

The Impacts and Outcomes of Presurgical Nasoalveolar Molding (PNAM) in Newborn Sequential Therapeutic Implementation

Vonda Trivosa^{1*}, Michael Halim² and Gao Yongyan³

Abstract

Cleft lip and palate is a common congenital malformation in the oral and maxillofacial regions. According to epidemiological investigation, the incidence rate is about 1.625%, and the incidence rate is high in poor areas and rural areas. Cleft lip and palate mainly involve the upper lip, hard palate, soft palate and nose, which can damage the appearance of children, affect pronunciation, swallowing and chewing, and also bring different degrees of psychological damage to children in the growth stage. Therefore, we should actively carry out sequential treatment and participate in the treatment work through multi-disciplines. Based on restoring the oral and maxillofacial function and health of children, we should also pay attention to their aesthetic needs, enhance the treatment confidence of parents and children, and lay the foundation for the follow-up repair treatment. Most patients with cleft lip and palate are complicated with malocclusion. Orthodontic treatment is an important part of the treatment of cleft lip and palate. The orthodontic treatment of cleft lip and palate can be divided into five periods: newborn period, deciduous dentition period, mixed dentition period, permanent dentition period and combined orthodontic and orthognathic treatment period. Presurgical nasoalveolar molding (PNAM) was used to reduce the severity of facial deformity in children with cleft lip and palate. This article discusses the therapeutic effect of newborn PNAM according to clinical cases. Objective to study the opportunity and current situation of PNAM in the treatment of children with cleft lip and palate, and to provide a favorable reference for clinical orthodontists, emphasizing the close communication between various disciplines.

Keywords:

Cleft lip and palate; Presurgical correction; Sequential therapy; PNAM; The newborn.

¹Department of Orthodontics, School and Hospital of Stomatology, Wuhan University, Wuhan, Hubei, China

²University of Salford, MSc Biomedical Science, Greater Manchester, United Kingdom

³Department of Endodontics, School and Hospital of Stomatology, Wuhan University, Wuhan, Hubei, China

* **Corresponding Author:** Vonda Trivosa, Department of Orthodontics, School and Hospital of Stomatology, Wuhan University, Wuhan, Hubei, China.

Accepted Date: 02-25-2021

Published Date: 03-22-2021

Copyright © 2021 by Trivosa V, et al. All rights reserved. This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Introduction

Presurgical Nasoalveolar Molding (PNAM) is a presurgical treatment of cleft lip and palate proposed by Grayson et al [1].

It is an effective method to improve the maxillofacial growth and development of the cleft lip and palate patients. The sequential treatment of cleft lip and palate has been started from the neonatal stage. Due to the soft cartilage, lack of elasticity and high plasticity of the newborn, orthodontic force is applied to the soft and hard tissues of the maxillofacial region. Through human intervention in the growth mode, the deformity of the alveolar bone is alleviated with the growth of age, which is the premise of creating a good tissue for the later surgical treatment of cleft lip and palate. However, PNAM technology has not yet formed an objective and unified clinical operation standard and efficacy evaluation system, lacking theoretical guidance. In clinical practice, doctors mostly design correction methods based on subjective experience. How to conduct PNAM scientifically has always been a difficult and hot issue in the field of cleft lip and palate research. This article will introduce the clinical application and curative effect of PNAM.

Maxillary morphology of infants with cleft lip and palate

Unilateral complete cleft lip and palate

One side of the maxilla is cracked, forming one side of the cleft lip, cleft alveolar process and cleft palate. The uncut side of the maxilla is larger and deviates from the midline. The main purpose of maxillary basal bone arch plastic treatment is to make the bone segments on both sides of

the basal bone arch close so that the bone segments are arranged in a normal or nearly normal shape of a maxillary basal bone arch.

Bilateral complete cleft lip and palate

The anterior jaw of the child is protrusive, far away from the front edge of the buccal bone segment of the maxilla, and the buccal bone segment collapses toward the midline of the face. The main purpose of the plastic treatment of the maxillary basal bone arch is to make the anterior jaw segment move backward and align with the buccal bone segment to form a nearly normal maxillary basal bone arch shape.

