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Outcomes of Combined Furlow Palatoplasty and Sphincter Pharyngoplasty for Velopharyngeal Insufficiency

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Abstract

Objective. To compare surgical outcomes between pharyngeal flap, sphincter pharyngoplasty, and combined Furlow palatoplasty and sphincter pharyngoplasty in the management of pediatric velopharyngeal insufficiency.

Study Design. Case series with chart review.

Setting. Tertiary care pediatric hospital.

Subjects and Methods. After exclusion of children with velocardiofacial syndrome, 96 patients who underwent surgical intervention between 2008 and 2012 were identified. Surgical interventions were categorized as pharyngeal flap, sphincter pharyngoplasty, and combined Furlow palatoplasty and sphincter pharyngoplasty. Main outcome measures included perceptual speech analyses, complications, and surgical revision rates.

Results. Of the 96 reviewed patients, 38 (39.6%) underwent pharyngeal flap, 20 (20.8%) sphincter pharyngoplasty, and 38 (39.6%) combined Furlow palatoplasty and sphincter pharyngoplasty. Choice of surgical intervention was based on patient characteristics, observed palatal length, and formal speech assessments. There were no differences in patient demographics or preoperative perceptual speech analysis scores among the 3 surgical groups. The mean speech improvement was significantly greater in both the pharyngeal flap ($P = .031$) and combined procedure ($P = .013$) compared with sphincter pharyngoplasty alone, but no differences were observed between the pharyngeal flap and combined procedure ($P = .797$). There were no differences in complications among the 3 surgical interventions ($P = .220$). The combined procedure required significantly less surgical revisions than the pharyngeal flap ($P = .019$).

Conclusion. Combined Furlow palatoplasty and sphinter pharyngoplasty is an effective procedure for the management of pediatric velopharyngeal insufficiency and may result in superior speech outcomes and lower revision rates than sphincter pharyngoplasty and pharyngeal flap, respectively.

Keywords

velopharyngeal insufficiency, Furlow palatoplasty, sphincter pharyngoplasty, pediatric, outcomes

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velopharyngeal insufficiency. Theoretically, this surgical approach accomplishes both palatal lengthening and circumferential narrowing of the velopharyngeal port, thereby creating a more physiologic sphincter mechanism. However, in the current literature, this innovative surgical approach has typically been reserved for children with a large velopharyngeal gap and poor lateral wall motion as demonstrated by preoperative endoscopy. We hypothesize that combined Furlow palatoplasty and sphincter pharyngoplasty will result in better surgical outcomes than either posterior pharyngeal flap or sphincter pharyngoplasty alone in the pediatric VPI population regardless of preoperative velopharyngeal characteristics.

Methods

After obtaining institutional review board approval at Children’s Hospitals and Clinics of Minnesota, a retrospective review was conducted of all pediatric patients with velopharyngeal insufficiency who underwent surgical treatment between January 1, 2008, and December 31, 2012. A total of 96 subjects were identified after exclusion of patients with inadequate medical records and those with velocardiofacial syndrome. Patients with velocardiofacial syndrome were excluded from the study due to anatomical differences documented within this patient population, such as platybasia, hypoplastic adenoid pad, and pharyngeal hypotonia. Data collected included age at surgery, sex, cleft presence and type, prior cleft surgery, prior speech surgery, hearing loss, syndrome, speech endoscopy, primary operation type, duration until postoperative evaluation, preoperative and postoperative speech assessments, postoperative complications, and need for a revision operation. Surgical interventions were categorized as pharyngeal flap, sphincter pharyngoplasty, and combined Furlow palatoplasty and sphincter pharyngoplasty. All operations were performed by 1 of 3 staff pediatric otolaryngologists (RJT, TAL, JDS) using similar operative techniques.

Operative Techniques

Pharyngeal flap. The pharyngeal flap procedure was performed by dividing the soft palate along the midsagittal plane, with subsequent dissection into oral and nasal mucosal flaps. A pentagonal, superiorly based pharyngeal flap was designed with the apex located as caudal as possible and width determined on an individual basis. The pharyngeal flap was then inset between the previously developed oral and nasal flaps, resulting in mucosal coverage of its ventral and dorsal surfaces.

