{4,6} Additionally, modifications of the classic Furlow DOZ have also been described in the literature.⁹⁻¹³ Such modifications allow for lengthening of the palate with better repositioning of the levator veli palatini muscle, thereby leading to decreased incidence of VPI. Most notably, Jackson et al⁹ have examined their 30-year experience, reporting that secondary pharyngeal surgery was indicated in 8.1% of patients treated and overall VPI declined over their study period.

Often, the desired gain in length is created at the expense of shortening the transverse axis. Therefore, it is difficult to achieve tension-free closure with DOZ in wide clefts. This increase in tension may correspond to regions of ischemia in the tips of the Z-plasty flaps and a greater risk of complications in these patients. To overcome these challenges, a modification has been employed by the senior author (A.S.M.) for the past 7 years. This modification provides greater mobility of the palatal flaps, decreases tension across the closure, increases vascularity for the mucosa-only flap and is well-suited to the repair of wide clefts.

Precise muscle repair is of paramount importance, and for this reason, it is performed using the operating microscope as described by Sommerlad^{14,15} at our institution. The aim of this study is to introduce a modified DOZ palatoplasty, or square-root palatoplasty (SRP), and critically evaluate outcomes compared with children who underwent SLR for cleft palate before the aforementioned modification.

METHODS

Following IRB approval, a retrospective chart review was performed of all nonsyndromic patients undergoing primary cleft palate closure either by SRP or SLR (as

described by Sommerlad¹⁴⁻¹⁶) at Akron Children’s Hospital between 2009 and 2017 by a single, fellowship-trained craniofacial surgeon (A.S.M). Exclusion criteria were known syndromic diagnosis, SRP performed for VPI, follow-up less than 3 months, and incomplete records. Patient characteristics such as age at surgery (months), sex, cleft type (submucous cleft palate, Veau classification), length of stay (LOS), and follow-up time (years) after surgery were documented. Early complications were defined as hemorrhage, airway compromise, return to the operating room, infection, prolonged hospitalization (greater than 7 d), readmission within 30 days, partial dehiscence within 30 days, or complete dehiscence within 30 days.

Outcomes of interest were rates of oronasal fistula formation, location of fistula, secondary surgery for fistula or speech, speech deficits (assessed by a certified speech pathologist experienced with cleft palate patients), resonance (on vowels; normal, hypernasality, or hyponasality), nasal air emission (NAE) (on consonants; audible, visible, or none), articulation errors (significant or non-significant), and overall velopharyngeal function (compensatory misarticulations/strategies; classified as good/adequate, fair, or poor).¹⁷ Oronasal fistula was defined as any size functional or nonfunctional fistula seen on the physical examination, including a pinhole fistula, and categorized according to the Pittsburgh Fistula Classification System.¹⁸ Nonverbal patients, children with global developmental delay, sensorineural hearing loss, or age less than 3 years were excluded from the subset for speech analysis. Secondary speech surgery was recommended based on a consensus after multidisciplinary evaluation and imaging (Fig. 1).