Deformity characteristics of cleft lip and palate

Deformity characteristics of unilateral cleft lip and palate

Lip deformity

The continuity of the upper lip side is interrupted, showing different degrees of cleft lip. Orbicularis oris muscle adheres to the base of the nasal columella and the base of affected nasal alar along the cleft lip. Muscle contraction caused the columella to deviate to the healthy side and the affected side, and the alar base to expand downward and outward; the cartilage of the nasal septum was twisted, and the affected side nostril was flat.

Alveolar and palatal cleft

A cleft lip is usually accompanied by an alveolar cleft, which is manifested as a submucosal notch of the alveolar process; alveolar cleft; through the alveolar to incisor hole. Different degrees of cleft

palate, even from incisor to alveolar cleft hard palate and nasal septum is not connected, resulting in oral and nasal communication.

Nasal deformity

The nasal deformity is three-dimensional, the base of alar on the fissure side moves downward and outward, the alar cartilage collapses downward, the alar becomes straight and flat, forming a collapsed arch and downward hanging nostril and tip; alar cartilage is twisted, making the columella shorter; if accompanied by cleft palate, the deviated nasal septum can make the base of the nose deviate to the healthy side, showing a long alar edge of the affected side.

Deformity characteristics of bilateral cleft lip and palate

Lip deformity

Cleft lip appears on both sides of the upper lip, and the cleft on both sides may be symmetrical or asymmetric, such as complete cleft on one side and incomplete cleft on the other side.

Alveolar and palatal cleft

Often accompanied by alveolar cleft and cleft palate. If the bilateral alveolar process split to the incisor hole, the anterior jaw showed protrusion, accompanied by rotation or deflection.

Nose deformity

The anterior lip of protrusion is connected with the tip of the nose, the columella is short or missing, and the tip of the nose is flat. The width of the nasal floor increased significantly, and the alar cartilage was flat and sunken at the position where it should

be domed. The most difficult part of aesthetic reconstruction is the lack or too short columella.

The time sequence of Presurgical nasal alveolar shaping treatment

At birth

The palatal plate made of soft resin was placed [2]. Orthodontists should make a palatal plate or use an elastic band for infants before the operation, and achieve the best position before the operation to form a normal relationship between maxillary bone arch and lip, which is more conducive to the repair of cleft lip and improve the operation effect.

3 months after birth

Soft palate repair [3] and cleft lip surgery can separate the nasal cavity from the oral cavity and form a nearly normal velopharyngeal closure, which lays a good foundation for the development of the the velopharyngeal region and language training in the future.

6 months after birth

Early correction of unilateral and bilateral nasal membrane supports.

8-12 months after birth

The beginning of voice training. For patients with cleft palate, regular speech examination and speech training after palatoplasty are very beneficial. A small number of children with cleft palate due to the dysfunction of the soft palate muscle group can lead to excessive nasal sound, loss of nasal breathing, and articulation. For this kind of patient, it is suggested that the initial speech development assessment should be carried out during the age of 2-3

years, and individualized speech training programs should be developed for planned speech training.

18-20 months after birth

Hard palate surgery and continuous voice training, cleft palate surgery is generally carried out in 8-12 months.

Indications of PNAM orthopedic treatment

PNAM is mainly suitable for the following patients:

Unilateral or bilateral grade III cleft lip and palate with severe cleft lip and alveolar process and nasal asymmetry.

Mild unilateral or bilateral cleft lip and palate, if accompanied by obvious nasal asymmetry, should also be nasal shaping treatment. 7-14 days after birth is the best time to start nasal alveolar shaping treatment. Because the plasticity of facial soft tissue and cartilage is the best within 3 months after birth, especially the nasal cartilage within 6 weeks after birth.

