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REVIEWS

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MOULDING MIRACLES: PRESURGICAL NASO ALVEOLAR MOULDING IN EARLY CLEFT LIP AND PALATE MANAGEMENT

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Abstract:

"Orofacial clefts" represent one of the most frequently encountered congenital craniofacial anomalies worldwide and are associated with significant functional, aesthetic, and psychosocial consequences. The complex nature of these deformities, combined with their multifactorial origin, necessitates early intervention through a coordinated multidisciplinary approach. In recent decades, "Presurgical Naso alveolar moulding" (PNAM) has gained widespread acceptance as an effective presurgical orthopaedic technique. By harnessing the temporary plasticity of neonatal cartilage and alveolar tissues, PNAM enables gradual approximation of cleft segments and reshaping of nasal structures, thereby creating a more favourable anatomical foundation for primary surgical repair.

Objective: The purpose of this narrative review is to provide a comprehensive and critical overview of contemporary PNAM therapy. Emphasis is placed on clinical protocols, underlying biomechanical concepts, treatment outcomes, benefits, inherent limitations, and the growing role of digital technologies in enhancing treatment efficiency and precision.

Methods: A systematic literature exploration was undertaken using PubMed, Scopus, and Web of Science databases. Peer-reviewed publications focusing on conventional PNAM appliances, biomechanical mechanisms, treatment outcomes, digital workflows, CAD/CAM-based appliance fabrication, and future innovations were carefully screened, analyzed, and synthesized to develop a coherent and evidence-based narrative.

Results: The cumulative evidence strongly supports PNAM as an effective presurgical modality capable of significantly improving nasal symmetry, reducing alveolar gap width, and enhancing the predictability of surgical outcomes. Recent advances in digital technology, including intraoral scanning, virtual treatment planning, and three-dimensional printing, have further refined appliance design and fabrication. These developments have contributed to improved accuracy, reduced chairside time, enhanced reproducibility, and better caregiver compliance, ultimately optimizing patient experience and clinical efficiency.

Conclusion: Presurgical naso alveolar moulding continues to play a pivotal role in modern cleft care by minimizing the severity of deformities before surgical correction. The integration of digital innovations has elevated PNAM therapy by improving precision, efficiency, and treatment consistency, while preserving its fundamental biological and biomechanical principles. Ongoing technological advancements are expected to further enhance clinical outcomes, appliance comfort, and long-term acceptance, reinforcing PNAM as an indispensable component of comprehensive cleft management.

PNAM continues to play a pivotal role in modern cleft care by reducing deformity severity prior to surgery. Integration of digital technologies has refined NAM therapy, improved efficiency and reproducibility while preserving its biological and biomechanical foundations.

Future developments in PNAM appliances promise to enhance its clinical applications and patient acceptance. Advances including digital workflows, CAD-CAM design, intraoral scanning, and 3D-printed appliances—have significantly enhanced the precision, efficiency and patient comfort associated with NAM. Current literature strongly supports the continued integration of conventional and digital NAM in modern cleft care.

Key words: Presurgical Naso alveolar moulding, orthodontics, cleft lip and cleft palate.

INTRODUCTION

“Cleft lip and palate” (CLP) represent one of the most common congenital craniofacial anomalies worldwide, imposing significant functional, aesthetic, and psychosocial burdens on affected children and their families. Beyond visible facial disfigurement, this condition adversely influences feeding efficiency, speech development, facial aesthetics, dentoalveolar growth, and overall psychological well-being. [1] In cases of unilateral cleft lip and palate, the deformity is particularly intricate, characterized by discontinuity of the alveolar ridge, malpositioned and rotated lip segments, nasal asymmetry, and distortion of nasal cartilaginous structures. If left inadequately addressed, these abnormalities may result in long-term social, emotional, and developmental challenges for both the child and caregivers.

"Presurgical nasoalveolar moulding" (NAM) was introduced as an early orthopaedic intervention to correct these anatomical discrepancies prior to definitive surgical repair. The primary objectives of NAM include improvement of nasal contour, approximation of alveolar segments, and reduction in cleft width, thereby facilitating improved surgical outcomes and minimizing postoperative tension. [2] More recently, advancements in digital technology have led to the emergence of digital NAM (d-NAM), which has gained increasing attention since 2019. Contemporary literature highlights the advantages of digital workflows in enhancing appliance precision, streamlining clinical procedures, improving reproducibility, and increasing patient comfort. [3]

By initiating controlled tissue remodelling during the neonatal period—when cartilage exhibits heightened plasticity—NAM enables progressive correction of naso alveolar deformities and establishes a more favourable anatomical foundation for primary repair. Consequently, this early intervention contributes to improved surgical predictability, reduced need for secondary corrective procedures, and enhanced long-term functional and aesthetic outcomes.

