Cleft Lip and Palate Surgery: An Update of Clinical Outcomes for Primary Repair

Andrew Campbell, DDS, FRCD(C)a,b, Bernard J. Costello, DMD, MD, FACSa,b,c,* , Ramon L. Ruiz, DMD, MDd,e,f

The comprehensive management of cleft lip and palate has received significant attention in the surgical literature over the last half century. It is the most common congenital facial malformation in the United States and has a significant developmental, physical, and psychological impact on those with the deformity and their families. In the United States, current estimates place the prevalence of cleft lip and palate or isolated cleft lip at 16.86 per 10,000 live births (approximately 1 in 600).1 There is significant phenotypic variation in the specific presentation of facial clefts. Care of children and adolescents with orofacial clefts needs an organized team approach to provide optimal results.2–4 Specialists from multiple areas are needed for successful management from infancy through adolescence. These include oral and maxillofacial surgery, otolaryngology, plastic surgery, genetics and dysmorphology, speech-language pathology, social work, psychology, orthodontics, pediatric dentistry, prosthodontics, audiology, and nursing.4 The specific goals of surgical care for children born with cleft lip and palate include:

- Normalized esthetic appearance of the lip and nose
- Intact primary and secondary palate
- Normalized speech, language, and hearing
- Nasal airway patency
- Class I occlusion with normal masticatory function
- Good dental and periodontal health
- Normal psychosocial development

These goals are best achieved when surgeons with extensive training and experience in all phases of care are actively involved in the planning and treatment.5–7 Surgical treatment must be based on the best available clinical research to avoid unfruitful, biased treatment schemes and optimize outcomes. Ideally, randomized prospective controlled trials with comparative data and appropriate outcome measures would guide one’s decisions. Outcome studies pertaining to the multiple outcome measures, such as facial appearance, facial growth, occlusion, patient satisfaction, and psychosocial development, are essential. Unfortunately, this level of published
evidence is lacking for this patient population. The cleft population as a whole is heterogeneous, making it difficult to standardize groups of patients and to provide valid comparison and outcome data. Individual clefts of the lip or palate are as unique, as are the patients with the deformity. Patients have complete or incomplete clefts that may be isolated to the lip or palate only, can be unilateral or bilateral, wide or narrow, and found in syndromic or nonsyndromic individuals, to mention the most obvious variations. Infants with clefting can present with cardiac, neurologic, renal, and other developmental deficits that can delay treatment and affect outcome, further complicating this patient population. The heterogeneity of the population, the difficulty in coordinating and compiling multi-center data, and the final results of surgical intervention not being seen for approximately 2 decades make high-level outcome research with long-term, reliable results difficult. Few studies currently stand up to the rigorous criteria of level I evidence. The vast majority of publications deal with single-surgeon experience, retrospective cohort studies, and case series. A lack of comparison or control groups in these studies provides little for evidence-based decision making. However, considerable experience can be used to guide some of one’s decisions. Thus, dogmatic claims about the best therapies across large populations of patients are often inappropriate, given the lack of valid data. This article provides an update on current primary cleft lip and palate outcome data and its implications in our treatment decisions.

CLEFT LIP REPAIR

Cleft lip and palate is a complicated and 3-dimensional malformation. Distortion of the skin, musculature, mucous membranes, underlying skeletal structures (bones and cartilage), and dentition occurs with varying severity. The goals of unilateral cleft lip repair include the creation of an intact upper lip with appropriate vertical length and symmetry, repair of the underlying muscular structures producing normal function, and primary treatment of the associated nasal deformity (Fig. 1). Original lip reconstruction techniques consisted of simple straight-line closures. In the mid-1800s, the first reports of lip repair that diverged from previous simple closures were published by Malgaine and Mirault. The Tennison technique with use of a triangular flap to vertically reposition cupid’s bow was presented in 1952. Millard changed cleft lip surgery when he published the rotation-advancement flap technique in 1957. In short order, the technique became popular and remains the most common technique used today. Numerous modifications to Millard’s original description have been published since then. Prominent surgeons around the world modified their own and others’ distinctive repairs, including Asensio, Delaire and colleagues, and Nakajima and Yoshimura, lending to the diversity that is cleft lip and nose repair.