Methods of PNAM orthopedic treatment

As early as the 17th century, Hoffman was the first scholar to use the headgear as the anchorage to retract the anterior jaw of protrusion and narrow the cleft palate. McNeil [4] used a resin palatal plate to move the fractured alveolar bone to its normal position. Hotz et al [5]. Used the elastic resin material to make the maxillary palatal plate, which was worn from the birth of the child. After cleft lip surgery, it continued to be used until the cleft palate surgery and the eruption of the first deciduous molar. It used the growth of the

maxilla itself to align the alveolar bone segments. Latham [6] appliance can retract the anterior part of protrusion, move forward the affected alveolar bone segment and expand the posterior alveolar bone segment. These methods can only correct the serious displacement of alveolar bone, but not the nasal deformity.

Alar cartilage shaping was first proposed by Matsuo [7] and other doctors [8]. The lack of elasticity of cartilage, ligament and connective tissue in the neonatal stage is due to the high levels of estrogen and hyaluronic acid in the body. They use this feature to shape the nose with a silicone tube-like nasal orthosis device. The direction of force application of the nose shaper is to all sides. Patients with grade III cleft lip have a split nasal floor, so they can't wear the nose shaper. In 1993, Grayson et al [9]. Combined the Hotz palatal plate and nose shaping, and put forward the simultaneous Presurgical shaping treatment of nasal and labial deformities. At present, the clinical methods of Presurgical nasal alveolar shaping are similar.

Make the maxilla model of the newborn, take the model when the child is awake; no respiratory tract infection; do not drink water and milk 1 hour before taking the model; prepare the oral aspirator, and clean the saliva and pharyngeal secretion before taking the model. When the child cries, the maxilla size should be visually measured, and a special pediatric tray should be selected. The edge of the tray should exceed the alveolar ridge on both sides. During the removal of the model, the child was supine to ensure the doctor's clear vision. When using silicone rubber impression material, the amount of catalyst

should be doubled, to accelerate the curing time of the material in the oral cavity and shorten the model taking the time. The anterior part of the bilateral cleft lip was protruded, and the impression material was pressed lightly to wrap the anterior part. Use a cotton swab or mouth mirror to compress the tongue and keep the respiratory tract open. After complete curing, gently take out the tray, check whether there is any impression material debris in the mouth of the child; perfuse the model, and make the palate guard.

The production and adjustment of the palatal plate the nasoalveolar shaper include two parts: the palatal plate inside the mouth and the nasal support outside the mouth. Only the palatal plate is worn on the first visit. In the model, the palatal plate was made first, and the cleft palate was filled with wax to restore the hard palate vault; the continuity of the alveolar ridge was restored at the alveolar cleft, which was conducive to the movement of alveolar bone and the patency of the nasal airway. When trying to wear the palate guard, observe whether the oral mucosa is

compressed and whitened, adjust the grinding in time to avoid causing ulcers; determine the position of the fixed rod in the cleft lip closure, and make an angle with the maxillary plane, so as not to compress the lower lip. Grayson et al [9]. Asked the children to return to the clinic every week, to add lining and adjust grinding to the palatal plate, to reset the displaced alveolar process.

Adjustment of nasal support: the alveolar cleft is reduced to about 6 mm; add nasal support and support it at the upper corner of the affected nostril; bend the connector with 0.019-inch $\times$ 0.025 inch (4.826 mm $\times$ 6.350 mm) stainless steel square wire, which has good elasticity and strength; adjust the wire to make the alar cartilage slightly stressed, and the nasal skin at the vault slightly white. The diameter of the first nasal support ball was 3 mm; 2 weeks later, it was increased to 5-6 mm, and the direction of force application was adjusted to the front and top; during the treatment, with the increase of nostril height, the height of the nasal support was gradually adjusted to shape the affected nostril.

Figure 1: Nasal molding (A). The force components in the Grayson technique in a UCLP patient. (B). The force components in a UCLP patient treated with the modified nostril retainer.