This review comprehensively explores the historical evolution of NAM, technological advancements, clinical protocols, biomechanical principles, therapeutic benefits, limitations, and emerging future directions.

HISTORY AND EVOLUTION OF "NASO ALVEOLAR MOULDING"

Presurgical nasoalveolar moulding has undergone significant evolution over the past seven decades, reflecting continual advancements in clinical understanding, biomechanics, and technology. The foundational concept of presurgical orthopaedic intervention in infants with cleft deformities was first introduced by McNeil in 1950. He proposed the use of serially adjusted appliances to progressively approximate cleft alveolar segments, thereby improving surgical access and enhancing postoperative outcomes.

Building upon these early principles, Grayson and his colleagues advanced the technique by incorporating nasal cartilage reshaping into the presurgical orthopaedic protocol, thereby establishing the basis of contemporary NAM therapy.[4] Based on their functional mechanisms, NAM appliances were subsequently classified into two principal categories: passive appliances, which rely on intrinsic forces such as lip pressure and natural tissue growth for segmental guidance, and active appliances, which deliver controlled external forces to reposition alveolar segments more predictably.

A pivotal advancement occurred in 1989, when Matsuo et al. introduced the first non-surgical nasal moulding approach. Their work demonstrated that neonatal nasal cartilage exhibits enhanced plasticity during the initial six weeks of life, enabling effective reshaping through gentle, sustained pressure. This concept was further refined by Nakajima, who emphasized the clinical utility of nasal splints in preserving nostril configuration following primary lip repair.

In 1993, Grayson and co-workers developed the first comprehensive NAM appliance that combined an intraoral moulding plate with a nasal stent, enabling simultaneous alveolar approximation and nasal cartilage remodelling. [5] This integrated approach marked a major milestone in cleft care, significantly improving nasolabial form, surgical precision, and long-term aesthetic outcomes. Consequently, this innovation strengthened the role of multidisciplinary cleft teams in achieving stable and harmonious facial results following primary surgery. [6]

More recently, rapid technological advancements—including computer-aided design and manufacturing (CAD/CAM), three-dimensional printing, and virtual treatment planning—have propelled NAM into the digital era. [7] These innovations have markedly enhanced appliance accuracy, treatment efficiency, reproducibility, and caregiver convenience, thereby redefining modern standards of presurgical cleft management.

CLINICAL GOALS OF NAM

The objectives of NAM therapy include:

- Reducing the alveolar gap and aligning alveolar segments
- Enhancing nasal tip projection and restoring dome symmetry
- Correcting alar cartilage collapse on the cleft side
- Retracting and derotating the protrusive premaxilla in bilateral clefts
- Lengthening the columella in bilateral cleft lip and palate
- Decreasing surgical complexity and improving long-term aesthetic results

By guiding tissue adaptation during a biologically favourable period, NAM establishes an improved anatomical framework for definitive surgical repair.

TIMING OF INITIATION OF NASOALVEOLAR MOULDING

The optimal timing for initiating Naso alveolar moulding (NAM) therapy remains a subject of clinical discussion. Although some clinicians recommend postponing treatment until partial spontaneous alveolar alignment has occurred, the prevailing consensus supports commencing NAM at the earliest possible stage, preferably within the first week after birth. Early intervention allows clinicians to take full advantage of the heightened plasticity of neonatal cartilage, which is largely attributed to elevated maternal oestrogen levels and increased concentrations of hyaluronic acid during the immediate postnatal period.

Clinical evidence indicates that earlier initiation of NAM yields more favourable outcomes. Shetty et al. reported significantly improved nasal and alveolar moulding results in infants who began therapy within the first month of life compared to those who received delayed treatment.[8] In certain clinical scenarios, particularly in cases exhibiting severe segmental collapse or pronounced premaxillary protrusion, preliminary lip taping may be employed to achieve partial segmental repositioning before insertion of the moulding appliance, thereby enhancing treatment effectiveness and appliance stability.

