Lateralization of the Pharyngeal Flap for Treatment of Lateral Velopharyngeal Gap

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Abstract: Pharyngeal flap is usually used for treatment of velopharyngeal insufficiency (VPI); it is bridged between the posterior pharyngeal wall and the soft palate traversing the central part of the velopharyngeal port. The aim of this study was to assess the efficacy of lateralization of the pharyngeal flap for treatment of VPI in patients with lateral velopharyngeal gap. Fifteen patients with VPI due to lateral velopharyngeal gap were subjected to closure of the gap by pharyngeal flap that was lateralized to fill the gap. Preoperative and postoperative assessment of velopharyngeal functions including flexible nasopharyngoscopy, auditory perceptual assessment (APA), and nasometric assessment were performed. Postoperatively, flexible nasopharyngoscopy showed complete velopharyngeal closure in all the patients, with significant improvement of speech parameters as measured by APA. Also, nasalance score showed significant improvement for oral and nasal sentences that was measured by nasometry. Lateralization of the pharyngeal flap for treatment of VPI in patients with lateral velopharyngeal gap is an effective method; it improves the velopharyngeal closure and the speech of the patients.

Key Words: Hypernasality, lateral velopharyngeal gap, pharyngeal flap, velopharyngeal insufficiency

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Velopharyngeal insufficiency (VPI) is the incomplete closure of the velopharyngeal port during speech; it leads to hypernasality that is an excessive nasal resonance, with the consequent unintelligible speech error. A child with hypernasal speech may have psychological problems as a result of difficult communication, which is usually reflected on their family.[1] Depending on the degree of VPI, the patients may also have nasal air emissions, weak consonants, short utterance length, obligatory, and compensatory articulation defects.[2]

The velopharyngeal port is the area situated between the nasopharynx and oropharynx; it is bounded anteriorly by the soft palate, posteriorly by the posterior pharyngeal wall, and on each side by the lateral pharyngeal walls. This port is closed during speech production with different velopharyngeal closure (VPC) patterns; it is a dynamic sphincter that is controlled by the surrounding palatal and pharyngeal muscles.[3,4] Presence of an open gap during vowel production may lead to leakage of air with increase in speech resonance.[4] Repair of this gap can be done by either lengthening of the palate as in Furlow palatoplasty and push back techniques, or shelving of the pharyngeal wall as in pharyngeal flap, sphincter pharyngoplasty, and posterior pharyngeal wall augmentation procedures.[5,6] Each surgical method has its indication, with special preference of the surgeon to a particular technique.

Pharyngeal flap is usually used to obturate a central velopharyngeal gap; it is bridged between the posterior pharyngeal wall and the soft palate traversing the central part of the velopharyngeal port. The flap is formed of myomucosal tissues from the posterior pharyngeal wall, either superiorly or less commonly inferiorly based.[5] When the velopharyngeal gap is situated laterally, the surgeon may need to lateralize the flap to fill the gap. The aim of this study was to assess the efficacy of lateralization of the pharyngeal flap for treatment of VPI in patients with lateral velopharyngeal gap.

METHODS

This study was conducted on 15 patients complained of hypernasal speech, 9 females and 6 males, their ages ranged from 5 to 16 years with a mean age of 8 years and 3 months. The patients were referred to the Otolaryngology outpatient clinics of our institute calling for surgical intervention after failure of speech therapy. The study was conducted in the period from July 2012 to August 2014. Only patients with lateral velopharyngeal gap as seen by flexible nasopharyngoscopy were enrolled in the study (Fig. 1). Informed consents were obtained from the parents and the principles outlined in the Declaration of Helsinki were followed.

FIGURE 1. Flexible nasopharyngoscopic view during articulation, the gap is seen laterally as a dark area.

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The study was carried out in the Departments of Otolaryngology in both Cairo University and Beni Suef University, Egypt.
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All patients were subjected to the following:

1. Otolaryngologic examination
   Full ear, nose and throat, and head and neck examination was performed for detection of other associated diseases. Ear examination, including tympanometry, was performed for detection of middle ear effusion, and oral examination was performed to assess the condition of the palate.
2. Preoperative assessment of velopharyngeal function
   All patients were subjected to quantitative assessment of velopharyngeal function: auditory perceptual assessment (APA) of speech, nasometry, and flexible nasopharyngoscopy, as follows.

