



# Superiorly based pharyngeal flap and posterior pharyngeal wall augmentation

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## KEYWORDS:

Velopharyngeal insufficiency;  
Resonance disorder;  
Surgical correction

Creating the structural elements necessary for velopharyngeal closure is the essential goal of surgical correction of velopharyngeal insufficiency (VPI). Collaboration with speech pathologists is essential for maximal outcome. The author describes his techniques for surgical correction of VPI using a superiorly based pharyngeal flap, the workhorse for velopharyngeal surgery. In some children with VPI, the defect is more limited, and alternative procedures, which are also described in this articles, exist to correct the resonance problem while minimizing the potential for obstructive complications associated with a pharyngeal flap.

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Velopharyngeal insufficiency (VPI) reduces oral pressure, resulting in weak consonants and speech that often sounds muffled and unclear. The ability to project the voice is also limited because of the lack of oral pressure. Turbulent airflow through a partially closed velopharyngeal opening can be appreciated as an audible nasal rustle.<sup>1</sup>

Normal velopharyngeal closure patterns vary in the population. Nearly half the population will demonstrate a coronal pattern of velopharyngeal closure, with the free edge of the soft palate approximating the posterior pharyngeal wall. The circular pattern of closure is exhibited by 40% of people, with the lateral walls and the soft palate contributing to closure. Passavant's ridge (specialized fibers of the superior pharyngeal constrictors) may occasionally contribute to velopharyngeal closure. Generally, however, this ridge is well below the level of velopharyngeal closure and does not contribute to the production of normal resonance. The sagittal closure pattern is found in 15% of the population. In this mode of closure, the soft palate contributes little to the closure of the velopharyngeal sphincter, whereas the lateral walls medialize to create an airtight seal.<sup>2</sup>

Nasopharyngoscopy is essential for the optimal management of patients with VPI. It allows the level of velopharyngeal closure to be precisely determined. It permits an assessment of the closure pattern demonstrated by the patient and identifies the size and location of the area of velopharyngeal escape. It also allows an assessment of the posterior pharyngeal wall for the presence of medialized carotid arteries. Surgical intervention is reserved for those individuals with structural or neurologic deficits of velopharyngeal function. This article will describe the author's method for performing a posterior pharyngeal flap. The reader is encouraged to refer to a separate article on sphincter pharyngoplasty.

## Superiorly based pharyngeal flap

### Indication

The superiorly based pharyngeal flap is the workhorse for velopharyngeal surgery. It acts as an obturator against which the lateral walls can medialize. It is ideally suited to close central gaps, where the lateral walls of the velopharynx can medialize against the inset flap to effect complete velopharyngeal closure. Often there is little movement of

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the lateral walls on the preoperative assessment. Medial movement of the lateral walls will develop over time through the intervention of speech therapy, after the pharyngeal flap is in position. Lack of lateral wall movement in the preoperative assessment of VPI is not a contraindication to the placement of a pharyngeal flap.

### Complicating factors

Because the pharyngeal flap is creating a partial obstruction of the upper airway, care must be taken to identify patients with other sources of airway obstruction so as not to cause obstructive sleep apnea postoperatively. The most common condition complicating the postoperative recovery after placement of a pharyngeal flap is adenotonsillar hypertrophy. If a patient has any signs of obstructive breathing patterns, or has tonsils that are enlarged, an adenotonsillectomy before the placement of a pharyngeal flap is indicated. An interval of 4-6 weeks should elapse before performing a pharyngeal flap after an adenotonsillectomy.

Patients with a history of retrognathia need to be assessed for the adequacy of their upper airway before placing a pharyngeal flap. Retrognathic patients, especially those who required a tracheotomy as an infant, need to be approached with caution. A pharyngeal flap may obstruct their upper airway severely, necessitating a flap take-down, continuous positive airway pressure, or a tracheotomy. Allowing these children additional time for growth will often allow a flap to be performed without the complication of airway obstruction. A sleep study in this patient population is often warranted if preoperative airway concerns are raised. This provides a means to determine an appropriate time for surgical intervention and thus minimize postoperative airway complications. Despite superior speech outcomes being associated with patients having surgical intervention at younger ages, a delayed approach in this patient population is advisable.

