Abstract
First described in 1978 by Furlow for the repair of a cleft soft palate, the double-opposing z-plasty, also known as the Furlow palatoplasty, is an excellent procedure for repairing a submucous cleft. It is also useful in patients with touch closure who simply need lengthening of the soft palate and as an option for patients with anomalous carotid vasculature where pharyngeal flaps and sphincter pharyngoplasty are precarious. The primary aims of this chapter are to provide the clinician with indications for when to consider utilizing the Furlow palatoplasty and to give a stepwise description of how to perform the procedure.

Introduction
The Furlow double-opposing z-plasty, initially described by Leonard Furlow in 1978 [1] for repairing a cleft soft palate, is a useful procedure for repairing velopharyngeal insufficiency (VPI) in patients with sagittal orientation of the levator veli palatini muscle. The goal of this surgery is to reorient the levator sling and lengthen the soft palate. Therefore, it serves as a useful tool for VPI patients with touch closure or a submucous cleft palate or for those with VPI following adenoidectomy (fig. 1).

Preoperative evaluation by nasopharyngoscopy and evaluation of the orientation of the levator sling and of the size of the velopharyngeal gap is essential when deciding whether a Furlow palatoplasty is the operation of choice. In a 2004 prospective study by Perkins et al. [2], 148 pediatric patients with mild to severe VPI underwent Furlow palatoplasty. Seventy-three percent of patients with mild VPI had resolution of symptoms, while only 13% of patients with severe VPI had resolution. Therefore, the algorithm used by these authors suggested the use of a
different surgical procedure, such as a pharyngeal flap or the use of a combination procedure of a Furlow palatoplasty and sphincter pharyngoplasty for patients with larger gaps.

Special mention is given to patients with velocardiofacial syndrome, or 22q11 deletion syndrome. In many of these patients, the presence of a submucous cleft leads to VPI, where a Furlow palatoplasty is the ideal procedure. However, a subset of these patients demonstrates a frozen palate, where Furlow palatoplasties are not as effective. A study from Rottgers et al. [3] demonstrated a 45% success rate in patients with velocardiofacial syndrome when using Furlow palatoplasty alone as the primary procedure. Therefore, alternative procedures, such as a pharyngeal flap or a palatal lift, should be considered. As these patients are not uncommonly found to have medialized carotid vasculature, obtaining vascular imaging prior to choosing the best surgical procedure is prudent. It is the senior author’s practice to obtain either an MRI or CT scan for all patients with 22q11 deletion syndrome. If a large velopharyngeal gap is present in conjunction with medialized carotid vasculature, the parents are given the option of either undergoing a Furlow palatoplasty with the possibility of needing an obturator postoperatively or of being fitted with an obturator without surgical correction.

While the risk of postoperative obstructive apnea is extremely small, the creation of an oronasal fistula in a patient with a previously intact soft palate is the dreaded complication of the procedure when performed for velopharyngeal insufficiency. A 2001 retrospective review from Seattle Children’s Hospital [4] demonstrated a low fistula rate of 4% (2/48 patients). It is the senior author’s opinion that if the posterior flap remains well posterior to the soft/hard palate junction and care is taken to meticulously close the nasopharyngeal mucosa in a tension-free manner, the likelihood of a fistula remains extremely low.

![Fig. 1. Furlow palatoplasty.](image)

**a** Two mirror-image z-plasties are drawn with the cleft as their central limbs. **b** The oral-side z-plasty flaps are elevated with the levator-palatopharyngeus muscle in the posterior-based flap. Only mucosa is elevated in the anterior-based flap. **c** The nasal flaps are elevated with the remaining muscle in the posterior-based flap. Transposing the two sets of flaps overlaps the palatal muscles and lengthens the soft palate. Reprinted with permission [1].

Patient Evaluation

1. Office Visit.
   a. History, including genetic disorders, previous operations, cleft palate, etc.
   b. Physical exam, including nasopharyngoscopy to evaluate the velopharyngeal closure pattern and evidence of medialized carotid arteries (see Chapter 3). A touch closure pattern is best suited for a Furlow palatoplasty.

2. Speech pathology evaluation, including fluoroscopy if recommended by a speech pathologist (see Chapter 2).

3. Adjunct studies as needed, including cine MRI (see Chapter 4) and/or vascular imaging.

Indications

- Touch closure pattern where lengthening of the palate will allow for improved apposition with the posterior pharyngeal wall. Posterior pharyngeal augmentation can also be considered in these patients.
- Submucous cleft where reorientation of the levator sling is needed.
- VPI in patients with medialized vasculature where a pharyngeal flap or sphincter pharyngoplasty may be precarious.

Contraindications

- Wide palate defect.
- Neuromuscular deficits causing an immobile palate or clefts that are too wide to be repaired where an obturator/palatal lift is needed.

Anesthesia Considerations

- Midline endotracheal tube – an Oral RAE or armored tube is preferred to prevent ‘kinking’ of the tube during the course of the procedure.