Flexible Nasopharyngoscopy

Visualization of the velopharyngeal port was performed using a fiberoptic flexible nasopharyngoscope, equipped with a high-intensity cold light and a special endoscopic television system for videotape recording. The system was composed of a high-resolution Karlheinz Hinze S/N 151385 endoscope (Karlheinz Hinze Optoengineering GmbH & Co, Hamburg, Germany), a Storz endoscope video camera (Karl Storz GmbH & Co KG; Tuttlingen, Germany), and a Panasonic SR 500 video recorder (Osaka, Japan). The velopharynx was inspected, and VPC was assessed while the patients were repeating Arabic sentences loaded with high oral pressure consonants. Detection of the site and size of the velopharyngeal gap was performed, also the VPC pattern was detected.

Auditory Perceptual Assessment of Speech

Hypernasality, nasal emission of air, and weak pressure consonants were analyzed. Parameters were graded on a 5-point scale (0–4) in which 0 indicates normal and 4 indicates severe illness, with a total score of 12 on the 3 elements. A lower score on this scale indicates less dysfunction.

Nasometric Assessment

Assessment of nasalance was performed using a nasometer (Model 6200; Kay Elemetrics Corp., Lincoln Park, NJ), which provides an acoustic measure of movement of the vibrational energy through the vocal tract. Nasometric data were obtained while the patients read or repeated standardized Arabic nasal and oral sentences.

Operative Procedure

Under general anesthesia with oral endotracheal intubation, a Davis-Boyle mouth gag was inserted, the site of the incisions in the posterior pharyngeal wall and the palate was marked with methelyne blue. The marked areas were injected with adrenaline in saline 1/200,000, a superiorly based myomucosal flap was created from the posterior pharyngeal wall, the width of the flap was accustomed to the size of the velopharyngeal gap as seen by flexible nasopharyngoscopy preoperatively, and also its site was lateralized to obturate the gap. A palatal split was performed at the site of the velopharyngeal gap; the free edge of the flap was passed through the palatal split. Suturing of the flap to the palate was performed with 4 0 Vicryl sutures after peeling of mucosa from the free edge of the flap (Figs. 2 and 3). The donor area was left unclosed to avoid over narrowing of the airway.

Postoperative Assessment of Velopharyngeal Function

Following routine postoperative instructions and follow-up, patients were directed to return after 6 months for APA, nasometric assessment, and flexible nasopharyngoscopy using the same parameters that were used preoperatively.