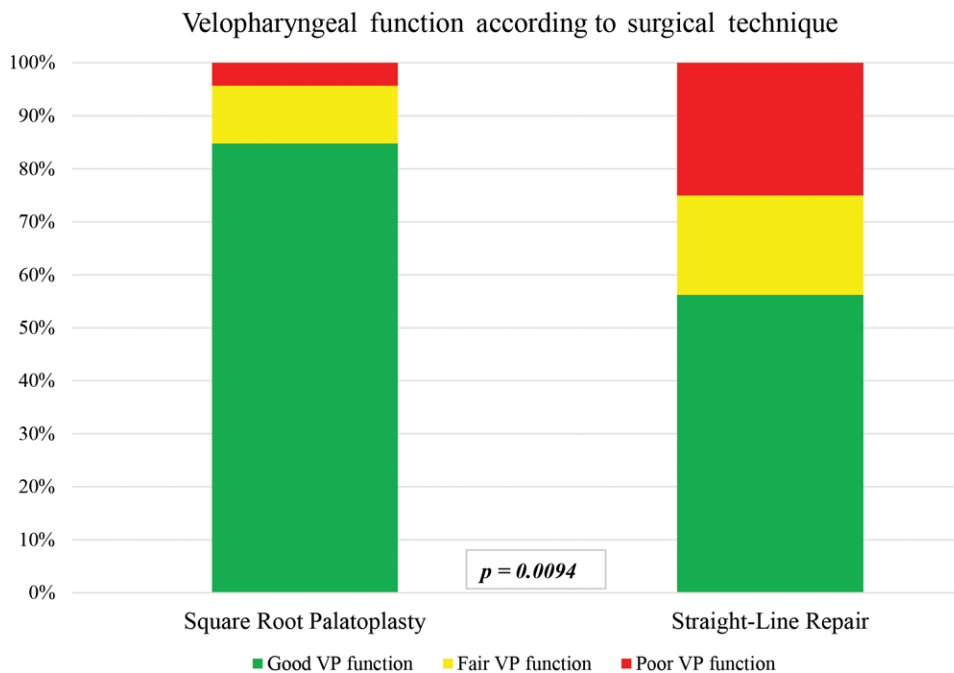


Fig. 1. Velopharyngeal function following SRP versus SLR. Thirty-nine children (84.78%) in the SRP group demonstrated good VP function, whereas five (10.87%) and two (4.35%) had fair and poor VP function, respectively. In the straight-line group, by contrast, 18 (56.25%) had good VP function, six (18.75%) fair, and eight (25%) poor. These differences were statistically significant ($P = 0.0094$).

Statistical Analysis

The Wilcoxon rank sum test was used to assess potential differences in age and LOS by surgery type (SRP and SLR). Linear regression was conducted to evaluate the potential effect of surgery type on LOS while controlling for diagnosis (cleft type). The chi-square test of independence (or Fisher's exact test in cases of counts ≤ 5) was used to assess potential associations of surgery type with categorical demographic and clinic information. Logistic regression was used to assess for the effect of surgery type on categorical outcomes while controlling for diagnosis. Statistical analyses were completed using SAS 9.4/14.2 and results interpreted at a type I error rate of $\alpha = 0.05$ level of statistical significance.

SRP Markings and Surgical Technique

Differing from Furlow's classic description, the square-root modification includes a narrow-based myomucosal flap and a wide-based mucosa-only flap (Fig. 2) (see figure, Supplemental Digital Content 1, which was taken using the operating microscope, and depicts the conclusion of the procedure before tension-free closure of the oral mucosa; for orientation, the posterior-most aspect of the repaired soft palate and uvula is superior, while the alveolus is inferior, <http://links.lww.com/PRSGO/B764>). Modified DOZ flaps are planned only in the soft palate. Similar to classical Furlow, anteriorly based flaps are mucosal, whereas posteriorly based flaps are myomucosal. The angle of posteriorly based oral myomucosal flap is marked around 30° as opposed to 60° in the traditional Furlow

repair. The anteriorly based mucosal flap is planned 90° to the cleft edge. The opposite is true for the nasal surface. When completed, the final Z-plasty flaps resemble a square-root sign (Fig. 2).

Key Maneuvers

Mucoperiosteal flaps of the hard palate are elevated and retracted with retention sutures.¹⁹ Dissection is extended in the submucosal plane over the aponeurosis. A lateral incision through the oral-side musculature is made to visualize and isolate the levator.²⁰ A lasso suture is placed around the levator muscle after dissection. Tensor tendon tenopexy is performed as described previously.²¹ On the contralateral side, the levator muscle remains attached to the nasal mucosa. Once again, the levator is visualized and isolated via a lateral incision through oral palatal musculature and tagged with a suture. A narrow nasal myomucosal flap can be raised since the muscle has been identified and isolated laterally. Next, the nasal soft palate Z-plasty flaps are transposed, uvula repaired, and the posterior oral flap is secured. Levator muscles are approximated to each other with the aforementioned lasso sutures. Progressive tension sutures are placed into the muscle to increase (subjective) tension across the sling. After repositioning, Alloderm is placed over the nasal mucosal layer of the soft palate and secured to lateral musculature and posterior border of the hard palate (Fig. 3). The remainder of the Z-plasty is completed and hard palate mucoperiosteal flaps are brought into the midline and closed with mattress sutures (Videos 1–3) (see Videos 1–3 [online],

