Nasoalveolar molding: A review
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Abstract
Cleft lip and palate (CLP) is the most common congenital defect of the oral cavity which possesses a serious socioeconomic trouble. It varies in form and severity. In these patients who have deficient hard and soft tissue structures presented a major task to bring about a functional and cosmetic outcome. Recently, nasoalveolar molding (NAM) has gained more attention as it improves facial appearance and function. The objectives of presurgical NAM involves correcting lip segments, lower lateral alar cartilages, and alveolar cleft segments. Results of NAM are promising for CLP, hence are encouraged to be used promptly after the birth and continued till further specific corrective surgeries are performed.

Introduction
Cleft of the lip, alveolus and palate (CLAP) are the most common congenital mal-formations of the head and neck. India being the second most populated country in the world with a population of 1.21 billion, it is estimated that out of 24.5 million births per year - the birth prevalence of clefts is between 27,000 and 33,000 clefts.\[1\] The incidence of CLP in India is 1 in 781 live births.\[2\]

Unilateral clefts are nine times as common as bilateral clefts, and occur twice as frequently on the left than the right. The ratio of left:right-bilateral clefts are 6:3:1. Males are predominantly affected by CL\$\times$P (M: F - 2:1) whereas females are more commonly affected by isolated CP.\[3\]

The management of cleft patients should be approached as a multidisciplinary team. It has evolved dramatically in recent years because of advanced surgical techniques, timing, and integration of methods like presurgical orthopedics. The basic treatment objective is to restore normal anatomy. In past decade, it has been made known that improvement of nasal abnormality by elongating of the nasal mucosal lining, and attainment of nonsurgical columella lengthening can be united with shaping of the alveolar process in these patients.\[4,5\]

Presurgical nasoalveolar molding (PNAM) is a non-surgical method of reshaping the gums, lips and nostrils previous to CLP surgery, thus lessening the severity of the cleft. Before the introduction of the concept of NAM, repair of a huge cleft involved several surgeries between birth and 18 years of age, setting the child at risk for emotional and social adjustment problems. With the advent of PNAM multiple surgical procedure is bypassed, and better results are obtained, with only one or two surgeries.\[6\]

History
In 317 AD, Chinese general Wei Yang-Chi corrected his CL by cutting and stitching the edges. Many methods have been accepted over the centuries to recover the location of the cleft alveolar segments [Table 1].\[7-9\]

Principle of NAM
PNAM works on the principle of “Negative sculpturing” and “Passive molding” of the alveolus and adjacent soft tissues. In
passive molding, custom made molding plate of acrylic is used gently to direct the growth of the alveolus to get the desired result later on. While in negative sculpturing serial modifications are made to the internal surfaces of the molding appliance with addition or deletion of material in certain areas to get desired shape of the alveolus and nose.[6]

Objectives
- Primary goal of PNAM is to decrease the severity of the primary cleft deformity and provide symmetry to distorted nasal cartilage.
- Nonsurgical lengthening of the columella.
- Approximation of lip segments to decrease tension in the tissues after lip repair and thus reduce scarring.
- To produce additional favorable bone formation by decreasing the size of the cleft and improving nasal tip projection, decreasing the width of nasal alar base and nasal tip.
- Reduce the need for secondary alveolar bone grafts.

Table 1: History details

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
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<tbody>
<tr>
<td>1556</td>
<td>Pierre Franco gave the first detailed description of the indications, surgical technique, and post-operative care of the CL.</td>
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<tr>
<td>1575</td>
<td>Amboise Pare pioneered a technique that bears his name involving lip repair with cleft lip pins</td>
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<td>1689</td>
<td>Hoffmann demonstrated the use of facial binding to narrow the cleft and prevent postsurgical dehiscence</td>
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<tr>
<td>1790</td>
<td>Desault used similar technique to retract the maxilla before surgical repair in patients with bilateral cleft repair.</td>
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<tr>
<td>1844</td>
<td>Hullihen stressed the importance of presurgical preparation of clefts using an adhesive tape binding</td>
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<tr>
<td>1927</td>
<td>Brophy demonstrated the passing of a silver wire through both the ends of the cleft alveolus, and then progressively tightened the wire to approximate the ends of the alveolus before lip repair</td>
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<tr>
<td>1946</td>
<td>Pritchard observed that the rate of bone healing was inversely proportional to the size of the gap</td>
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<tr>
<td>1950</td>
<td>McNeil used a series of plates to actively mold the alveolar segments into the desired position</td>
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<tr>
<td>1952</td>
<td>Tennison developed a technique preserving the accurate position of Cupid’s bow</td>
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<td>1958</td>
<td>Burston, further developed McNeil’s technique and made it popular</td>
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<tr>
<td>1960</td>
<td>Millard's rotation advancement closure technique brought the Cupid's bow and the philtrum into a symmetrical position</td>
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<tr>
<td>1975</td>
<td>Georgiade and Latham introduced a pin-retained active appliance to simultaneously retract the premaxilla and expand the posterior segments</td>
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<tr>
<td>1987</td>
<td>Hotz described the use of a passive orthopedic plate to slowly align the cleft segments</td>
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<tr>
<td>1993</td>
<td>Grayson et al. described a new technique to pre-surgically mold the alveolus, lip and nose in infants born with CLP</td>
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- In infants with bilateral CLAP, the goal consists of the nonsurgical lengthening of the columella, retraction of premaxilla gently to accomplish continuity with the posterior alveolar cleft segments and centering of the premaxilla along the mid-sagittal plane. The main point of nasal molding is to move the alar domes anteriorly in a sagittal path for increasing length of columella.[10,11]