Sphincter pharyngoplasty. The sphincter pharyngoplasty was performed as described by Ortiz-Coffoca via elevation of bilateral palatopharyngeus myomucosal flaps to create a dynamic velopharyngeal sphincter. Once elevated, the flaps were inset into a mucosal incision created along Passavant’s ridge, as cephalad as possible in the posterior pharyngeal wall adjacent to the adenoid pad. Following midline approximation of the flaps, the resultant central port was bordered by the mobile soft palate edge and mucosal surfaces of the bilateral posterior tonsillar pillars.

Combined Furlow palatoplasty and sphincter pharyngoplasty. First described by Dr Furlow in 1986, the double-opposing Z-palatoplasty combined the principles of velar lengthening and muscular repositioning to optimize velopharyngeal closure and speech results. When performed in combination with a sphincter pharyngoplasty, the soft palate is split in the midline, and the sphincter pharyngoplasty procedure is performed as described above. Then, the Furlow double-opposing Z-palatoplasty is performed as previously described.

Speech Assessment

Perceptual speech analyses were performed annually by specialized speech pathologists in conjunction with an interdisciplinary cleft and craniofacial team. Nasal resonance was classified as hypernasal, hyponasal, or mixed. The severity of resonance pathology was graded on a numeric scale as (0) within acceptable limits, (1) mild hypernasality, (2) mild to moderate hypernasality, (3) moderate hypernasality, (4) moderate to severe hypernasality, and (5) severe hypernasality. In addition, hyponasal and mixed resonance were assigned scores of 0 and 2, respectively, in accordance with the Pittsburgh Weighted Values for Speech Symptoms Associated with Velopharyngeal Incompetence Instrument.

Basic preoperative planning for VPI surgery included consideration of the patient age, prior surgery, associated syndrome, preexisting airway obstruction, observed palatal length, and perceptual speech analysis. Additional instrumental assessments of velopharyngeal function were not routinely employed. Nasal endoscopy was performed on 29 patients, including 9 cases of diagnostic uncertainty and 20 of surgical revision.

Statistical Analyses

Patient characteristics and outcomes measures were compared among the 3 operative techniques. The χ² test or Fisher exact test was used for the evaluation of categorical variables as appropriate for the corresponding sample size. Continuous data were expressed as mean ± standard deviation. The t test and 1-way analysis of variance (ANOVA) were used in the evaluation of continuous variables with normal distributions; the Mann-Whitney U test was applied for continuous variables without normal distributions. All analyses were performed using SPSS 20.0 software (SPSS, Inc, an IBM Company, Chicago, Illinois). Statistical significance was set a priori at P < .05.

Results

Patient Demographics

After exclusion criteria, 96 pediatric patients with surgically managed velopharyngeal insufficiency were identified. Thirty-eight (39.6%) underwent pharyngeal flap, 20 (20.8%) sphincter pharyngoplasty, and 38 (39.6%) combined Furlow palatoplasty and sphincter pharyngoplasty. The patient age at the time of surgery ranged from 2.6 to 18.8 years (mean ± SD, 6.8 ± 3.3 years). Within the studied population, 1
(1.0%) patient developed velopharyngeal insufficiency following adenoidectomy in the absence of palatal clefting pathology. Of the remaining 95 patients, 4 (4.2%) had submucous clefts, 3 (3.1%) had clefts confined to the soft palate, 35 (36.5%) had clefts partially involving the hard palate, 37 (38.5%) had complete unilateral clefts, and 16 (16.7%) had complete bilateral clefts.

Ninety patients (93.4%) underwent prior cleft repair surgery and 20 (20.8%) underwent prior speech surgery. Previously performed cleft palate repairs included 2-flap, 4-flap, V-Y pushback, Veau-Wardill-Kilner, and von Langenbeck techniques. There were no cases of Furlow Z-palatoplasty performed for initial cleft palate repair. Previously performed speech surgeries were evenly divided between pharyngeal flap (50%) and sphincter pharyngoplasty (50%) techniques. There were no statistically significant differences identified among the 3 surgical groups with regard to any analyzed preoperative patient characteristic (Table 1).

### Speech Outcomes

The mean ± SD preoperative hypernasal severity score was 2.24 ± 1.38 for pharyngeal flap patients, 1.70 ± 0.92 for sphincter pharyngoplasty patients, and 2.42 ± 1.29 for combined procedure patients (Table 2). There was no significant difference in preoperative scores among the 3 surgical groups (P = .120).