PRINCIPLES OF PRESURGICAL NAM

NAM therapy is based on the transient plasticity of neonatal cartilage, influenced by elevated maternal hormone levels[9]. Matsuo proposed that increased hyaluronic acid concentration enhances tissue malleability, allowing effective cartilage reshaping during the early neonatal period[10],[11].

The basic principles include:

- Gradual approximation of alveolar segments through selective trimming and addition of acrylic.
- Controlled nasal reshaping via elastic activation of nasal stents.
- Use of external taping to generate traction and stabilize the appliance.
- Weekly adjustments to ensure precise directional movement.

PNAM TECHNIQUE AND PROCEDURES:

DESIGN OF NAM APPLIANCE

The appliance consists of:

- An acrylic moulding plate (orthodontic acrylic)
- A 0.032" stainless steel nasal stent
- Retention tapes and elastics

The moulding plate is fabricated on infant maxillary casts and modified periodically to shape alveolar segments. Weekly additions of soft liner and gradual trimming of hard acrylic enable predictable redirection of tissue growth[12].

NAM treatment typically progresses through two phases:

- Alveolar moulding with lip taping
- Nasal moulding with attached nasal stent

To prevent excessive tension on the alar rim, nasal moulding is initiated only after the alveolar gap has sufficiently narrowed.

PNAM PROCEDURES

A. CONVENTIONAL GRAYSON’S METHOD

Grayson et al. outlined the classical technique for obtaining primary impressions, fabricating appliances, and conducting weekly modifications[13].

Surgical Timing: Primary lip and nasal repair are performed around 3–5 months of age when the alveolar segments are approximated. “Gingivoperiosteoplasty” (GPP) may also be performed during this stage[14,15].

Grayson’s procedure follows the steps:

- Impression Procedure

The primary impression is taken soon after birth using heavy-body silicone, with the infant held in an inverted position (head down) to prevent tongue fall back which may cause airway obstruction and to facilitate the drainage of fluids from the oral cavity. Once the impression is set the tray is removed, and the oral cavity is examined for any residual impression material. (Figure 1,2)[16].

- The cast is prepared in dental stone, and a moulding plate is fabricated using durable and transparent self-cure acrylic.[17] (Figure 3,4)[16].
- A retention button is placed at a 40-degree angle on the anterior surface (Figure 5)[16].
- A safety airway hole (6–8 mm) is incorporated into the palatal region.
- Nasal Stent Fabrication

Once the alveolar gap narrows to 5–6 mm, a nasal stent made from 0.036" wire is added (Figure 7,8)[16]. The stent features a "swan-neck" design with a bilobed acrylic tip lined with soft liner to support the nostril apex and lift the nasal dome.

- Retention Method

The appliance is stabilized extra orally using surgical tapes and orthodontic elastics placed on the cheeks (Figure 6,7)[16].

- Clinical Adjustments

Weekly visits allow modification of the acrylic to achieve gradual alveolar movement

Not more than 1 mm modification per week is advised

Ulcerations and tissue irritation must be monitored

BIOMECHANICS OF PNAM

The nasoalveolar moulding (NAM) appliance comprises an intraoral acrylic molding plate with an anteriorly positioned retention button, intranasal stent(s), and micropore adhesive tapes used as base and retention tapes (Fig. 10). [18] These components work together to facilitate controlled alveolar and nasal molding in infants with cleft lip and palate. In unilateral cleft lip and palate (UCLP), the maxilla is divided into two segments: a medially displaced lesser segment on the cleft side and a comparatively larger greater segment on the non-cleft side. One of the primary objectives of NAM therapy is to progressively reduce the distance between these segments, thereby minimizing cleft width prior to surgical repair. The acrylic molding plate serves as the principal biomechanical element guiding this approximation process.

