Nasoalveolar Molding for Unilateral and Bilateral Cleft Lip Repair

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BACKGROUND
Presurgical infant orthopedics is a collective term to describe a treatment method or appliance designed to lessen the severity of the cleft deformity before primary cheiloplasty and rhinoplasty. The first descriptions of these appliances date back to the seventeenth century. Most of the early appliances sought to retract the protrusive maxilla with an external appliance. With these, there was minimal change to the alveolar segments. Beginning with McNeil’s molding plate described in the 1940s to 1950s, there have been several techniques designed to reposition the alveolar segments.\textsuperscript{1–5} They range from lip taping to the pin-retained Latham appliance, which retracts the premaxilla and expands the posterior alveolar segments. However, none of these directly affect the primary nasal deformity that characterizes cleft lip and palate. As the most visible manifestation of cleft lip and palate, it can present a significant surgical challenge and it is common for patients to undergo multiple surgical procedures to improve nasal form. This problem led Grayson and colleagues\textsuperscript{6–18} in 1993 to develop an appliance that is able to shape the nasal cartilage while also molding the alveolar process. The technique, termed nasoalveolar molding (NAM), has been shown to improve nasal cartilage symmetry and increase columella length. Since it was originally described, NAM has become a mainstay for the presurgical management of children born with cleft lip and palate.

GOALS OF NASOALVEOLAR MOLDING
The primary goal of NAM for both unilateral and bilateral clefts is to reduce the severity of the cleft by modifying the position of the alveolar processes and improving the nasal deformity before the primary surgical reconstruction. In unilateral cleft lip and palate (UCLP), the gap between the greater and lesser segments and the corresponding lip elements, realign the cleft alar base, elevate the cleft-sided lower lateral cartilage, and straighten the deviated columella. In the bilateral cleft lip, NAM functions to reorient the ectopically positioned premaxilla toward the midline and expand the alveolar segments as needed. The nasal form is improved by molding the lower lateral cartilages to achieve symmetry and elongating the columella to increase projection of the nasal tip.
and lesser alveolar segments are reduced, the lip elements are approximated, the cleft alar base distance is decreased, and the deviated columella is straightened. The collapsed lower lateral alar cartilage on the affected side is elevated and molded to a more symmetric and convex form. For bilateral cleft lip and palate (BCLP), NAM is able to move the ectopic premaxilla toward the midline and into a less protrusive position. The collapsed alveolar segments are expanded, as necessary. The nasal form is changed through increased projection of the nasal tip. The nose is molded to achieve symmetry and the columella is nonsurgically elongated.

NAM APPLIANCE

The NAM appliance consists of an intraoral acrylic molding plate and intranasal stents. The molding plate allows for approximating the greater and lesser alveolar segments in UCLP; in BCLP, the premaxilla is oriented to the alveolar segments. The nasal stent is made of wire and lined with acrylic. It molds the nasal cartilage on the affected side in UCLP; in BCLP, there are 2 nasal stents, which insert into both nostrils. The retention buttons are acrylic attachments on the anterior aspect of the appliance. They allow placement of orthodontic elastics attached to Steri-Strips (3M Corporation, St Paul, MN), which function to secure the appliance within the mouth. The typical course for NAM treatment entails weekly or biweekly adjustments of the appliance for 3 to 4 months for UCLP and 4 to 6 months for BCLP.

TREATMENT PLANNING

Because of the variability in presentation of cleft lip and palate, a customized plan is made for each patient before beginning molding. It depends on several factors, including the type and severity of the cleft, age of the infant, and practical considerations. The plan should be developed in conjunction with the surgeon and orthodontist and should involve the cleft team. NAM should ideally begin as soon after birth as possible to exploit the plasticity of the nasal cartilage in early infancy. In addition, the infant is more likely to accept the appliance at an earlier age. There is generally less coordinated hand and finger movement and therefore minimal ability to remove the taping and appliance. Regular follow-up is coordinated with the team to ensure the infant is feeding and gaining weight appropriately before starting molding and while in treatment.

There are occasions when beginning NAM treatment may be delayed or deferred because of a unique presentation of the cleft. For instance, the alveolar segments may be severely collapsed in BCLP, resulting in a blocked-out premaxilla. This condition requires expanding the alveolar segments before molding. If the premaxilla is protrusive, it should be retracted through lip taping before beginning NAM. Another common occurrence is the presence of a neonatal tooth on the cleft margin. These teeth are typically nonviable and have minimal bone support. These teeth should be extracted and the oral soft tissues allowed to heal before beginning molding.