There is a high incidence of velocardiofacial syndrome in patients presenting with VPI without an overt cleft of the palate. This syndrome is associated with a chromosomal microdeletion of 22q11.2. The phenotypic expression of this syndrome includes VPI, submucous cleft palate, learning disabilities, cardiac anomalies, retrognathia, malar flattening, pharyngeal hypotonia, slender hands and fingers, small stature, and congenital conotruncal cardiac anomalies.<sup>3</sup> They may also have medialized internal carotid arteries that could complicate the planned surgical procedure. These medialized vessels can be visualized on flexible endoscopy, and adjustments to the planned surgical procedure can be made. Magnetic resonance imaging of the neck is not generally required in this patient population. Antibiotic prophylaxis to prevent subacute bacterial endocarditis is often required for this patient population if congenital heart disease is present.

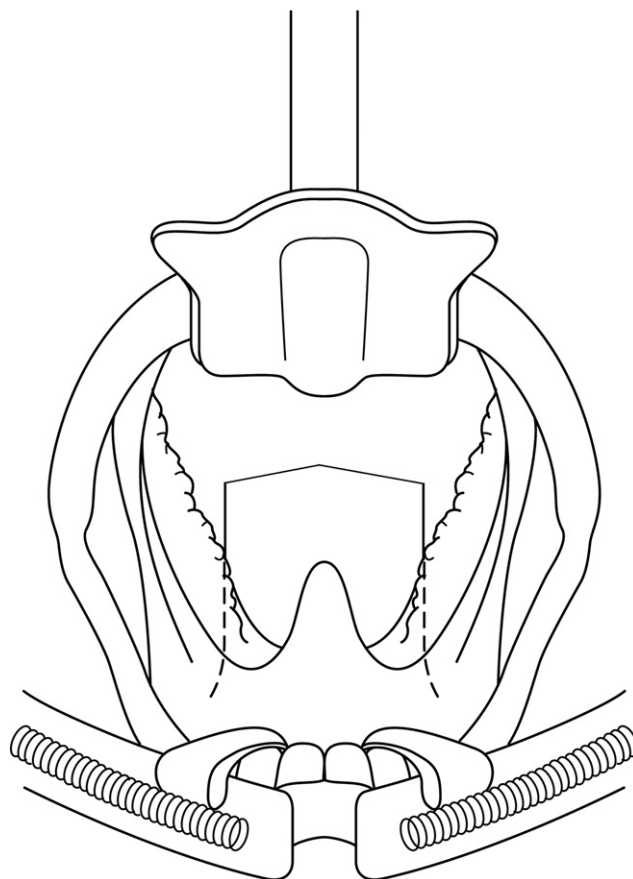
### Procedure

The patient is positioned on a shoulder roll and a mouth gag is inserted. The posterior pharyngeal wall is visualized

and palpated to identify any significant vessels in the operative field. The internal carotid arteries may be medialized in velocardiofacial syndrome patients. These vessels will be deep to the prevertebral fascia and should not interfere with the operation, but increased care in raising the flap is necessary.

The proposed posterior pharyngeal wall incision lines are infiltrated with 1% lidocaine with 1:100,000 units of epinephrine to affect vasoconstriction and ease the raising of the flap. The standard width of a pharyngeal flap generally approximates the distance between the posterior tonsillar pillars (Figure 1). The inferior extent of the flap should be near the midpoint of the tonsil. The length of the flap can be checked by estimating the distance from the posterior pharyngeal wall to the free margin of the soft palate and then measuring down from the level of velopharyngeal closure. A problem will be encountered if the pharyngeal flap that is raised is too long. The proximal end of an excessively long flap will settle inferiorly and adhere to the posterior pharyngeal wall, thus dropping the level of the flap away from the proper level of velopharyngeal closure.

The superiorly based pharyngeal flap is elevated by incising through mucosa, down to the prevertebral fascia. This fascial layer is bright white in color, and the plane will be essentially avascular. The amount of pain experienced by



**Figure 1** Outline of a pharyngeal flap on the posterior pharyngeal wall, with the lateral extent of the flap approximating the location of the posterior tonsillar pillars. The flap is superiorly based, with the incisions trending laterally as they extend into the nasopharynx.