Recent surveys of active North American cleft surgeons indicate that the Millard rotation advancement or a modification of the technique is used by 84% of respondents; triangular flaps are used by 9%; and Delaire functional cheilorhinoplasty, by 2%. A detailed description of each repair is presented elsewhere and the reader is referred to a prior publication for detailed discussions. Studies providing comparison data for results of the various repairs are lacking. The few available randomized comparison studies investigated nasal and labial esthetics of patients treated with the rotation advancement technique versus a triangular flap technique. Overall, these studies found no significant differences in esthetic outcomes and ultimately advocated either technique. The variations in technique for repairing cleft lip and nasal deformities and the uniqueness of each cleft make comparison studies difficult. Surgical results are also influenced by other variables, such as the use of presurgical orthodontic/orthopedic treatment, simultaneous gingivoperiosteoplasty (GPP), and specific timing of surgery—the particular procedure perhaps being only one of many important factors. The surgical repair of the cleft lip, more than any other area of cleft care, remains an art with little compelling evidence to promote one technique over the other. There are currently no adequate controlled studies published that compare different primary techniques of lip repair and their long-term outcomes.

Primary Nasal Reconstruction

The reconstruction of a cleft lip defect also involves correction of the associated nasal deformity. Thompson and Reinders found that residual nasal deformity required approximately twice as many revisions as the lip. In the past 2 decades, much attention has been given to performing cleft nasal reconstruction in a primary fashion, but controversy still exists. In 2008 Sitzman found that 52% of active cleft surgeons in North America performed primary nasal reconstruction routinely, and 22% never used the technique. The typical nasal deformity is characterized by a cleft-side dome depression, splaying of the ala, and eversion of the alar rim exposing the nasal mucosa. The septum is directed to the noncleft
Fig. 1. Complete unilateral cleft lip illustrating the typical deformities of cleft-side alar displacement, deviation of nasal septum, and cleft of the nasal floor (A). Markings for typical cleft repair design incorporates the goals of hypoplastic tissue excision and precise approximation of lip vermilion and white roll (B). Dissection of all 3 tissue layers (skin, muscle, mucosa) and excision of hypoplastic tissue is completed. Abnormal muscle insertions at the anterior nasal spine and nasal ala are completely freed (C). Functional repair of the orbicularis oris muscle with multiple interrupted sutures; the nasal floor and oral mucosa are approximated (D). Completed repair with advancement of the cleft side lateral flap and inferior rotation of the medial segment. Vertical scar designed to resemble the philtral column on the unaffected side, with the remaining incisions being hidden in the contours of the nose and lip (E). (From Fonseca R, Marciani R, Turvey T, editors. Oral and Maxillofacial Surgery, vol. 3. 2nd edition. St Louis (MO): Saunders; 2009. p. 730; with permission.)
side along with the premaxilla and nasal dorsum because of aberrant muscular insertions and activity.22 Traditionally, surgeons avoided primary nasal correction for fear of growth retardation and further deformity. McComb23–25 published his primary cleft rhinoplasty technique in 1975, with follow-up studies in 1985 and 1996. In his technique, access to the nasal cartilages is obtained through the cleft lip incisions; this avoids incisions in the nasal lining, which may contribute to later stenosis. Using the existing incisions, wide undermining of the nasal cartilages from the nasal skin is undertaken from the nostril rim to the nasion; the lower lateral cartilages are then supported in proper position with sutures. McComb reported stable long-term correction with the technique, without drooping of the nasal rim. Anastassov and colleagues26 found increased nasal deviation, increased nasal obstruction, higher rates of sinusitis, and increased requirement for nasal revision surgery in those treated with delayed rhinoplasty. According to these philosophies, the considerable nasal deformity and functional abnormalities resulting from delayed repair can be explained by growth not being “helped” by a proper initial repair, and the deformities worsen with time.27 Later, Anderl and colleagues28 reported a similar technique with more extensive mobilization and undermining of the nasal skin and cheek to allow improved medialization of displaced structures without the need for support sutures. The technique proved to have satisfactory results in 80% of 130 patients, with the remaining 31 individuals requiring revision surgery. Anderl and colleagues concluded that growth is not inhibited and that no adverse sequelae resulted from scar tissue secondary to the wide undermining. The technique benefits unilateral and bilateral deformities. Other surgeons remove some of the fibrofatty tissue located between the domes of the lower lateral cartilages and use interdomal suturing during the primary nasal repair. Studies to date regarding primary nasal reconstruction provide level III evidence illustrated by retrospective case review, observational studies, systematic reviews, and experienced surgeon opinion. No randomized controlled studies are available that compare primary versus secondary nasal reconstruction. Despite the poor level of evidence, results from the studies mentioned and similar reports29–33 indicate that primary nasal reconstruction can be performed to improve overall nasal esthetics and function and possibly to reduce the number of revision surgeries. Large studies are needed to adequately assess the comparative results between different treatment protocols before strong statements can be made regarding the utility of one protocol or procedure over another.

