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Presurgical Naso-Alveolar Molding in Cleft Lip and Palate Infants-A Narrative Review

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Review Article

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Abstract

Purpose: To evaluate and assess the current scientific evidence pertains to the efficiency and usefulness of Presurgical Naso-alveolar molding (PSNAM) in cleft lip and cleft palate patients.

Methods: A comprehensive scientific literature search was carried out using PUBMED electronic database which focus on the current concept of PSNAM and those which critically analyse its long term effects in the treatment of cleft lip, palate and nasal deformity, using different terminologies like the 'presurgical nasoalveolar molding', 'nasal moulding' and 'infant orthopaedics' and documented articles over a period of 30 years were selected for the narrative review.

Results: Following PUBMED search, a total of 58 articles were retrieved. These 58 articles were investigations pertaining to the effect of PSNAM on different aspects of cleft including effects of PSNAM on facial growth, maxillary arch, dentition and occlusion, its effects on nasal symmetry and nasolabial appearance, and on speech.

Conclusions: Presurgical Naso-alveolar molding can be a useful adjunctive treatment modality for management of cleft lip and palate patients. This technique being a cost effective is more beneficial in reducing the number of future surgeries required in the management of cleft lip and palate patients.

Keywords: PSNAM; Cleft Lip and Palate; Naso-Alveolar moulding; Upper Lip

Abbreviations: CLAP: Cleft Lip and Palate; PSNAM: Pre-Surgical Naso-Alveolar Molding.

Introduction

Cleft lip and palate (CLAP) is the most frequently encountered congenital or ofacial deformity in day today life due to abnormal facial development caused by embryological defects during formation of the face. This anomaly not only affects the cosmesis but also affects speech and hearing [1,2]. In these patients, the alar cartilage on the cleft side is flattened or concave and protruded out by the alveolar gap, resulting in depression and displacement of the nasal tip towards the side of the cleft [3]. Reconstruction of the symmetrical lip and a natural looking nose in these patients is a great challenge and has revolutionized dramatically in recent years. Two schools of thoughts exist pertaining to the treatment of CLAP. One hypothesis suggests for surgical treatment and other school of thought advocates for some sort of orthopaedic molding of the defect prior to surgery

[3,4]. Although the final outcome is improving over the years because of better surgical techniques, many authors suggest that even after multiple surgical corrections the final acceptable result remains to be questionable [5]. As a result, the quest over the concern for final nasal form lead to the introduction of new treatment approach called pre-surgical naso-alveolar molding (PSNAM) [6]. As the literature search revealed paucity of scientific evidence pertaining to benefits and concept of PSNAM in the treatment of CLAP patients, this critical review was designed to evaluate the same.

Methods

A literature search was carried out in PUBMED database using the terms 'presurgical nasoalveolar molding,' 'nasal molding' and 'infant orthopaedics'. Related articles on these topics which focus on the current concept of PSNAM and those which critically analyse its long term effects in the treatment of both unilateral and bilateral CLAP were selected for the critical review. Individual case presentations and case series were excluded from the review.

Results

Following PUBMED search using the appropriate key words pertaining to PSNAM, a total of 58 articles were retrieved. These 58 articles were investigations pertaining to the effect of PSNAM on different aspects of cleft including effects of PSNAM on facial growth, maxillary arch, dentition and occlusion, its effects on nasal symmetry and nasolabial appearance, and on speech (Table 1).

S. No	Author	Year	Type of the study/Objectives	Results/Conclusions
1.	Smahel Z, et al. [1]	1988	Cross sectional cohort study.	Significant reduction in alveolar gap width
2.	Karling J, et al. [2]	1993	Evaluated speech	No significant difference in articulation or resonance found between groups.
3.	Ross RB, et al. [3]	1994	Evaluated facial appearance	PSNAM has no lasting effect on esthetics of lip and nose and facial aesthetics and does not alter the need for subsequent revisionary surgery.
4.	Santiago PE, et al. [4]	1998	Compared PSNAM and primary gingivoperioplasty.	Reduced need for alveolar bone grafting in PSNAM group.
5.	Bennun RD, et al. [5]	1999	Evaluated nasal symmetry.	Better and permanent nasal symmetry, increased columellar length and no alar cartilage luxation.
6.	Grayson, et al. [7]	1999	Studied long term effects of PSNAM on 3 dimensional shape of nose.	Significantly increased symmetry of the nose.
7.	Maull, et al. [8]	1999	Retrospective study	PSNAM statistically improved the nasal symmetry.
8.	Mishima, et al. [9]	2000	Evaluation of maxillary arch dimension	No difference was noticed in alveolar arch form, degree of palatal surface curvature and anterioposterior distance of palate between the two groups at 4 years age.
9.	Konst, et al. [10]	2003	Assessed speech	No effects on language development
10.	Lee CT, et al. [11]	2004	Retrospective study	Midface growth in sagittal or vertical planes was not affected.
11.	Liou, et al. [12]	2004	Assessed nasal symmetry	Improvement in the nasal symmetry after PSNAM and further corrected after cheiloplasty.
12.	Deng, et al. [13]	2005	Evaluated nasal symmetry	Obtained better nostril height and nasal profile.
13.	Pai, et al. [14]	2005	Prospective study	PSNAM improved symmetry of nose in width, height and columella angle.
14.	Singh GD, et al. [15]	2005	Prospective longitudinal study	PSNAM significantly increased the nasal symmetry. However slight overcorrection of the alar dome on the cleft side was recommended to maintain the PSNAM results.