Micropore tapes applied externally across the cheeks generate horizontal forces, while elastic retention tapes connect these facial tapes to the retention button, allowing effective transmission of controlled orthopedic forces. Selective addition and removal of acrylic on the molding plate modulate both the magnitude and direction of force application. Removal of hard acrylic reduces resistance in targeted areas, whereas the addition of soft acrylic increases localized pressure. In UCLP, optimal segmental approximation is achieved by selectively relieving hard acrylic from the buccal surface of the lesser segment and the palatal surface of the greater segment. Concurrently, soft acrylic is added to the palatal aspect of the lesser segment and the buccal surface of the greater segment, directing forces toward closure of the cleft. Typically, the anterior portion of the lesser segment exhibits marked medial displacement, while the greater segment often requires alignment correction (Fig. 10). [18]

Nasal moulding is accomplished using an intranasal stent aimed at improving nasal projection and correcting alar cartilage asymmetry. In UCLP, a single nasal stent is employed, whereas in bilateral cleft lip and palate (BCLP), two nasal stents are used. The nasal stent is fabricated from a custom-bent 0.036-inch stainless steel wire combined with hard acrylic and lined with soft denture material in the intranasal portion. The wire is contoured into an "S" configuration, with the intranasal segment resembling an "R" shape. Hard acrylic is added to form a bilobed, kidney-shaped structure, while the intranasal surface is covered with a soft liner for patient comfort. The stent is positioned so that the inferior lobe supports the nostril apex, while the superior lobe elevates the nasal dome and tip, facilitating controlled nasal reshaping. [18]

In BCLP, the maxilla is anatomically separated into a protrusive premaxillary segment and two medially displaced lateral alveolar segments (Fig. 11).[18] In such cases, micropore tapes generate posteriorly directed forces, producing resistance primarily on the buccal surfaces of the lateral segments. To reduce this resistance, hard acrylic is selectively relieved from the buccal aspects of the lateral alveolar segments and from the palatal surface of the premaxilla. Additionally, soft acrylic is applied to the palatal surfaces of the lateral segments to generate corrective forces toward the space created by acrylic removal, while soft acrylic added to the labial surface of the premaxilla facilitates its posterior repositioning (Fig. 10).[18] In BCLP, two nasal stents are interconnected using soft denture liner to promote columellar elongation and enhance nasal symmetry. Activation of the nasal stents is carefully controlled through clinical assessment to prevent excessive force that could lead to nasal mucosal injury. [18]

B. DIGITAL PNAM

Yu et al. introduced computer-aided NAM (CAD/NAM) in 2011, transforming clinical workflows through digital activation[19]. Digital NAM uses:

- Intraoral scanning
- Digital segmentation of alveolar segments
- Virtual simulation of movement
- 3D printing of sequential models
- CAD-designed NAM appliances[7,20]

  Digital Workflow Steps:

- TRIOS or equivalent scanner captures 3D intraoral data
- Alveolar segments are digitally separated
- Virtual alignment is performed
- Appliances designed digitally

- Devices printed directly in biocompatible materials

Digital NAM offers reduced infant handling, improved precision, and reduced chairside time[21].

C. PNAM DESIGNED WITH RAPID PROTOTYPING AND COMPUTER AIDED REVERSE ENGINEERING.

Laser-scanned plaster casts generate detailed digital models.[22] A series of progressive digital models representing treatment stages is produced using reverse-engineering software[23]. The design of the appliance consists of, digital model of maxillary denture which is divided into multiple sections, each of which represents the movement of the alveolar segments throughout NAM therapy.[23] The digital geometrical data is exported to print a scale model with rapid prototyping system when the treatment design is formulated and a series of appliances is created according to the scale models. A retentive button and a dental plate with a thickness of 2 mm comprise each pair of NAM devices. Parents receive a set of pre-fabricated appliances, changed weekly at home. Monthly clinical reviews ensure appropriate progress.[23]

D. RAPID PNAM APPROACH

An alternate digital workflow for PNAM therapy is the digital design of a corresponding sequence of appliances made using computer-aided manufacturing technology, like 3D printing, after virtual treatment planning. In terms of additive manufacturing, Rapid PNAM entails digitizing plaster casts, virtualizing the models, and creating a number of PNAM devices via CAD/CAM.[21]

Rapid PNAM uses envelope trajectories to harmonize the arch and pre-plan movement along ideal curves[24]. This digital workflow includes:

- Ventilation holes
- Fixation pins
- Attachment points for nasal stents
- The process minimizes chair time by automating appliance fabrication.

