A Staged Expansion Screw Protocol to Retract the Premaxilla In BCLP Infants with Delayed Nasoalveolar Molding

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Currently, the treatment protocol for cleft palate at several centers around the world involves primary lip repair around 3-4 months of age, using presurgical nasoalveolar molding, which is done soon after birth. Unfortunately, in cases where treatment is delayed, the potential for repositioning the nasoalveolar apparatus is severely limited. The purpose of this paper is to illustrate a novel use of an expansion screw appliance to aid in the faster and more efficient active molding of the premaxillary and lateral maxillary segments in infants for whom the start of PNAM therapy is delayed, without the side effects commonly seen with pin-retained active molding appliances.

Keywords: Cleft lip and cleft palate, presurgical nasoalveolar molding, nasoalveolar molding, expansion screw appliance.

INTRODUCTION

Although great strides have been made in the surgical repair of cleft lip and cleft palate (CLCP) patients, there has been increasing evidence to show that surgical repair alone cannot completely repair a deformity that is multifactorial.[1] The challenge of reconstructing the nasolabial complex in three dimensions, incorporating soft and hard tissues and anticipating further changes of growth and distortion, is certainly a challenging task.[2]

Previously, all children with complete alveolar clefts would typically require an alveolar bone graft during the mixed dentition. The old concept regarding bilateral complete cleft lip concluded that the columella was inadequate, so tissue had to be harvested from the prolabium or the nostril sills. Additionally, the malposed alar cartilages were overlooked early on. Secondary procedures were often needed as the children aged, which resulted in peculiar tertiary deformities.[3,4]

Dissatisfied with the stigmata caused by a bilateral cleft lip and nasal deformity, a small group of North American and Australian surgeons focused more on the primary nasal correction. The pioneers of this philosophy were Broadbent and Woolf[5] and later McComb,[6,7] Mulliken,[3,8] Trott and Mohan,[9] and Cutting et al.[10] It was no longer acceptable to postpone correction of the columella and the nasal tip in children born with a bilateral cleft lip.[2]

Additionally, in 1984, Matsuo et al.[11] described a technique to non-surgically correct auricular deformities in newborns by taking advantage of the plasticity of infantile cartilage. This was thought to be the result of elevated levels of circulating maternal estrogen in the infant's bloodstream. Finally, in 1993, Grayson et al[12] expanded upon Matsuo's concept and described a new technique to pre surgically mold the alveolus, lip, and nose in infants born with cleft lip and palate.

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This treatment philosophy gave excellent presurgical reshaping of the anterior maxillary segment, lips, and nostrils before the cleft lip and palate surgery, thus lessening the severity of the cleft. Currently, the treatment protocol at several cleft centers around the world involves primary lip repair to be undertaken at 3-4 months of age, using presurgical nasoalveolar molding (PNAM) done soon after the patient is born.[13]

However, in developing countries, primary care providers are not well aware of the benefits of early PNAM and thus the request for treatment is often delayed which severely limits the potential for repositioning the patient's nasoalveolar apparatus. Grayson et al,[12] comprehensively stated that the plasticity of the cartilage fades over the first 6 months of age, and a state of elasticity eventually sets in. Alteration of the shape of the nasal cartilage and apposition of alveolar and lip segments becomes increasingly difficult with passive molding appliances, whenever treatment is delayed.

In a study done to assess the effects of early vs. delayed PNAM therapy, Mishra et al[14] found that when PNAM was done within the first 6 weeks from birth, the columellar length increased by 42.1% and the alveolar gap reduced by 50.1%, while treatment done between 4-6 months of age resulted in the columellar length increasing by 26% and the alveolar gap reducing by 33.3% .

PNAM done at a later stage still holds promise, however the mechanics and force systems need further development to overcome the increased elasticity of cartilage. To further achieve better results for infants with CLCP for whom the start of treatment is delayed, the purpose of this paper is to illustrate a novel use of expansion screws to aid in the faster and efficient molding of the premaxillary and lateral maxillary segments, offering the potential for better results than with conventional PNAM alone and without the side effects of altered alveolar growth commonly seen with pin retained active molding appliances. Accelerated alveolar molding would also allow for nasal correction to be initiated earlier, increasing the potential of soft tissue modulation.

