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Treatment with nasoalveolar modeler in a child with bilateral transforamen cleft through reverse engineering: case report

Tratamento com modelador nasoalveolar em criança com fissura transforame bilateral através da engenharia reversa: relato de caso

Anna Vitória Mendes Viana **Silva**[1] 0000-0002-1867-2126
Esdras Alves **Diniz**[1] 0009-0003-4720-3841
Kamila Rodrigues Junqueira **Carvalho**[1] 0000-0003-3144-0570
Pâmella de Moura **Dario**[1] 0009-0002-1128-0338
Saul Martins **Paiva**[1] 0000-0002-3968-1638
Soraia **Macari**[1] 0000-0001-7643-6589

ABSTRACT

Cleft lip and palate are common and highly complex congenital malformations that require early and multidisciplinary interventions to ensure satisfactory functional

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[1] Universidade Federal de Minas Gerais, Faculdade de Odontologia, Departamento de Saúde Bucal da Criança e do Adolescente. Av. Antônio Carlos, 6627, Pampulha, 31270-901, Belo Horizonte, MG, Brasil. Correspondence to: AVMV Silva. E-mail: <annavitoriavitoriamendes@gmail.com>.

and aesthetic outcomes. This case report describes an infant with a bilateral transforaminal cleft lip and palate treated with the Nasoalveolar Molding protocol starting at 14 days of life as preparation for primary surgery. The treatment involved the fabrication of customized orthopedic plates using reverse engineering technology, along with the concurrent use of a nasal elevator and lip tape. After seven weeks, there was a significant reduction in the alveolar cleft width and nasal remodeling, resulting in improved symmetry and favorable anatomical conditions for cheiloplasty and palatoplasty surgeries. Continuation of the protocol through the postoperative period demonstrated important aesthetic and functional gains, reflecting the effectiveness of Nasoalveolar Molding in the presurgical management of complex cleft lip and palate cases. This case highlights the importance of individualized follow-up, family commitment, and the integrated work of a multidisciplinary team for therapeutic success, contributing to an improved quality of life for the patient.

Keywords: Cleft palate. Nasoalveolar molding. Orthopedic procedures. Rehabilitation.

RESUMO

As fissuras labiopalatinas são malformações congênitas comuns e de alta complexidade, que demandam intervenções precoces e multidisciplinares para garantir resultados funcionais e estéticos satisfatórios. Este relato descreve o caso de um lactente com fissura labiopalatina bilateral transforame incisivo tratado com o protocolo do Modelador Nasoalveolar desde os 14 dias de vida, como preparo para a cirurgia primária. O tratamento incluiu a confecção de placas ortopédicas personalizadas por meio de tecnologia de engenharia reversa, além do uso concomitante do elevador nasal e tape labial. Após sete semanas, houve significativa redução da largura da fissura alveolar e remodelação nasal, proporcionando melhor simetria e condições anatômicas favoráveis para as cirurgias de queiloplastia e palatoplastia. A continuidade do protocolo até o pós-operatório evidenciou ganhos estéticos e funcionais importantes, refletindo a eficácia do Modelador Nasoalveolar no manejo pré-cirúrgico de fissuras labiopalatinas complexas. Este caso reforça a importância do acompanhamento individualizado, do comprometimento familiar e da atuação integrada da equipe multidisciplinar para o sucesso terapêutico, contribuindo para a melhoria da qualidade de vida do paciente.

Termos de indexação: Fissura palatina. Moldagem nasoalveolar. Procedimentos ortopédicos. Reabilitação.

INTRODUCTION

Cleft lip and palate are among the most common congenital malformations, affecting approximately 1 in every 650 live births worldwide [1,2] and 1 in every 1,924 in Brazil [3,4]. These anomalies occur between the 4th and 12th weeks of intrauterine life due to failures in the fusion of facial and/or palatal embryonic processes, and are influenced by both environmental and genetic factors [5-7]. In Brazil, the most widely used classification is that of Spina et al. [8], modified by Silva Filho et al. [9], which categorizes clefts into four groups based on the incisive foramen. Clefts may be unilateral or bilateral, complete or incomplete.

The treatment of cleft lip and palate aims to restore the anatomy of the affected region, providing improved surgical and functional outcomes [10]. Presurgical Infant Orthopedics (PSIO), particularly the Nasoalveolar Molding (NAM) technique introduced by Grayson et al. [11], plays a crucial role in tissue expansion and alignment of structures prior to surgery, thereby reducing surgical complexity [12,13]. NAM takes advantage of the plasticity of neonatal cartilage to mold the alveolar processes, nasal cartilages, and elongate the columella, promoting greater nasal symmetry and enhancing surgical prognosis [14,15]. In addition, it reduces cleft width, improves the shape of the alveolar arch, and facilitates the proper positioning of erupting teeth [16-18].

Among the main devices used in the NAM protocol are the palatal alveolar molding plate, the nasal stent, and lip taping. The alveolar molding plate helps guide the growth of facial and mandibular bones, contributing to the correction of the deformity and assisting in infant breastfeeding [12,18]. The nasal stent corrects nostril asymmetry, improves nasal alignment, and reduces the need for future surgeries [15]. Lip taping brings the lip segments closer together and adjusts the alar base on the affected side, reducing columella asymmetry and promoting a better aesthetic outcome [11,19,20].