E. CLEAR ALIGNER AND 3D PRINTING WORKFLOW IN PNAM

In Comparison to traditional approach PNAM aligners provides similar benefits. A hybrid workflow incorporates clear aligners to achieve sequential moulding:

- Digital segmentation
- Stagewise aligner fabrication
- Addition of nose piece with 0.030" wire

Triad resin for nasal support[25]. Studies have shown comparable effectiveness between conventional and digital PNAM[26,27]. In a comparison between 3D PNAM and standard PNAM, Ritschl et.al found that both approaches were equally effective.[26] El-Ashmawi NA et.al compared the effectiveness of Naso alveolar Moulding using Grayson method Versus Computer-Aided Design PNAM in Infants with Bilateral Cleft Lip and Palate and concluded that both the interventions were effective but the

CAD/PNAM required less chair side time compared to the PNAM treatment.[27]

"Digital PNAM" has transformed presurgical cleft therapy. It uses: Intraoral scanners,3D digital modelling, 3D-printed appliances. Digital PNAM reduces manual errors, speeds fabrication, and decreases infant handling during impression-taking.[4,12,28]

ADVANTAGES OF PNAM

PNAM offers numerous clinical and psychosocial advantages:

- Reduces the severity of cleft deformity
- Improves nasal symmetry and columella length
- Decreases the need for secondary nasal surgeries[29]
- Enables "GPP" in over 90% of cases[31] and in more than 60% of patients(figure9)[16] and it eliminates subsequent alveolar bone transplants by taking advantage of cartilage adaptability and flexibility, which is expected to last during the first three months of a baby's life due to high amounts of oestrogen and hyaluronic acid[30]
- Reduces long-term treatment costs
- Enhances caregiver confidence and bonding
- Provides superior aesthetic outcomes compared to surgery alone[32]

DESPITE ITS BENEFITS, PNAM HAS LIMITATIONS:

- Caregiver compliance is essential
- Requires frequent follow-ups (weekly adjustments)
- Appliance-related irritation may occur
- In bilateral clefts, mismanagement of the premaxilla can cause collapse or extrusion[33]
- Difficulty maintaining arch coordination[34]
- Surgical lip adhesion carries added trauma and cost
- Skilled clinicians are required for fabrication and adjustment
- Misaligned premaxilla might make fistula closure problematic creating difficulties in surgical repair, orthodontic care, and speech therapy.
- Digital systems may increase cost

FUTURE TRENDS IN PNAM (2025 AND BEYOND)

Automated digital adjustment algorithms, remote monitoring via smartphone apps, AI-assisted prediction of nasal/alveolar morphology, fully printed hybrid NAM devices are trending in PNAM therapy and research supports the integration of AI and advanced simulation in cleft orthodontics [15].

Fig 1. Pretreatment with a unilateral large cleft

Fig 2. impression taking position

Fig 3 impression of the cleft

Fig 4.working cast with wax blocking

Fig 5 .NAM appliance

Fig 6.tape & elastic system with the appliance

Fig 7. nasal stent

Fig 8 nasal conformer inside the nose

Fig 9.Posttreatment view with less lip and nasal distortion.