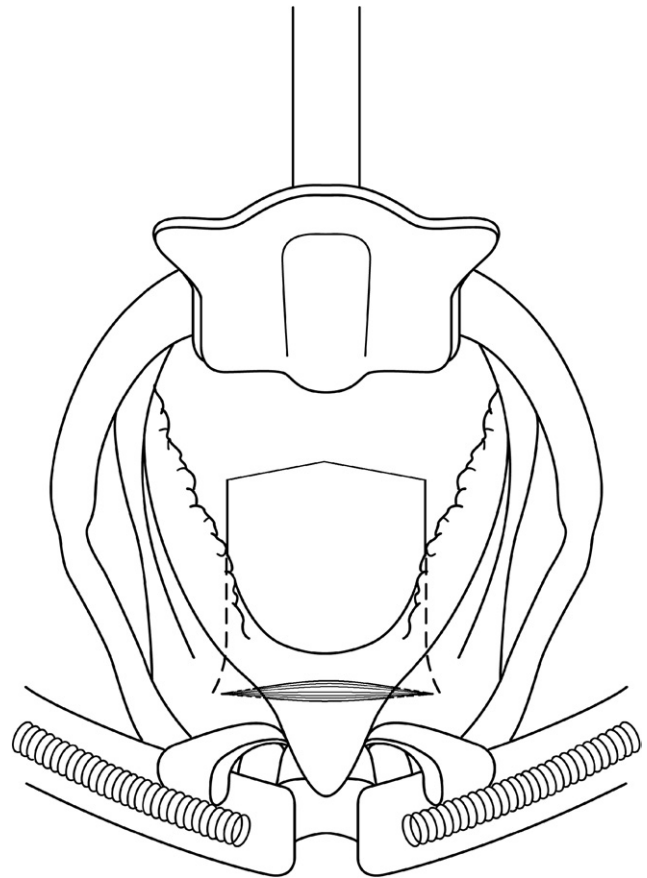
the patient increases substantially if this facial plane is violated. Hemostasis can be accomplished with monopolar cautery. The superior limbs of this incision are curved slightly laterally near the pedicle of the flap to maximize the blood supply to the flap. There is a tendency for the surgeon to narrow the flap as one extends the lateral incisions superiorly.

Elevation of the pharyngeal flap needs to be high into the nasopharynx, to the natural level of velopharyngeal closure. Failure to raise the flap high enough will result in tethering of the free edge of the soft palate inferiorly, compromising velopharyngeal function. A low-set pharyngeal flap will be positioned such that it is out of the plane of velopharyngeal closure, creating a condition where VPI will persist postoperatively. It is not possible to set a flap "too high" in the nasopharynx.

Closure of the flap donor site is accomplished with 3-0 vicryl suture. Undermining of the surrounding mucosa is rarely necessary. Suturing the mucosa directly to the prevertebral fascia will prevent tenting of the mucosa and the creation of dead space. Superiorly, beneath the pedicle of the flap, the donor site is left to granulate. Overzealous closure of the donor site superiorly can lead to nasopharyngeal stenosis. It is possible to bring the mucosa from the hypopharynx superiorly to assist in the closure of the donor site if desired, thus minimizing the lateral narrowing that may be associated with closing of this donor site.

A pocket is created in the posterior aspect of the soft palate to accept the pharyngeal flap. The posterior aspect of the soft palate can be infiltrated with 1% lidocaine with 1:100,000 units of epinephrine at the same time the posterior pharyngeal wall injections are made. The free edge of the soft palate is rolled anteriorly to allow visualization of the nasal surface of the soft palate. An incision is made on the nasal surface of the posterior soft palate, where it is estimated that velopharyngeal closure occurs. Care needs to be exercised to incise the mucosa with an adequate area of separation to allow the flap to be inset. The incision should be horizontal across the entire posterior soft palate, avoiding the tendency to make a curvilinear incision inferiorly toward the posterior tonsillar pillar (Figure 2).

The lateral ports are created by placing nasal stents from the nose into the oropharynx. These serve as a guide when suturing the flap into position.<sup>4</sup> Children aged  $\leq 6$  years tolerate lateral ports sized with 3.5 endotracheal tubes. Children aged  $\geq 8$  years have no airway obstruction when 4.0 endotracheal tube stents are used. To sew the flap into the pocket created in the posterior soft palate, 3-0 vicryl sutures are placed in a horizontal mattress manner through the soft palate, through the muscle of the flap, and then back through the soft palate to exit within 2 mm of the first pass of the suture. Four sutures are placed, two laterally and two in a paramedian position. The sutures should pass through the flap near the junction of the proximal and middle thirds of the flap. This will allow the flap to be snugged into the pocket, preventing it from relaxing against the posterior wall that would raise the risk of it adhering in an inferior location (Figure 3).