15.	Spengler, et al. [16]	2006	Prospective study	Significant decrease in the premaxillary protrusion and deviation. Significant reduction in the width of the larger cleft was also observed.
16.	Baek, et al. [17]	2006	Prospective study	Alveolar molding effects took place mainly in the anterior alveolar segment and growth took place mainly in posterior alveolar segment and palatal segment.
17.	Bongaarts, et al. [18]	2006	Prospective randomized controlled clinical trial	PSNAM does not have any influence on the maxillary arch dimensions.
18.	Suzuki, et al. [19]	2006	Evaluated speech	Effective in preventing zed articulation
19.	Ezzat, et al. [20]	2007	Prospective study	Decrease in the intersegment alveolar cleft distance.
20.	Jaeger, et al. [21]	2007	Evaluated alveolar arch and nasal symmetry	Significant improvement in the nasal shape and reduction in alveolar gap.
21.	Liou EJ, et al. [22]	2007	Longitudinal study	Both PSNAM and primary cheiloplasty lengthened the columella in bilateral cleft lip-cleft palate patients.
22.	Lee, et al. [23]	2008	Evaluated nasolabial appearance	Elongation in the columella length.
23.	Bongaarts, et al. [24]	2009	Evaluated facial growth	No significant effect
24.	Barillas, et al. [25]	2009	Assessed nasal symmetry	The lower lateral and septal cartilages were more symmetric in PSNAM treated patients compared to patients treated with surgery alone.
25.	Kecik, et al. [26]	2009	Prospective study	Significantly helpful treatment for patients with unilateral CLAP. The reduction in the alveolar cleft region and the nasal reshaping are favourable.
26.	Nakamura N, et al. [27]	2009	Evaluated effectiveness of PSNAM	The nostril height and width ratio and the height of the top of the alar groove in the experimental group were significantly superior compared with those of the controls.
27.	Hsieh, et al. [28]	2010	Retrospective study	The sagittal growth of the maxilla would be affected more adversely in the group treated with gingivoperioplasty.
28.	Ijaj A, et al. [29]	2010	Evaluated effectiveness of PSNAM of bilateral CLAP infants with orthopaedic ring plate.	Caused significant retraction of the premaxillary segment without applying extra oral forces. It produced columellar elongation and increase in prolabium length facilitating the primary cheiloplasty and rhinoplasty to be precise and without additional scarring.
29.	Mishra, et al. [30]	2010	Evaluated PSNAM in the correction of cleft lip nasal deformity	Significant improvement in the nostril width, columella lengthening and alar perimeter and more reduction in alveolar gap.
30.	Clark, et al. [31]	2011	Evaluated the long-term effectiveness of PNAM in patients with unilateral CLAP.	A long term clinical improvement in nasal and lip anatomy of unilateral complete cleft lip patients.
31.	Garfinkle JS, et al. [32]	2011	A longitudinal, retrospective study	Patients with bilateral CLAP treated with PSNAM and primary nasal reconstruction, performed at the time of their lip repair, attained nearly normal nasal morphology through 12.5 years of age.