**CLEFT LIP MUSCULAR RECONSTRUCTION**

Delaire has described the anterior facial muscles as several different groupings of balanced rings. The middle and lower rings are disrupted when cleft of the lip or palate occurs. The resultant disturbance in muscular function within these anatomic muscular units secondarily produces distortions in the subsequent growth of surrounding skeletal and cartilaginous structures that theoretically increase over time.34,35 Accurate reconstruction of the various muscular layers of the lip is important for normal lip function and prevents further distortion of underlying hard tissue structures.34–36 According to this theory, treatment of the clefted skin and muscular components improves soft tissue symmetry and, through molding forces, also improves osseous symmetry. The facial musculature adjacent to the cleft deformity has increased collagen content, atrophy, and hypoplasia.37 Mooney and colleagues38 have reviewed these concepts and documented that a 3.5-week delay in muscle development occurs in the unilateral cleft lip and that fiber insertions are abnormal and asymmetric. In nonclefted individuals, the perinasal and perioral muscles attach to the caudal-anterior nasal septum, which functions to exert forward growth of the midface. When a facial cleft is present, the abnormal muscular balance results in the midface deviating to the nonclef side. Nasal distortions include widening of the alar base, vertical displacement of the ala, asymmetric nares, lack of supratip break, underprojected tip, deviated nasal septum, and a short and drooping columella.26 Clefting causes the orbicularis oris to course obliquely along the cleft edges displacing the superficial musculoaponeurotic system (SMAS) inferoposteriorly on the affected side. The zygomaticus muscles pull the SMAS and perioral musculature laterally, posteriorly, and inferiorly, as attachments with the caudal septum are lost on the cleft side.27 Each of these theoretically contributes to asymmetry.

Joos36 retrospectively compared 2 groups of patients undergoing cleft lip repair, one with 50 patients receiving musculoperiosteal reconstruction and no presurgical orthopedics and the other with 60 patients receiving the Millard repair and presurgical orthopedic treatment using a pin-retained device. Improvements in skeletal development were noted in the first group, suggesting to the authors that midfacial muscular reconstruction is important and that this cannot be compensated for by orthopedic therapy. These results were echoed by a similar technique described by Markus and Precious.39 Confounding variables make
it difficult to make direct comparisons between the 2 studies. These reports are theoretical and represent Level III evidence. Whether to perform the midfacial dissection in the superperiosteal or subperiosteal plane is another controversial technical point. Regardless of the depth of dissection, modern techniques rely on restoration of the perinasal and perioral muscular anatomy in an attempt to create balanced facial growth. When such a correction does not occur, the secondary deformities that plagued earlier repairs are the result. These concepts have been generally self-reported by those who advocate them and using mostly Level III data. However, considerable positive experience with these techniques warrants additional investigation to determine the possible improved results purported by the advocates of these techniques and philosophies.

PRESURGICAL ORTHOPEDICS

Some of the more significant challenges commonly discussed in the literature on cleft lip and nasal repair are the optimal results of nasal reconstruction and repair of the wide unilateral or bilateral cleft lip. Wide and extensive cleft deformities are associated with more significant nasolabial deformity. In an attempt to improve results in these difficult cases, surgeons and orthodontists have developed presurgical methods to approximate the soft tissues and osseous structures. One of the best known devices was introduced by Latham in 1975 and subsequently used in the Millard-Latham protocol. This pin-retained active device widened lateral segments while approximating the alveolar arches and, in bilateral cases, retracted the protruding premaxilla. Long-term follow-up of patients treated with these pin-retained orthopedic devices has revealed significant negative effect on maxillary growth making their use limited.

The modern era of presurgical nasoalveolar molding (PNAM) was introduced by Grayson and colleagues in 1993, using a passive intraoral device with the addition of nasal prongs. It is theorized that neonatal nasal cartilages have plasticity and can be actively molded and repositioned to the benefit of long-term esthetics. Overall goals of PNAM have been described as improved nasal appearance that persists, fewer secondary nasal surgeries, columellar elongation, minimizing the need for alveolar bone grafting, limited maxillary growth disturbance, and economics. Controversy exists as to whether these benefits are truly achieved and maintained over time. Lack of adequate long-term controlled studies prevents evidence-based recommendations on use of PNAM. Bennum and colleagues report improved nasal symmetry lasting into childhood when PNAM is used, compared with children excluded from orthopedic treatment. Conversely, subsequent publications note that the initial improvement in nasal symmetry noted with PNAM before unilateral repair has shown significant relapse in the first year after surgery. Nasal asymmetry is known to worsen with growth in cleft patients, especially at the prepubertal growth spurt; therefore, a controlled study with follow-up into adulthood is required.