Case Report

A three and half-month old girl with a complete bilateral cleft lip and palate reported to the Department of Orthodontics and Dentofacial Orthopedics, YMT Dental College and Research Institute, Mumbai, India for presurgical orthopedics (Figure 1).

On examination, the patient presented with the following features:

1. Premaxilla suspended from the nasal tip and rotated to the left.
2. Flattening of the right nasal dome with increased interalar width
3. Poor nasal tip projection.
4. Deficient and malposed columella
5. Complete cleft of the palate

As the parents were unaware about the early intervention, they reported late due to which the use of conventional PNAM approach was not recommended. We decided to incorporate a multi-staged protocol to achieve targeted correction with predefined goals within the shortest time possible. The following treatment goals were established:

Stage 1: Alignment of posterior lateral segments with simultaneous derotation of the premaxilla

Stage 2: Guided retraction of the premaxilla and elongating the columella

Stage 3: Molding of the nasal cartilages, and correction of the nasal projection

Treatment protocol

Impression compound was used to make a working model impression to fabricate a self–cure acrylic custom impression tray. The custom tray was then used to record the final impression with a polyvinyl siloxane impression material (Dentsply, USA). The master cast was prepared for the passive alveolar molding plate fabrication by blocking the undercuts (Figure 2).

Stage 1: The alveolar molding plate was fabricated using a self-cure acrylic resin with retentive arms extending from the premaxillary region at 45 degrees. A relief hole was created in the plate for any airway emergency that might arise due to plate loosening and subsequent airway blockage (Figure 3A, B).

The plate was retained in place by elastics delivering 2 oz. force per side, taped on to Tegaderm (3M, USA) supported cheek pads to prevent ulceration. Lip taping was done with Transpore (3M, USA) tape that closely approximated lip segments horizontally while delivering a vertical pull on the columella (Figure 3C). The parents were trained towards home care protocols and instructed to change the tape and clean the appliance daily.

As the premaxilla was deviated and rotated towards the left, there was a need to establish a postero-laterally directed force system at the right side of the premaxilla by labial acrylic addition and palatal acrylic removal. On the contralateral side, the reverse was performed to generate a derotating couple system. Weekly acrylic modifications over four weeks activated this force system and molded the premaxilla towards the desired correction (Figure 4).

Post derotation the patient was already 4.5 months old, necessitating accelerated premaxillary retraction and nasal molding with an efficient force system, to overcome the reduced plasticity of the cartilage.

Stage 2: The accelerated premaxillary retraction was aided by an expansion screw in the following steps:

1. A new impression was made for fabrication of the expansion plate after premaxillary derotation. The working model was sectioned into premaxillary and lateral maxillary segments (Figure 5A).
2. The inter-segment plaster was trimmed off the working model and the premaxilla was repositioned to the desired final position.
3. Plaster relief was added to account for growth change in the areas where growth was to be permitted to make predicted end-of-treatment palatine shelves and a premaxillary position.
4. An expansion screw appliance was fabricated with the expansion screw oriented anteroposteriorly between the posterior acrylic component (the two lateral maxillary halves) and the anterior premaxillary component.

Figure 1. Facial and intraoral views of the infant presenting with bilateral cleft lip and palate.

