Case Report

Presurgical Nasoalveolar Molding Techniques for a Complete Unilateral Cleft Lip and Palate Infant: A Case Report

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The purpose of this article was to present a modified protocol and devices of presurgical nasoalveolar molding techniques to improve deformity of lip, nose and alveolus at Department of Orthodontic, Khon Kaen University (KKU). This new protocol was developed in order to address nasal problems as early as possible with a new extra-oral type of nasal molding device, "forehead type of nasoalveolar molding device". Extra-oral strapping was applied to approximate lip segments and also help to reduce alveolar cleft rapidly. The remaining alveolar cleft was reduced till completely, using alveolar molding plate with traction screw. The forehead type of nasal molding device could be used continuously after cheiloplasty to maintain nasal configuration until the secondary palate repaired.

A case of complete unilateral cleft lip and palate girl was presented to clearly demonstrate treatment steps and results of lips, nose and alveolus after being treated with this new presurgical nasoalveolar molding protocol and devices for a period of four months.

Keywords: *Presurgical nasoalveolar molding, Unilateral cleft lip and palate*

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Cleft lip and palate deformities are congenital craniofacial abnormalities and cause disfigurement to the face. Unilateral cleft lip and palate usually present with separated lip segments and significant abnormality of the nasal structure due to the lack of the tissue that is attached to the medial and lateral portion of the nostril aperture. This results in a wide nasal base with depressed and concave lower lateral nasal cartilage. Nasal asymmetry occurs due to a shortened columella on the cleft side pulling the nose to the unaffected side[1-4]. Intra-orally, the alveolar segments are displaced to abnormal positions with the medial surface of the greater segment rotated laterally and the lesser segment collapsed medially[5].

Many techniques have been practiced to realign or approximate lip and alveolar segments. These techniques are called "Presurgical infant orthopedics (PSIO)". In 1950, MacNiel introduced an intra-oral device to reposition the cleft alveolar segments. The alveolar segments were molded into the desired position. Several different approaches to PSIO have been further developed after MacNeil. However, one of the problems of these approaches is that it failed to correct the deformity of the nasal cartilages[6,7].

In 1988, Matsuo et al found that the nasal cartilages could be molded and repositioned. The newborn received estrogen from mother during first month after birth. This hormone led to increasing the level of hyaluronic acid, which inhibited intercellular matrix linkage of nasal cartilage. Thus the nasal cartilage was soft with high plasticity. The level of estrogen remained for the first six weeks after birth and then begins to decline[7,8].

Grayson in 1993 used the principle of moldable nasal cartilage to develop the new technique "Presurgical Nasoalveolar Molding (PNAM or NAM)" therapy[9]. This technique could overcome weak points of traditional PSIO because it not only could aid correction of the alveolar and lip clefts, but it also could improve nasal configuration in cleft lip and palate infants.

NAM has been shown to improve the surgical outcomes of the primary repair of cleft lip and palate significantly. Moreover, it can reduce the rate of secondary alveolar bone graft in a mixed dentition

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period[10,11].

The purpose of this article was to present the treatment procedure and outcomes of an infant with unilateral cleft lip and palate after presurgical nasoalveolar molding techniques.

A treatment technique protocol

Cleft patients are routinely referred to the Orthodontic department as soon as possible after they were delivered. At first visit, the records are taken including medical status of cleft infant patients, general appearance and extra- and intra-oral conditions. The width of nasal base, upper lip cleft and alveolar cleft are measured as a baseline. Three dimensions (3D) and two dimensions (2D) photographs of extra- and intra-oral, abnormalities of other organ and family members who have similar abnormalities (only if permitted) are taken. Advices regarding process and objectives of treatment are provided to both parents followed by signing a consent form. A special infant tray is used to create the impression of upper dental arch (Fig. 1) and fast set an alginate impression. In order to prevent aspiration, the child is usually positioned upright and provided with high power suction. At least one hour of fasting is practiced before impression in order to prevent possible regurgitation of fluid while registering the impression.