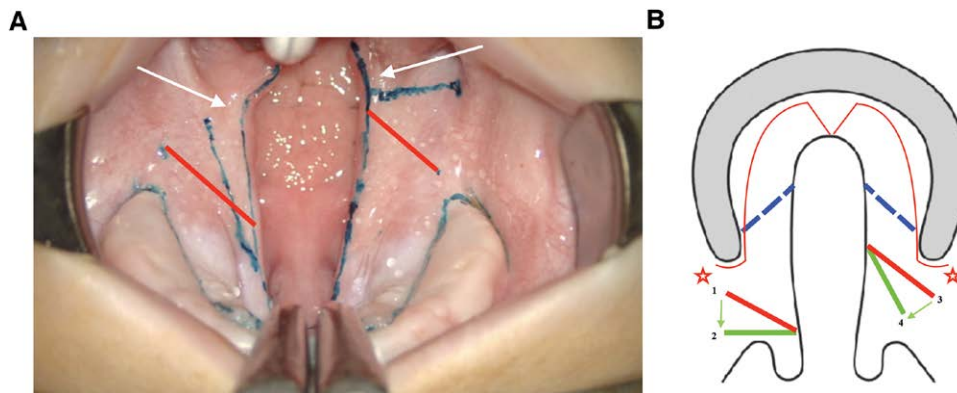


Fig. 2. Intraoperative photograph and diagram demonstrating markings for the SRP (A); for orientation, the posterior-most cleft margin is at the top of the photograph (uvula partially obscured by endotracheal tube), whereas the alveolus is at the bottom of the photograph and partially covered with the limbs of a Dingman retractor. For comparison, the red lines represent the mirror-image Z-plasty incisions as originally described by Furlow, designed with approximately 60° angles.¹ Note that the 90° component in SRP is chosen based upon pliability annotated with white arrow. The base of the narrow triangular flap annotated with white arrow, is selected in a spot between the hamulus and base of the uvula, which allows for rotation of the soft palatal flap upon inset. The image (B) represents a simple schematic comparing marking/incisions for classic Furlow repair (thick red lines) and SRP (thick green lines); the stippled blue lines represent the hard–soft junction, while the thin red lines within the hard palate (anteriorly) represent incisions for elevation of mucoperiosteal flaps and posterior alveolar releasing incisions, respectively. The numbers and corresponding thin green arrows illustrate the change in degrees between Furlow's traditional flap design and the SRP: 60° to 90° (1 to 2) and 60° to 30° (3 to 4). The red stars denote the area where there is a limited bridge of tissue that supplies the mucosa, which can easily be cut across or compromise blood supply to the edge of the flap due to the narrow base; by widening one flap to 90° the blood supply to the mucosa-only flap is increased, while the same holds true when narrowing the contralateral flap to 30° (increasing the distance from the posterior alveolar releasing incision).

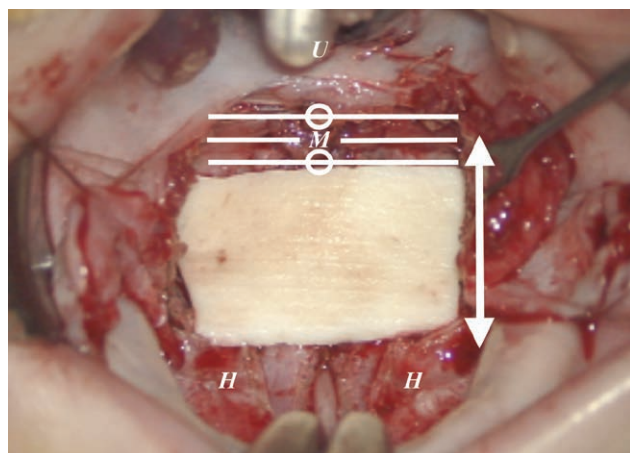


Fig. 3. Intraoperative photograph, taken using the operating microscope, following approximation of the levator muscles with previously placed retention sutures and closure of the soft palate nasal mucosa. Alloderm is then placed above the nasal mucosal layer and secured to lateral musculature and the posterior border of the hard palate. For orientation, the muscle transposition and repair is immediately posterior to the Alloderm (marked with *M* and annotated with transverse white lines; the *O* represents suture placement) and the uvula (albeit slightly obscured with the endotracheal tube) is marked with *U*; inferior to the Alloderm is the hard palate, marked with *H*. The double-sided arrow in the right side of the image denotes the space between the muscle repair after repositioning and the posterior shelf of the hard palate, over which the Alloderm is placed. Finally, the hard palate mucoperiosteal flaps are brought into the midline and closed with mattress sutures, enveloping the dermal matrix as shown in [Figure 2](#).

which demonstrate the entire operation, including markings, operative technique, and accentuated key maneuvers along with annotations and narration).

