Principles of Cleft Lip Repair: Conventions, Commonalities, and Controversies

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Learning Objectives: After reading this article, the participant should be able to: 1. Understand the principles of contemporary methods for repair of unilateral and bilateral cleft lip. 2. Understand the design elements of a poor repair that predispose to a suboptimal outcome.

Summary: The authors describe the evaluation and management of unilateral and bilateral cleft lip (with or without cleft alveolus and with or without cleft palate). Each deformity is presented in a “principles-based” manner. For unilateral cleft lip, the authors discuss common modifications of rotation-advancement and Fisher’s anatomical subunit approach. In expert hands, both techniques can give excellent results. For bilateral cleft lip, Mulliken’s method is presented. Methods for synchronous correction of the cleft lip nasal deformity are also discussed. (Plast. Reconstr. Surg. 139: 764e, 2017.)

The surgical care of children with orofacial clefts is a field of such breadth, depth, and historical richness that it represents a unique surgical subspecialty in its own right. Testament to the complexity of cleft care, different aspects of this topic have been covered periodically by this Continuing Medical Education/Maintenance of Certification series. For those desiring additional background in cleft epidemiology, anatomy, classification, and treatment, the reader is referred to two prior reviews, expertly written by Monson et al. and by Fisher and Sommerlad.

The goal of the present work is to expound on the modern techniques of unilateral and bilateral cleft lip repair, to provide clarification on existing points of controversy, and to illustrate methods developed to avoid revision procedures. Specifically, we present the subject matter in a “principles-based” manner that we hope will complement prior reviews and will provide an instructive perspective for the reader. While attempting to provide an objective view of contemporary practices, the authors would be remiss in not acknowledging that it is difficult to completely exclude personal preferences, and also that certain omissions may occur herein for the sake of brevity.

Planning: Timing and Sequence of Interventions

Cleft lip repair may be performed safely at any age; however, standard practice among many cleft teams is to repair the cleft lip in infancy, between 3 and 6 months of age. The plan of care and choice of operative technique are dependent on the specific cleft phenotype and the age at presentation. Cleft lip only may be repaired directly. In the cases of cleft lip with cleft alveolus and cleft lip with cleft palate, preliminary preparation may be warranted before cheiloplasty. These concepts are explored further in the sections below.

Presurgical Preparation

Presurgical Infant Orthopedics

Presurgical infant orthopedics refers to remodeling of the dentofacial skeleton using orthodontic

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techniques. In general, manipulation of the alveolar arch may be accomplished passively (e.g., by means of lip taping or labial/nasolabial adhesion) or actively (e.g., through Georgiade-Latham devices and nasoalveolar molding appliances). The various methods—and even the very concept of presurgical infant orthopedics in general—have been debated fiercely; however, we have found both the Georgiade-Latham device and nasoalveolar molding to be effective at rotating the greater segment of unilateral cleft lip with cleft alveolus or unilateral cleft lip with cleft palate, and at widening a collapsed maxillary arch and repositioning the projecting/proclined premaxilla in bilateral cleft lip with cleft alveolus or bilateral cleft lip with cleft palate. Duration of therapy is typically shorter for the Georgiade-Latham appliance (approximately 4 to 6 weeks) compared with nasoalveolar molding (approximately 3 to 4 months). Both techniques require expert planning and follow-up care from a pediatric dentist and/or craniofacial orthodontist throughout this period. Although requiring more time for completion, nasoalveolar molding has the advantage of molding the nose using outrigger nasal prongs. An excellent point-counterpoint article summarizing the merits and demerits of each technique was recently published.

Labial Adhesion

Presurgical infant orthopedics requires the expertise of a craniofacial orthodontist and involves weekly or biweekly clinic visits. This requirement makes presurgical infant orthopedics unavailable in many geographic areas and unfeasible for some families. In situations where presurgical infant orthopedics is not used, the surgeon may opt to perform labial (or nasolabial) adhesion as a preparatory step for subsequent definitive cheiloplasty. Principally, adhesion is intended to remodel the dentoalveolar segments by way of the mechanical forces of the soft-tissue envelope. In performing the adhesion, the surgeon is advised to first draw the markings for the definitive cheiloplasty (as described in the sections below) and then perform the adhesion using the tissues of the cleft margins that will be discarded in the subsequent definitive repair. Typically, muscular dissection is kept to a minimum during the adhesion. A description of the technique of labial adhesion is available.