Steps for NAM therapy
Evaluation of the infant for PNAM is started soon after birth. During the 1st week or early 2nd week after birth the clinical procedures and fabrication of PNAM plate should be started. Molding of tissues is easier because of raised level of hyaluronic acid and maternal circulating estrogen in neonates. PNAM should ideally be completed before 6 months of age.[6]

Impression technique
The initial impression is made with a heavy-bodied silicone impression material. It should be taken soon after birth as the cartilage is plastic and is moldable. The presence of the surgeon is important during the procedure to help in case of an airway emergency. Grayson and Maull[6] held infant upside down position to keep the tongue forward which permitted fluids to draw off the oral cavity and impression tray is placed. The tray should be placed until impression material just begins to extrude from the posterior border. Yang et al.[7] took the impression using a pre-trimmed customized pediatric tray with the baby mainly in the erect position, being held by one of the parents.

Impression material is allowed to set, and then the tray is taken out of infant’s mouth [Figure 1]. The mouth is checked for remaining impression material. A cast or model is prepared with a dense plaster material (dental stone) [Figure 2]. The plate is made-up on the stone model.[6] Using special tray, and putty consistency polyvinyl elastomeric impression material final impression is made, with the same technique as of primary impression.[6]

Appliance fabrication
Undercuts present on the cast are blocked out with utility wax. Separating media is applied. The NAM plate described by Grayson and Maull[6] is prepared up of hard, clear self-cure acrylic. It is lined with a thin layer of a denture soft material. The retention arm is located at about 40 degrees to get appropriate activation and to avoid dislodgment of the NAM plate from palate. The retention arm’s vertical position should be at the intersection of the upper and lower lip while retention button with the aid of elastics and
extra-oral tapes secures the molding plate in the oral cavity. This is the most commonly used NAM appliance [Figure 3]. Various materials have been substituted for an auto polymerizing resin in fabrication of the appliance by various researchers. They are heat-cure polymerizing material (Sharma et al.\(^2\); Soltan-Karimi et al.\(^{13}\)), light-cure polymerizing material (Yang et al.\(^7\)) and 2 mm thermoplastic base plate (Upadhyay et al.\(^{14}\)).

**Appliance insertion**

The molding plate is examined for rough areas and then is inserted in the oral cavity. Appliance is checked for proper fitting and retention. The primary retention of the appliance is through extra-oral bilateral facial adhesive tapes applied to cheeks [Figures 4 and 5] and to acrylic extension from oral plate that is positioned between lips under the cleft and at one end orthodontic elastics are attached.

The elastics used should have an inner diameter of 0.25 inch, and it should be stretched about two times the diameter for activation force of about 2 oz.\(^8\) Depending on the clinical purpose and mucosal tolerance the quantity of force used may vary.\(^9\)

One-retention arm is used in cases with the unilateral cleft only, and it is positioned on the labial border of the plate. It is determined by pulling, the CL segments together while centering the philtrum and columella. Approximation of lip segments with no lower lip obstruction is seen when vertical position of the retention arm rests at the junction of upper and lower lips.\(^3\) After the initial insertion, the baby is observed for several minutes to check the stability of the appliance in place against the palate. Bottle feeding was done to ensure proper sucking without gagging.\(^6\) Some authors suggest a liquid adhesive such as Mastisol painted with a cotton-tipped applicator horizontally on the cheeks where the Steri Strips will be placed.\(^7\)

The plate is kept in the mouth for full time, and parents are instructed only to remove it for daily cleaning. Initial days parents may find difficulty or need time to adjust to feeding infant with the NAM appliance.
Maintaining the tight apposition of lip segments with the tape results in the orthopedic benefits of the traditional lip adhesion without the consequent scar. It also serves to improve the position of the nasal base region by bringing the columella toward the mid-sagittal plane and by progressing the regularity of the nostril apertures. The lip adhesion alone produces uncontrolled orthopedic benefits; whereas the lip tape adhesion combined with the molding plates produce controlled movement of alveolar segments.[15]