RESULTS

Surgical Technique, Gender, and Length of Follow-up

Seventy-eight patients met inclusion criteria. Forty-six (58.97%) underwent SRP, and 32 (41.03%) underwent SLR ([Table 1](#)). SLR was used exclusively from 2009 to 2012; then, the SRP was utilized exclusively from 2013 to 2017. During the first time frame, the surgeon had been in practice over 5 years. The gradual change in technique was prompted by dissatisfaction with observations following SLR. Twenty-seven patients (34.62%) undergoing SRP were boys and 19 were girls (24.36%), whereas 17 boys (21.79%) and 15 girls (19.23%) underwent SLR ($P = 0.6255$). The mean length of follow-up among all patients was 4.07 years (range 0.68–8.37 y); mean of 2.8 and 5.9 years for SRP and SLR, respectively.

Surgical Technique, Age, and LOS

The median age at surgery of children who underwent SRP was 8.1 months (range 5.2–86.8), whereas the median age of children who underwent SLR was 8.6 months (range 6.2–38.6; $P = 0.1624$) ([Table 1](#)). The median LOS for both SRP and SLR was 1 night (range 1–2; $P = 0.8442$). Neither age nor LOS were significantly different between children who underwent SRP and SLR ($P = 0.8367$). When

Table 1. Demographics, LOS, Cleft Type, Fistulae, Speech Delay, and Surgical Technique

	SRP	SLR	<i>P</i>
Patients (n = 78)	46 (58.97%)	32 (41.02%)	
Male	27 (34.62%)	17 (21.79%)	
Female	19 (24.36%)	15 (19.23%)	0.6255
Age (median)	8.1 mo	8.6 mo	0.1624
Length of stay (median)	1 night	1 night	0.8442*
Submucous cleft palate	5 (6.41%)	2 (2.56%)	
Veau I	12 (15.38%)	1 (1.28%)	
Veau II	7 (8.97%)	1 (1.28%)	
Veau III	19 (24.36%)	17 (21.79%)	
Veau IV	3 (3.85%)	11 (14.1%)	
Developed oronasal fistula	4 (8.7%)	10 (31.25)	0.0008
Required fistula surgery	1 (2.17%)	7 (21.88%)	0.0159
Speech delay	8 (17.39%)	20 (62.5%)	<0.001

*When controlling for cleft type, surgical technique was not a significant predictor of LOS ($P = 0.3501$).

P values in boldface are statistically significant.

controlling for diagnosis, the type of surgery was not a significant predictor of LOS ($P = 0.3501$).

Surgical Technique and Cleft Type

Amongst the patients who underwent SRP, five (6.41%) had submucous cleft palates, 12 (15.38%) Veau I, seven (8.97%) Veau II, 19 (24.36%) Veau III, and three (3.85%) Veau IV ([Table 1](#)). The cleft type in patients who underwent SLR was as follows: two (2.56%) submucous cleft palates, one (1.28%) Veau I, one (1.28%) Veau II, 17 (21.79%) Veau III, and 11 (14.1%) Veau IV. The association between surgical technique and cleft type was statistically significant ($P = 0.0008$).

Oronasal Fistula

Four children (8.7%) who underwent SRP developed oronasal fistula, compared with 10 (31.25%) who initially received SLR ([Table 1](#)). Among the children who underwent SRP, fistula location was as follows: three lingual-alveolar (type VI), one hard palate (type IV); one type VI was a pinhole; and only one child (2.17%) underwent surgery for repair of the fistula. Notably, no children developed an oronasal fistula at the hard–soft junction. Among the SLR group, fistula location was as follows: one hard palate (type IV), three lingual-alveolar (type VI), three primary-secondary palate junction (type V), two soft palate (one pinhole) anterior to uvular base (type I), and one unspecified; seven children (21.88%) underwent surgery for fistula repair. With regard to type VI, gingivoperiosteoplasty (GPP) was performed when able but examining the effect of GPP was not a goal of this study. The odds ratio (OR) of not developing an oronasal fistula was 4.8 times higher in children who underwent SRP [$P = 0.0159$, 95% confidence interval (CI) 1.3–17]. When adjusting for cleft type, the OR of 1.8 was no longer statistically significant ($P = 0.5261$, 95% CI 0.4–7.5), suggesting that the rate of oronasal fistula could be equivalent between the two repairs for a given Veau classification ([Table 2](#)).