In comparison, the mean ± SD postoperative severity score was 0.61 ± 1.00 among pharyngeal flap patients, 0.90 ± 0.91 among sphincter pharyngoplasty patients, and 0.74 ± 1.03 among combined procedure patients (Table 2). All 3 surgical groups demonstrated statistically significant improvement in speech analysis scores following surgical intervention (pharyngeal flap, P < .001; sphincter pharyngoplasty, P = .012; and combined procedure, P < .001). Post hoc analysis showed that the mean speech improvement was significantly greater in both the pharyngeal flap (P = .031) and combined procedure (P = .013) compared with sphincter pharyngoplasty alone, but no differences were observed between the pharyngeal flap and combined procedure (P = .797).

### Complications

Noted postoperative complications included bleeding (n = 1), surgical site dehiscence (n = 3), nasopharyngeal stenosis (n = 4), persistent velopharyngeal insufficiency (n = 9), transient obstructive sleep apnea symptoms (n = 2), and persistent obstructive sleep apnea requiring further surgery (n = 5) (Table 3). The overall complication rate was 31.6% in the pharyngeal flap group, 20% in the sphincter pharyngoplasty group, and 21.1% in the combined procedure group. There were no statistically significant differences in overall complication rates among the 3 surgical interventions (P = .220).

### Surgical Revision

Indications for a revision operation included persistent resonance pathology and polysomnographic evidence of obstructive sleep apnea. The surgical revision rate was 28.9% (11/
Statistical analysis determined the combined procedure required significantly less surgical revisions than the pharyngeal flap ($P = .019$). There were no differences in revision rates between the sphincter pharyngoplasty and either the pharyngeal flap ($P = .463$) or the combined procedure ($P = .182$).

Revision surgeries included pharyngeal flap refinement ($n = 7$), sphincter pharyngoplasty refinement ($n = 3$), pharyngeal flap addition ($n = 4$), sphincter pharyngoplasty addition ($n = 1$), and combined procedure addition ($n = 3$). The average time interval between the index surgery and revision was 1.16 years.

### Discussion

Since its inception in 1862, many surgical techniques have been developed for the management of velopharyngeal insufficiency. Although each approach offers distinct strengths and limitations, no consensus exists regarding specific indications for any particular procedure. Numerous complex diagnostic algorithms with instrumental assessments have been proposed to assist with surgical decision making, yet none have been universally adopted. Oftentimes, the choice of surgical intervention is based largely on individual surgeon experience.

This nonuniformity in patient selection criteria likely contributes to the reported variation in surgical success rates of each procedure. Successful surgical management of velopharyngeal insufficiency is predicated on the achievement of adequate velopharyngeal closure without symptomatic upper airway obstruction. Thus, speech results, postoperative complications, and surgical revision rates were selected as the 3 main outcomes of this study.

Herein, we describe the outcomes of an innovative surgical treatment for VPI management, the combined Furlow palatoplasty and sphincter pharyngoplasty, in comparison to pharyngeal flap and sphincter pharyngoplasty alone. In this study, the mean speech improvement was significantly greater in both the pharyngeal flap and combined procedure compared with sphincter pharyngoplasty alone, but no differences were observed between the pharyngeal flap and combined procedure.

These findings are consistent with a recently published case series suggesting increased efficacy of the combined Furlow palatoplasty and sphincter pharyngoplasty, in comparison to pharyngeal flap and sphincter pharyngoplasty alone. In this study, the mean speech improvement was significantly greater in both the pharyngeal flap and combined procedure compared with sphincter pharyngoplasty alone, but no differences were observed between the pharyngeal flap and combined procedure.

Revision surgeries included pharyngeal flap refinement ($n = 7$), sphincter pharyngoplasty refinement ($n = 3$), pharyngeal flap addition ($n = 4$), sphincter pharyngoplasty addition ($n = 1$), and combined procedure addition ($n = 3$). The average time interval between the index surgery and revision was 1.16 years.

### Table 2. Speech outcomes.

<table>
<thead>
<tr>
<th>Surgery Type</th>
<th>Nasality Severity Score</th>
<th>Mean ± SD</th>
<th>$P$ Valuea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharyngeal flap ($n = 38$)</td>
<td>Preoperative</td>
<td>2.24 ± 1.38</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Postoperative</td>
<td>0.61 ± 1.00</td>
<td></td>
</tr>
<tr>
<td>Sphincter pharyngoplasty ($n = 20$)</td>
<td>Preoperative</td>
<td>1.70 ± 0.92</td>
<td>.012</td>
</tr>
<tr>
<td></td>
<td>Postoperative</td>
<td>0.90 ± 0.91</td>
<td></td>
</tr>
<tr>
<td>Combined Furlow + sphincter ($n = 38$)</td>
<td>Preoperative</td>
<td>2.42 ± 1.29</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Postoperative</td>
<td>0.74 ± 1.03</td>
<td></td>
</tr>
</tbody>
</table>

*a* $P$ values were calculated using the paired sample t test to compare differences in preoperative and postoperative severity scores.