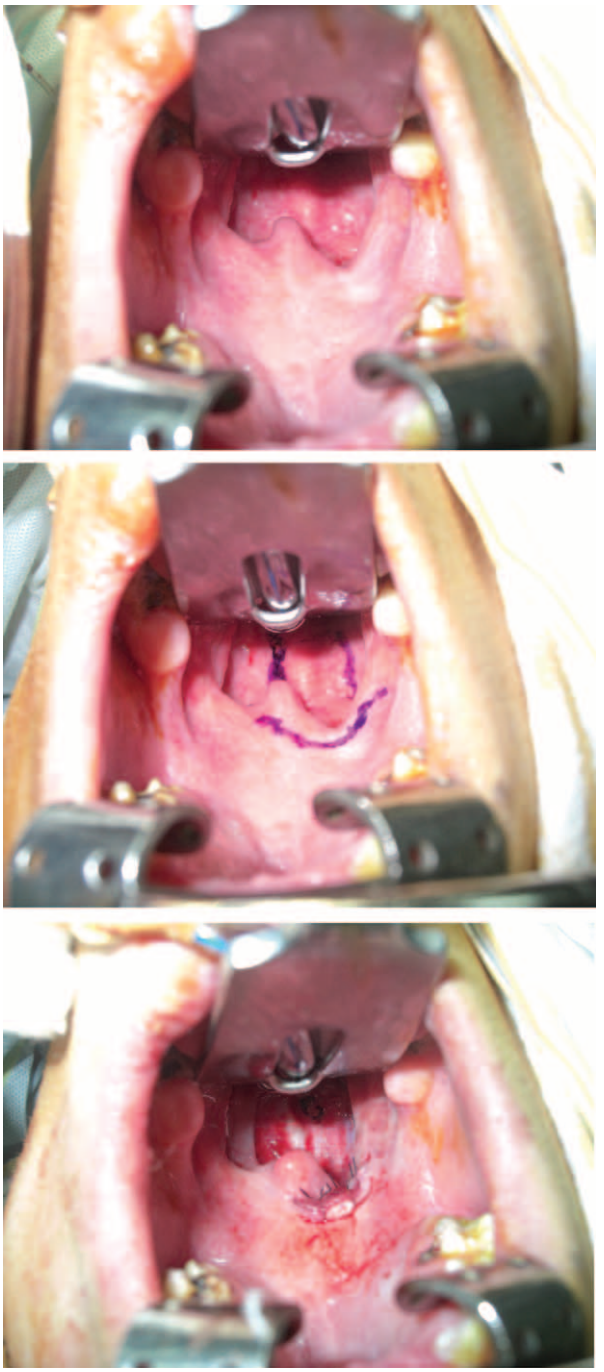

FIGURE 2. Surgical procedure of pharyngeal flap. (A) A notch is seen on the right side of the soft palate. (B) The incisions sites were marked with methelyne blue. (C) The flap was elevated from the posterior pharyngeal wall and it was inserted into the soft palate anterior to the defect.

Statistical Methods

Data were coded and summarized using Statistical Package for Social Sciences version 19.0 for windows (SPSS Inc, Chicago, IL). Quantitative variables are presented as mean ± standard deviation, and categorical data as frequency and percentage. Comparison of preoperative and postoperative results of auditory perceptual assessment and nasometric assessment was done using paired

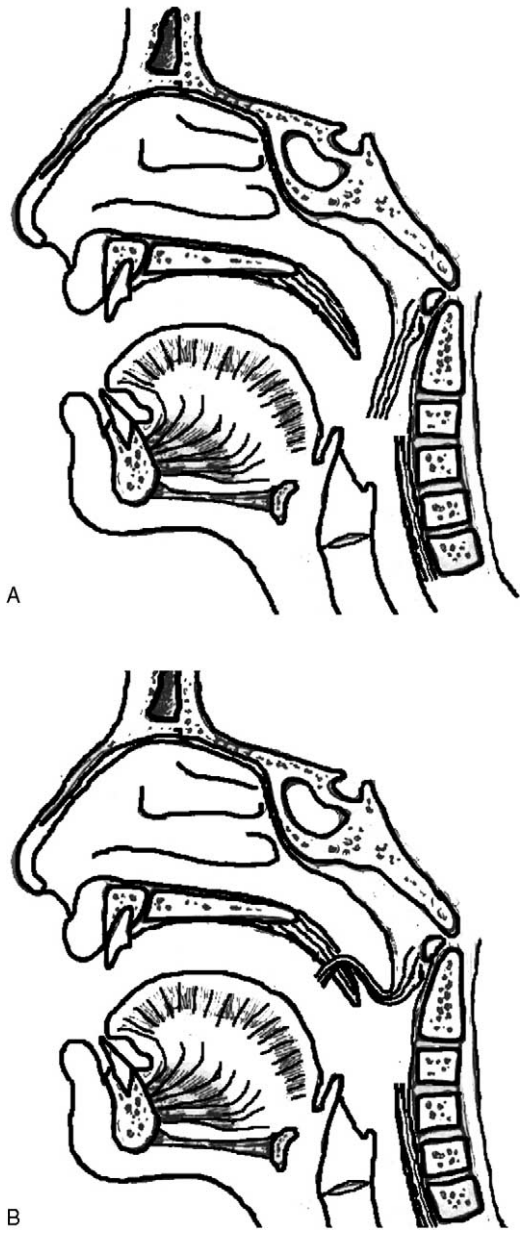

FIGURE 3. (A) Elevation of a superiorly based pharyngeal flap. (B) Insertion of the free edge of the flap into a palatal split on the side of the velopharyngeal gap.