Figure 2. A, Primary impression in impression compound; B, final model

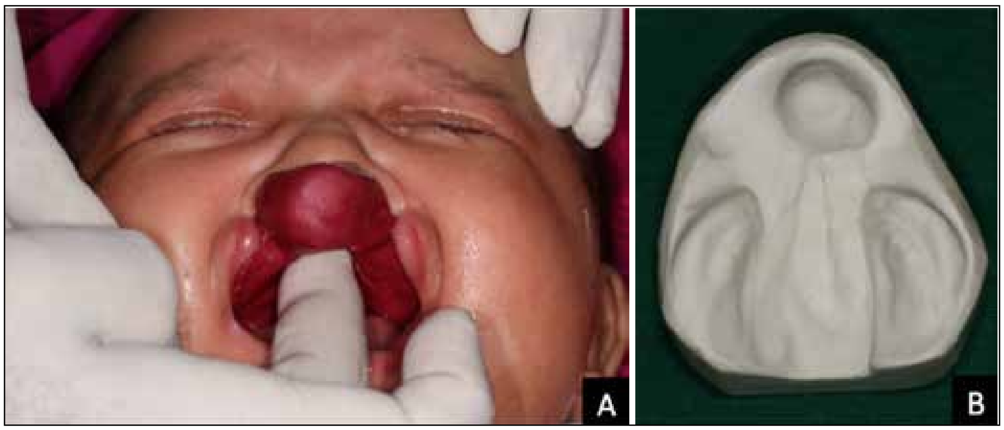
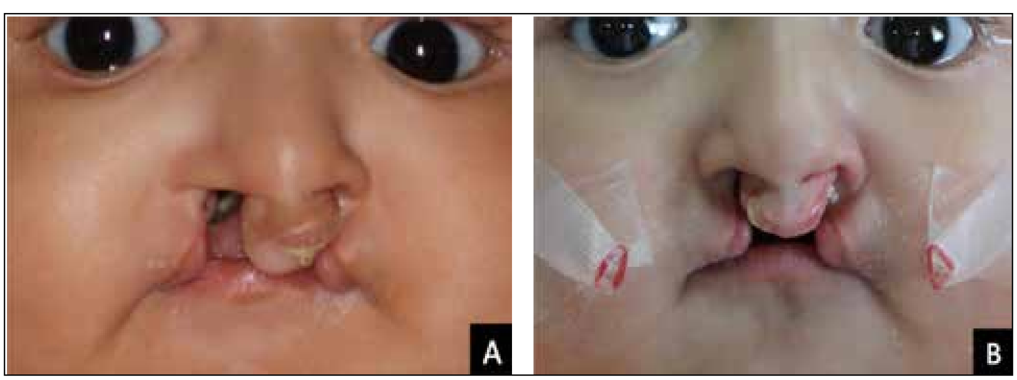


Figure 3. A, The alveolar molding plate made in self-cure acrylic; B, retentive arms angulated at 45º; C, lip taping and elastic traction.

Figure 4. A, Preatment premaxillary position; B, premaxillary derotation and centering completed at end of stage 1.



5. The plate was then expanded to the current dimensions of the patient's cast, relined with soft liner intraorally to permit placement into the current arch dimensions, and inserted at the end of Stage 1 (Figure 5B).
6. The appliance was activated in a reverse manner 0.5 mm/day to allow for anteroposterior segment approximation to the predetermined position in Step 2 (Figure 5C).

Stage 3: After 15 days of using the expansion screw appliance, the intersegment distance was less than 8 mm. Nasal stents were incorporated into the appliance at this stage.[13] Nasal stent incorporation earlier than this can potentially cause a meganostril formation. The traditional placement of the nasal stent wires (0.036-inch stainless steel) in the anterior component was modified and they were placed in the posterior segment instead (Figure 6). This was done to prevent the frequent adjustments that would be necessary with our retracting premaxilla changing the spatial orientation of the nasal stents.

The swan neck shaped nasal stents were positioned mesially, to elevate the nasal tip and position the alar cartilages optimally. The nasal stents were kidney-shaped and lined with soft acrylic to prevent any trauma to the nasal mucosa. Activation of the nasal stents was done until a slight blanching at the tip of the nose was evident. A prolabial acrylic bar was also used to connect the two nasal stents to provide a restraining element to the nasal apparatus, when a vertical pull was applied on the columella (Figure 6B).

The parents were instructed on the appliance usage and a reverse screw activation protocol was established at the rate of 0.5 mm/day. After a month of following this protocol, the child was adequately prepared for primary lip closure surgery by 5.5 months of age.

