



Best Result of Palatoplasty Using Furlow Technique

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Abstract

There are several techniques for cleft palate repair, with modifications of each.

It is important to evaluate the type of cleft palate to choose the appropriate repair type.

The Veau classification system is commonly used to describe varying degrees of cleft palate and has implications for chosen technique and outcomes. The main outcome measure for palatoplasty is speech resonance. Other factors to consider are Eustachian tube dysfunction, postoperative fistulas, velopharyngeal insufficiency, and maxillary growth.

Keywords: Cleft Palate; Palatoplasty; Surgical Technique

Introduction

There are several factors that should be considered when planning cleft palate repair. First, it is important to review the patient's associated comorbidities, because this can impact decisions on perioperative management and counselling that is provided to family members. Many comorbidities can change the risk of postoperative airway obstruction, velopharyngeal insufficiency (VPI), or fistula formation. It is also critical to determine the type of cleft palate that will be addressed, because this influences the decision on which technique is most appropriate for an optimal patient outcome. Although many different systems are available for describing palatal defects, [1] the Veau classification is widely known and split into groups that follow well with surgical planning:

- **Group I:** Cleft of the soft palate.
- **Group II:** Cleft of soft and hard palate, that does not extend further than the incisive foramen (secondary palate).

- **Group III:** Cleft of soft and hard palate that extends anterior to incisive foramen and through the alveolus on one side.
- **Group IV:** Complete bilateral cleft palate. It is worth commenting on the submucous cleft palate (SMCP), which does not fall within the Veau classification system. With SMCP, mucosa is intact along the entire hard and soft palate, but here is disruption of the palatal sling musculature in the midline. Although this is not as clearly observed clinically as overt cleft palate, these patients may present with a bifid uvula, a notch at the hard and soft palate junction, or translucent mucosa in the midline at the site of muscular discontinuity, called the "zona pellucida." In cases of occult SMCP, there is no evidence of clefting in the oral examination, but furrowing of the nasal surface of the soft palate is noted. McWilliams [2] performed a study of 130 patients that reported 44% of SMCP did not require surgical intervention for speech development. However, when discussing management options, it is worth noting that the rate of VPI with SMCP has been reported

between 5% and 67% [3]. Surgeons can counsel families that VPI may be present up to 50% of the time, necessitating repair. Primary cleft palate repair is commonly performed at 9 to 12 months of age, although should be tailored to the patient based on size, weight and comorbidities. Overall, the goals of this operation are to close the defect, lengthen the palate, and gain normal velopharyngeal function while minimizing negative growth effects. A key aim of palatal repair is normal speech resonance, so surgery should ideally be performed before 12 to 15 months of age, before speech acquisition. Although there are instances where anatomic or medical concerns cause delay in repair, this time frame is ideal for most of the population. Patients who are otherwise healthy and have clefts involving the soft palate only can have surgical repair performed earlier, around 7 to 8 months, their size permitting. There have been several techniques described for cleft palate repair [4-8]. These include the unipedicled two-flap palatoplasty (Bardach and Salyer), bipedicled flap palatoplasty (von Langenbeck), V-Y pushback palatoplasty (Veau-Wardill-Kilner), and double-opposing Z-plasty (Furlow). These techniques were developed and described by the named surgeons, but there have been many modifications made to these original techniques. The choice of technique is based on surgeon's comfort and preference, but it is important that technical details of these operations be described by current surgeons for accurate portrayal of procedural steps and comparison of outcomes. It is important to understand and be able to perform multiple techniques, given that choice of repair is case dependent. Factors that weigh into this decision include anatomic considerations, such as the Veau classification; quality of available tissue; distance from the medial edge of the cleft to the vomer and alveolus (i.e., width of the cleft); airway concerns; and developmental prognosis. Further more, an individual's training and experience also play into the decision-making process. Although a multitude of closure options exist, holding to the appropriate timeline and managing associated comorbidities are necessary for optimal results, regardless of operative technique. Although the separate techniques are covered in further detail, there are some commonalities across cleft palate repair methods that are discussed here. Patients generally are intubated with an oral endotracheal tube that is secured to the midline of the lower lip, and cases

are performed with a Dingman mouth gag in place to obtain a wide, unobstructed view of the palate. Local anesthetic with epinephrine is injected into the palate, with special care taken not to exceed 7 mg/kg if using 1% lidocaine with 1:100,000 epinephrine. To avoid ischemic injury to the tongue and postoperative edema and airway concerns, the Dingman retractor is loosened regularly (e.g. every 20-30 minutes) to allow for tongue reperfusion [9,10]. This can also be a useful time for surgeons to stretch their necks and shoulders, because palate repair causes strain in these areas (Personal communication, Dr D. Kacmarynski, 2022).