Many surgeons using PNAM also perform GPP and report reduction in the need for secondary bone grafting and minimal growth inhibition. Results show that at least 40% of patients having GPP require secondary bone grafting to obtain alveolar continuity and allow tooth eruption. Secondary maxillary bone grafting procedures have a success of 96%, making the 40% failure rate of GPP unreasonably high. GPP has been abandoned at some centers because of the frequent lack of adequate bone formation and its detriment to growth and the final overall result. Experiences with similar primary bone grafting techniques in the 1960s had poor growth results, leading to recommendations against the procedure.

Additional stated benefits of PNAM are improved feeding efficiency and growth. A randomized 2-arm long-term multicenter trial providing rare level I evidence is being carried out in the Netherlands (Dutchcleft) and is providing interesting results regarding presurgical orthopedics using passive plates without active nasal molding. Results have shown that there were no sustained effects on maxillary arch dimensions in the primary dentition; initial improvements in language skills and facial esthetics were no longer realized by age 6 years; no benefits were noted in feeding or weight gain; greater satisfaction with treatment results was not shown by mothers; and ultimately, the cost-effectiveness of presurgical orthopedic treatment should be questioned. Similar to other studies, Dutchcleft lacks follow-up into adulthood; future results of this well-performed study are anxiously awaited. A randomized controlled trial of 50 nonsyndromic infants with cleft palate by Masarei and colleagues found no benefit in feeding efficiency or body growth when presurgical orthopedics were used. The published or stated benefits of PNAM have largely been unproven and are based mainly on self-reported level III evidence. Incorporating these devices into cleft care bears a significant financial cost and parental burden. Currently,
they are without proven benefit and show poor results in well done comparative studies. The clinical use of PNAM is not strongly supported by the literature.

**TIMING OF CLEFT LIP REPAIR**

Cleft lip/nasal repair represents the initial surgical endeavor in the care of an individual with cleft lip and palate. Each cleft team advocates a slightly different timing for lip reconstruction, with actual correction being performed from the neonatal period to 6 months or later. Intrauterine repair of the cleft lip deformity has been contemplated, but it is not viable considering the life-threatening position in which it places the mother and fetus. Antenatal and neonatal repair have prompted interest based on experimental findings indicating that wounds in the fetus heal without scar tissue early in gestation. Despite theoretical and experimental benefits, neonatal repair has not seen improvement in esthetic outcomes over repair at 3 months. In fact, problems with excessive scarring and less esthetic outcomes have resulted. Proponents of traditional repair at 10 to 12 weeks argue that this timeline provides for improved esthetic results, because the lip musculature is more developed and allows for proper reconstruction, decreased risk of anesthesia-related complications, and time for the parents to accept the malformation. Early cleft lip repair has not been shown to improve maternal bonding or have other psychosocial benefits. Surgery was traditionally delayed for several weeks based on the “rule of tens.” These guidelines included the infant weighing a minimum of 10 pounds, having a hemoglobin level of 10 g/mL, and reaching an age of 10 weeks and were based on minimizing anesthetic morbidity and mortality. Current anesthesia and pharmacologic methods make earlier surgery safe, but without a significant benefit to neonatal repair; most teams choose to wait the traditional 3 months. There is currently no compelling evidence for a repair performed at an earlier time.

**SUMMARY: CLEFT LIP**

Cleft lip repair has many aspects that require consideration; surgeons have the responsibility of making decisions using the best available data to optimize results. A critical appraisal of the literature reveals deficient level I evidence. Decisions need to be made using published cohort studies, comparison data, case series, and reviews by experts in the field. Based on the best available evidence, some statements can be made regarding primary cleft lip repair. Repair is still appropriate when performed at age 3 months or older. Earlier repair can be safely performed but offers no benefits in esthetics or maternal bonding. The use of presurgical orthopedics and GPP has many advocates but hypothesized benefits remain largely unsupported, and results of the available level I evidence indicate no significant improvements in outcome. Significant financial and parental resources are required when presurgical orthopedics is undertaken, making the cost-benefit ratio unreasonable. There is little debate over the need to perform accurate perinasal/perioral muscular reconstruction and nasal reconstruction at the time of primary lip repair. Insufficient data exist to advocate one type of repair over another; if the principles of muscular and nasal repair are followed, one can perform the rotation-advancement, Delaire chelirhinoplasty, or triangular technique and obtain excellent results.