Treatment progress

Treatment records were evaluated for changes concerning cleft reduction and achieved symmetry. The following landmarks were considered for evaluation: (adapted from Shetty et al.[13]) (Figure 7).

Facial landmark measurements (Figures 7A, C)

1. Columella length: vertical distance between the most superomedial (A) and inferomedial (A') points along the inner medial surface of the nostril apertures.
2. Nasal width: the horizontal widest distance between the right (B) and left (B') lateral nostril borders.

Model landmark measurements (Figures 7B, D)

3. Intersegment distance (right): the shortest possible distance between the right lateral shelf (C) and premaxilla (C')
4. Intersegment distance (left): the shortest possible distance between the left lateral shelf (D) and premaxilla (D')
5. Cleft width: shortest distance from the medial central portion of the right (E) and medial central portion of the left (E') palatine shelves

Figure 5. A, The working model prepared for sectioning; B, the expansion screw appliance adapted and relined to the end of state 1 dimensions; C, the appliance fitted intraorally to begin premaxillary retraction.

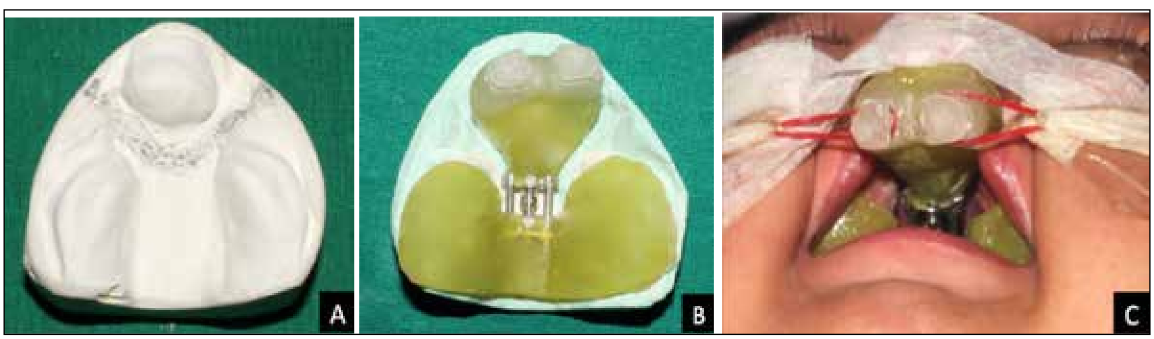


Figure 6. A, The modified appliance with nasal stents supported from the posterior segment; B, appliance in position with swan neck shaped nasal stents positioned mesially in the nostrils.

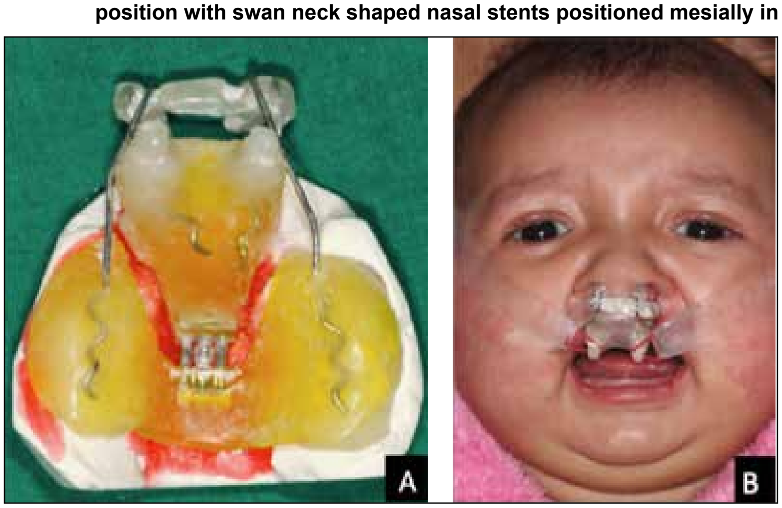


Figure 7. Pre- and posttreatment records were evaluated for changes with respect to cleft reduction and symmetry achieved. A, pretreatment facial landmark measurement (AA': columella length, BB': nasal width); B, pretreatment model landmark measurement (CC', DD': intersegment distances for right and left sides respectively, EE': cleft width); C, posttreatment facial landmark measurement; D, posttreatment model landmark measurement.