For patients with alveolar shaping, nasal mold should be used for at least 6 months after cleft lip repair. The overall shape and nostril size of the nose were significantly improved, and the effect could be maintained until late childhood. Jahanbin et al [11]. Compared the patients who used nasal support at different stages after the operation. After using nasal support for two months, facial scanning and related parameter measurement showed that the symmetry of bilateral nostril height, nostril width, columella height, nasal floor width and nasal vault height was reduced to varying degrees.

Principle of nasal support

Complete cleft lip and palate nasal deformity is caused by three major factors: abnormal anatomy of external nasal cartilage, imbalance of muscle balance and abnormal jaw development. Therefore, Converse et al [12]. Used the triangle bracket theory to explain the occurrence principle of cleft lip and palate nose deformity, that is, the external nose is regarded as a triangle cone, the center of the cone support is the tip of the nose, both sides are bilateral nasal wings, and the

middle is the nasal septum. When one side of the piriform foramen area is osteodysplasia or lack of bone, the triangle cone inclines, leading to the collapse of the nasal alar and limiting the development of the nasal septum, making it bend along the sagittal plane and protrude to the affected side of the nasal cavity. Because of the tilt of the stent, local soft tissue and cartilage dysplasia, the shape and position of the nasal alar changed. The focus of nasal support is on the top of the affected nostril vault, which can support the collapsed alar, increase the strength of alar cartilage formation, and also play a traction role in the nasal septum and columella. Therefore, it is beneficial to the development of nose.

Complications of PNAM

Facial skin rash is the most common complication, which can be recovered without appliance.

Preventive measures: the use of infant anti-allergy breathable tape, tape width of about 5 mm. After soaking with warm water, remove the tape and adjust the position of the tape.

The incidence of oral or nasal ulcers is very low.

Preventive measures: ask parents to clean children's mouth and appliance every day, and stop wearing appliance after finding nasal cavity or oral mucosa redness and swelling and ulcer. The surface of the nose ball is smooth. Before wearing, apply Vaseline or baby oil on the surface to lubricate it. The volume of the nose ball increases gradually without using too much force.

During the removal of the impression, the impression material fell off, leading to foreign body or suffocation in the trachea

Preventive measures: it is best to use silicone rubber impression, increase the amount of catalyst, shorten the curing time in the mouth.

The correction effect of PNAM on nasolabial deformity

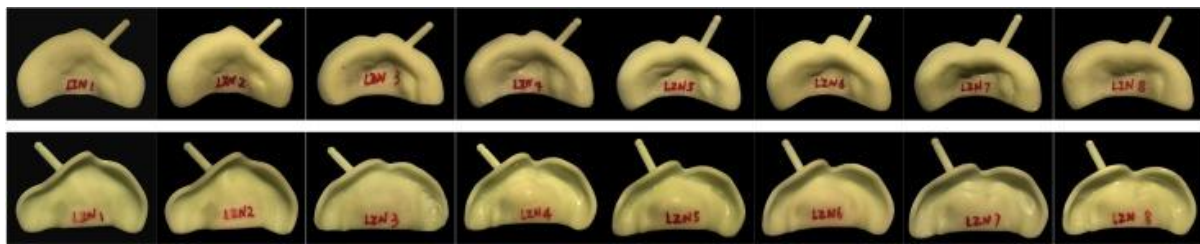
After PNAM treatment, the cleft lip soft tissue and alveolar cleft were significantly reduced, the nasal alar was raised, and the affected nasal columella was prolonged. After alveolar molding, the lip and alveolar process on both sides of the cleft are close to each other, which reduces the postoperative lip tension and reduces scar formation [13]. The reasons why nasal alveolar shaping therapy can narrow the alveolar cleft are as follows: 1) the prone position is used to change the shape of dental arch; 2) the medial surface of palatal plate is adjusted to guide the growth of bone segment; 3) the strength provided by lip adhesive tape. Huang et al [14]. Pointed out that the alveolar fissure width of patients with prone sleep decreased the fastest. The pressure of sucking on the

palatal plate makes the alveolar process of the contralateral side close to the affected side. The adhesive tape provides external pressure to make the upper lip and alveolar cleft close to each other, reduce the width of the nasal floor, reduce the tension of the upper lip before and after the operation, and finally reduce the formation of scars [9].