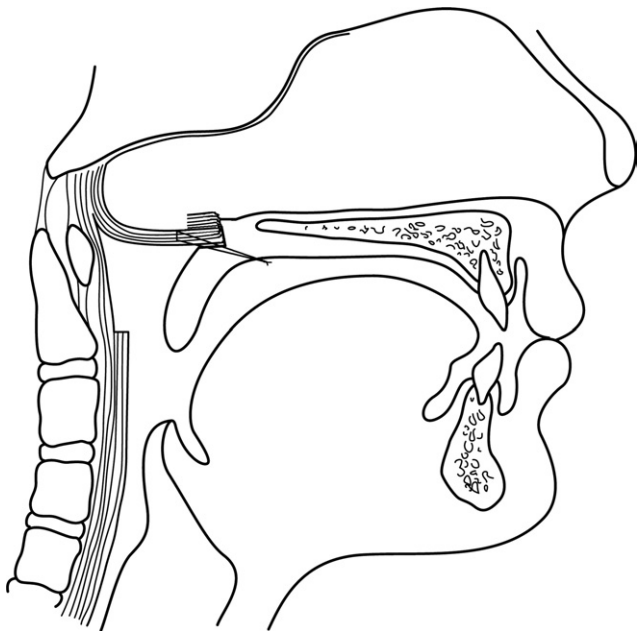


**Figure 2** A pocket is created on the nasal side of the soft palate by retracting the velum and incising the nasal surface of the soft palate. This pocket must be at the level of velopharyngeal closure, and must not drop inferiorly as the pocket is developed laterally.

Proper creation of the lateral ports brings the flap to the medial extent of the nasal stents. The flap should not "wrap" around the stent. The stent is used as a guide to determine the proper lateral position of the flap such that lateral wall motion can contact the flap during speech, yet an adequate nasal airway is preserved for respiration. A mirror is used to evaluate the lateral ports. If a port is too large (the flap is loose around the stent), additional sutures are placed to bring the flap into better position around the nasal stent. Lateral port closure should not be under tension. With the flap in proper position, it should not be visible when viewing the oropharynx. It must be high in the nasopharynx.

To minimize the risk of airway obstruction during the postoperative period, the nasal stents are secured with a tape to the nose. They are positioned with their distal end in the mid oropharynx and left in this position overnight (Figure 4). Suction catheters are measured to extend 1 cm beyond the end of the stent to minimize plugging. Suctioning of the stents is performed every 8 hours, and at any time, there seems to be an obstruction within the stent. The stents are removed the following morning if no airway obstruction was identified overnight, and the patient is discharged from the hospital after a second night of observation if no airway compromise was documented.

Speech therapy is required to teach the patient how to "use" the flap. It is best to initiate speech therapy after the



**Figure 3** The flap is pulled into the pocket created in the soft palate. It is important to maximize contact of the raw surfaces of the flap and the soft palate to ensure proper healing. The free edge of the flap must be pushed into the nasopharynx to prevent contact of epithelium within the pocket.

pain and induration associated with the procedure have resolved. This can generally be started 3-4 weeks postoperatively. A repeat assessment of velopharyngeal function should be performed 3 months postoperatively.

### Complications

Snoring is expected after a pharyngeal flap in the postoperative period. Obstructive events, however, need treatment. Steroids assist with postoperative surgical edema, but should not be used on a routine basis because of their detrimental effects on wound healing. Occasionally, continuous positive airway pressure may be used to improve obstructive events until the postoperative situation subsides. Stenosis of the lateral ports leading to hyponasality and obstructive breathing needs surgical correction if symptoms continue longer than 6-12 weeks.

Continued VPI secondary to failure of the lateral ports to close may develop despite appropriate speech therapy. Failure to show improvement by 3 months suggests that further surgery may be necessary to narrow the lateral ports.

### Posterior pharyngeal wall augmentation procedures

Some patients presenting with VPI are found to have a small gap, and a pharyngeal flap may be considered “excessive” for the structural defect that is present. In these patients, alternative procedures exist to correct the resonance problem while minimizing the potential for obstructive complications associated with a pharyngeal flap.