Lip Taping

Once a decision has been made to move forward with NAM, parents begin lip taping in the time that elapses between initial presentation and beginning NAM. It serves multiple roles: (1) it allows the infant to become accustomed to the use of lip tapes; (2) lip taping can serve as an indicator of how the baby’s skin will respond to the adhesive on the skin (there are instances in which the skin is sensitive and alternative tapes or barriers may be considered before starting NAM. This can avoid troubleshooting during active NAM treatment); (3) taping can begin reducing the gap between the alveolar segments in the time it takes to begin NAM.

Lip taping is common to both UCLP and BCLP. A base tape made from a hydrocolloid bandage is applied to the cheeks and maintained for up to 1 week. Steri-Strips are then connected with orthodontic elastic in between them. This tape is then placed from the noncleft side to the cleft side under tension. For BCLP, 2 elastics are used with a Steri-Strip in between and 2 Steri-Strips on either side. The central tape is positioned over the prolabium and the tapes on the outside are stretched onto the cheeks.

Impression Technique, Appliance Fabrication, and Design

A maxillary and nasal impression is obtained once the infant has been cleared by the medical team to undergo NAM. At minimum, the infant should be healthy and there should be appropriate weight gain. The impression is taken in a clinical setting with the infant awake. In the event there is an airway emergency, there should be a professional who is trained to manage an infant airway.

First, an impression tray is selected based on the size of the maxilla. Heavy-body polysiloxane putty material (Coltène Rapid soft putty, Coltène, Altstätten, Switzerland) is then loaded into the tray. The swaddled infant is held upside down and the impression tray is seated with positive...
pressure. If the premaxilla is ectopically positioned, it can be moved to the midline just before seating the impression tray. Clear visualization of the airway is possible by gently pushing the dorsal surface of the tongue superiorly with a dental mirror handle. Once the impression material is fully set, the tray is removed and the oral and nasal cavities are confirmed to be free of impression material. The impression should capture the alveolar segments including the premaxilla and the vestibular anatomy, and should extend posteriorly to include the entire alveolus (Fig. 1A,C).

At the same time as the palatal impression, an initial record of nasal anatomy may be captured with an impression of the nose. The impression is taken with a light-body siloxane material (Memosil 2 [polyvinylsiloxane], Heraeus Kulzer, Hanau, Germany). During the impression, the eyes are kept closed and the medial canthi captured to serve as a registration for position of the nose (Fig. 1B,D).

The impressions are poured in dental stone and the resulting cast is trimmed (Fig. 1A,C). Any undercuts are blocked out and the cast coated with a separating agent. The appliance is made from hard, clear, self-cure acrylic that is 2 to 3 mm in thickness. Once set, the frenum attachments are relieved and the walls of the appliance are trimmed to allow 2 mm of space between the appliance and the vestibule. A hole approximately 5 mm in diameter is made, centered in the palatal portion of the appliance, to maintain a patent airway should the appliance become dislodged and block the oral airway. The appliance is now ready for delivery, at which time the retention button will be added.

**Appliance Delivery**

Delivery is an important time point, because the appliance is adjusted for the infant and the parents given instructions on its use, taping, and care. The appliance is initially inserted into the mouth and all of the tissues in contact with the acrylic plate are carefully assessed for possible impingement. The most frequently observed sites for possible overextension of the acrylic is in the vestibule or near the midline and/or lateral frenum. If this is the

![Fig. 1](https://clinicalkey.com/asset/2020/07/22/72b22651-9607-5017-a497-a94025c29f90.png)

**Fig. 1.** Oral and nasal models for unilateral (A, B) and bilateral (C, D) cleft lip and palate. The oral impressions should capture the alveolar segments and extend posteriorly to include the entire alveolus. An initial record of the nasal anatomy may be captured with an impression of the nose. The impression is completed with the eyes closed and the medial canthi captured to serve as registration landmarks for the position of the nose.
case, they are marked and the acrylic subsequently relieved.

Once the molding plate is appropriately relieved for a passive fit, the retention button is added to the appliance. For UCLP, the location of the button is between the lip elements, favoring the noncleft side and avoiding impingement of the lip. The rationale for this is that the greater segment moves toward the lesser segment with molding. For a bilateral NAM appliance, the location of the two retention buttons is one on each side of the distal aspect of the premaxilla and between the lip elements. The length of the button is based on the distance required to clear the lips with the retention tapes once attached. To maximize retention of the appliance, the button is added at a 30° to 40° angle to the occlusal plane to allow a slight vertical vector of force to be applied from the tapes.