Appliance adjustment
The appliance is left for 24 h in mouth and parents are instructed to remove it only for cleaning purposes. After 24 h patient is recalled to evaluate and correct sore spots or other problems with the appliance, if any. The recall appointments are scheduled weekly to modify the molding plate by selective trimming and addition of acrylic to direct the alveolar fragments into the required location. As the alveolar gap come closure, the lip segments come together, reducing the nasal base width, and bring in laxity of the alar rim. Addition of Nasal stent should be delayed till laxity of the alar rim is achieved because it may result in the enlarged circumference of the nostril. The elastics should be changed on regular bases which ensures the efficiency of the appliance by maintaining the tension.[6-10]

Nasal stent
The incorporation of nasal stent is recommended when the alveolar gap width is decreased to 5mm. It is made up of 0.036 gauge round wire and resembles kidney shape [Figure 6]. It is added to the vestibular shield of the appliance. Tip of nasal stent is pointed in the direction of the medial wall of the defective nostril. Wire is allowed to extend into the nostril, and then it is curved back to create a small loop which helps in retaining the intranasal portion. The upper lobe enters the nose and lightly elevates the dome until a reasonable amount of tissue blanching is apparent. The lower lobe elevates the nostril apex and delineates the top of the columella. The alar rim, stretched at birth will demonstrate a little laxity, and with the nasal stent, this is elevated into a proportioned and convex form.[8,9]

Major surgical closure of the lip and nose are performed between 3 and 5 months of age.

As the alveolar segments are in approximation, a gingivo-periosteoplasty (GPP)is simple to perform, which avoids widespread dissection and not affecting growth of the mid-face.[8]

Active and passive appliances
Appliances are classified into active or passive or semi-passive depending on forces required.

Active appliances are fixed intra-orally and apply traction through mechanical means such as elastic chains, screws, and plates. Passive appliances maintain the distance between the 2 maxillary segments while external force is applied primarily to reposition the segments posteriorly. External taping of the lip, head cap with elastic straps across the prolabium, or a surgical lip adhesion applies external forces. Active maxillary appliances use controlled forces to move the alveolar cleft segments in a predetermined manner, but passive appliances act only as a hinge on which the forces produced by surgical lip closure, shape and mold the alveolar segments in an expected manner.[16-18]

Modifications
They are modified muscle-activated maxillary orthopedic appliance used by Suri and Tompson[19] in NAM therapy; Retnakumari et al.[17] described alveolar molding appliance with expansion screw; dynamic presurgical nasal remodeling intraoral appliance designed by Bennun and Figueroa;[20] extra-oral nasal molding appliance by Doruk and Kiliç[21] and self-retentive appliance with orthodontic wire used by Singh et al.[22] and Ijaz in presurgical infant orthopedics.

Complications
The complications associated with NAM.

- Irritation of the oral mucosal.
• If there is more force application by the upper lobe of the nasal stent, it may cause inflammation of intranasal lining of the nasal tip.
• If the lower lobe is not positioned correctly notching can occur along the alar rim.
• If the band is too tight, the region under the horizontal prolabium band may become ulcerated.
• Loss of valuable treatment time if parent’s compliance is poor.
• The risk of dislodgement of the molding plate which may obstruct the airway.
• Possibility that the posterior limit of the NAM plate may drop down onto the tongue if the arms are taped too horizontally or with inadequate activation.
• Pressure from molding plate may cause premature emergence of the labial surface of maxillary deciduous central incisors.

Benefits

The benefit of NAM is that it enables the surgeon to accomplish a better outcome with a lesser scar tissue formation. It decreases the cleft side alar curvatures, increases length of columella, makes prolabium more visible. Studies show that the nasal shape is stable with better lip and nasal form. NAM decreases the required number of surgical revisions for oronasal fistulas, excessive scar tissue, and nasal, labial deformities. Adult teeth erupt in a good position with sufficient periodontal support.

Studies show that patients who were treated with NAM and GPP did not necessitate secondary bone grafting. NAM has proven to be cost effective for families due to the fewer number of surgeries and is a chance for the parents to take part keenly in the habilitation of their child.

Conclusion

NAM technique has been significantly shown to improve the surgical outcome of CLP patients compared with other techniques of presurgical orthopedics. NAM has proved to be a simple yet effective adjunctive therapy for reducing hard and soft tissue cleft deformity before surgery. However, it is crucial that members of the cleft team provide the parents and caregivers adequate training, education, active support, and encouragement during NAM treatment. Lack of parent or caregivers’ compliance and commitment results in less than ideal clinical outcomes. It is reported in the literature that the presurgical molding used to reduce the cleft deformity does not inhibit mid-face growth. Despite the relative paucity of high-level evidence, NAM appears to be a promising technique that deserves further study.

References