The treatment starts by using extra-oral strapping combined with nasal molding device. Extra-oral strapping is made from self-adhering athletic wrap (CobanTM 3M) and the end is covered with adhesive tape (Fig. 2A). Benzoin tincture is applied to the cheeks to reduce irritation on skin that is caused by adhesive tape and then placing micropore (3M) tape before strapping (Fig. 2B). Extra-oral strapping is used to approximate greater and lesser lip and alveolar segments.

The forehead type of nasal molding (Fig. 3) helps in elevating and molding nasal dome. The strapping presses against base of nose whilst the nasal molding device pushes the nasal tip forward. When these devices are used simultaneously, the synergistic effect will result in stretching and lengthening the columella.

This forehead type of nasal molding is prepared as a pre-form device (Fig. 3A). It is constructed from hard acrylic in a rectangular shape on forehead cast and is lined with soft closed cell foam that is non-absorbent and easy to clean (Fig. 3B). The nasal stent is constructed by 0.8 mm round stainless steel wire extended from a forehead acrylic pad. The wire is bent

Fig. 1 Special infant tray and impression of upper dental arch.

Fig. 2 A) extra-oral strapping with adhesive tape, B) benzoin tincture and micropore (3M) tape on cheeks.

into coil spring 3 mm in diameter and then bent into right angle (Fig. 3B). The end of the wire is covered with hard acrylic in teardrop or kidney shape about 7-8 mm (Fig. 3C). The forehead acrylic pad is placed approximately mid-forehead and secured with micropore tape around the edge of the acrylic pad (Fig. 6). The nasal stent is inserted into the nostril aperture and gently stretched for the nasal dome moving upward until a moderate amount of tissue blanching is discovered (Fig. 6). The devices are kept in place all the time except during cleaning.

Extra-oral strapping kit (Fig. 4) and instruction are given to parents, as well as phone number in case of emergency or difficulties.

Two weeks later, patients are recalled to assess outcomes of extra-oral strapping and nasal molding. If lip segments come close enough, an impression of upper dental arch is made for construction of an active alveolar molding plate. The use of extra-oral strapping with nasal molding is extended and

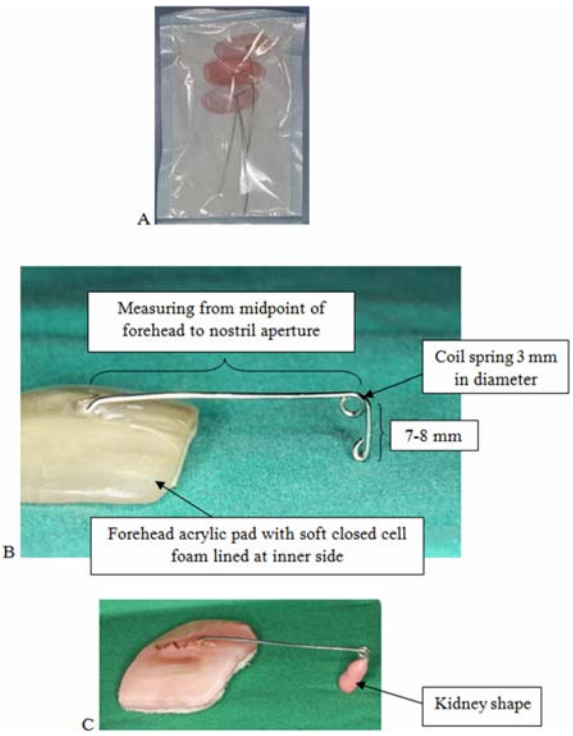

Fig. 3 A) pre-form forehead type of nasal molding device, B) forehead type of nasal molding device, C) acrylic cover over the end of wire as a kidney shape.

Fig. 4 Extra-oral strapping kit (including benzoin tincture, micropore tape, extra-oral strapping tape and adhesive tape) is supported by our department.

followed-up every one- or two-week intervals until the favorable outcomes.