2-sample *t* test, and Pearson x2 was used for comparison of preoperative and postoperative results of velopharyngeal gap size. $P < 0.05$ was considered statistically significant.

RESULTS

Fifteen children with VPI due to lateral velopharyngeal gap were enrolled in the study. A lateralized superiorly based pharyngeal flap was performed for treatment of VPI with preoperative and postoperative assessment of velopharyngeal function. Eleven patients had repaired cleft palate and 4 patients developed the problem after adenotonsillectomy; those latter patients showed no palatal abnormality apart from notched soft palate on one side.

The preoperative flexible nasopharyngoscopy showed lateral velopharyngeal gap in all the patients; it was situated on the left side in 9 patients and on the right side on 6 patients. The velopharyngeal closure pattern was coronal in 11 patients and circular in 4 patients. Postoperatively, complete velopharyngeal closure was achieved in all the patients (Fig. 4).

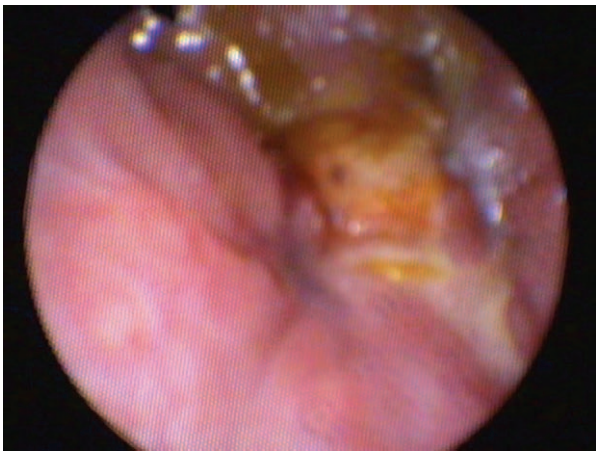

FIGURE 4. Flexible nasopharyngoscopic view during articulation, the velopharyngeal port is completely closed with the flap in place and covered with crusts.

Speech was significantly improved following surgery. The mean preoperative baseline of auditory perceptual assessment was 8.13 (±0.072), whereas the postoperative was reduced to 4.22 (±0.26). The difference between preoperative and postoperative scores was significant.

Nasalance was also improved following surgery. The preoperative scores were 34.21 (±0.16) for the nasal sentences and 13.77 (±0.31) for the oral sentences, whereas postoperative scores declined to 30.11 (±0.41) for the nasal sentences and 11.06 (±0.14) for the oral sentences. The changes were statistically significant for both nasal and oral sentences.

No complications were reported postoperatively apart from throat pain and severe dysphagia which disappeared completely after about 2 weeks. Snoring was reported in all patients, while 3 patients demonstrated obstructive sleep breathing attacks that improved spontaneously after 2 months.

DISCUSSION

The velopharyngeal port is a dynamic sphincter; it is critically important for normal speech production, because it is responsible for regulation of transmission of the sound energy between the oral and nasal cavities. Hypernasality that is an excessive nasal resonance of speech is the result of incomplete closure of this port; it makes the speech unintelligible and unpleasant with negative impact on the social life of the patients. The condition is usually associated with other speech problems such as nasal emission of air, weak pressure consonants, nasal rustle, articulation inversion, and facial grimace.[5] The problem is common after cleft palate repair, about 15% to 45% of cleft palate patients may develop hypernasality following repair of their clefts; it may be attributed to shortening of less mobile fibrotic palate, or less commonly the occurrence of fistulae.[7] Also, the problem may be due to a hidden anatomical abnormality as in the submucous cleft palate and it may follow adenotonsillectomy. The adenoid can compensate for a short or a poorly mobile palate, following adenoidectomy; this mechanism of compensation is eliminated and VPI can result.[8]