**CLEFT PALATE**

Le Monnier, a French dentist, reported the first successful cleft palate repair in Paris in 1766. Subsequently, many surgical techniques for cleft palate closure have been described. There is still active debate over which technique produces superior results. A lack of clinical data from prospective trials forces clinical decisions to be made from retrospective studies, cohort studies, and surgeon experience. Because of the inherent bias and uncontrolled nature of this level of evidence, clinicians need to be aware of the shortcomings and incorporate the information appropriately into practice. It may be prudent to consider repair of the hard and soft palates as separate entities, because the outcome measures for each are different. The primary objective of soft palate closure is the development of normalized speech. Outcome measures for hard palate closure should include maxillary growth, facial profile, dental occlusion, and fistula formation. An overall detrimental effect of surgery on growth has been shown, and this should be minimized by considering the timing of the repair. Bernard von Langenbeck described a palatoplasty technique in 1861, which is the oldest such procedure used today. The von Langenbeck palatoplasty involves bipedicled mucoperiosteal flaps with medialization of nasal and oral side mucosa for closure. The technique leaves minimal hard palate exposed but does not lengthen the velum and can impair access for repair of the nasal lining and velar musculature. Subsequently, multiple palate repair techniques incorporated a push-back component designed to lengthen the palate and
decrease the incidence of velopharyngeal insufficiency (VPI). These include variations of the V-Y pushback described separately by Veau, Kilner, and Wardill. Mucoperiosteal flaps are raised based on the greater palatine vasculature, then retropositioned via a V-Y technique, resulting in lengthening of the velum at the expense of denuded anterior hard palate. Poor growth outcomes and anterior fistula formation has limited the use of this technique.

The Bardach 2-flap palatoplasty was described in 1967 and further refined with excellent anatomic and functional results. In the Bardach repair, 2 mucoperiosteal flaps based on the greater palatine vessels are raised; as the flaps are not pedicled anteriorly, visibility is optimal for closure of the nasal layer and velar musculature (Fig. 2). The technique also limits hard palate bone exposure, because the flaps are rotated downward at the expense of palatal depth. These cleft palate surgical procedures are now collectively termed the 2-flap palatoplasties. In 1978, Leonard Furlow introduced a novel technique of repairing palatal clefts using double-opposing z-plasties of the velum.

![Fig. 2. Typical complete cleft of the primary and secondary palates (A). In the Bardach palatoplasty, incisions are designed along the cleft edges and at the junction of the alveolus and hard palate, bilaterally. Two large full-thickness mucoperiosteal flaps are raised on the hard palate; the soft palate is dissected into 3 layers (nasal mucosa, soft palate muscle, oral mucosa). Incisions end at the area of the incisive foramen anteriorly (B). Layered palatal closure proceeds with approximation of the nasal mucosa followed by release of the levator palatini muscles from the posterior hard palate. The newly released levator muscles are then posteriorly repositioned and repaired to create a dynamic sling that allows for velar closure (C). Closure of the oral mucosal flaps completes the repair; first, the midline is sutured, followed by the lateral releases. Rarely, the lateral releases are left to heal by secondary intention. The cleft anterior to the incisive foramen is left untouched and will be repaired in the mixed dentition stage of development (D). (From Fonseca R, Marciani R, Turvey T, editors. Oral and Maxillofacial Surgery, vol. 3. 2nd edition. St Louis (MO): Saunders; 2009. p. 730; with permission.)](image-url)
toward less VPI. In contrast, Sommerlad et al. re-
not. However, the IVV group showed a tendency
clefts repaired with IVV versus those who did
or incidence of VPI among patients who had their
found no significant difference in speech outcome
a prospective study, Marsh and colleagues reported superior results using this procedure as
compared with his experience with the 2-flap pal-
atoplasty. Many centers adopted the Furlow pal-
rehablation and have reported better outcomes. These reports consist mostly of experience from
a single center or surgeon and limited retrospective comparisons of techniques. They do not
provide powerful enough data to make definitive statements. Currently, only some Level II and
mostly Level III evidence is available to help make clinical decisions regarding repair tech-
niques. Successful cleft palate repair requires adequate muscular reconstruction of the velum to
create a new musculature and functional soft palate. The 2-flap and Furlow palatoplasties reconstruct
the velar musculature (ie, levator veli palatini and palatopharyngeus) into a dynamic sling but do so in
different ways.

TWO-FLAP PALATOPLASTY

In these techniques, hard palate repair is performed in a 2-layered fashion, with mucoperiosteal flaps for oral side closure and nasal mucosa with or without vomer flaps to reduce tension and fistula formation. The amount of denuded hard palate should be minimized, because this has been shown to inhibit maxillary growth in all dimensions. Ross et al. found improved maxillary incisor position when von Langenbeck repair is performed instead of push-back procedures, and similar results were reported by Friede. This is probably due to the reduced scarring present with more limited procedures during the early part of the maxillary growth process.