32.	Hou YX, et al. [33]	2011	Evaluated PSNAM effectiveness	17 infants were treated successfully with the closure of cleft lip and alveolar processes, reposition of the deformed nasal cartilages, and increased length of columella. The lip and nasal deformities of 9 infants were corrected partly, which were helpful for surgery.
33.	Nazarian-Mobin SS, et al. [34]	2011	Retrospective study	There are differences in efficacy between unilateral and bilateral CLAP patients undergoing PSNAM.
34.	Yu Q, et al. [35]	2011	Evaluated useful ness of PSNAM using computer-aided reverse engineering and rapid prototyping technique in infants with unilateral CLAP.	The cleft was narrowed, and the malformation of nasoalveolar segments was aligned normally.
35.	Fedeles J, et al. [36]	2012	Longitudinal study	No statistical significant difference in nostril height, width, collumelar length, inter-alar distance and nostril symmetry between unilateral complete cleft lip/palate patients undergoing PSNAM and incomplete cleft lip patients/palate with no need of presurgical moulding, proving PSNAM combined with primary nasal correction is a very efficient management for CLAP children with outstanding results
36.	Gomez DF, et al. [37]	2012	Evaluated nasal changes after PSNAM treatment in unilateral cleft lip and nose patients using photogeometric analysis.	Significant reduction of cleft columella deviation with an increase in columella length, nostril height, and axial inclination on the cleft side were recorded. This resulted in an increase in the projection of the nasal tip. The non-cleft measurements remained without significant changes. The cleft nostril area increased significantly more than the non-cleft side by 90% with PSNAM treatment. Significant normal growth changes were observed in nasal width and nasal height.
37.	Shetty, et al. [38]	2012	Evaluated PSNAM treatment outcome in infants treated with different ages.	Younger infants treated at the age of 1 month benefited better than 1-5 months old infants.
38.	Hak, et al. [39]	2012	Assessed maxillary growth	The growth of the arch length was comparable to that observed in the non-cleft group.
39.	Lopez-Palacio, et al. [40]	2012	A longitudinal study	Improved nasal tip projection and alar cartilage depression and decreased partially columella deviation before rhinocheiloplasty.
40.	Sasaki, et al. [41]	2012	Evaluated the effects of PSNAM with an orthopedic appliance and compared them with a passive orthopedic method.	The width of the alveolar and palate cleft gap was significantly narrowed in the PSNAM group, and the cleft gap at the initiation of PSNAM correlated significantly with the Hausdorff distance after cheiloplasty. PSNAM improved the form of the naris after primary cheiloplasty and decreased the palate cleft gap more effectively than HP and that the width of the palate cleft gap was correlated with the surgical outcome of the naris.
41.	Dec W, et al. [42]	2013	Retrospective study	PSNAM reduced the need for secondary alveolar bone grafting by 60% in patients with unilateral CLAP.

42.	Punga, et al. [43]	2013	Comparative evaluation of cases done with and without nasal stents.	Nasal stents attached to the alveolar molding appliance, yield significant improvement of the nasal morphology and better nasal aesthetics presurgically.
43.	Sulaiman, et al. [44]	2013	Evaluated nasolabial appearance and nasal symmetry.	A significant improvement in the nostril height and width ratio and height of alar groove and maintained for 15 years.
44.	Chang, et al. [45]	2014	Compared modified Figueroa and modified Grayson nasoalveolar molding techniques.	Both techniques produced similar nasal outcomes.
45.	Li W, et al. [46]	2014	Evaluated a novel modified PSNAM device with retraction screw.	The modified PSNAM device with retraction screw can simultaneously correct nasolabial and palatal deformities and also rapidly retract and centralize the premaxilla.
46.	Liao, et al. [47]	2014	Compared modified Figueroa and modified Grayson nasoalveolar molding techniques.	Figueroa technique is associated with fewer oral mucosal complications and more efficiency.
47.	Zhong, et al. [48]	2014	Evaluated the effect of PSNAM devices on the palatal deformities in unilateral complete CLAP patients.	PNAM treatment is a non-surgical early treatment for the effective improvement of palatal primary deformities in unilateral CLAP patients.
48.	Mandwe, et al. [49]	2015	Retrospective study	A statistically considerable rise in cleft nostril height and columellar width. Significant reduction in both intraoral cleft width and columellar deviation
49.	Rau, et al. [50]	2015	Evaluated PSNAM using 3 dimensional analyses.	Inter-segmental alveolar distance, inter-segmental lip distance, nostril height, nostril width and columella deviation angle were significantly changed in unilateral CLAP.
50.	Rubin, et al. [51]	2015	Retrospective study	PSNAM-prepared patients are more likely to have less severe clefts and to be less likely to need revision surgery when compared with patients not prepared with PSNAM.
51.	Shen, et al. [52]	2015	Efficacy of PSNAM using prefabricating sets of PSNAM appliances using three-dimensional technology.	Alveolar cleft widths narrowed significantly, soft-tissue volume of each segment expanded, and the arc of the alveolus became more contiguous across the cleft.
52.	Yu Q, et al. [53]	2015	Evaluated the effect of PSNAM based on computer-aided design technique.	Maxillary alveolar morphology could be improved in unilateral CLAP infants treated with computer-aided PSNAM. The width of the cleft could be reduced and the maxillary midline corrected effectively. However, the alveolar height decreased significantly after the treatment.
53.	Koya, et al. [54]	2016	Prospective study with blinded measurements	PSNAM therapy improved nasal asymmetry by columellar lengthening and effectively molded the maxillary alveolar arch.