### Table 3. Complications.

<table>
<thead>
<tr>
<th>Complication</th>
<th>All Patients (N = 96)</th>
<th>Pharyngeal Flap (n = 38)</th>
<th>Sphincter Pharyngoplasty (n = 20)</th>
<th>Combined Furlow + Sphincter (n = 38)</th>
<th>$P$ Valuea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bleeding</td>
<td>1 (1.0)</td>
<td>0</td>
<td>0</td>
<td>1 (2.6)</td>
<td>.220</td>
</tr>
<tr>
<td>Dehiscence</td>
<td>3 (3.1)</td>
<td>2 (5.3)</td>
<td>0</td>
<td>1 (2.6)</td>
<td></td>
</tr>
<tr>
<td>Infection</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Nasopharyngeal stenosis</td>
<td>4 (4.2)</td>
<td>4 (10.5)</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Persistent VPI</td>
<td>9 (9.4)</td>
<td>3 (7.9)</td>
<td>2 (10.0)</td>
<td>4 (10.5)</td>
<td></td>
</tr>
<tr>
<td>Transient OSA</td>
<td>2 (2.1)</td>
<td>0</td>
<td>0</td>
<td>2 (5.3)</td>
<td></td>
</tr>
<tr>
<td>OSA</td>
<td>5 (5.2)</td>
<td>3 (7.9)</td>
<td>2 (10.0)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>24 (25.0)</td>
<td>12 (31.6)</td>
<td>4 (20.0)</td>
<td>8 (21.1)</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: OSA, obstructive sleep apnea; VPI, velopharyngeal insufficiency.

*a* $P$ value was calculated using the Fisher exact test to compare total complication rates.
Historically, the tailored pharyngeal flap has often been cited as the most effective procedure for eliminating symptoms of velopharyngeal insufficiency with 80% to 90% success rates.28-32 This finding was corroborated by a recent meta-analysis comparing pharyngeal flap and sphincter pharyngoplasty, which suggested a trend favoring pharyngeal flap for VPI resolution with a combined odds ratio of 2.95.32 Therefore, the lack of detectable difference in speech outcomes between pharyngeal flap and the combined procedure is also notable and may suggest that the combined procedure is an equivalent alternative for the management of VPI symptoms.

Furthermore, no statistically significant differences in complication rates were detected among the 3 surgical interventions. This finding is also consistent with 2 recent randomized trials that failed to demonstrate a difference in complications between the pharyngeal flap and sphincter pharyngoplasty, including the long-term incidence of sleep apnea.33,34 Finally, the combined procedure required significantly less surgical revisions than the pharyngeal flap. There were no differences in revision rates between the sphincter pharyngoplasty and either the combined procedure or pharyngeal flap.

To our knowledge, this study represents the largest review of combined Furlow palatoplasty and sphincter pharyngoplasty outcomes to date. However, the retrospective nature of this study presents an inherent limitation in the conclusions that can be drawn from this analysis. Another potential study limitation is the use of more than 1 speech pathologist for the perceptual speech analyses without an evaluation of interrater reliability. Individual speech pathologists may differ in their perception of resonance pathology and application of severity scores. Speech assessment results may have also been influenced by transient environmental factors, such as persistent postoperative edema or concurrent rhinitis. Finally, the need for revision surgery is an intrinsic subjective outcome measure. Secondary operative indices can be variable between different surgeons and institutions.

In conclusion, combined Furlow palatoplasty and sphincter pharyngoplasty is an effective procedure for the management of pediatric velopharyngeal insufficiency and might result in superior speech outcomes and lower revision rates than sphincter pharyngoplasty and pharyngeal flap, respectively. We propose that this combined technique may be used as a first-line therapy for velopharyngeal insufficiency in all children regardless of preoperative velopharyngeal characteristics.

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**Author Contributions**

Lauren A. Bohm, study design, data acquisition, interpretation, manuscript writing; Noëlle Padgitt, study design, data acquisition, critical review; Robert J. Tibesar, critical review, final approval; Timothy A. Lander, critical review, final approval; James D. Sidman, study conception and design, critical review, final approval.

**Disclosures**

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**References**