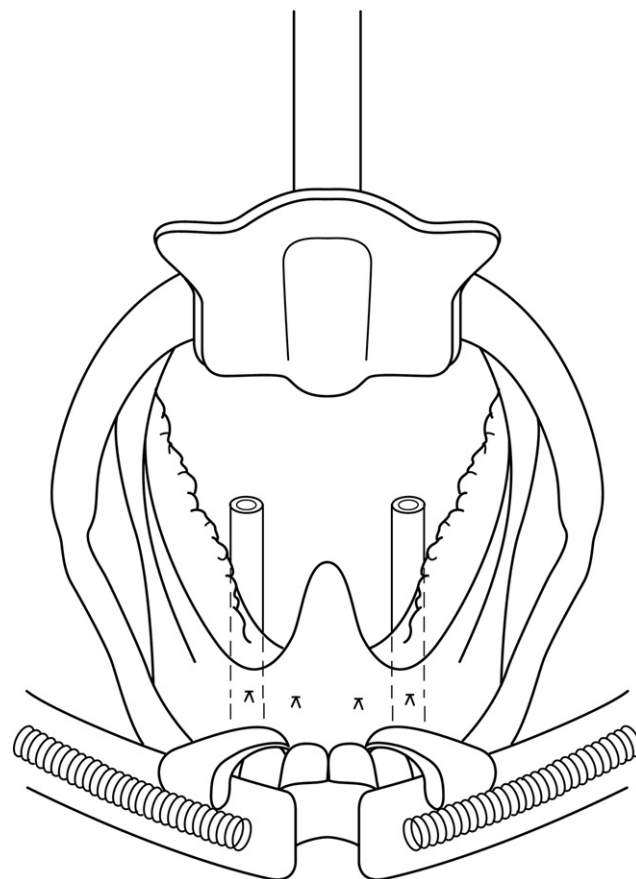
### Rolled pharyngeal flap

#### Indications

A rolled pharyngeal flap may be considered when significant VPI is associated with a longitudinal gap, no more than 2 mm in anterior and/or posterior dimension, across the posterior pharyngeal wall.

#### Procedure

The standard pharyngeal flap is planned. The mucosa is raised as a superiorly based flap, then the underlying muscle is elevated separately. The muscle is then rolled onto itself superiorly and tacked to the prevertebral fascia. The mucosa is then returned to its original position to minimize secondary intention healing. A muscular bulge is thus created at the site of velopharyngeal closure to augment the area and provides the patient with the ability to close the velopharyngeal sphincter. The rolled flap offers a buttress for the free edge of the soft palate to engage in patients with coronal or circular patterns of closure<sup>5</sup> (Figure 5).



**Figure 4** Four sutures secure the flap in proper position. The flap is not visible on a transoral view of the posterior pharyngeal wall. Nasal stents are positioned in the oropharynx to minimize the risk of airway obstruction developing from the surgical trauma associated with raising and positioning the flap.

**Figure 5** The rolled pharyngeal flap raises the oropharyngeal mucosa and the superior constrictor muscle as separate superiorly based flaps. The muscle is rolled upon itself and sutured to the prevertebral fascia high in the nasopharynx. The mucosa is returned to its proper anatomic location to minimize secondary intention healing, which may lower and flatten the muscular bulge created with this operation.

### Posterior pharyngeal wall augmentation with injectable materials

#### Indication

Significant VPI associated with small gaps along the posterior pharyngeal wall of no more than 2 mm in size (anterior and/or posterior dimension) are appropriate for injection pharyngoplasty. Patients with touch closure of the velopharyngeal sphincter mechanism that cannot withstand increased intraoral pressure are also good candidates for this technique. Wind instrument players may present with this problem despite having no abnormalities with speech and resonance.

#### Procedure

Injections are administered under general anesthesia. The posterior pharyngeal wall is visualized, and the site of nasal escape is identified.

There are several options available for injection into the posterior pharyngeal wall. Medical-grade teflon carries the risk of infection, granuloma formation, inferior displacement over time,<sup>6</sup> and, theoretically, embolization.<sup>7</sup> For these reasons, it is no longer used in the correction of VPI. Homologous fat may be injected and can be harvested from the abdomen or buttock. Commercially available collagen products are available. Hydroxy-apatite is available in a form that can be injected through a needle and tends to remain in position for a maximum of 6 months. Little experience exists, however, in the use of these materials in the posterior pharyngeal wall. The amount of absorption