**REPAIR OF UNILATERAL CLEFT LIP**

**Principles and Objectives**

The preparatory methods above only set the stage for the definitive cheiloplasty. Ultimately, success in cleft lip repair is equally dependent on repair design and technical skill: Neither a sound design executed poorly nor a flawed design performed perfectly can be expected to yield a favorable result. Since 1900, the story of unilateral cleft lip repair has been a quest to innovate and disseminate the “optimal design” (a process inevitably rife with disagreements and disputes). Rather, we posit that although each technique has advantages and disadvantages, a distillation of the “lessons learned” from each technique will yield a common set of principles to guide repair of unilateral cleft lip (Table 1).

Moreover, as is discussed thoroughly below, it is quite clear that contemporary modifications of rotation-advancement and geometric-style repairs (i.e., Fisher anatomical subunit repair), in expert hands, are both capable of producing superb results. We believe that each technique offers advantages and has certain inherent compromises. The differences between techniques relate predominantly to placement of skin incisions—that is, regardless of technique chosen, a surgeon may use the same maneuvers for mucosal, gingival, and muscular repair, and even for correction of the nasal deformity. Therefore, in discussing the relative advantages and disadvantages of rotation-advancement and the Fisher technique, we are primarily discussing location and orientation of the scars and the resulting effect on symmetry. For the individual surgeon, a thorough understanding of both approaches enables one to more responsibly carry out his or her preferred technique. Indeed, the expert surgeon may skillfully adapt his or her choice of incision to best match the patient’s needs.

**Early Techniques of Unilateral Cleft Lip Repair**

Until the 1930s, most repairs were performed by paring the cleft margins and approximating the incised edges in a straight line. In a complete cleft (and most incomplete clefts), the vertical heights of the lip on the normal and cleft sides are unequal (Fig. 1). Innovations over the subsequent 20 to 30 years incorporated geometric designs to address this problem (e.g., the Tennison and LeMesurier methods) (Fig. 2). These were milestones in cleft lip repair that ingenuously solved the problem of vertical height deficiency and balanced the Cupid’s bow; however, this came at the expense of creating scars that disrupted the continuity of the philtral column, often quite visibly.

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The era of rotation-advancement

In 1955, Millard introduced the rotation-advancement technique that would become the predominant technique used worldwide. Millard sought to address the shortcomings of the geometric repairs by providing balance to Cupid’s bow without interrupting the continuity of the philtral column. The original rotation-advancement design (Fig. 3, above) provided a scar more closely resembling a continuous philtral column; however, because the rotation incision extended from the apex of the philtral ridge on the noncleft side (cphs point), the design inherently caused asymmetry of the philtral ridges, which met at this point (Fig. 4). To make the scar less oblique, Millard himself modified the technique by adding a back-cut that would allow for greater rotation of the medial segment; this modification is commonly referred to as the “Millard II” technique (Fig. 3, below). The shortcoming of this modification is the potential for scars to lie more inferiorly, where they are more noticeable.

Millard’s rotation-advancement approach departed conceptually from all other techniques at the time because the matter of vertical height disparity (leveling of the Cupid’s bow, or equalizing the cleft-side and non–cleft-side cphs–cphi distance along the philtral ridge) was approached visually—a “cut-as-you-go” technique—rather than by strict geometric measurements. At the time, this was a radical change in philosophy; it was not immediately embraced, and it required an entire generation of young surgeons to lead the change in practice that

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**Table 1. Guiding Principles for Repair of Unilateral and Bilateral Cleft Lip**

Unilateral cleft lip repair

**Design**
- Design a closure interface (scar) that closely mirrors the contralateral philtral ridge in shape and length
- Limit the total scar burden inherent in the design