In this study, 15 children with lateral velopharyngeal gap complained of hypernasality, and were treated by superiorly based pharyngeal flap. Eleven patients gave history of cleft palate repair

and 4 patients developed the problem after adenotonsillectomy; VPI after palatoplasty may be due to limited mobility of weak, fibrotic, and/or short palate.[5,7,8] However, persistent VPI after adenotonsillectomy is rare and may constitute 1 in 1500 patients,[9] our patients showed notched soft palate lateral to the uvula on one side; it may be due to either palatal injury by the adenoid curette, or excessive retraction of the palate by a rubber catheter during adenoid removal, resulting in palatal tear with consequent fibrosis leaving a defect.[5]

The pharyngeal flap was lateralized to the side of the gap, and its width was tailored to the size of the defect. Preoperative and postoperative assessments of velopharyngeal function including flexible nasopharyngoscopy, APA, and nasometric assessment were performed. Postoperatively, flexible nasopharyngoscopy showed complete velopharyngeal closure in all the patients with the flap stable in place, speech was significantly improved, and also the nasality was reduced. Pharyngeal flap is considered by some authors as the black hoarse treatment of VPI,[10] Ysunza et al,[2] Marsh,[11] Trier,[12] and Morris et al[13] achieved complete correction of VPI in about 90% of their patients. However, the velopharyngeal gap of their patients was not laterally situated, and the VPC pattern was sagittal, so the closure was dependent mainly on the medial displacement of the lateral pharyngeal wall against the midline pharyngeal flap. Our patients had lateral velopharyngeal gap, so the flap was used as a mechanical obstructive element for the laterally situated gap. Treatment of our patients was easier as it was dependent on a simple idea; where the gap is, the flap will be.

Pharyngeal flap is performed by elevation of the posterior pharyngeal wall as a superiorly or rarely an inferiorly based myomucosal flap that is inserted in the free edge of the soft palate, leaving a lateral port on either side for breathing. Sphincter pharyngoplasty is created by elevation of bilateral superiorly based myomucosal flaps from the lateral pharyngeal walls to be inserted into an incision on the posterior pharyngeal wall.[1,4,5] Indeed, pharyngeal flap has been historically considered the treatment of choice for VPI, regardless of VPC pattern,[3,14] recently most authors advised pharyngeal flap for sagittal VPC pattern where the lateral pharyngeal walls are the main contributor in closure, and sphincter pharyngoplasty for coronal VPC pattern where the palate is the main contributor in closure.[3,10,11] So, we can achieve the most optimal results by leaving the most mobile part to close against the introduced flap, and decreasing the failure by avoiding scarify the most contributing wall in closure.[5] In our study, we did not apply this recent theory as our patients had lateral velopharyngeal gap, so it was easy to close the gap by a laterally displaced pharyngeal flap. In other words, the aim of the flap is to close the defective part of the velopharynx, so our technique achieves this goal with no need to narrow the whole velopharyngeal port.

The most common complication of pharyngeal flap is the postoperative airway obstruction with consequent snoring and sleep apnea. The severity of the airway obstructive effect is usually at its maximum in the early postoperative period; it may be increased by edema.[14–16] In our study, 3 out of 15 patients developed obstructive sleep apnea that improved spontaneously after 2 months. However, the mechanical obstructive effect of pharyngeal flap is less when the flap is lateralized than when it is bridging the middle part of the velopharynx. Another complication that could be happened postoperatively is the dysphagia; however it is a transient problem. Dysphagia may be due to pain, discomfort from the sutures, the healing process, and by the adaptation to the changes in pharyngeal structures. The mechanism of swallowing is not adversely affected after pharyngeal flap surgery as the function of the superior constrictor muscle which is included in the flap, is usually compensated by the surrounding muscles.[17] Our patients returned to their regular feeding after about 2 weeks.

In conclusion, lateralization of the pharyngeal flap for treatment of VPI in patients with lateral velopharyngeal gap is an effective method; it improves the velopharyngeal closure and the speech of the patients without major complications.

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