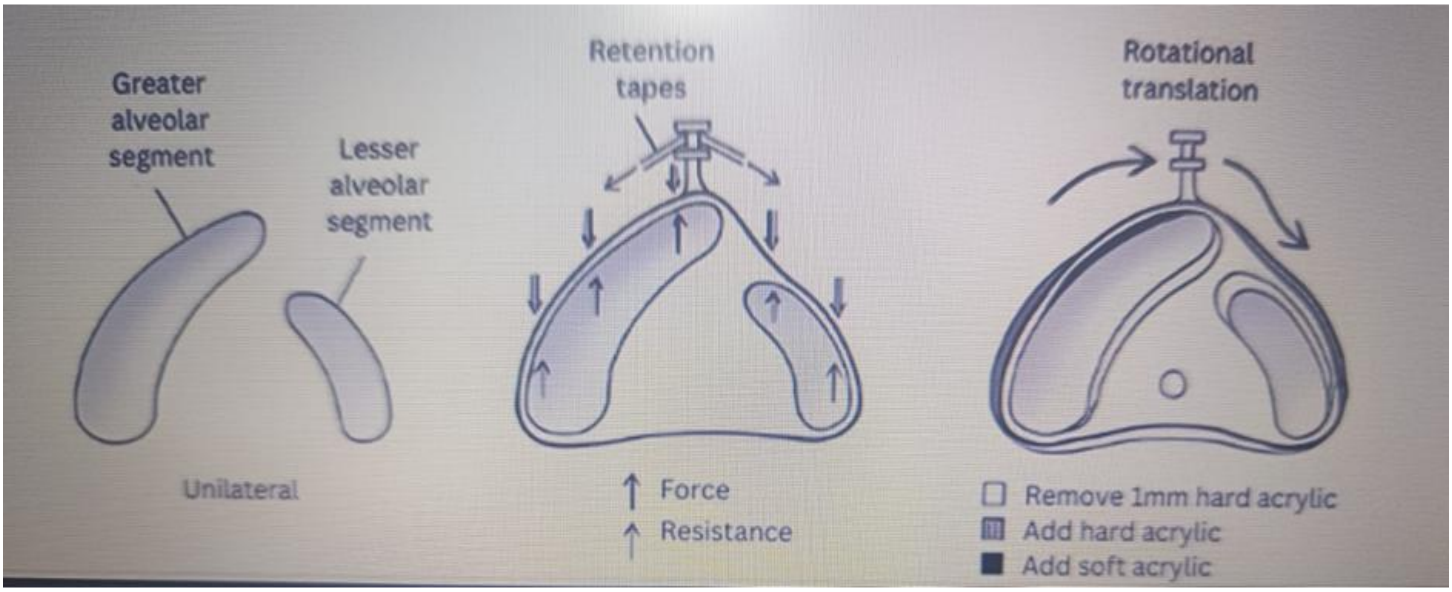

fig10. Biomechanics behind PNAM Therapy in bilateral cleft lip

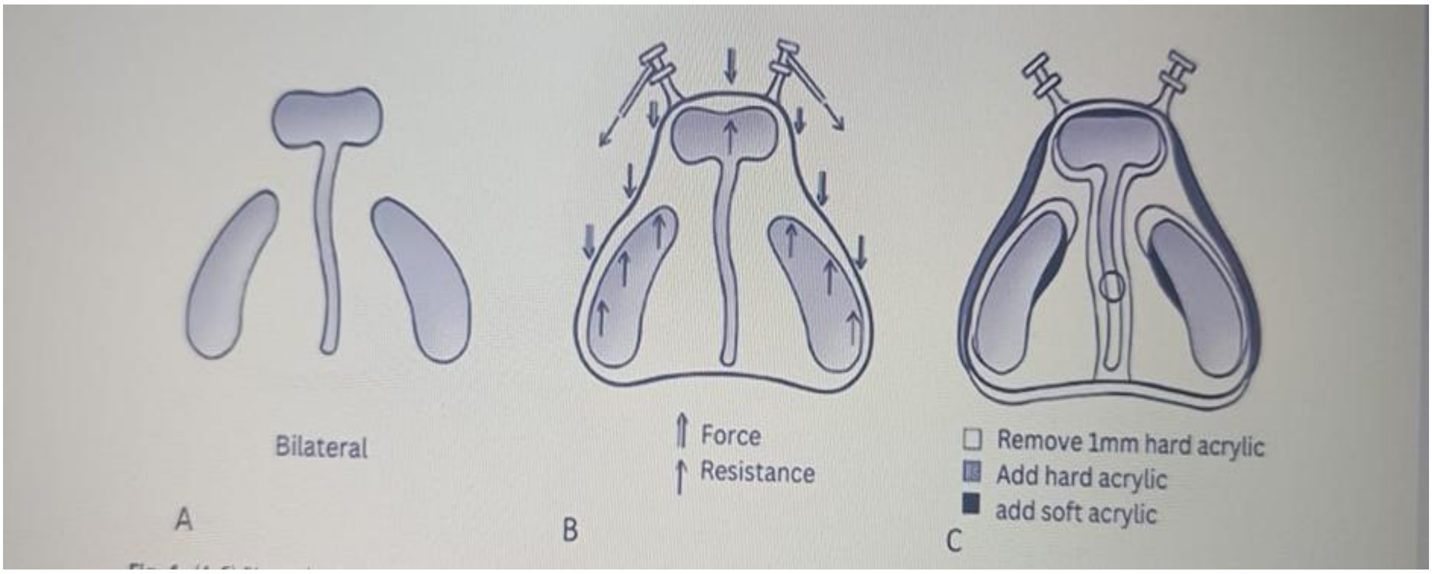

fig 11.Biomechanics behind PNAM Therapy in bilateral cleft lip

CONCLUSION

Presurgical Naso alveolar moulding remains a cornerstone of contemporary cleft lip and palate management. By exploiting neonatal cartilage plasticity, NAM reduces deformity severity and enhances surgical predictability. The integration of digital technologies has refined NAM therapy, improving efficiency and reproducibility. Continued innovation in biomechanics and digital workflows will further strengthen the role of both conventional and digital NAM in multidisciplinary cleft care.