**Execution**
- Create a symmetric and natural Cupid’s bow
- Match the volume of vermilion on each side of the cleft
- Restore muscular continuity such that normal lip movement results
- Create a labial sulcus of normal depth
- Create a normal nasal floor, nasal sill, and alar base
- Centralize the columella and elevate the columella base

Bilateral cleft lip repair

**Planning and preparation**
- Maintain (or establish) symmetry
- Prepare the projecting premaxilla
- Anticipate future changes that will occur with growth*

**Execution**
- Construct a full central lip using lateral labial elements and discard prolabil vermilion
- Deepen the gingivolabial sulcus using premaxillary mucosa
- Establish muscular continuity primarily
- Address the nasal deformity synchronously

*Particularly in the design of the size and shape of the philtral flap.

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**Fig. 1.** Vertical length of complete and incomplete clefts. The vertical length of the lip on the noncleft side is greater than on the cleft side. This discrepancy, and scar contracture, were responsible for vertical deficiency and whistle deformity in straight-line repairs. Without a strategy to provide additional length to the cleft side, this resulted in a short lip on the cleft side with asymmetric vertical position of the Cupid’s bow peaks—an unbalanced Cupid’s bow.
eventually occurred. In the 50 years since the introduction of the rotation-advancement, many further refinements have been proposed, including those by Byrd, Cutting, Mohler, Mulliken, Stal, and others.9,10 Arguably the most popular modification is that of Mohler, which is able to orient the incision to better mirror the vertical orientation of the contralateral philtral ridge11 (Figs. 5 and 6). Indeed, the orientation of the philtral ridge may be an important determinant for choice of location, orientation, and shape of incision. By 2008, variants of the rotation-advancement technique were taught in 84 percent of plastic surgery training programs, with dominance of Mohler’s modification. Some of the popularity of the Mohler technique arose through its dissemination by Court Cutting, who demonstrated remarkable results with his “extended” Mohler method in conjunction with nasoalveolar molding (Fig. 6).12 The reader may review a surgical video of a modified rotation-advancement provided in a prior Continuing Medical Education/Maintenance of Certification article (http://links.lww.com/PRS/A914 and http://links.lww.com/PRS/A915, published in Monson LA, Kirschner RE, Losse JE. Primary repair of cleft lip and nasal deformity. Plast Reconstr Surg. 2013;132:1040e–1053e).

**Fisher Anatomical Subunit Repair**

Modified rotation-advancement techniques address many goals but have two particular shortcomings:

1. Most rotation-advancement modifications incorporate a series of complex scars beneath the nose, including two three-point (T-point) closures. This not only disturbs the continuity and aesthetics of the columellar-labial crease but also complicates placement of the traditional transcolumellar incision at the time of future open rhinoplasty (Fig. 7).

2. In rotation-advancement techniques that rely on rotation alone to increase the vertical length of the medial lip, the position of the Noordhoff point may be required to lie more lateral than desired to match the vertical height of the medial and lateral elements. Consequently, the horizontal length of the lateral lip element is shortened (Figs. 8 and 9).

To address these concerns, Fisher devised the anatomical subunit approximation technique, which is a substantial evolution of the geometric-style repairs.13 The Fisher technique is illustrated in Figure 10, and a clinical case of left unilateral complete cleft lip, alveolus, and Veau III palate (without prior nasoalveolar molding) is provided in Figure 11 and Videos 1 through 3. (See Video, Supplemental Digital Content 1, which displays cleft lip markings. This video is available in the “Related Videos” section of the full-text article on PRSJournal.com or at http://links.lww.com/PRS/C57. See Video, Supplemental Digital Content 2, which displays part 1 of the cleft lip repair operation. This video is available in the “Related Videos” section of the full-text article on PRSJournal.com or at http://links.lww.com/PRS/C58. See Video, Supplemental Digital Content 3, which displays part 2 of the cleft lip repair operation. This video is available in the “Related Videos” section of the full-text article on PRSJournal.com or at http://links.lww.com/PRS/C59.) In addition, the readers may also review Dr. Fisher’s video from a prior
Specifically, with regard to criticism 1, above, the Fisher repair places the scar precisely along the interfaces of anatomical subunits. Thus, the medial labial incision exactly mirrors the normal side philtral ridge. No scars are placed along the columella, nasal base, or ala, and the incision line is simple and continuous, without a T-point.