In the 2-flap technique an intravelar veloplasty (IVV) is performed with dissection of the levator palatini muscle (and palatopharyngeus), releasing its abnormal attachment to the posterior hard palate followed by retropositioning of the muscular posteriorly. Ultimately, the muscle fiber direction is re-oriented from a sagittal direction to a transverse one. The idea of IVV was first proposed by Kriens in 1969 and has since been incorporated into many techniques. Comparative data on IVV are lacking and conflicting, most probably because of variability in how surgeons perform the muscular dissection and repositioning. In a prospective study, Marsh and colleagues found no significant difference in speech outcome or incidence of VPI among patients who had their clefts repaired with IVV versus those who did not. However, the IVV group showed a tendency toward less VPI. In contrast, Sommerlad and colleagues reported improved outcomes with his version of IVV. Andrades and colleagues reported lower re-operation rates for VPI and better speech outcomes when IVV was performed than when IVV was omitted. Similarly, Hassan and Askar did a prospective cohort study of nonsyndromic patients with cleft palate, comparing those who received IVV with those who had a 2-layered closure. Improved velopharyngeal and eustachian tube function was found in the IVV group. Currently, the consensus among surgeons seems to suggest that soft palate function is improved when IVV is performed. The available literature also supports the procedure. Reasonable Level II and III evidence is available to guide decisions in this area, and considerable experience seems to indicate that using an IVV in some manner is important to long-term speech results. Level I evidence is still lacking to a great extent in this particular area of cleft palate repair and outcome measurements.

DOUBLE-OPPOSING Z-PLASTY

Closure of a cleft using the Furlow technique involves hard palate closure in a similar manner to that described in the 2-flap palatoplasty, with the goal of a tension-free 2-layered closure. The soft palate is closed in a unique manner that allows theoretical lengthening of the soft palate and reconstruction of the musculature into an anatomically appropriate position. The technique uses opposing, mirror-imaged z-plasties, one on each side of the oral mucosa and the other on each side of the nasal mucosa. The posteriorly based flaps on the nasal and oral surfaces contain mucosa and muscle; the anteriorly based flaps contain only mucosa. The posteriorly based oral myomucosal flap is designed on the patient’s side; the incision is made along the cleft edge just shy of the midline hard palate junction, extending toward the hamular notch. The flap containing muscle and mucosa is then raised with a posterior base, leaving the nasal side mucosa intact. On the patient’s right side, an oral side mucosa-only flap is developed based anteriorly; the incision is along the cleft edge and extends from the uvular area to the hamular notch, leaving the musculature attached to the nasal mucosa. The nasal side z-plasties are a mirror image of the oral side. On the patient’s right, an incision is made just shy of the midline hard palate junction to the hamular notch, making a posteriorly based myomucosal flap. On the left, an incision is made through nasal mucosa from uvula to hamular notch, thus creating an anteriorly based mucosal flap. Dissection proceeds bilaterally into the space of Ernst, and the tensor palatini tendons are released to allow...
adequate mobilization of all flaps. The flaps are repositioned and closed accordingly. This repair has many similarities to the IVV, without having to dissect the muscle off the mucosal flaps as is performed in a 2-flap palatoplasty. This effectively reduces the volume of the closure port for the velum, making it easier for the palate to achieve closure. Documentation of “lengthening” of the palate is not present in the literature, but observation during the repair reveals a 3-dimensional narrowing of the space that the velum must close during speech.

One criticism of this technique relates to the higher fistula rates found by many studies when compared with 2-flap techniques. Fistula rates reported in the literature are infamous for reporting bias, for differing definitions and classifications of fistulae, and for faulty study design. This makes meaningful comparisons nearly impossible, and several investigators have recommended

---

Fig. 3. Complete cleft of the secondary palate consisting of a defect in hard and soft tissue from the incisive foramen to the uvula (A). A Furlow double-opposing z-plasty requires the creation of oral side and nasal side z-plasties. Note that both musculomucosal flaps are based posteriorly (B). The nasal flaps are transposed for lengthening the soft palate and creating a dynamic levator palatini sling to enhance velar closure. Closure of the nasal mucosa anterior to the hard/soft palate junction is performed in the standard manner (C). The oral side flaps are transposed, placing the musculomucosal flap posteriorly; closure proceeds with interrupted sutures (D). (From Fonseca R, Marciani R, Turvey T, editors. Oral and Maxillofacial Surgery, vol. 3. 2nd edition, St Louis (MO): Saunders; 2009. p. 730; with permission.)
strategies to decrease fistula rates—particularly with the Furlow technique. The placement of acellular dermis between the oral and nasal flaps is recommended by some, and this has shown a significant reduction in fistula rates comparable to 2-flap closures.98–100 Some recent reviews of fistula formation after 2-flap palatoplasty revealed the fairly low rates of 3.4% and 3.2%, respectively.101,102 Helling100 reported a fistula rate of 3.2% when acellular dermis was used in conjunction with the Furlow technique.