54.	Leverde, et al. [55]	2016	Longitudinal study	Significant reduction in cleft width, increase in nostril height of cleft and reduction in facial asymmetry of nostril width. Also, nasal base width asymmetry was decreased from 64%.
55.	Zuhaib, et al. [56]	2016	Longitudinal study	Promising reduction in the cleft size, significant improvement in nasal symmetry including the columellar length on the cleft side.
56.	Hongyi, et al. [57]	2016	Retrospective study using 3 dimensional analysis (Cone Beam Computed Tomography).	PSNAM significantly corrected alveolar deformity and improved appearance.
57.	Shetty V, et al. [58]	2017	A randomized controlled trial	PSNAM significantly reduced intersegment distance and thereby improved arch symmetry and stability, and thus may prevent arch collapse in the long term.
58.	Liang Z, et al. [59]	2017	Two-group, parallel, prospective, randomized clinical trial.	PSNAM is beneficial before primary cheiloplasty, but it is insufficient to maintain long-term nostril symmetry after primary cheiloplasty without nasal cartilage dissection.

Table 1: Review of published studies on PSNAM therapy in the management of Cleft Lip and Palate infants.

Discussion

PSNAM is a non-surgical treatment approach of reshaping or moulding the alveolus, lips and nostrils in infants born with CLAP prior to surgical therapy. This new technique was introduced by Grayson et al, in 1993.6 The design of this appliance is characterized by a removable alveolar molding acrylic plate made from an impression of the infant's maxilla. The nasal stent is bent at the end of a 0.032 inch stainless steel wire that is incorporated into the anterior part of the alveolar molding plate. The appliance is held in position with a combination of adhesive tapes applied to the cheeks and cleft lip segments. Both intraoral acrylic molding plate and nasal stent are adjusted weekly or biweekly over a period of 4 to 6 months to gradually mould the nasal and alveolar deformities and to finally achieve nasal and alveolar symmetry, nasal tip projection and approximation of the cleft segments [6].

The rationale behind the concept of PSNAM is attributed to the Matsuo and Hirose hypothesis [60], which states that amount of plasticity in neonatal cartilage, is highest after birth and gradually reduces as infants grow. This might be because of high levels of hyaluronic acid in estrogen hormone that was transferred from the mothers to the infants. Hyaluronic acid reduces cartilage, ligaments, and connective tissue elasticity by breaking down the intracellular matrix. The cartilage subsequently loses its pliability at around 6 weeks. Therefore, PNAM is most successful during the first 3–4 months of life. One more school of thought is based on chondral-modeling hypothesis, 8 which hypothesized that PSNAM may be acting as a catalyst that stimulates the chondroblasts, producing interstitial expansion and improvements in nasal form.

The main goals of PSNAM therapy are

- Facilitating intraoral feeding;
- Improving the projection of the nasal tip;
- Reducing nasal deformity;
- Improving maxillary growth;
- Retracting and repositioning the premaxilla posteriorly in bilateral cleft patients and
- Facilitating primary lip, alveolar and nasal surgeries [1-5].

Apart from these, PSNAM treatment has various advantages. They are

1. Requirement of less extensive orthodontic treatment at later ages;
2. Reduces tongue interference with the palatal shelves which may encourage the normal growth of the palatal shelves, thus allowing spontaneous reduction in the width of the cleft;
3. Improved speech development due to improved physiological tongue function and position and finally
4. A positive psychological effect on the parents.

However, view of the opponents on PSNAM should also be considered which claims that PSNAM

1. Is a complex and expensive therapy that is ineffective and unnecessary because parents are obliged to travel frequently to the treatment centre and endure an increase burden of care;

2. There is no significant improvement in parents satisfaction;
3. Restricts maxillary development as a result of the molding process [1-6,60].

Although various controversies and much debate exists with PSNAM in the field of CLAP surgery, different investigations have been done to study the effects of the appliance on different aspects of cleft including the effects of PSNAM on facial growth, maxillary arch, dentition and occlusion, its effects on nasal symmetry and nasolabial appearance and on speech [1-61]. These researches have shown that PSNAM could manipulate the infant's oronasal complex, reduces cleft width, corrects the anatomical position of the maxillary segment and finally improves the angulation of the palatal shelves to more horizontal position, corrects the malpositioned nasal cartilages, columella and philtrum, brings the columella toward the midsagittal plane; increases columella length, and improves the symmetry of the nostril apertures and reduces scar formation after cheiloplasty. It also decreases the need for alveolar bone graft. The detailed review of PSNAM therapy in the treatment of CLAP is elaborated in Table 1.

Conclusion

Based on the current literature review, it was concluded that PSNAM appears to be more beneficial and useful adjunct in the treatment of CLAP. The PSNAM treatment is usually rendered either by a Pedodontist or Orthodontist. Therefore, a strong coordination among all the specialities of the CLAP care team is absolutely essential to render a holistic therapy for the long term benefit of these patients.

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