Speech Deficits

Eight children (17.39%) who underwent SRP demonstrated speech deficits, compared with 20 (62.5%) that

Table 2. Logistic Regression Adjusting for Cleft Type and Surgical Technique

Pathology	OR	P
Oronasal fistula	1.8 (95% CI 0.4–7.5)	0.4014
Speech delay	7.3 (95% CI 2.1–24.7)	0.0016
Resonance	2.6 (95% CI 0.9–7.7)	0.0777
NAE	7.0 (95% CI 2.1–24.0)	0.0019
Articulation errors	8.0 (95% CI 2.4–26.1)	0.0006
VP function	2.8 (95% CI 0.9–8.9)	0.0856
Secondary speech surgery	7.8 (95% CI 1.5–41.1)	0.0154

ORs denote the likelihood of *not* developing the specified pathology when SRP was utilized.

P-values in boldface are statistically significant.

received SLR (Table 1). The OR of not having speech deficits was 7.7 times higher in children who underwent our modified technique ($P < 0.001$, 95% CI 2.7–22.0). When adjusting for cleft type and age at the time of surgery, the OR of 7.3 remained statistically significant (95% CI 2.1–24.7; Table 2).

Resonance

Thirty-six children (78.26%) in the SRP group demonstrated normal resonance, whereas seven (15.22%) and three (6.52%) had hypernasal and hyponasal speech, respectively (Table 3). In the straight-line group, by contrast, 14 (43.75%) had normal resonance, 15 (46.88%) hypernasal, and three (9.38%) hyponasal. These differences were statistically significant ($P = 0.0043$, OR 4.0, 95% CI 1.5–10.6); however, when adjusting for the cleft type, the OR of 2.6 was no longer significant ($P = 0.4237$, 95% CI 0.9–7.7), indicating that the risk of developing a resonance disturbance could be equivalent between the two repairs for a given Veau classification (Table 2).

Nasal Air Emission

Six children (13.04%) who underwent SRP demonstrated NAE (audible or visible), compared with 19 (59.38%) that received SLR (Table 3). The OR of not having NAE was 9.7 times higher in children who underwent our modified technique ($P < 0.001$, 95% CI 3.2–29.6). When adjusting for the cleft type, the OR of 7.0 remained statistically significant (95% CI 2.1–24.0; Table 2).

Articulation Errors

Eight children (17.78%) who underwent SRP demonstrated articulation errors, compared with 22 (68.75%) that received SLR (Table 3). The OR of not having articulation errors was 10.2 times higher in children who underwent our modified technique ($P < 0.001$, 95% CI 3.5–29.6). When adjusting for the cleft type, the OR of 8.0 remained statistically significant (95% CI 2.4–26.1; Table 2).

Velopharyngeal Function

Thirty-nine children (84.78%) in the SRP group demonstrated good/adequate velopharyngeal (VP) function, whereas five (10.87%) and two (4.35%) had fair and poor VP function, respectively (Table 3). In the straight-line group, by contrast, 18 (56.25%) had good VP function, six (18.75%) fair, and eight (25%) poor. These differences were statistically significant ($P = 0.0094$, OR 4.6 95% CI 1.6–13.3; Fig. 1); however, when adjusting for cleft type,

Table 3. Resonance, NAE, Articulation Errors, VP Function, Secondary Speech Surgery, and Surgical Technique