After making a working model, it is adjusted by 2 mm toward the desirable direction. This alveolar molding plate is constructed from self-cured hard acrylic on setup model combine with traction screw and inserted in this visit (Fig. 5). This active plate is worn 24 hours a day except for cleaning after eating/feeding. For additional retention, active plate is held in place by denture adhesive. The parents are instructed to activate traction screw twice a day (0.4 mm/day). The objective of active plate is to realign greater segment inward toward the cleft. The patients are called every two to four weeks to evaluate the position of alveolar segments, to record soft tissue deformities of nose and lip that composed of alar base width, nasal nares width and nose tip deviation and to adjusted nasal stent by reshaping the acrylic or activating the coil spring. All these devices are worn until cheiloplasty.

The patients are assessed after two to three months following the treatment outcomes, and the records are entered before referring for cheiloplasty. Just before the surgical procedure, at the operating room, the devices are removed and sent back to the Orthodontic Department. Two weeks after cheiloplasty, maintenance of nose should be continued because nose structures tend to collapse[3]. Thus, a nasal retainer should be done after cheiloplasty at least six months to prevent nasal collapse or until secondary palate repaired[11,12]. Patients are usually recalled and assessed for treatment outcomes every two to four weeks, taken records at three months after cheiloplasty and referred for a secondary palate repair at the age of ten to 12 months. Discarding the use of all devices and following-up every 3, 6 months and every year after a secondary palate repaired are scheduled. Steps of early treatment of cleft lip and palate patients at Khon Kaen University are summarized in Table 1.

Case Report

Unilateral cleft lip and palate

A one-month-old girl baby originally from Laos People's Democratic Republic was brought to the Department of Orthodontics, Faculty of Dentistry, Khon Kaen University by her parents due to her facial appearance. The baby was diagnosed with left unilateral complete cleft of primary and secondary palate without syndrome. An extra-oral assessment showed she had a moderately wide separate lip segment extended through the nasal base on the left side and wide nostril base. Lower alar cartilage was depressed laterally and inferiorly. Nasal tip and columella deviated to the right side. An intra-oral assessment revealed rotation of the

greater segment outward with 4.5 mm width of cleft (Fig. 6).

During her first visit, she was treated with extra-oral strapping and a forehead type of nasal molding device (Fig. 7).

After one and a half months following the extra-oral strapping and nasal molding device, nasal tip projection had improved, the columella was upright and the lower alar cartilage showed more convexity. The lip segments were in closer at rest and the significant reduction in width of cleft between greater and lesser from 4.5 mm to 1.5 mm (Fig. 8).

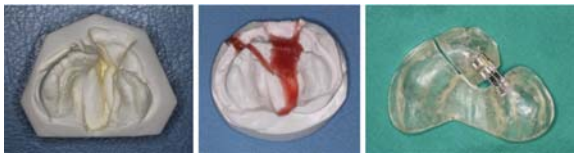

Fig. 5 A set up model and active alveolar molding plate with traction screw.

In this second visit, the baby had started active alveolar molding plate. In this case, traction screw was not included because the remaining of alveolar gap was small enough to be closed by solely alveolar plate from setting up model.

Fig. 6 Pre treatment extra- and intra-oral photographs and a study model.

Table 1. Steps of treatment by using NAM device at Khon Kaen University (KKU NAM)