Maull [15] compared the long-term study of children with Presurgicalnasalveolar correction and those who only wear palatal plate without nasal molding Presurgical nasal shaping can significantly improve the nasal symmetry, nostril height, nostril width, length of the columella, and the deviation of the nasal septum is also weak. McComb et al's [16] long-term study also showed that nasal asymmetry did not improve with age. After three years of follow-up, Liou et al. [17] Found that the nasal symmetry of children with unilateral cleft lip and palate was improved significantly after 3 months of birth, and the nasal symmetry recurred significantly 1 year after the operation, but gradually stabilized 3 years after the operation. McComb's [16] 10-year long-term follow-up showed that nasal symmetry was maintained for a long time. The above studies show that Presurgical nasal alveolar shaping has good long-term stability. In 2019, Zheng Jie et al [18] Made a maxillary model by special pediatric impression tray, obtained 3D model by laser scanning, then used reverse engineering software to calculate, reproduced the three-dimensional model data of infant's mouth, and finally used acrylic resin material rapid prototyping processing technology to make solid, used as a palatal plate in the Presurgical period, improved the children's arch shape, reduced cracks, and

significantly improved the nose significance.
Morphology, has important clinical

Figure 2: A series of 3D-printed molding plates [18].



Conclusion

With the rapid development of medical care and social development, health education and publicity in pregnancy gradually spread to the countryside, towns and villages. The incidence rate of cleft lip and palate has been greatly reduced, the ultrasonic equipment upgrading in medical institutions, the promotion of 3-dimensional to four-dimensional ultrasound, the promotion of related pre-pregnancy screening programs, and the improvement of medical staff's technical level, the early detection of cleft lip and palate is no longer a problem. This enables pregnant women to understand the situation of children with cleft lip and palate before delivery and develop a follow-up treatment plan, early and timely treatment, improve the repair effect of children. The promotion of Smile Train [19] also prompted more parents to realize that cleft lip and palate is only a congenital malformation, not accompanied by mental retardation, and can completely change the deformity through postnatal correction and surgery. With the development of information and technology, interdisciplinary cooperation and exchange have been realized. For example, the connection between obstetrics and maxillofacial surgery: if the newborn is diagnosed with cleft lip and palate disease,

the obstetrician immediately asks the maxillofacial surgery for consultation. The consultation doctor tells the family members of the child about the treatment plan for cleft lip and palate, when to correct early when to perform what kind of operation, and sends the treatment process schedule to the family members of the child. The family members of the child can carry out the sequential treatment in the outpatient department according to the schedule. In the process of sequential therapy, when the child reaches a certain age, such as deciduous and mixed dentition, orthodontists or prosthodontics need to cooperate. Early correction in infancy is very important. Surgeons all give a positive evaluation of the effect of early correction after sequential treatment.

In recent years, computer-aided technology and 3D printing technology are widely used in the field of Stomatology, such as prosthetic processing, implant, surgical jaw reconstruction and so on. The simple description of this technology is that after CBCT scanning, the computer uploads the individual data to the processing mechanism, and then through 3D printing and other technologies, the new material is used to make the structure that conforms to the individual missing mandible, and the missing mandible is reconstructed surgically. This application technology plays

an important role in the Presurgical correction of cleft lip and palate. The digital and visual treatment method

eliminates the uncertainty of traditional treatment and better restores the appearance of children.