	SRP	SLR	P
Normal resonance	36 (78.26%)	14 (43.75%)	
Hypernasal	7 (15.22%)	15 (46.88%)	
Hyponasal	3 (6.52%)	3 (9.38%)	
NAE	6 (13.04%)	19 (59.38%)	0.0043
Articulation errors	8 (17.78%)	22 (68.75%)	<0.001
Good VP function	39 (84.78%)	18 (56.25%)	<0.001
Fair VP function	5 (10.87%)	6 (18.75%)	
Poor VP function	2 (4.35%)	8 (25%)	
Secondary speech surgery	2 (4.35%)	12 (37.5%)	0.0094
Revision of secondary speech surgery	0	3 (9.38%)	0.0002

P-values in boldface are statistically significant.

the OR of 2.8 was no longer significant ($P = 0.67$, 95% CI 0.9–8.9), indicating that the risk of developing VPI could be equal between the two repairs for a given Veau classification (Table 2).

Secondary Speech Surgery

Two children (4.35%) who underwent SRP required secondary speech surgery, compared with 12 (37.5%) that received SLR (Table 3). Among the former group, one child required nasal port tightening, whereas the other underwent a pharyngeal flap; no children required a subsequent operation for uncorrected or recurrent speech dysfunction. Amongst the SLR cohort, four children required a pharyngeal flap, four pharyngoplasty, three Furlow, and one nasal port tightening; three children (9.38%) required revision of the initial secondary speech surgery for refractory dysfunction, and of these, one child required four operations in total. The OR of not requiring secondary speech surgery was 13.2 times higher in children who underwent our modified technique ($P = 0.0002$, 95% CI 2.7–64.6). When adjusting for cleft type, the OR of 7.8 remained statistically significant (95% CI 1.5–41.1; Table 2).

DISCUSSION

Furlow published his method for cleft palatoplasty by DOZ in 1986.¹ Since that time, modifications have been designed and performed with admirable outcomes, measured by decreased incidence of VPI and oronasal fistula.^{9–13} However, several challenges remain after Furlow palatoplasty that may compromise a functional palatal repair. There is tension along the midline closure coupled with decreased vascularity at the tip of the mucosa-only flap. Additionally, after levator veli palatini retropositioning, there remains a mucosa-to-mucosa connection anteriorly up to the hard palate. This gap can result in scar contraction and may tether the muscle repair.

Geometry

The senior author's modifications include a narrow myomucosal flap and a wide-based mucosa-only flap. In designing the posteriorly based myomucosal flap to be inclusive of mucosa directly superficial to the levator

muscle, the vascularity is supplied by direct musculomucosal perforators, thereby allowing a narrow flap design. This allows for a more posterior position of this flap limb, once rotated, since the angle is approximately 30°. It is the authors' observation that when the myomucosal flap is kept with a wide base, there is inherent restriction at the hard–soft junction that decreases the amount of movement allowed.

The anteriorly based mucosa-only flap is designed with a wide base as to maximize its vascularity since there is no direct muscle deep to this tissue that would orient to an anatomic and physiologic position once corrected. Marking anteriorly based mucosal flap with a greater angle than classical Furlow repair has two advantages: (1) accidental tearing of mucosa toward the greater palatine artery, where it receives its primary blood supply, is prevented and (2) positioning of this flap entirely in soft palate allows a greater mobility. By designing the back-cut close to the uvular base, recruitment of the most pliable tissue within the soft palate is allowed, as opposed to being restricted by the hard–soft junction. Additionally, wide-based z-plasty theoretically provides the most gain in length, and we feel that this also accommodates the acute angle of the myomucosal flap. These two advantages result in well-vascularized and mobile flaps that likely account for the findings observed in our patients.

In 1971, Furnas and Fischer²² reported findings from a canine study that examined the biomechanics and mathematics of the z-plasty local tissue rearrangement. Interestingly, the observed lengthening achieved across various configurations was less than mathematical predictions might suggest. The Furlow repair (60° tip angles), for instance, lengthened approximately 45% (approximately 75% predicted), whereas tip angles of 90° and 30° (ie, the SRP) lengthened about 30% (compared with 51% predicted). Perhaps, due to the lesser mathematical lengthening between classic Furlow and SRP, we have never encountered sleep apnea that plagues overly long palates. Therefore, SRP may be the perfect option for a functional palate reconstruction in certain patients.