Two-flap palatoplasty

The two-flap palatoplasty is one of the most used techniques and is viable for any palatal defect that involves the hard palate, whether unilateral or bilateral (Figure 1). Bilateral hard palate flaps are raised, each as a mucoperiosteal flap that receives blood supply from the greater palatine artery. Planned incisions are marked along the medial edges of the soft and hard palate cleft edges, with care taken to mark 1 to 2 mm lateral from the edges for appropriate tissue length to close the nasal layer. Markings for the lateral incisions are placed 1 cm posterior to the maxillary tuberosity and are brought anteriorly just inside the alveolar ridge until this meets the cleft edge anteromedially. Typically, all incisions are made and the flap elevated on one side, then the other. The medial incision is started at the tip of the uvula and carried forward to the anterior most aspect of the planned incision, with the incision made down to bone over the hard palate. The lateral incision is begun at the anterior end, just behind the alveolus. This is taken down to bone as the dissection continues posteriorly, but when nearing the posterior end of the hard palate the incision should become more superficial to avoid damage to the greater palatine artery vascular pedicle. A submucoperiosteal flap is then raised, beginning anteromedially, typically with blunt dissection instruments and monopolar cautery as needed.

This dissection is carefully brought posteriorly until the greater palatine artery and associated neuro-vascular bundle are identified and preserved. The pedicle is circumferentially dissected without damaging the vessel, to allow for appropriate laxity for later closure. Finally, musculature of the palatal sling that is abnormally inserted along the posterior hard palate edge is freed. Now attention is turned to raising the nasal layer of the hard palate. Mucoperiosteum is elevated at the medial cleft edge and extended

laterally along the nasal floor until enough nasal mucosa is raised for a tension-free closure. This mucosa must be raised carefully to avoid any tears that could affect appropriate closure. This can easily occur at the bony margin if not careful. In a unilateral cleft palate, if necessary because of a wide cleft or lack of necessary tissue, the noncleft side is augmented with a vomer flap for nasal layer closure. If this is pursued, then a mucoperiosteal flap must be raised along the appropriate side of the vomer.

With the oral and nasal layers raised from the hard palate anteriorly, the next step is soft palate dissection bilaterally. Depending on patient size and palate length, this portion is repaired with a double-opposing Z-plasty (also known as Furlow palatoplasty, described in further detail later) or with an intravelar veloplasty (IVV) and straightline repair, which is described presently. Because the muscle fibers have been freed from the posterior hard palate, they are now dissected free from the nasal mucosal layer of the soft palate in a medial to lateral direction. These muscle fibers are also freed, in varying degrees, from the edge of the oral mucosal layer of the soft palate to allow for necessary reorientation of the fibers into a transverse plane. Whether a Furlow or IVV with straightline repair is pursued, the goal should be to improve soft palate function by orienting the levator muscular sling into a transverse direction. Once flaps are raised along the soft and hard palate bilaterally, mobility should be assessed to make sure that the flaps can meet in the midline without tension. A key area of tension, and possible complication such as oronasal fistula, is at the hard and soft palate junction, because of several factors. Special attention should be given to completely dissecting free mucosa in this area to help provide tension-free closure. If tension is encountered, there are various maneuvers that are performed to release this. If needed, the tensor veli palatini is dissected off the hamulus, or the hamulus is infrafractured. The neurovascular pedicle is dissected further until there is sufficient tissue laxity. Also, further blunt dissection is performed in the space of Ernst, which is the plane between the superior constrictor muscle and the pterygoid muscle. Flap mobility must be checked after performing each maneuver to assess when an appropriate end point has been reached. With adequate tissue release and laxity, closure is performed in three layers with absorbable sutures per surgeon preference. First, the nasal layer is closed with interrupted or running sutures, or a combination thereof. Next, the palatal musculature is closed in the midline with horizontal mattress sutures. Then, the oral layer

is closed in interrupted fashion, typically with simple interrupted and vertical mattress sutures to evert the wound edges for optimal healing. The uvula is also approximated and closed with simple interrupted sutures, along the oral and nasal layers and at the apex. This multilayer midline closure helps prevent oronasal fistulae formation. At the end of midline closure, lateral gaps are present, which heal by secondary intention over the exposed bone. The surgeon can place one to three horizontal mattress “airknotted” sutures bilaterally to stabilize these flaps for further closure, but one should be careful not to create tension on the midline closure with these because it could affect surgical site healing. Finally, hemostasis should be obtained before complete closure to lessen risk of postoperative bleeding.