Visit	Treatment
1	1.1) History taking, clinical examination, diagnosis and treatment plan. 1.2) Advising treatment processes to parents and signed the consent form. 1.3) Taking records including: 1.3.1) 3D photography and take photographs of - extra-oral, intra-oral, abnormalities of other organs - family members who have similar abnormalities (only if permitted) 1.3.2) Measuring the sizes of nose and upper lip 1.3.3) Taking impression for study model 1.4) Applying extra-oral strapping and forehead type of nasal molding device. 1.5) Providing extra-oral strapping kit to parents, giving an advice on oral hygiene care, how to use and taking care of devices.
2	2.1) After 2 weeks, assessing the outcomes of extra-oral strapping and nasal molding device, taking records and adjusting the devices. 2.2) Taking impression for working model and then constructing active alveolar molding plate. 2.3) Inserting active alveolar molding plate and advising parents to activate the retraction screw with rate twice a day.
3	3.1) Following up every 2-4 weeks (taking records and make a new devices if needed). 3.2) About 2-3 months after treatment, assessing treatment outcomes, taking records before referring the patients for cheiloplasty.
4	Cheiloplasty and gingivoperiosteoplasty.
5	5.1) Following-up at 2 weeks after cheiloplasty and taking records. 5.2) Applying nasal molding device and extra-oral strapping as nasal retention until secondary palate repaired (at this stage, patients will tend to give less cooperation). 5.3) Recalling and assessing the treatment outcomes every 2-4 weeks until secondary palate repaired. 5.4) Taking records at 3 months after cheiloplasty.
6	Taking records and referring the patients for a secondary palate repaired at the age of 10-12 months.
7	Discarding all devices and following-up every 3, 6 months and every year after the secondary palate repaired and taking records.

She wore extra-oral strapping, a nasal molding device and an active acrylic plate (Fig. 9) for two weeks until she had undergone cheiloplasty. At that time, there was no gap between alveolar segments (Fig. 10C and 11). Lip segments contacted each other (Fig. 11). The nasal tip projection located almost centrally and the columella was nearly completed upright (Fig. 11). There was significant improvement in nostril width and convexity of nasal dome (Fig. 11).

During the scheduled follow-ups in one week (Fig. 12) and seven weeks (Fig. 13) after cheiloplasty, minimal lip tension was noticed due to approximation of the lip and alveolar cleft. More symmetry of nostril aperture was also observed.

In order to prevent further nasal collapses from scar contraction after surgery, nasal molding should be continued to maintain nasal position. The forehead type of a nasal molding device was used for nasal retention until secondary palate repaired (Fig. 14).

Fig. 7 A patient with extra-oral strapping and a nasal molding device.

Fig. 8 A patient after 1.5 months having treatment with NAM.

Discussion

Presurgical Nasoalveolar Molding (PNAM or NAM) is developed from presurgical infant orthopedic treatment to address the problems of nasal deformities[3]. Presurgical nasoalveolar molding including a reduction of nasal base width[3], an increase in nasal height[3], the realignment of the columella and nasal septum into an upright and more midline position[4], improvement of nasal tip projection[4] and convexity of lower alar cartilages[4]. A nearly normal nasal structure before primary surgical repair leads to more esthetic results, less complicated surgery and

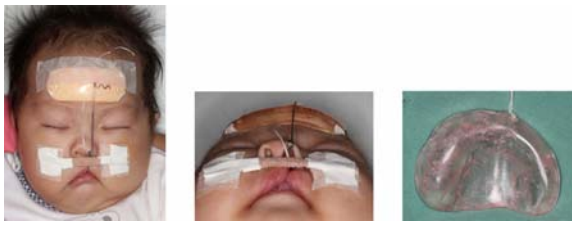

Fig. 9 A patient with active alveolar molding plate, extra-oral strapping and a nasal molding device.

Fig. 10 A study model: A) before treatment, B) 1 month after extra-oral strapping, C) 2 weeks after treating with active plate by setting up model.

Fig. 11 The extra and intra-oral appearance before lip repaired.

Fig. 12 The extra- and intra-oral appearance after one week of lip repaired.

Fig. 13 The extra- and intra-oral appearance at seven weeks after lip repaired.

Fig. 14 Using the forehead type of a nasal molding device as a nasal retention.

minimal scar formation. Therefore, multiple surgical revisions are possibly avoided[4,6].

Proper alignment of lip and alveolar segments into a normal position during the surgery help facilitate surgical repair, subsequently, better outcomes with minimal lip scar can be found[4]. In the case that gingivoperiosteoplasty is included in the protocol, evidence showed a need of bone graft had decreased in 60% of patients[2,10,13].

There were evidences supporting that NAM can significantly increase the symmetry of nose in unilateral cleft lip and palate and this positive effect remained in the long-term through early childhood[14,15].