With regard to criticism 2, the Fisher method uses a cutaneous triangle above the white roll to directly adjust the height of the medial labial element (cphs–cphi). Traditional rotation-advancement does not include this triangle and thus relies solely on the rotation (superiorly) to increase the vertical height. If enough rotation is not obtained, the cleft-side cphi point is too high with respect to the non–cleft-side, resulting in elevation of the Cupid’s bow peak. This result can worsen with any scar contracture that may occur. The inclusion of a cutaneous triangle directly equalizes the vertical length of the philtral ridges and also serves to break up this scar,
which reduces the tendency toward scar contracture. It is noteworthy that several contemporary rotation-advancement modifications have also incorporated inferior cutaneous triangles into their design.

Addressing Discrepancy of the Vermilion Height: The Noordhoff Triangular Flap

Another milestone in cleft lip repair that is worth highlighting is the Noordhoff vermilion triangular flap. The height of the dry vermilion on the medial labial element is invariably less than that on the lateral labial element. When a significant discrepancy in the heights of vermilion is present, the result is a visible notch, or whistle deformity. Noordhoff described a technique to avoid this problem in which this excess vermilion on the lateral labial element is used to form a triangular flap that is inset at or just above the red line (Fig. 12). The vermilion triangular flap has been incorporated into many contemporary repairs, including the Fisher method and several modifications of rotation-advancement.

Repair of the Bilateral Cleft Lip Deformity

Principles and Objectives

There are seven principles\(^{15,16}\) that inform the modern approach to bilateral cleft lip repair, summarized in Table 1. In the past, repair of the bilateral cleft lip was approached in the straight-line or geometric manner of unilateral cleft lip. To deal with the difficulty of the projecting premaxilla, which would put the labial repair under too much tension, repair of bilateral cleft lip was \textit{staged} to correct one side first, followed by the other side. Many experts today have proposed that such staged repairs be abandoned, as this strategy destroys the symmetry with which most cases of bilateral cleft lip begin. In contemporary practice, premaxillary projection in the infant may be corrected by

![Image](https://example.com/image.png)

\textbf{Fig. 4.} In traditional (nonmodified) rotation-advancement repairs, the peak of the cleft-side philtral column is designed to lie coincident with the peak of the normal side philtral column or just medial to it. This can create a closure/scar that lies obliquely across the philtrum. A repair technique that is capable of matching the obliquity or vertical nature of the normal philtral column may alleviate this asymmetry.

![Image](https://example.com/image.png)

\textbf{Fig. 5.} Lester Mohler demonstrated that the majority of school age children he studied had philtral columns that were more vertical in orientation, extending downward from the lateral aspects of the columella and that only a minority had philtral columns that joined together at or below the base of the columella. The shape of the philtral column may be an important determinant in decision of skin incision. For example, Mohler’s namesake modification sought to align the final closure less obliquely according to the more vertical orientation of the noncleft philtral column.
way of presurgical infant orthopedics (or preliminary labial adhesion), thus allowing for definitive cheiloplasty of both sides at the same time. Thus, symmetric cases of bilateral cleft lip (i.e., bilateral complete or bilateral incomplete cleft lip, with or without cleft alveolus and/or cleft palate) should proceed directly to definitive cheiloplasty after presurgical orthopedics, if warranted.