Furlow (Double opposing z-plasty) palatoplasty

This type of palatoplasty is often used for closing clefts of the soft palate only, submucous clefts.



Figure 1: Wide, U-shaped cleft palate defect with incisions marked for von Langenbeck palatoplasty.

Note that a small double opposing Z-plasty was performed for the soft palate to resist scar contraction, or as an adjunct for posterior palatal closure and lengthening in conjunction with the techniques listed previously. However, Furlow palatoplasty can be modified for use in any type of cleft palate [11]. Although the original description of this technique comments that lateral relaxing incisions are not necessary [12], they can often be useful for helping decrease tension with wider clefts. Because this form of repair is a Z-plasty, it lengthens the soft palate, which brings

the soft palate closer to the posterior pharyngeal wall and helps to reduce the risk of VPI, but at the cost of losing palatal width growth potential. Of equal importance is that this Z-plasty works to reorient the levator veli palatini muscle more posteriorly and in a transverse direction across the palate, leading to a functional muscular sling. It also narrows the velopharyngeal port when considering the area in three dimensions. All of these aspects have the potential to decrease velopharyngeal insufficiency. When designing the Z-plasty flaps, the posteriorly based flaps should be myomucosal, whereas the anterior flaps are mucosal (with retained submucosa for flap bulk). To avoid direct apposition of multiple layers of closure, and increased risk of fistula formation, the oral and nasal flaps are mirror images of one another. The step-by-step procedure described here is best suited for the right handed surgeon; left-handed surgeons may opt to plan incisions in the opposite direction as long as the musculature remains in the posteriorly based flaps. Typically, the Z-plasty flaps are designed to be 60 degrees (Figure 2). Oral mucosal incisions are marked with the left side extending from the cleft margin just posterior to the hard palate shelf, near the hamulus. These incisions should be somewhat curvilinear to create broader flap tips, and a cuff of tissue should be left anteriorly to allow for suturing. On the patient's right, the incision begins at the base of the uvula and moves outward to the hamulus. Dissection typically begins on the left side, with scalpel incisions made through the submucosa until palatal muscle is found. This is then released from the hard palate edge posteriorly if there are any abnormal attachments remaining. With tenotomy scissors, the palatal musculature is raised with the posteriorly based oral flap. Next, sharp dissection down to muscle is performed on the right side, and the oral flap is developed anteriorly, with tenotomy scissors used to leave muscle down on the anteriorly based nasal flap on this side. Once again, care is taken to remove erroneous muscular attachments from the hard palate edge, and submucosa and salivary gland tissue should be taken up with the oral flap to aid with flap bulk and adequate closure. Next, the nasal flaps are developed. Scissors are used to cut the left nasal flap from the uvular base toward the hamulus and Eustachian tube, and the right flap is cut along the hard palate shelf toward the hamulus and Eustachian tube. Similar to the oral layer, it is important to leave a cuff of tissue on the right side where flaps will be sutured close to the posterior hard palate margin. If necessary, flaps can be sutured to the bone in children less than 1 year of age. With these incisions made, and because of how oral

flaps were raised, the left side nasal layer should have an anteriorly based mucosal flap, whereas the right side should have a posteriorly based myomucosal flap. This is the opposite of the oral layer and allows for appropriate reorientation so that an intact palatal sling is established along the posterior soft palate. Now the nasal flaps are brought into their new, appropriate orientation, and the three limbs are closed in a simple interrupted and/or running fashion with absorbable suture. The same process is then performed with the oral layer, which will rest in a mirror image of the nasal layer, so that there is minimal overlap of suture lines, and thus a lower risk of palatal fistula formation. Finally, the uvula is closed at its apex and then along the nasal and oral sides with absorbable sutures, in a simple interrupted fashion. With a successful Furlow palatoplasty, the muscular sling has been established in the correct transverse direction posteriorly and the soft palate has been lengthened. If a Furlow palatoplasty is planned in conjunction with any of the aforementioned techniques, it is worthwhile to make the Z-plasty incisions after complete dissection of the anterior mucoperiosteal flaps is complete and the vascular pedicles can be assessed. If there is any damage or concern for flap viability, a straight closure with IVV may be a more successful option, because raising of additional flaps may compromise vasculature.