Devices

Various designs of NAM devices have been introduced. The forehead type of nasal molding devices was introduced due to the following advantages:

1) The molding plate and the nasal retractor are independent from each other. Therefore, it can be used to control each organ independently. The disadvantage of nasal alveolar molding that comes with all-in-one piece is that when the nasal stent is activated, the reaction force will push alveolar molding plate to come off, resulting in addition of an extra retentive buttons (acrylic extension) or retention strap into alveolar plate in order to increase retention making it looked too bulky.

2) The forehead type of nasal molding devices is easy to fabricate. These devices could be previously prepared at a laboratory by using only first time forehead impression, and the forehead impression could reduce the risk of airway obstruction because an impression of the nasal or intra-oral region is not needed.

3) The forehead type of nasal molding devices can also be used in the maintenance of nasal configuration after cheiloplasty without requiring a new device. The forehead type is superior than the intra-oral type because it will not interfere or irritate wound healing of the upper lip and is not necessary to grind the acrylic plate to make room for erupting primary teeth or change a new one due to the enlarged alveolar ridge from growth.

However, the disadvantage of using unilateral nasal molding device may result in over deviation of nasal tip to the opposite site; therefore, the authors suggested using bilateral nasal molding devices with unilateral cleft lip and palate patients.

The protocol

According to this technique, it is recommended to start nasal molding as early as possible without waiting for molding alveolar segments until the reduction of cleft width. Whereas originally, Grayson[4] recommended not to add nasal stent to intra-oral plate until the width of cleft alveolar segments less than six mm. to avoid undesirable widening of lateral alar wall. However, nasal molding should begin early. According to Matsuo's study[7], in the first few months,

cartilage would still remain soft because of estrogen received from the mother, so the nasal molding device could be effectively performed in this period. If nasal molding is postponed until alveolar segments are approximated, it could not take advantage of cartilage flexibility. Subsequently, it may result in ineffective nasal molding. Bajaj et al[16] also suggested that nasal cartilage should be molded as soon as possible, however, alveolar cleft width should not exceed 12 mm.

Among various techniques to reduce the alveolar gap, the department preferred extra-oral strapping at the first two weeks to reduce some alveolar cleft and later to close the remaining alveolar cleft by active alveolar molding plate with traction screw instead of using alveolar plate solely all the time, despite the claim that extra-oral strapping cannot control the movement of alveolar segment[4]. Not only does extra-oral strapping help in easy and quick reduction in the alveolar cleft, but it also stretches and lengthens the columella when applied together with nasal molding devices[4]. In addition, a large cleft gap is reduced subsequently from extra-oral strapping and the remaining cleft gap could be closed easily narrowing by one to two active alveolar molding plates with traction screws. Therefore, a need of intra-oral impression was lessened resulting in decreasing the risk of airway obstruction during upper arch impression. Monasterio[17] reported the advantages of extra-oral nasal molding devices, including easy fabricating, easier for parents to understand and manage, and a dental specialist is not required. Another case study demonstrated similar findings as our report[18].

Liou et al[12] recommended using nasal conformers for four to six months to compensate for collapses and differential growth of nose. Pai et al[3] also supported that some collapses were found in symmetry of nose in width (10%), height (20%) and columella angle (4.7%). From the earlier reasons, our department suggested maintaining good nasal configuration to prevent nasal collapses by using the forehead type of nasal molding devices as a nasal retainer instead of a nasal conformer. Patients already had this device and were familiar with it, resulting in more acceptance and co-operation. Moreover, in the case of nasal collapses, this device could be activated to solve this problem.

In order to achieve an effective action of devices, it is necessary to confirm that parents understand how to wear the devices and can do it correctly before they return home. Thus, authors recommend that both parents should attend consultations because they will help each other in case one of them cannot remember how to place the devices.