In the case of asymmetric bilateral cleft lip (e.g., complete with incomplete), a different strategy may be necessary. Because these cases do not begin with the symmetric foundation characteristic of bilateral complete or bilateral incomplete cleft lip, performing definitive cheiloplasty directly and achieving a symmetric result is much more difficult. For this reason, preliminary labial or nasolabial adhesion may be performed to convert the complete side to incomplete. This creates an intermediate stage of “bilateral incomplete cleft lip” before proceeding with the definitive cheiloplasty. (Note: It is important for the reader to understand the difference between “staging” the repair by performing a preliminary adhesion to establish symmetry and the traditional sense of staging repair of one side followed by repair of the other side, which destroys the symmetry that initially existed. The former is judicious and beneficial; the latter is ill-advised.) Adding the labial adhesion to the treatment protocol must always weigh the benefit of achieving symmetry against the risk and burden of an extra anesthetic event. Thus, the decision is case-specific and dependent on the degree of asymmetry.

In older presentations, the severely projecting/rotated premaxilla would prevent establishment of muscular continuity during cheiloplasty.

**Fig. 6.** Mohler repair. The rotation incision initiates higher, within the columella. The back-cut is then extended to the apex of the normal philtral column. This allows for necessary rotation while creating a philtral column that originates at the lateral aspect of the cleft-side columella, coinciding with Mohler’s observations of more vertical normal philtral relationships. The C-flap again back into the defect at the base of the columella, which augments the columella, but results in two three-point closures along the base of the nose.
Therefore, the surgeon should first perform a premaxillary ostectomy and setback, which properly positions the premaxilla for subsequent labial repair. Premaxillary setback can be safely combined with either palatoplasty or with labial adhesion and gingivoperiosteoplasty, which help to stabilize the premaxilla; a dental splint may also be used for additional protection and support.

It is important not to attempt cheiloplasty at the same time as the setback: The ostectomy disrupts the posterior blood supply such that the premaxilla is perfused only by the anterior blood supply from the columnellar arteries. Consequently, elevation of the philtral flap during cheiloplasty will result in premaxillary necrosis. Definitive cheiloplasty should be deferred until 3 to 4 months after successful setback.

**Mulliken Technique for Bilateral Cleft Lip Repair**

Although several techniques for bilateral cleft lip repair have been described,\(^1\),\(^17\),\(^18\) we present the Mulliken technique below.\(^15\),\(^16\),\(^19\) It is important to note that asymmetric bilateral cleft lip involving microform or mini-microform defects on the lesser side is best treated according to alternate strategies, as described by Yuzuriha and colleagues and depicted in Figure 13.\(^20\),\(^21\)

Markings for the operation are depicted in Figure 14 and should include the standard anthropometric landmarks: subnasale (sn), subalaris (sbal), labiale superius (ls), crista philtri superioris (cphs), and crista philtri inferioris (cphi). When taking measurements for symmetry, sn should serve as the main reference for prolabial markings and sbal for lateral lip markings. The vermilion/mucosal junction (“red line”) of the lip should be marked with a dotted line. On the prolabium, the philtral flap is designed. For the typical infant, this flap should be 2 mm wide superiorly (cphs-cphs),...
4 mm wide inferiorly (cphi–cphi), and 6 to 7 mm in height (sn–ls), with sides drawn gently concave. These dimensions may be adjusted for the older child.\textsuperscript{16,22} Flanking flaps should be drawn 2 to 3 mm in width on each side. These flanking flaps, which will be deepithelialized, will improve the vascular supply of the philtral flap and may also simulate the philtral ridge. C-flaps are drawn on each side of the prolabium. On the lateral labial elements, the Noordhoff point is marked, although it may be slightly adjusted laterally symmetrically to ensure 3 mm of white roll medial to this proposed location of the cphi points on each side. The cutaneous advancement flaps are drawn just above the white roll and up to sbal. Dilute anesthetic with epinephrine is infiltrated, key landmarks are tattooed, and markings are gently scored with a scalpel.

The operation begins with deepithelialization of the flanking flaps and elevation of the philtral flap en bloc with the flanking flaps. Any remaining prolabial skin and vermilion is discarded; the prolabial mucosa is preserved for later use. Prolabial submucosa is excised with scissors. Next, the lateral labial flaps are incised at the superior

![Image](image_url)

**Fig. 9.** In this case, a Millard II repair was performed. The vertical lengths of the philtral columns are nearly symmetric, and the Cupid's bow is well balanced. The transverse lip lengths, however, are markedly unequal. This case illustrates the importance of selecting the Noordhoff point at the most medial extent possible to preserve transverse length, and also maintain vermilion height and white roll quality. It also illustrates the potential risk in compromising the Noordhoff point selection to accommodate vertical discrepancies in rotation-advancement.