Materials

- Crowe-Davis mouth gag/tonsil set.
- Colorado-tip Bovie.
- Multiple 4-0 Vicryl sutures on a small taper needle.
Set-Up

- Modified Rose position with generous shoulder roll for neck extension is used if the surgeon is seated for the procedure.
- The proposed z-plasty incision is marked with either Gentian Violet or a surgical marker (fig. 2). The right-sided limb of the z should be anterior to the uvula and directed toward the right hamulus, while the left-sided limb should be posterior and directed toward the left hamulus. The vertical limb should terminate approximately 0.5–1 cm anterior to the hard-soft palate junction. The senior author does not routinely divide the uvula if it is not already bifid, and therefore, the author does not extend the vertical limb of the incision through the uvula.
- Local injection of lidocaine with 1:100,000 of epinephrine should be performed along the proposed incision lines, with a wait time of 5–7 minutes to ensure adequate hemostasis.

Procedure

Furlow Palatoplasty: Online supplementary video (for online supplementary material, see http://www.karger.com/Article/FullText/368022).

- An incision is made with a Colorado-tip Bovie through the mucosa of the soft palate as marked.
- The left side is addressed first. Curved iris scissors or angled Potts scissors are used to identify the level of the levator musculature and incise it. A myomucosal flap is raised with the scissors from the side closest to the hard palate toward the uvula, using a pickup with teeth to gently grasp the flap. Care must be taken not to violate the nasopharyngeal mucosa.
  - It should be noted that the myomucosal flap is always elevated from the edge closest to the hard-soft palate junction toward the uvula (resulting in the myomucosal flap always being the flap closest to the uvula and farthest from the hard palate).
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Doing so will ensure the proper re-orientation of the muscular palatal sling and allow for greatest palatal lengthening. This holds true for both the oropharyngeal and nasopharyngeal-sided flaps and will help for incision and flap-planning regardless of right- or left-handedness. Determining which flap is only mucosal and which is myomucosal can be very confusing, and these are steps where the surgeon should take extra time, if needed, to make sure that the flaps are designed properly.

- The right side is then addressed. The scissors are used to elevate a mucosal flap from the edge closest to the uvula toward the hard-soft palate junction with care taken to leave the levator musculature down. The flap must be handled gently to avoid trauma, as it can be quite thin.
- A Beaver6900 blade or iris scissors are used to make a vertical incision through the nasopharyngeal mucosa, creating the vertical limb of the opposing z incision.
- The lateral limbs of the z are now made using the iris scissors in the opposite fashion from how the first z was made. Here, the left-sided incision is made starting at the vertical limb closest to the uvula, while the right-sided incision is made starting at the end closest to the hard-soft palate junction. This left-sided flap is simply a mucosal flap, while the new right-sided flap is a myomucosal flap (again, anteriorly-based).
- The nasopharyngeal-sided z-plasty is now closed by suturing the apex of the right-sided myomucosal flap to the corner of the cut edge of the nasopharyngeal mucosa on the left side using a 4-0 Vicryl suture. A second suture is placed to secure the remainder of the flap to the nasopharyngeal mucosa (fig. 3).
- The left-sided nasopharyngeal mucosal flap is then sutured to the corner of the cut edge of the levator muscle on the right side using a 4-0 Vicryl suture. Care is taken to avoid the overlying oropharyngeal mucosal flap. A second suture is placed spanning from the mucosal flap to the superior edge of the myomucosal flap, thus closing the cleft defect that had been created. Additional sutures are placed as needed between the two flaps to completely close the cleft defect.
- The oropharyngeal-sided z-plasty is now closed by suturing the apex of the left-sided myomucosal flap to the corner of the cut edge of the oropharyngeal mucosa.
on the right side using a 4-0 Vicryl suture. A second suture is placed to secure the remainder of the oropharyngeal mucosal flap (fig. 4).

- The right-sided mucosal flap is then sutured to the corner of the cut edge of the oropharyngeal mucosa on the left side using a 4-0 Vicryl suture. Again, additional sutures are placed to secure the remainder of the flap to the oropharyngeal mucosa (fig. 5).
- The flaps of the second z-plasty are then sutured together (fig. 6).
- The mouth gag is then carefully removed, and the patient is turned over to anesthesia for awake extubation.

**Postoperative Care**

- The patient should be monitored overnight for edema and respiratory difficulty.
- Care must be taken to prevent trauma to the repair and might involve the use of arm restraints during the postoperative period if the child has a propensity to put his/her fingers in the mouth. Additionally, the use of ‘sippy’ cups and straws should be avoided for approximately 3 weeks after surgery.
- Solid foods should be of a pureed consistency for 3 weeks following surgery.
Surgical Pearls

- Adequate hemostasis is vital in order to properly identify the surgical planes of dissection.
- The myomucosal flap should always be the flap that is elevated from the side closest to the hard-soft palate junction toward the uvula, whether it is on the oropharyngeal or nasopharyngeal side. This will help plan incisions regardless of whether the surgeon is right- or left-handed.
- The mucosal flap should be handled very gently, as it can easily shred with trauma. Elevation with some minor salivary gland tissue on the posterior surface can help add some thickness to the flap while still leaving the muscle down.
- The nasopharyngeal-side z-plasty must be closed well to prevent fistula formation. Suturing the two flaps together is important to close the surgically created cleft.
- The vertical limb of the z incision should not extend to the hard/soft palate junction to decrease the likelihood of fistula formation.

References


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