Retention tapes are fabricated from 6 × 100-mm (0.25 × 4 inch) Steri-Strips and orthodontic elastics (6 mm [0.25 inch] or 5 mm [0.19 inch], 128 g [4.5 oz]). They are used from the acrylic plate and adhere to the cheeks, simultaneously securing the appliance as well as delivering the active force needed for correction. For a UCLP, 2 retention tapes are applied from the single retention button, extending to the left and right cheeks. For a BCLP, 1 retention tape is used from each retention button, extending to the left and right cheeks.

In order to minimize irritation to the cheeks, a base tape made from a hydrocolloid bandage is first applied to each. They are to be placed just outside of the nasolabial creases and below the eyes, at an angle, with the medial portion lower than the lateral portion. The retention tapes, which are frequently changed through the course of a day, are then directly adhered to them. The base tapes can be maintained for up to a week.

Nasal Molding

The primary objectives of nasal molding include (1) to increase projection of the nasal tip; (2) to obtain symmetry of the lower lateral alar cartilages; (3) nonsurgical lengthening of the columella. Nasal molding is accomplished through use of a single nasal stent in UCLP and bilateral nasal stents in BCLP (Fig. 2). The nasal stents are added to the appliance once the gap between the alveolar segments is 5 mm or less. This reduction in the distance between the alveolar segments allows for elevation of the cleft alar rim when they are under less tension.

The nasal stent consists of 0.91-mm (0.036-inch) round stainless steel wire; hard, clear, self-cure acrylic; and soft denture liner. The wire is embedded into the appliance using acrylic and is bent to give it an accentuated curve allowing for future activations during routine adjustment appointments. The terminal nasal portion is made up of 2 lobes, a superior and inferior, formed from acrylic and covered with soft denture liner. The superior lobe is positioned within the nostril to project the nasal dome and tip. The inferior lobe supports the nostril apex. The nasal stent is gradually adjusted to lift, provide support, and mold the cleft nostrils.

Unique to a BCLP is the use of the nasal stents to provide nonsurgical elongation of the columella. In order to accomplish this, the nasal stents are connected with a band of soft denture liner. This resulting columella band is positioned at the nasolabial junction inferiorly and can gradually be increased in size to elongate the columella. To facilitate this elongation, an additional Steri-Strip with 2 orthodontic elastics can be fabricated and applied from the prolabium to the retention buttons.

**Nasoalveolar Molding for Unilateral Cleft Lip and Palate**

The goal in molding of the greater and lesser segments in a UCLP is to reduce the space between the 2 segments to 5 mm or less (Fig. 3). Decreasing the width between the greater and lesser alveolar segments facilitates reduction in the width of the alar base, thereby minimizing the tension in these tissues.

Reduction of the width between the 2 segments is possible through successive removal of acrylic

![Fig. 2. NAM devices with nasal molding extensions for unilateral (A) and bilateral (B) cleft lip and palate.](image-url)
within the molding plate along the lesser segment as selective force is applied through the retention tapes. To avoid impingement of posterior tissues as the appliance rotates, acrylic is removed from the posterior aspect. Throughout the process, the addition of soft denture liner can help detail the correction within the greater and lesser segments. However, care must be taken to maintain equal removal of acrylic and addition of soft denture liner to prevent compression of the alveolar process.

The stepwise removal of acrylic with or without addition of soft denture liner requires weekly or biweekly modification of the appliance. Each adjustment of the appliance is limited to 1 to 2 mm of addition and/or removal of material, which minimizes the potential for developing any pressure sores or irritations. In addition, the appliance tends to be better adapted and more stable with gradual adjustments increasing the infant’s tolerance of the treatment. Clinical progress is assessed frequently during the molding process, in anticipation of lip and nasal repair at approximately 6 months of age (Fig. 3C–G).

**Nasoalveolar Molding for Bilateral Cleft Lip and Palate**

Alveolar molding in a BCLP is geared toward positioning the often protrusive and ectopic premaxilla between the alveolar segments (Fig. 4). This process requires the premaxilla first to be centered to the midline before retraction. Similar to the techniques used with a UCLP, this is accomplished through sequential removal of acrylic and addition of soft denture liner while applying a selective force with the retention tapes. In situations in which the alveolar segments are collapsed palatally, they can and must be expanded through successive removal of acrylic and addition of denture liner before retraction of the premaxilla.