REFERENCES

[1]. Raman S, Jacob M, Jacob MS, Nagarajan R. Providing intervention services for communication deficits associated with cleft lip and / or palate - A retrospective analysis. Asia Pacific Disability Rehabilitation Journal 2004;15(2):78-85

[2]. Salari N, Darvishi N, Heydari M, Bokaee S, Darvishi F, Mohammadi M. Global prevalence of cleft palate, cleft lip and cleft palate and lip: A comprehensive systematic review and meta-analysis. Journal of stomatology, oral and maxillofacial surgery. 2022 Apr 1;123(2):110-20.

[3]. Banerjee R, et al. Digital vs conventional NAM: A multicenter randomized clinical trial. J Dent Res. 2025.

[4]. Grayson BH, Shetye PR. Presurgical nasoalveolar moulding treatment in cleft lip and palate patients. Indian Journal of Plastic Surgery. 2009 Oct;42(S 01): S56-61.

[5]. Murthy PS, Deshmukh S, Bhagyalakshmi A, Srilatha KT. Pre surgical nasoalveolar molding: changing paradigms in early cleft lip and palate rehabilitation. Journal of international oral health: JIOH. 2013 Apr;5(2):70.)

[6]. McNeil C. Orthodontic procedures in the treatment of congenital cleft palate. Dent Records 1950; 70:126-32

[7]. Loeffelbein DJ, Ritschl LM, Rau A, Wolff KD, Barbarino M, Pfeifer S, Schönberger M, Wintermantel E. Analysis of computer-aided techniques for virtual planning in nasoalveolar moulding. British Journal of Oral and Maxillofacial Surgery. 2015 May 1;53(5):455-60.

[8]. Shetty V, Thakral A, Sreekumar C. Comparison of early onset nasoalveolar molding with patients who presented for molding up to 1 year of age. Journal of Oral and Maxillofacial Surgery. 2016 Apr 1;74(4):811-27.)

[9]. Matsuo K, Hirose T, Otagiri T, Norose N. Repair of cleft lip with nonsurgical correction of nasal deformity in the early neonatal period. Plast Reconstr Surg. 1989; 83:25.).

[10]. Grayson BH, Santiago PE, Brecht LE, Cutting CB. Presurgical nasoalveolar molding in infants with cleft lip and palate. Cleft Palate Craniofac J. 1999; 36:486

[11]. Tankittiwat P, Pisek A, Manosudprasit M, Punyavong P, Manosudprasit A, Phaoseree N, Wangsrimongkol B, Pisek P, Manosudprasit A. Function of Nasoalveolar Molding Devices in Bilateral Complete Cleft Lip and Palate: A 3-Dimensional Maxillary Arch Analysis. The Cleft Palate-Craniofacial Nov;58(11):1389-97. Journal. 2021

[12]. Latham RA, Kusy RP, Georgiade NG. An extraorally activated expansion appliance for cleft palate infants. Cleft Palate J 1976;13: 253-61.

[13]. Grayson BH, Maull D. Nasoalveolar molding for infants born with clefts of the lip, alveolus and palate. Cleft lip and palate. 2006:451-8.

[14]. Santiago P, Grayson B, Cutting C, Gianoutsos M, Brecht L, Kwon S. Reduced need for alveolar bone grafting by presurgical orthopedics and primary gingivoperiosteoplasty. Cleft Palate Craniofac J 1998; 35:77–80

[15]. Wood R, Grayson B, Cutting C. Gingivoperiosteoplasty and midfacial growth. Cleft Palate Craniofac J 1997; 34:17–20

[16] Mitali M et al. Nasoalveolar moulding-boon to cleft lip & cleft palate patients:JWBIDA 2011;3

[17]. Levy-Bercowski D, Abreu A, DeLeon E, Looney S, Stockstill J, Weiler M, Santiago PE. Complications and solutions in presurgical nasoalveolar molding therapy. The Cleft palate-craniofacial journal. 2009 Sep;46(5):521-8.