![Image](image_url)

**Fig. 10.** Fisher anatomical subunit repair. The Fisher repair equalizes vertical lip lengths and balances the Cupid's bow and it also (1) maintains the integrity of the lip-columella crease, (2) places no scar in or below the columella, (3) produces no scar around the ala, (4) eliminates three-point closures, and (5) allows the surgeon to designate and maintain the ideal position of the Noordhoff point regardless of the vertical height or transverse length of the lip. The difference in the heights of the noncleft and cleft philtral columns are determined. This difference is reconciled with the additional height of a small inferior triangle (minus a corrective factor of 1 mm to accommodate additional length provided by slight rotation that occurs). Although it is not specifically included in the original design by Fisher, the author incorporates a curvature to the medial incision to mirror the natural slight curvature of the normal philtral column. This also adds a slight contribution to vertical length. Consequently, the surgeon must be careful not to exceed the calculated dimension of the inferior triangle at the risk of providing more length than necessary.
**Fig. 11.** Preoperative (left) and postoperative (right) images of a child with left unilateral complete cleft lip, alveolus, and Veau III palate, treated by the Fisher technique.

**Video 1.** Supplemental Digital Content 1, which displays cleft lip markings. This video is available in the “Related Videos” section of the full-text article on PRSJournal.com or at [http://links.lww.com/PRS/C57](http://links.lww.com/PRS/C57).

**Video 2.** Supplemental Digital Content 2, which displays part 1 of the cleft lip repair operation. This video is available in the “Related Videos” section of the full-text article on PRSJournal.com or at [http://links.lww.com/PRS/C58](http://links.lww.com/PRS/C58).
aspect and the maxilla is exposed. The alar base is released sharply from the piriform rim. Submuscular (supraperiosteal) dissection is continued laterally to the level of the malar eminences using a Tessier elevator to mobilize the cheek and decrease tension on the labial repair. The vermilion/mucosal flap is then divided from the cutaneous portion of the lateral advancement flap. Orbicularis oris muscle is separated from overlapping skin and underlying oral mucosa.

The mucosal flap is secured to the premaxillary periosteum at the anterior nasal spine, and gingivoperiosteoplasty is performed. The mucosal flap creates the posterior wall of the new gingivolabial sulcus. Vestibular mucosa is approximated at this time, although closure of the cutaneous nasal sill is deferred until later in the procedure. Next, lateral labial mucosa is closed, beginning laterally and marching toward the midline. In performing this step, it is critical to adequately advance the flaps medially with firm traction. As the mucosal flaps overlie the premaxilla, the free edge of the lateral labial mucosa will be sutured to the free edge of the mucosal flap, completing the creation of the gingivolabial sulcus. Next, the orbicularis oris muscle is approximated in the midline and secured at its superior aspect to the anterior nasal spine.

The previously tattooed cphi points on each vermilion flap are again identified, and a new point 3 mm medial to cphi is marked on each flap. These two points are approximated to create the new ls, into which the point of the philtral flap will

![Video Available Online](Video 3. Supplemental Digital Content 3, which displays part 2 of the cleft lip repair operation. This video is available in the “Related Videos” section of the full-text article on PRSJournal.com or at http://links.lww.com/PRS/C59.

**Fig. 12.** The vermilion height of the medial lip element is typically deficient. An uncorrected vermilion deficiency is among the most common causes for minor lip revision, and it is completely avoidable. The Noordhoff triangular flap may be incorporated into the design of any unilateral cleft lip repair to equalize vermilion height. Because this tissue would otherwise be discarded, there is little rationale against its routine use.
later be inset. The paired vermillion flaps are contoured as necessary to create the median tubercle.