As with a UCLP, care must be taken to remove acrylic from the posterior aspect of the appliance during retraction to avoid impingement of posterior tissues. Gradual removal and/or addition of material is critical to minimize development of sores and maintain a well-fitting appliance throughout treatment. Clinical progress is assessed during the molding process, with changes noted in the premaxillary position, lateral

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**Fig. 3.** NAM for unilateral cleft lip and palate. The alveolar gap noted in the initial impression (see Fig. 1A) is narrowed significantly following NAM (A). The apposition of the alveolar segments, molding of the lower lateral cartilage, and narrowing of the alar base results in less tension on the tissues and facilitates surgical repair (B–G).
alveolar segments, as well as alar base morphology and columella. Synchronous lip and nasal repair is performed at approximately 6 months of age (see Fig. 4C–G).

**QUESTIONS FOR CONSIDERATION**

*What Is the Impact of Nasoalveolar Molding on Maxillary Growth?*

A recent randomized controlled clinical trial evaluating the early effects of NAM on maxillary growth in UCLP showed that NAM is effective for realigning the greater and lesser segments without immediate adverse effects on vertical or transverse arch growth. These findings are consistent with those reported by Fuchigami and colleagues, who, based on a three-dimensional evaluation of dental casts in patients with UCLP, showed that NAM improved maxillary arch morphology and symmetry, as well as nasolabial contour, including columellar positioning. NAM was reported to prevent alveolar width widening with growth. Long-term effects on maxillary growth remain an area of active investigation; such effects may be confounded by surgical technique for lip and palate repair.

*What Are the Outcomes of Nasoalveolar Molding?*

Outcomes of NAM have been the subject of several recent investigations. Although generalizations about the effectiveness are limited by heterogeneity between studies, as well as inconsistent follow-up times, a few trends have been observed. A survey study of surgeons evaluating patients with cleft lip plus or minus palate suggests that surgeons assessed the likelihood of revision to be less in patients who underwent NAM. Broder and colleagues report better caregiver-reported outcomes following surgery in patients undergoing NAM versus those who had not undergone NAM. The difference was most notable with regard to nasal appearance. The observation regarding nasal appearance is consistent with data from Barillas and colleagues, who evaluated nasal morphology in patients with nonsyndromic UCLP. These investigators retrospectively assessed 4 nasal anthropometric distances and...
2 angular relationships in patients with UCLP who underwent NAM compared with patients with UCLP who underwent surgical correction alone. They report a greater degree of nasal symmetry in patients undergoing NAM at an average of 9 years postoperatively. The same group reported improvements in columellar length and a decreased need for nasal surgery at 3 years of age in patients with BCLP who underwent NAM, compared with those who did not undergo NAM. Subsequent work by this group showed nearly normal nasal morphology at 12.5 years of age in patients with BCLP who were treated with NAM and primary nasal reconstruction at the time of lip repair. As with surgical techniques for management of cleft lip and palate, there are identifiable differences in outcomes for NAM in UCLP versus BCLP. Nostril breadth was more favorably modified in UCLP, as was bialar width. In BCLP, NAM more effectively increases columellar height and width.

What Are the Risks of Nasoalveolar Molding?

These purported benefits should be weighed against the risks of NAM. A review of NAM-related complications noted that nearly three-quarters of patients had an adverse event related to soft tissue, most commonly ulcerations. Noncompliance was reported to occur 40% of the time. Although these data do not suggest that NAM is a high-risk undertaking, they do stress the importance of team-based, multidisciplinary care for patients with cleft-related differences.

SUMMARY

NAM is a powerful presurgical technique used to reduce the severity of the cleft through improved alignment of the alveolar segments and lip elements. However, its ability to improve on the primary cleft nasal deformity before surgical correction is unique. This improvement includes increased nasal tip projection, improved symmetry of the lower alar cartilage, and nonsurgical elongation of the columella. Since its introduction, the singular benefits it offers have been recognized by numerous practitioners, leading to its adoption as the treatment of choice at cleft centers throughout the United States, as well as the rest of the world. However, as with choosing any treatment modality regarding UCLP and BCLP, careful consideration needs to be taken regarding the individuality of every case, with decisions ultimately being made following conscientious discussions between the orthodontist, surgeon, cleft team, and patient.

DISCLOSURE

The authors have nothing to disclose.

REFERENCES