Our decision to move from 60° to 90° is because (1) the base of the mucosa-only triangle at 60° would rest in more nonpliable hard palatal mucosa, which allows for less muscle transposition (this area is, in fact, left open due to the inability to close, which is also consistent with Furlow's original description); however, with a 90° incision, the base remains in mobile soft palatal mucosa and eases transposition; (2) the base of the mucosa-only triangle would either be close to, or may in fact connect to the releasing (Von Langenbeck) incision along the posterior alveolus/retromolar trigone—by keeping the base at 90°, there remains little chance of undercutting the base. The posteriorly based flap can be decreased to 30° because of greater vascularity despite a narrow flap (secondary to myomucosal composition). There exists almost no tension along this limb, which allows for free movement of the reconstructed muscle sling and less of a distance for the 90° triangle to traverse.

Muscle Repair

Sommerlad^{14,15} has advocated the use of the operative microscope to meticulously identify, dissect, and isolate the levator veli palatini muscle. Often, the levator muscle is not adequately or entirely visualized, and therefore, an anatomic repair is not achieved. With the use of the microscope, it is easy to see the correct orientation of the cranially oriented muscle fibers. There is also a subtle color change that is visible with the microscope. Years earlier, Sommerlad also described the benefit of progressive muscle tightening at the site of muscle repair and found that with increased tension at the muscle repair site, there was overall better function and decreased rates of VPI.²⁰ In addition, the previous literature has demonstrated that SLR with careful muscle dissection remains significantly superior to those without it.²³

Dead Space

After performing the SRP, which allows for generous repositioning, dead space at the hard–soft junction is created. Left untreated, this space has the potential for adherent scarring and pro-positioning of the muscle. To mitigate this, the senior author utilizes Alloderm (Allergan Corporation, Madison, N.J.) as a spacer—this was not, however, used in children who underwent SLR and could contribute to the results observed. Prior studies have demonstrated that Alloderm is a readily available, time-efficient, and effective adjunct in preventing fistula formation after primary palatoplasty but also in the repair of palatal fistulas.²⁴ For those that have reservations about using Alloderm on pediatric patients, the use of buccal fat pad flaps has been previously described to help obliterate this dead space.²⁵

Straight-line versus Furlow

Although there is no consensus on which repair is superior, prior studies have examined the two techniques, as well as others, and assessed outcomes including VPI and the need for secondary surgeries.^{26,27} Direct comparisons, however, remain sparse.^{28,29} Timbang et al³⁰ performed a systematic review comparing DOZ and straight-line intravelar veloplasty and identified almost a two-fold increase in failure of primary palatoplasty for isolated cleft palate patients (9.7 versus 16.5, DOZ to straight-line, respectively) and a 1.5 time increase in failure for unilateral cleft lip-cleft palate patients (11.1 versus 17.1, DOZ to straight-line, respectively). They also noted higher risk of requiring secondary speech surgery in straight-line versus DOZ ($P = 0.03$). Our analysis builds upon this prior work by demonstrating that among children of comparable age and gender, and after controlling for cleft type, there are decreased odds of speech deficits, NAE, articulation errors, and need for secondary speech surgery in those who underwent our modified-Furlow repair compared to SLR (Tables 1 and 3).

Limitations

Limitations of this study include those pertinent to any retrospective review and single-surgeon experience. Our sample size, although small, still achieved statistical significance for the outcomes studied. Importantly, we

were also able to perform an adjusted analysis based upon cleft type which maintained statistically significant findings (Table 2). We admit that speech deficits and articulation are not independent variables and could be related independent of VPI. Additionally, the fact that VPI rates were not different between groups could suggest that the technique may have varied outcomes. Our primary goal is to be honest and observational about modifications aimed at improving the outcomes of DOZ, and a final recognized limitation includes the challenge of tracking adherence and follow-up with speech training between the two groups.

CONCLUSION

This review defines a technique for a modified-Furlow DOZ—the SRP. The angle of posteriorly based oral myomucosal flap is marked around 30° as opposed to 60° in the traditional Furlow repair; the anteriorly based mucosal flap is planned 90° to the cleft edge. This modification allows for optimal flap vascularity, generous retroposition, and excellent mobility within the soft palate. After adjusting for Veau classification in nonsyndromic children of comparable age and gender, with mean follow-up time of over 4 years, SRP is associated with less speech deficits, NAE, articulation errors, and need for secondary speech surgery when compared to children who underwent SLR.

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