The outcome data for the Furlow palatoplasty technique compared with the 2-flap techniques have generally been favorable. Multiple investigators have reported improved speech results and low rates of VPI with Furlow versus von Langenbeck techniques.93,86,103–105 These studies consist of single-surgeon and single-center experience before and after adoption of the Furlow technique. Although compelling, these data represent Level III evidence and have not had the statistical power to convincingly provide a wave of change in the surgical community. Despite flaws in the study designs, the reduction in reported rates of VPI is impressive. Randall and colleagues106 confirmed a decrease in VPI from 68% to 25% after instituting the Furlow technique. Williams and colleagues104 report a VPI rate of 13% with the Furlow and 25% with von Langenbeck palatoplasties. A small number of uncontrolled studies have reported no significant difference in speech or VPI outcomes between the Furlow and Veau-Wardill-Kilner or von Langenbeck techniques.107,108 A current and impressive study being conducted at the University of Florida and Sao Paolo, Brazil seeks to compare outcomes of the Furlow and von Langenbeck palatoplasties. The results are unpublished but preliminary findings have suggested only minor differences in outcome, with the exception that the Furlow group has a higher fistula rate and the von Langenbeck, increased amounts of hypernasality as only one element of a comprehensive speech evaluation.109

The available published data has been weak Level II or Level III, and, as such, has been difficult to use when deciding between repair techniques. Consequently, the data at this time is not convincing enough to advocate the Furlow over the 2-flap palatoplasties. As evidenced by the available literature, good results can be obtained with 2-flap or double-opposing z-plasty techniques.

GROWTH

Growth outcome is a major area of study in cleft lip and palate care and an important long-term outcome variable. Outcomes traditionally measured include degree of maxillary horizontal and vertical retraction, transverse arch restriction, and occlusion. It is generally accepted that the surgical repair (and resultant scarring) of the palate and lip and other interventions in cleft correction contribute greatly to midface growth restriction. Ross72,85–90 has demonstrated, however, that the final facial form is a result of treatment effects, inherent growth potential, and features specific to each deformity. He also concluded that surgeons performing the same repairs can have significantly different growth outcomes. With such an integrated mechanism complicated by the myriad of surgical variables, growth inhibition continues to be an area of controversy. Among dozens of studies, a minority based their results on a series of consecutively treated patients (eg, longitudinal). Many of these have reported maxillary growth deficiency in adolescents with a decreased sella-nasion-subspinale angle (an average of 4.5°) compared with noncleft controls.110–112 To improve growth outcomes, centers have attempted delayed hard palate closure with conflicting results, increased fistula rates, and poor speech outcomes in the short term. A major stated advantage of 2-stage repairs is the narrowing of the hard palate cleft after primary veloplasty.40 The reduced defect size allows for closure later in the growth curve, with smaller flaps and, presumably, less of a negative effect on future growth. Excellent growth results have been reported with this technique.113,114

One-stage palate repair remains the most common protocol in North America. Scarring of the hard palatal tissues is associated with maxillary growth inhibition.115 Techniques that minimize the degree of palatal scarring are considered beneficial to overall maxillary growth. The push-back palatoplasties leave areas of the anterior hard palate denuded to heal by secondary intention with resultant scarring. Multiple studies have reported greater growth impairment secondary to these techniques versus the von Langenbeck palatoplasty, with some centers abandoning the push-back for that reason.72,84–91 When a palatoplasty has been performed, there is the possibility of a residual palatal fistula developing at or posterior to the incisive foramen region. Oronasal communications anterior to the foramen are purposely left open, with plans for repair at the time of alveolar/maxillary bone grafting. A decision needs to be made on whether to repair symptomatic residual fistulae early or wait until more growth has occurred. The best data to aid in the decision making comes from a thorough speech examination, performed when the child is cooperative and linguistically developed enough to do one—often at about 3 years of age. Fistulae large
enough to interfere with proper language development or cause significant oronasal regurgitation need to be repaired. Repair of insignificant fistulae at an early age will probably restrict maxillary growth further and should be delayed. Whatever the cause of hypoplastic maxillae, a significant cohort of treated cleft lip and palate patients require maxillary advancement surgery. The frequency with which LeFort I surgery is required in the cleft population has a wide range, depending on the subgroup treated. A retrospective cohort study of a heterogeneous cleft population by Good and colleagues found an overall need for maxillary advancement of 20.9%. When subgroups were considered, they found a range of 0.0% to 47.7%; no patient with isolated clefting of the lip or secondary palate required LeFort I advancement, but 47.7% of those with cleft lip and palate required an osteotomy. Posnick states that rates of maxillary advancement range from 25% to 75% in a cleft population, depending on the criteria applied. The evidence available on this topic is level III in nature and often does not control for cleft type or the surgical variables. To reduce the need for maxillary advancement, consistent team care with a minimum number of surgical procedures and timely orthodontic intervention has been advocated. With roughly one-quarter of the cleft population requiring this additional surgical intervention, growth needs to remain an area of active investigation. More importantly, the concepts of how to potentially alter the current protocols based on the available Level III evidence remains a mystery. Given the multiple variables assessed in the long-term outcome of patients with clefts, larger studies are necessary to strongly advocate for one protocol over another.