[18] Hussain M. Alkhames Mohamed Hassan Unati Sai Kodali MuraliVenkata Rama Mohan Kodali Elwalid Fadul Nasir Eur J Gen Dent 2023; 12:7–13.

[19]. Al Mortadi N, Eggbeer D, Lewis J, et al. Design and fabrication of a sleep apnea device using computer aided design/additive manufacture technologies. Proc Inst Mech Eng, Part H: J Engineering in Medicine 2013;227:350–355

[20]. Gong X, Dang R, Xu T, Yu Q, Zheng J. Full digital workflow of nasoalveolar molding treatment in infants with cleft lip and palate. Journal of Craniofacial Surgery. 2020 Mar 1;31(2):367-71.

[21]. Kasper FK, Ghivizzani MM, Chiquet BT. Emerging applications of 3D printing in nasoalveolar molding therapy: a narrative review. Journal of 3D printing in medicine. 2019 Dec;3(4):195-208.

[22]. Gong X, Dang R, Xu T, Yu Q, Zheng J. Full digital workflow of nasoalveolar molding treatment in infants with cleft lip and palate. Journal of Craniofacial Surgery. 2020 Mar 1;31(2):367-71.

[23]. Yu Q, Gong X, Wang GM, Yu ZY, Qian YF, Shen G. A novel technique for presurgical nasoalveolar molding using computer-aided reverse engineering and rapid prototyping. Journal of craniofacial surgery. 2011 Jan 1;22(1):142-6.

[24]. Bauer FX, Schönberger M, Gattinger J, Eblenkamp M, Wintermantel E, Rau A, Güll FD, Wolff KD, Loeffelbein DJ. RapidNAM: generative manufacturing approach of nasoalveolar molding devices for presurgical cleft lip and palate treatment. Biomedical Engineering/Biomedizinische Technik. 2017 Aug 28;62(4):407-14.

[25]. Bous RM, Kochenour N, Valiathan M. A novel method for fabricating nasoalveolar molding appliances for infants with cleft lip and palate using 3-dimensional workflow and clear aligners. American Journal of Orthodontics and Dentofacial Orthopedics. 2020 Sep 1;158(3):452-8.

[26]. Ritschl LM, Rau A, Güll FD, Wolff KD, Schönberger M, Bauer FX, Wintermantel E, Loeffelbein DJ. Pitfalls and solutions in virtual design of nasoalveolar molding plates by using CAD/CAM technology—A preliminary clinical study. Journal of Cranio-Maxillofacial Surgery. 2016 Apr 1;44(4):453-9.

[27]. El-Ashmawi NA, Fayed MM, El-Beialy A, Attia KH. Evaluation of the clinical effectiveness of nasoalveolar molding (NAM) using Grayson method versus computer-aided design NAM (CAD/NAM) in infants with bilateral cleft lip and palate: a randomized clinical trial. The Cleft Palate-Craniofacial Journal. 2022 Mar;59(3):377-89.

[28]. Sharma MP, Sandhu BH, Kumar MA. Presurgical nasoalveolar molding in unilateral cleft lip and palate patient. Indian J DentAdv 2012; 4:1024-9.

[29]. Abbott MM, Meara JG. Nasoalveolar molding in cleft care: is it efficacious? Plastic and reconstructive surgery. 2012 Sep 1;130(3):659-66.

[30]. Matsuo K, Hirose T. Nonsurgical correction of cleft lip nasal deformity in the early neonate. Annals of the Academy of Medicine, Singapore. 1988 Jul 1;17(3):358-65.

[31]. Chao Y, Ning H, Bing S. Clinical research of presurgical orthodontie treatment of complete cleft lip and palate infant. West China Journal of Stomatology. 2011 Aug 1;29(4).

[32]. Pfeifer TM, Grayson BH, Cutting CB. Nasoalveolar molding and gingivoperiosteoplasty

versus alveolar bone graft: an outcome analysis of costs in the treatment of unilateral cleft alveolus. The Cleft palate-craniofacial journal. 2002 Jan;39(1):26-9.

[33]. Grayson BH, Garfinkle JS. Early cleft management: the case for nasoalveolar molding. American Journal of Orthodontics and Dentofacial Orthopedics. 2014 Feb 1;145(2):142.

[34]. Fedeles Jr J, Ziak P, Fedeles J. Nasoalveolar molding in complete cleft lip nasal deformity patients. Bratislavske lekarske listy. 2012 Jan 1;113(5):293-7