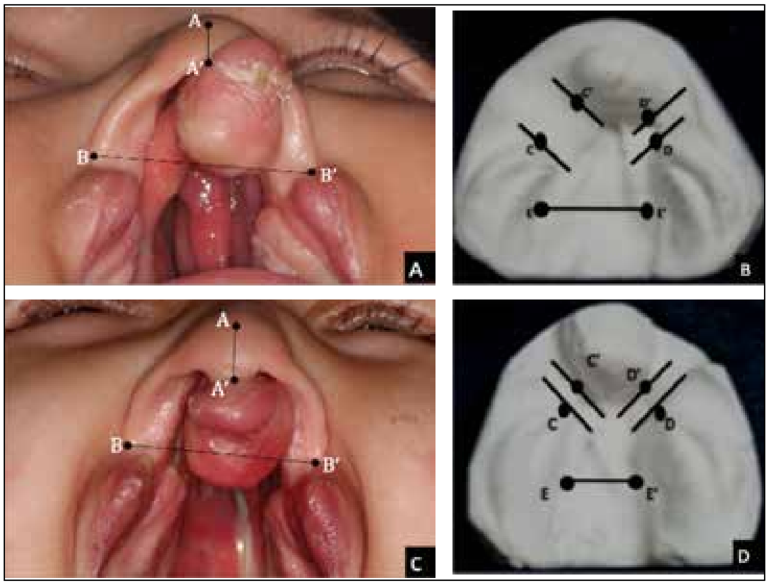


Figure 8. Progress photos (Figures 8A-D respectively) taken at days (0, 20, 30, 60) showing stage wise improvement in our patient.

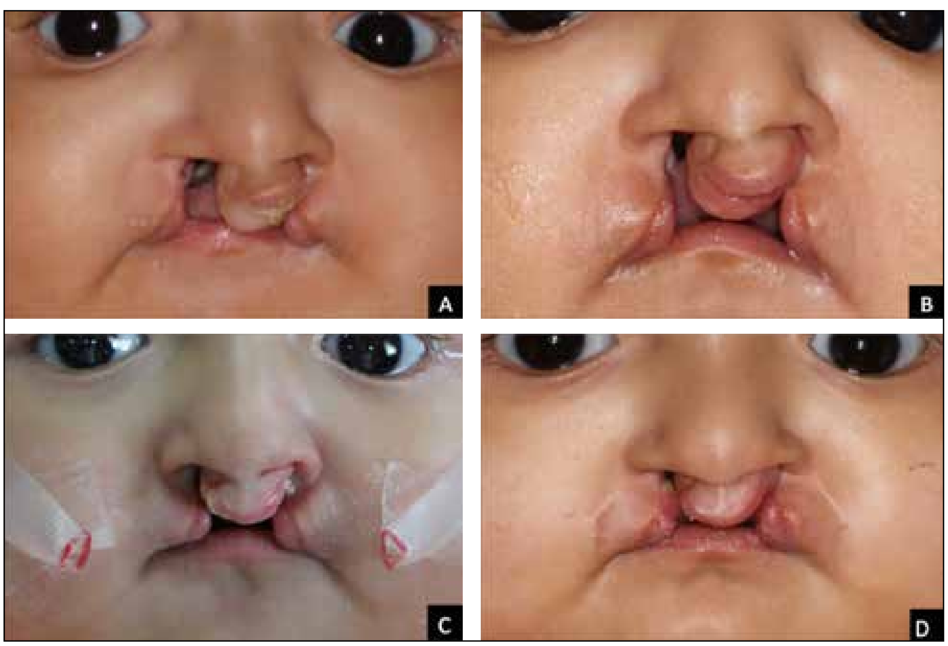


Figure 9. Postoperative facial photograph taken one week after lip closure surgery.