**TIMING OF PALATE REPAIR**

As has been stated earlier, the major goal of cleft palate repair is the development of normalized speech for the affected individual, while limiting the amount of maxillary growth restriction. For normalized speech to develop, an intact and appropriately functioning palate needs to be present at the time a child begins speech production. It is well known that surgery on the hard palate has a negative effect on maxillary growth. To prevent this, some authors advocated delayed hard palate closure. In 1944, Schweckendiek advocated early primary repair of the soft palate and delay of hard palate closure until after puberty. Later reports found merit in his technique with less maxillary growth restriction to the extent that up to 90% of patients had normal to near normal midface morphology. Bardach and colleagues visited Schweckendiek’s unit and documented high rates of VPI and compensatory misarticulations among patients treated with this protocol. Additional studies, many with critiques from speech pathologists, confirmed these results when patients were treated with similar protocols. Cleft palate centers in North America have mostly abandoned delayed hard palate closure; however, many European units favor these protocols.

Despite the lack of statistical power and the shortcomings of the available literature, some current studies suggest that cleft palate repair performed before age 14 months is associated with better speech when compared with repairs performed later. Dorf and Curtin found that children with palatal repair after age 12 months had a 90% likelihood of compensatory articulations (CAs) compared with less than 5% of children with repair before 12 months of age. Chapman and Hardin also found a 90% rate of CAs in their study of children receiving late surgery. Chapman and colleagues recently performed a multicenter prospective study examining 40 children, comparing timing of palatal surgery and lexical status with outcome. They found patients operated on with a mean age of 11 months and less lexical ability had better speech than those with a mean age of 15 months and more lexical ability. Kirschner and colleagues performed modified Furlow palatoplasties on 2 groups of patients, one between 3 and 7 months of age and the second aged 7 months or older. They found no significant differences in speech scores, VPI, or rate of secondary pharyngoplasty and stated that there is no benefit to performing palatoplasty before age 7 months. Chapman’s work represents some of the best evidence regarding timing of palate closure, corresponding to high quality level II data. However, most studies in this area consist of level III case series and single-surgeon experience. Consensus from the available data dictates that primary palatal surgery should most often be performed between about 7 and 15 months of age to appropriately balance growth and speech development.

**SUMMARY: CLEFT PALATE**

Over the past century, improved outcomes have been realized with cleft palate repair, primarily through improved understanding of anatomy, superior techniques, better training, and emphasis on interdisciplinary care. There are limitations in the currently available literature and a high level of heterogeneity exists in the cleft population. There is also variability in how different surgeons
perform the same operation. Despite the inherent difficulties in studying this population, there is enough evidence to guide surgeons in repairing the cleft palate deformity. However, it is inappropriate to be dogmatic regarding cleft repair techniques. Consensus has been reached for many general concepts, but the debate continues over several key technical considerations. It is probably beneficial to minimize denuded palatal bone to prevent scar formation and subsequent growth inhibition. Soft palate closure requires the anatomic reconstruction of the levator palatini muscle into a functional sling. Ideally, the levator muscle should overlap at the midline in a significantly retropositioned fashion. The creation of this dynamic sling can be performed with a 2-flap palatoplasty with intravelar veloplasty or Furlow double-opposing z-plasty palatoplasty, with similar results. Using acellular dermis interpositional grafts has been shown to reduce fistula rates—particularly with the Furlow technique. To optimize speech, the traditional timing in North America for cleft palate repair is before about 18 months of age. Recent research suggests that repair before 15 months of age but not earlier than 7 months may benefit speech without endangering growth. When evaluating the currently available literature, controversy still exists over many concepts. There is no current evidence that strongly supports one palate repair technique over another, and continued study is necessary to refine the choices made for repair technique modifications, timing, and other aspects of care.

REFERENCES