Outcomes after cleft palate repair

A primary complication to avoid through proper surgical technique is fistula formation. This occurs if the viability of the repair is compromised, or there is tension present in the closure. The junction of the hard and soft palate is the point of highest tension so it should be given adequate attention during closure to prevent fistula formation. There is a large variation reported in the rate of fistula formation, from 3% to 60%, although 10% is an agreed upon professional consensus [6,7,13]. Specifically, among otolaryngologists, one study reported a fistula rate of 6.6% of 453 patient cases [14]. This study also showed no difference in fistula formation among the operative surgeons, but rather Long and Petersson that a significant risk factor was Veau IV classification. The broader base of literature echoes this same point, that risk factors related to higher rates of fistula formation are higher Veau classification and wider cleft. Velopharyngeal insufficiency (VPI) is present in about 20% to 30% of patients after cleft palate repair [6,15]. Although it can be difficult to assess the impact of surgical technique [16-18], cleft width and age at time of repair (especially age > 2 years) shows an associated higher risk of VPI after repair

[17]. There is an increasing burden of evidence that Furlow palatoplasty of the soft palate can aid in obtaining velopharyngeal competency postoperatively [12,17,19]. Another area of interest is what effect palate repair has on facial growth. Although there have been several studies and systematic reviews, results prove to be conflicting when evaluating maxillary growth and occlusion. Commonly studied factors are timing of hard palate repair and technique performed, but a large variability among studies in relation to age range and timing of repair makes for muddled results [20]. Currently, the only clear consensus is that timing of repair does not affect the mandible's protrusion. Eustachian tube dysfunction (ETD) is consistently present in patients with cleft palate and is linked to the abnormal orientation of the levator and tensor veli palatini muscles. Because of chronic middle ear drainage issues in these patients, tympanostomy tubes are regularly placed at the time of cleft palate repair to negate a need for additional anesthesia. When considering which palatoplasty technique to perform with consideration for otologic outcomes, there are some conflicting data. Although some literature suggests that performing Furlow palatoplasty can improve ETD over two-flap palatoplasty based on number of myringotomy tubes placed after time of repair [21], other studies show no difference in otologic outcomes when comparing Furlow and von Langenbeck techniques [22]. The latter results were based on audiometry, rate of tympanostomy tube placement, and physical examination [22]. ETD is also improved when performing IVV versus not performing IVV [23]. At age 5 to 6, 60% of these patients had abnormal otoscopic examinations, although children within the study did not undergo tympanostomy tube placement at the time of cleft palate repair. Carroll and colleagues [24] demonstrated that at age 6, children with cleft palate repair via Furlow palatoplasty had the best pure tone average on audiometric testing when compared with V-Y advancement, two-flap, or von Langenbeck palatoplasties. When evaluating other outcome measures for children after cleft palate repair, there are sparse prospective randomized controlled data because it is tough to randomly assign patients to one technique versus others. Therefore, the best option in this case is multicenter studies that can develop and standardize methodology, study designs, follow-up, outcome measures, and so forth. One other improvement opportunity is described by Sitzman and colleagues [25], who sought to improve fistula rates through a process of peer feedback. Surgeons self-audited their own fistula rates, and feedback and peer coaching were provided to surgeons whose

means fell above the average. Collaborations such as this and multicenter opportunities can help to improve cleft care outcomes and provide greater care for patients with cleft lip and palate.



Figure 2: Postoperative result of palatoplasty reread using furlow technique (double opposing Z-plasty).

Summary

Choice of cleft palate repair technique depends on surgeon training and experience, but it is important to realize that cleft care is an ever-evolving field in which surgeons can continue to improve on techniques and potentially learn new ones. It is clear that comparative studies to help guide surgeons are difficult to perform, and years of follow-up are necessary to assess outcomes when changes are made. Having a thorough understanding of anatomy and how it affects speech resonance and ETD are important to optimize outcomes, and it is important to be aware that there is potential for midfacial growth disturbances. As such, multidisciplinary care is the gold standard for cleft care, allowing for long-term follow-up with all relevant specialties. Willingness of surgeons to collaborate, share outcomes and complications, and multi-institutional studies may allow for better patient outcomes and further the overall quality of cleft-related care.

Disclosure

The authors have nothing to disclose. Clinics care points.

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