Table 1 shows the recorded values for facial and model measurements. The columellar lengthening was sufficient and thereby, the requirement of rhinoplasty during lip repair was not recommended. Additionally, reduced nasal width, reduced intersegment distances, and decreased cleft width were observed at the end of the treatment. Photos taken at 0, 20, 30, and 60 days from the beginning of the treatment show a progressive, stage-wise improvement in our patient (Figure 8). Lip closure surgery was performed after 60 days of therapy (Figure 9).

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Table 1. Recorded values for facial and model measurements

Assessing Parameter (mm)	Pretreatment	Posttreatment
Columella length (AA')	3	6
Nasal width (BB')	21	17
Intersegment distance (right) (CC')	10	4
Intersegment distance (left)(DD')	6	4
Cleft width (EE')	17.5	11

DISCUSSION

For efficient PNAM procedures, newborns should be evaluated as early as possible, preferably within the first 2 weeks of life.[15] Alar cartilage is soft and plastic at birth much like auricular cartilage, so it is correctible in the early neonatal period because of the high estrogen concentrations in the newborn's blood during the first 15 days of life. Estrogen increases the level of hyaluronic acid, which subsequently increases the level of plasticity in the cartilage.[16]

However, a comparative longitudinal evaluation of the effects of nasoalveolar molding (*NAM*) in CLCP patients presenting for treatment at various ages has not been well documented. Several cleft centers worldwide perform primary lip repair at 3-4 months of age, hence there is a lack of studies on the effects of NAM on the nasoalveolar morphology in infants when treatment is delayed.[13]

As the start of treatment was delayed with our patient, i.e., at the age of 3.5 months, the potential for achieving good results with efficient PNAM treatment using passive appliances was already limited. Considering the severity of the patient's bilateral CLCP, multiple, staged surgeries would be most likely necessary to correct her nasoalveolar deformities.

One way around this problem would be to use an active molding plate to assist the molding process. In 1975, Georgiade and Latham[17] introduced a pin-retained appliance, the Latham appliance, that simultaneously retracted the premaxilla and expanded the lateral palatal segments in days.

The Latham appliance is a surgically placed, fixed intraoral device to expand the maxillary segments and retract a displaced premaxilla without external strapping. It consists of hard acrylic caps covering the premaxilla and palatal processes, joined together with a midline screw. However, this technique was invasive and might have retarded the maxillary growth of our patient.

The use of a reverse expansion screw to aid retraction of the premaxillary segment[18] is based on a similar, actively guided mechanism without the invasive pins used with the traditional Latham appliance. This technique, however, used a single-step linear retraction vector to approximate the premaxilla to the palatine shelves, and could not accommodate derotation and angular movements. The retraction was also dependent on the initial position of the premaxilla, not the desired final position.

Our multi-staged approach of sequential stage-wise premaxillary derotation, repositioning model segments in their final position on a model before fabricating a PNAM device and then retracting the premaxilla to a predefined position, allowed for a more controlled and predictable force system.

By incorporating a reverse expansion screw in the appliance, the retraction was accomplished with a 0.5 mm/day screw turn schedule, giving predictable and efficient retraction within the time constraints. We also modified the position of the nasal stents so they could be attached to the posterior segment of the appliance, thus eliminating their weekly repositioning to maintain optimal nasal projection, that would have undoubtedly been required, if they were attached to the retracting premaxillary segment. Using this protocol, cases where treatment has been delayed, can be predictably treated with PNAM.

CONCLUSIONS

This novel approach allowed us to mold a severe cleft efficiently before the child's lip repair surgery even though initial treatment was delayed. Since this was accomplished before the elasticity of her cartilages settling in at 6 months of age, the results were more predictable. This technique can be a boon to those centers where PNAM protocols are less known and infants routinely present late for treatment.

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