The prolabial C-flaps are then approximated to the alar base flaps. Attention must be paid to creating symmetry in this step. A Prolene (Ethicon, Inc., Somerville, N.J.) alar cinch suture may be placed to precisely control the alar base width; in infants, al–al is typically approximately 24 to 26 mm and should be smaller than en–en. “Myrtiform sutures” secured to the peristeum of the maxillae, just medial to each canine fossa, are then placed through the midpoint of each nasal sill to gently depress the nasal sill.

At this time, the surgeon should determine the method for nasal correction, as discussed in the subsequent section. Finally, following nasal correction, the lateral labial cutaneous advancement flaps are trimmed, as necessary, and the skin is closed.

**SYNCHRONOUS CORRECTION OF CLEFT LIP NASAL DEFORMITY**

The appearance of the cleft lip nasal deformity will worsen during the course of the cheiloplasty, as the nasal sill is created and as the alar base...
width is narrowed. The authors consider synchronous correction of cleft lip nasal deformity at the time of labial repair to be an essential element for an optimal outcome. The goal of nasal correction at this stage should be to establish a good foundation for future growth, such that nasal revisions are not necessary until the time of definitive rhinoplasty in young adulthood. All primary repair techniques focus on correction of the lower third of the nose. Later growth of the septum drives the development of the adult dorsal deformity and functional disturbances. Consequently, the notion that primary correction of the lower third at the time of lip repair will limit the need for future septorhinoplasty is valid for only the most minor clefts.

The technique for nasal correction varies widely among cleft surgeons. One of the most common approaches was originally described by McComb and later modified by Salyer (Fig. 15). In this approach, the ala is released from the piriform, the skin is elevated from the surface of the tip cartilages, and the lower lateral cartilage is suspended superomedially by means of a

Fig. 14. Repair of bilateral complete cleft lip, as described by Mulliken. (Above, left) Marking of key landmarks and incision lines; (above, center) creation and elevation of the philtral flap with deepithelialized flanking flaps; (above, right) gingivoperiosteoplasty and closure of the nasal floor; (second row, left) premaxillary mucosal flap. (Second row, center) Muscular closure; (second row, right) labial approximation and creation of the median tubercle; and (below) completed repair, including bilateral alar rim incisions for placement of intercartilaginous and interdomal sutures.
transcutaneous suture. Cutting describes a similar undermining of the lower lateral cartilages, but suspends superomedially by means of an intranasal mattress suture. Another technique popularized by Tajima incorporates a reverse-U incision at the soft triangle to allow for subcutaneous undermining and suspension of the dome and lateral crus. Mulliken and Monson et al. have described methods of cartilaginous repositioning through alar rim incisions.\textsuperscript{1,16}

Percutaneous and semiopen approaches are described below. Some surgeons prefer the percutaneous approach,\textsuperscript{10} whereas other surgeons use the semiopen approach for moderate and severe cleft lip nasal deformity. It should be noted that many experienced surgeons also choose not to perform any correction of the nose at the time of lip repair. Any primary intervention must be weighed against deleterious effects that it may have later in life relative to potential future rhinoplasty.\textsuperscript{2}

**Percutaneous Technique**

In the authors’ center, children with a complete cleft or those with incomplete clefts and significant nasal deformity are treated with presurgical orthopedic molding shortly after birth. The goal at the time of surgery, therefore, is to retain the corrected position of the dome superomedially and to address the ubiquitous vestibular web. Dissection of the skin over the delicate alar cartilages of an infant must be meticulous to avoid damage to these structures. Even when the procedure is performed properly, scarring in the dissection plane over the tip is an inevitable tradeoff in this approach.