References

1. Grayson BH, Shetye PR. Pre surgical nasoalveolarmoulding treatment in cleft lip and palate patients. *Indian J PlastSurg: Official publication of the Association of Plastic Surgeons of India.* 2009;42(Suppl):S56.
2. Toscano D, Baciliero U, Gracco A, Siciliani G. Long-term stability of alveolar bone grafts in cleft palate patients. *Am J OrthodDentofacialOrthop.* 2012;142(3):289-99.
3. Perko MA. Two-stage closure of cleft palate:(Progress report). *J Maxillofac Surg.* 1979;7:76-80.
4. McNeil CK. Orthodontic procedures in the treatment of congenital cleft palate. *Dent record.* 1950;70(5):126-32.
5. Hotz M, Perko M, Gnoinski W. Early orthopaedic stabilization of the praemaxilla in complete bilateral cleft lip and palate in combination with the Celesnik lip repair. *Scand J PlastReconstr Surg.* 1987;21(1):45-51.
6. Millard Jr DR, Latham RA. Improved primary surgical and dental treatment of clefts. *PlastReconstr Surg.* 1990;86(5):856-71.
7. Matsuo K, Hirose T, Tomono T, Iwasawa M, Katohda S, Takahashi N, et al. Nonsurgical correction of congenital auricular deformities in the early neonate: a preliminary report. *PlastReconstr Surg.* 1984;73(1):38-51.
8. Matsuo K, Hirose T, Quaba A. Preoperative nonsurgical over-correction of cleft lip nasal deformity. *PlastReconstr Surg.* 1992;89(6):1191.
9. Grayson BH, Santiago PE, Brecht LE, Cutting CB. Presurgicalnasoalveolar molding in infants with cleft lip and palate. *Cleft Palate Craniofac J.* 1999;36(6):486-98.
10. Titiz S, Gözlüklü O. A New Approach to PresurgicalNasoalveolar Molding in Patients With Unilateral Cleft Lip and Palate and Severe Cleft Width. *J Craniofac Surg.* 2018;29(8):2316-8.
11. Jahanbin A, Jamalinasab A, Ramazanzadeh BA, Zarch SH, Shafae H, Shojaeian R. The Effect of Immediate Versus Delayed Addition of the Nasal Stent to the Nasoalveolar Molding Plate on Nostrils Shape and Cleft Width in Infants With Unilateral Cleft Lip and Palate. *J Craniofac Surg.* 2020;31(6):1633-6.
12. Converse JM, Wood-Smith DO, McCarthy JG. Report on a series of 50 craniofacial operations. *PlastReconstr Surg.* 1975;55(3):283-93.
13. Santiago PE, Grayson BH, Cutting CB, Gianoutsos MP, Brecht LE, Kwon SM. Reduced need for alveolar bone grafting by presurgical orthopedics and primary gingivoperiosteoplasty. *Cleft Palate Craniofac J.* 1998;35(1):77-80.
14. Huang CS, Cheng HC, Chen YR, Noordhoff MS. Maxillary dental arch affected by different sleep positions in unilateral complete cleft lip and palate infants. *Cleft Palate Craniofac J.* 1994;31(3):179-84.
15. Maull DJ, Grayson BH, Cutting CB, Brecht LL, Bookstein FL, Khorrambadi D, et al. Long-term effects of nasoalveolar molding on three-dimensional nasal shape in unilateral clefts. *Cleft Palate Craniofac J.* 1999;36(5):391-7.
16. Mccomb HK, Coghlan BA. Primary repair of the unilateral cleft lip nose: completion of a longitudinal study. *Cleft Palate Craniofac J.* 1996;33(1):23-31.
17. Liou EJ, Subramanian M, Chen PK, Huang CS. The progressive changes of nasal symmetry and growth after nasoalveolar molding: a three-year follow-up study. *PlastReconstr Surg.* 2004;114(4):858-64.

18. Zheng J, He H, Kuang W, Yuan W. Presurgicalnasalveolar molding with 3D printing for a patient with unilateral cleft lip, alveolus, and palate. *Am J OrthodDentofacialOrthop.* 2019;156(3):412-9.
19. Louis M, Dickey RM, Hollier Jr LH. Smile Train: Making the grade in global cleft care. *Craniomaxillofac Trauma Reconstr.* 2018;11(1):1-5.