The success of treatment depends on many factors in which the most critical factor was parents' co-operation[19]. Thus, an explanation to parents about the objectives and steps of treatment is very important. In this present case, the upper lip and alveolar segments can come closer to touching each other completely. An alveolar gap was reduced mostly from strapping (3.5 mm from a total of 4.5 mm). Nasal soft tissue and cartilage were molded until achieving nearly normal anatomy. After cheiloplasty, the shape of repaired nostril was similar to that of the opposite-side and less scar on the upper lip, giving a symmetrical facial appearance. Despite the fact that the patient came at the age of one month, it has still turned out to be a very significantly successful case because of this technique and parents' good co-operation.

Conclusion

Favorable outcomes of nasolabial complex can be achieved in unilateral cleft lip and palate patients following the KKU NAM protocol. Nasal soft tissue and cartilage were molded till nearly normal shape. Lip and alveolus cleft gaps were approximated completely, subsequently, more esthetic of facial appearance after cheiloplasty.

What is already known on this topic ?

The original design of nasal alveolar molding device was all-in-one piece which often loosens when the nasal stent is activated. The nasal molding would begin since the width of cleft alveolar segments is less than 6 mm, which could not take any advantage of plasticized cartilage. Subsequently, it will cause ineffective nasal molding.

What this study adds ?

The KKU technique performs nasal molding as early as possible. Benefits of the KKU NAM devices are to: control each organ independently, maintain nasal configuration after cheiloplasty without making a new device, and would not interfere with wound healing of the upper lip. This technique could minimize number of visits and devices.

Remark

This patient's parents gave permission by signing the consent form for the use of all clinical photographs in this report for publication.

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Potential conflicts of interest

None.

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เทคนิคนาโซแอลวีโอลาร์โมลดิ้งในการรักษาเด็กทารกปากแหว่งเพดานโหว่ด้านเดียวอย่างสมบูรณ์ที่ใช้ในมหาวิทยาลัยขอนแก่น: กรณีศึกษา

มนเทียร มโนสุดประสิทธิ์, ปฐมพร จงจรวยสกุล, ทัศนีย์ วังศรีมงคล, พูนศักดิ์ ภิเศก

บทความนี้มีวัตถุประสงค์เพื่อนำเสนอการปรับปรุงเครื่องมือและวิธีการให้การรักษาโดยใช้เทคนิคนาโซแอลวีโอล่าร์ที่ ภาควิชาทันตกรรมจัดฟัน คณะทันตแพทยศาสตร์ มหาวิทยาลัยขอนแก่น ปรับปรุงใหม่เพื่อแก้ไขความผิดปกติของริมฝีปาก จมูก และสันเหงือก แนวทางการรักษาใหม่นี้ได้พัฒนาขึ้นเพื่อแก้ไขความผิดปกติของจมูกให้เร็วที่สุดเท่าที่จะเป็นไปได้ ด้วยเครื่องมือปรับปรุงเปลี่ยนแปลงรูปร่างของจมูกชนิดใหม่ เป็นเครื่องมือชนิดยึดติดกับหน้าผากร่วมกับใช้แถบคาดริมฝีปาก เพื่อดึงริมฝีปากและสันเหงือกที่แยกจากกันให้เคลื่อนเข้าหากันอย่างรวดเร็วจากนั้นเสริมด้วยแผ่นเพดานเทียมที่มีสกรูช่วยเคลื่อนสันเหงือกให้ชิดกันอย่างสมบูรณ์ หลังจากผ่าตัดซ่อมแซมริมฝีปากแล้วจะใช้เครื่องมือปรับปรุงเปลี่ยนแปลงรูปร่างของจมูกต่อไปอีก จนกระทั่งได้รับการผ่าตัดซ่อมแซมเพดานปาก

บทความนี้ได้แสดงขั้นตอนการรักษาในผู้ป่วยหญิงที่มีภาวะปากแหว่งเพดานโหว่ด้านเดียวอย่างสมบูรณ์ที่รวมถึงผลที่เกิดขึ้นต่อริมฝีปาก จมูกและสันเหงือกหลังได้รับการรักษาด้วยแนวทางและเครื่องมือใหม่นี้เป็นเวลา 4 เดือน