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**Fig. 15.** Primary nasal correction using Salyer’s approach. From the margins of the pared cleft, the skin overlying the lower lateral cartilage is elevated medially between the medial crura over the dome and laterally over the lateral crus using dissecting scissors. The ala is released from its tethering connection at the piriform, and mattress sutures are placed transcutaneously to retain the desired position of the dome superomedially and to address the ubiquitous vestibular web. Dissection of the skin over the delicate alar cartilages of an infant must be meticulous to avoid damage to these structures. Even when the procedure is performed properly, scarring in the dissection plane over the tip is an inevitable tradeoff in this approach.
Semiopen Approach

In the semiopen approach, bilateral alar rim incisions are made just within the vestibule, with care taken to respect the skin of the soft triangles. Sharp and blunt dissection are used to carefully expose the lower lateral cartilage. The lower lateral cartilage is cleaned of fibrofatty tissue, especially medially. A cotton-tip applicator placed in the nasal vestibule can be used to simulate the shape of the genua, which assists in identification of the proper location for suture placement. Two interdomal sutures (between the medial crura of each lower lateral cartilage) to decrease the interdomal angle and increase nasal tip projection. Two intercartilaginous sutures (between the superior border of the lower lateral cartilage and the inferior border of the upper lateral cartilage) are placed to suspend the lower lateral cartilage and create the “scroll region.” Any redundant domal skin can be carefully excised (if needed) to improve the contour of the alar rim. Any vestibular web is corrected by lenticular excision of mucosa.

It is important to note that the alar rim incision leaves a scar; while usually imperceptible, the scar may be noticeable in some patients. Excessive skin excision may be deforming and may cause eversion of nasal hair. For this reason, the authors advise conservative—if any—skin excision.

POSTOPERATIVE CARE

It is some surgeons’ practice to place temporary vented stents [Xeroform (Covidien, Mansfield, Mass.) wrapped around 19-gauge butterfly tubing] in each nostril for the immediate postoperative period. These are removed before discharge from the hospital. The intention of this is to improve nasal breathing by preventing bloody secretions from occluding the nostrils. Others have advocated prolonged nasal stenting to “mold” the nostril shape, but this recommendation is debated.

Most patients spend one night in the hospital and are discharged after demonstrating sufficient oral intake. Before discharge, the parents must be trained in proper wound care. Any blood on the incision or in the nostrils should be carefully cleaned with half-strength hydrogen peroxide, and the incision line should be protected with a thin layer of antibiotic ointment. Sutures are removed between 4 and 7 days postoperatively under mask anesthesia. Skin glue or a Steri-Strip (3M, St. Paul, Minn.) may be applied to reinforce the wound closure.

Sunblock (sun protection factor ≥50) should be applied daily beginning at 1 month. If the scar begins to thicken (which may cause cicatricial elevation of the cphi point), the parents should be instructed how to perform scar massage three to five times daily for 5 minutes each time. If this occurs, the surgeon should follow the patient closely. In some cases, intralesional injection of triamcinolone (Kenalog; Bristol-Myers-Squibb, New York, N.Y.) may be beneficial. This may be repeated every 4 to 6 weeks up to three times. Scar massage should be continued by the parents even if steroids are used.

REVISIONS AND SECONDARY PROCEDURES

It is the hope of all cleft surgeons that the initial surgery will be so effective that no further correction will be necessary.
The cleft lip repair is **definitive** that is, it should be the only operation required for the cutaneous lip. Minor revisions to the volume of the vermilion (e.g., dermal autograft) may be safely performed during the same anesthetic session as alveolar bone grafting. Correction of the nasal deformity during the labial repair should establish a satisfactory foundation for future growth such that few—if any—corrections will be required before the time of definitive rhinoplasty in young adulthood.

Adolescent (pubertal) growth will almost invariably result in worsening of the cleft lip nasal deformity, but correction is deferred until the time of skeletal maturity. If orthognathic correction is required (e.g., for maxillary hypoplasia), this should be performed before rhinoplasty.

**CONCLUSIONS**

Repair of unilateral and bilateral cleft lip, and correction of the corresponding cleft lip nasal deformity, is a difficult undertaking. The plan of care and choice of operative technique are dependent on the specific cleft phenotype and age of presentation (Fig. 13). This article has presented several common contemporary methods in a “principles-based” fashion. Regardless of the particular technique chosen for repair, the surgeon should be sure to understand and follow each of the foundational principles. The end goal is effective and efficient care in the safest manner possible.

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**REFERENCES**