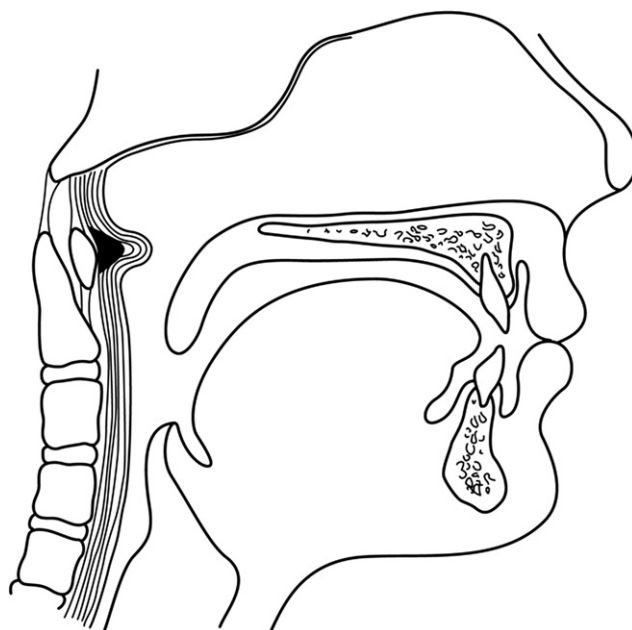
and the viability of these materials are variable. Overcorrection is required to account for absorption of the glycerin vehicle that permits injection through a small-gauge needle. Patients need to know that additional injections may be needed to obtain complete and lasting resolution of VPI (Figure 6).

These procedures do not require overnight observation. Postoperative antibiotics are advisable to minimize the risk of postoperative infection. Neck pain should be expected, as the prevertebral fascia is irritated by the injectable materials.

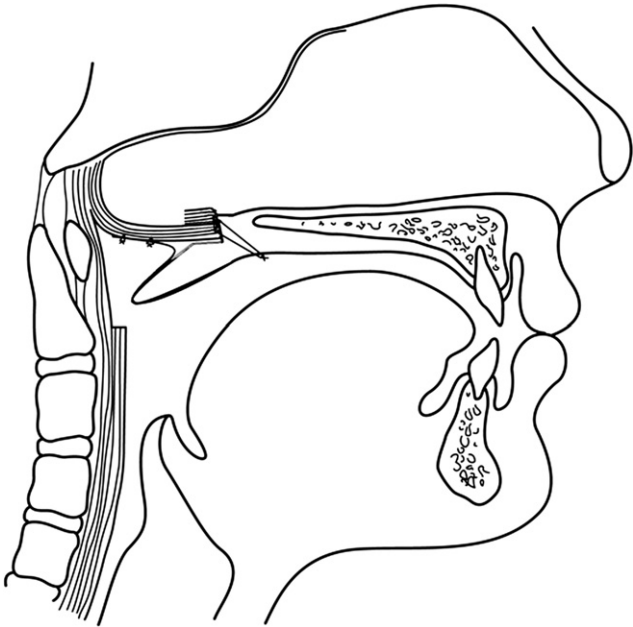
### Revision surgery for VPI

Revision surgery for VPI is possible. It is important to investigate the reason for the previous surgical failure so that precautions can be taken to minimize their recurrence. Pharyngeal flaps can be raised a second time 6-12 months after the first procedure.

When performing a pharyngeal flap for a second time, consideration should be given to "lining" the flap with mucosa taken from the nasal surface of the soft palate. The palate is divided in the midline to within a centimeter of its junction with the hard palate. The nasal mucosa flaps are created and pedicled on the free edge of the soft palate. The pharyngeal flap is then inserted onto the raw surface of the soft palate created through the elevation of the mucosal flaps. The palate is then closed in layers. The mucosal flaps are then sutured to the undersurface of the pharyngeal flap to minimize secondary intention healing that may reduce the width of the flap over time (Figure 7).



**Figure 6** Implantable materials may be injected on the surface of the prevertebral fascia to create a bulge or to fill in a defect on the posterior pharyngeal wall. Overcorrection is required as absorption of the injectable vehicle will occur over time. Several injections may be required to successfully correct a defect.



**Figure 7** Lining the undersurface of a pharyngeal flap with mucosa raised from the nasal surface of the soft palate reduces secondary intention healing of the undersurface of the flap and minimizes narrowing of the flap over time.

It is essential to objectively evaluate patients 3-6 months after reconstructive procedures to assess their nasal resonance. Precise terminology is necessary to judge outcome. “Normal” is not the same as “acceptable.” A family’s sat-

isfaction with the results of surgery does not equate to normal or acceptable resonance. Without objective scrutiny of postoperative outcomes, improvement in surgical results cannot occur. Not all patients with continued hypernasality need revision surgery. Developmental delays, compensatory articulation errors, and underlying syndromes will affect speech outcomes.

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