Considering this, the present study aimed to report the clinical case of a patient with a bilateral transforamen cleft treated using the NAM protocol, highlighting the treatment stages, the devices used, and the benefits observed throughout the process. This case report contributes to the literature by illustrating the adaptation of the technique to the patient's individual characteristics and reinforcing the importance of presurgical management in achieving better functional and aesthetic outcomes.

CASE REPORT

A male patient, 14 days old, born on October 27, 2021, from Barbacena, Minas Gerais, was referred by his pediatrician to the Cleft Lip and Palate Patient Care Project (NAM Project) at the School of Dentistry of the Federal University of Minas Gerais (FAO/UFMG). The project is recognized as a center of excellence in the application of NAM in patients with cleft lip and palate, standing out for its positive impact on presurgical preparation.

At the initial clinical examination, a bilateral transforamen cleft lip and palate was identified (figure 1), a condition that affects the child's aesthetics, function, and craniofacial development. Given the complexity of the case and the need for an early approach, the NAM protocol was initiated to guide the growth of the bony segments and to promote better positioning of the soft tissues prior to reconstructive surgery. For proper documentation and treatment planning, a palatal impression was taken using addition silicone, a material that provides an accurate reproduction of the patient's anatomical structures. The impression was then poured in dental stone to create a three-dimensional (3D) model, which was essential for fabricating the customized orthopedic appliance. This model was sent to the specialized laboratory Compass 3D, located in Belo Horizonte (MG) Brazil, which was responsible for producing the Ortho Aligner NAM alveolar molding device. During the first appointment, in addition to the impression and device planning, two essential components of the NAM protocol were also installed: the nasal stent and the lip taping. These components contribute to the projection and symmetry of the nasal tip and to the containment of the alveolar segments, promoting the gradual approximation of these structures throughout the treatment.

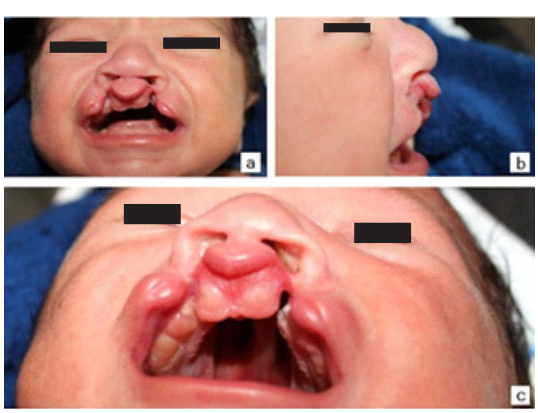

Figure 1. Records of the first consultation. a) Front view. The segmentation of the lips and alveolar ridge can be seen, in addition to the flattening of the nose; b) Side view. The nasal columella is poorly developed, the middle segment of the lip and the alveolar ridge are protruded; c) Visualization of the cleft palate.

At the second appointment, held seven days after the start of treatment, the first of seven alveolar molding plates fabricated for the patient was installed. The parents received detailed instructions regarding hygiene, frequency of use, and the need for periodic replacement of the device (figure 2). The molding plates were replaced weekly to keep up with bone growth and to guide the positioning of the alveolar segments, ensuring proper adaptation to the oral cavity.

Figure 2. Ortho Aligner NAM. a) Ortho Aligner NAM on 3D resin printed model; b) Patient with alveolar shaper adapted to the alveolar segments; c) Patient with alveolar shaper, nasal elevator and lip tape.

After seven weeks of treatment, significant approximation of the alveolar segments was observed, making a new sequence of molding plates unnecessary. By the end of this period, the patient had also reached the ideal weight for cheiloplasty, which was scheduled for the following months. At this point, the caregivers were reminded of the importance of maintaining the last alveolar molding plate, the nasal stent, and the lip taping until the time of surgery to preserve the gains achieved through orthopedic therapy. After 12 weeks of treatment, new photographic records were taken (figure 3), allowing for a detailed evaluation of clinical progress. A marked improvement was observed in the position of the nasal tip and facial midline, as well as in the approximation of the lip segments, the development of the nasal columella, and the retraction of the midsegment of the lip changes that significantly contribute to the success of the cheiloplasty.

A new palatal impression was also taken to create a comparative 3D model, in order to analyze the progress of the presurgical treatment. Centralization of the premaxilla, previously deviated to the right, was observed, along with a significant reduction in the cleft width between it and the left alveolar segment. Additionally, better alignment between the lateral alveolar segments, correction of the facial midline, retraction of the mid-lip segment, development of the nasal columella, and proper positioning of the nasal tip were noted.

Figure 3. Record after twelve weeks of treatment. a) Front view; b) Side view; c) Profile view; d) Bottom view.

When the patient was 4 months old, he underwent cheiloplasty, a procedure essential for correcting the cleft lip, restoring the continuity of the lip arch, and providing better oral sealing. Subsequently, at 12 months of age, palatoplasty was performed, a surgery aimed at closing the palate and rehabilitating speech and swallowing functions. The comparison between the initial clinical records and those obtained before cheiloplasty (figures 4 and 5) demonstrated the effectiveness of the NAM protocol, showing correction of the columella, alar base, and nasal tip, as well as significant advances in the approximation and alignment of the alveolar segments. These structural modifications were fundamental for the success of the surgery, ensuring better anatomical conditions for the reparative procedure and reducing the need for more complex future interventions. After the postoperative recovery period, the patient returned for clinical evaluation, where it was confirmed that the treatment under the NAM project was successfully completed. Figure 6 shows the result 1 year and 5 months after the patient's enrollment in the project.

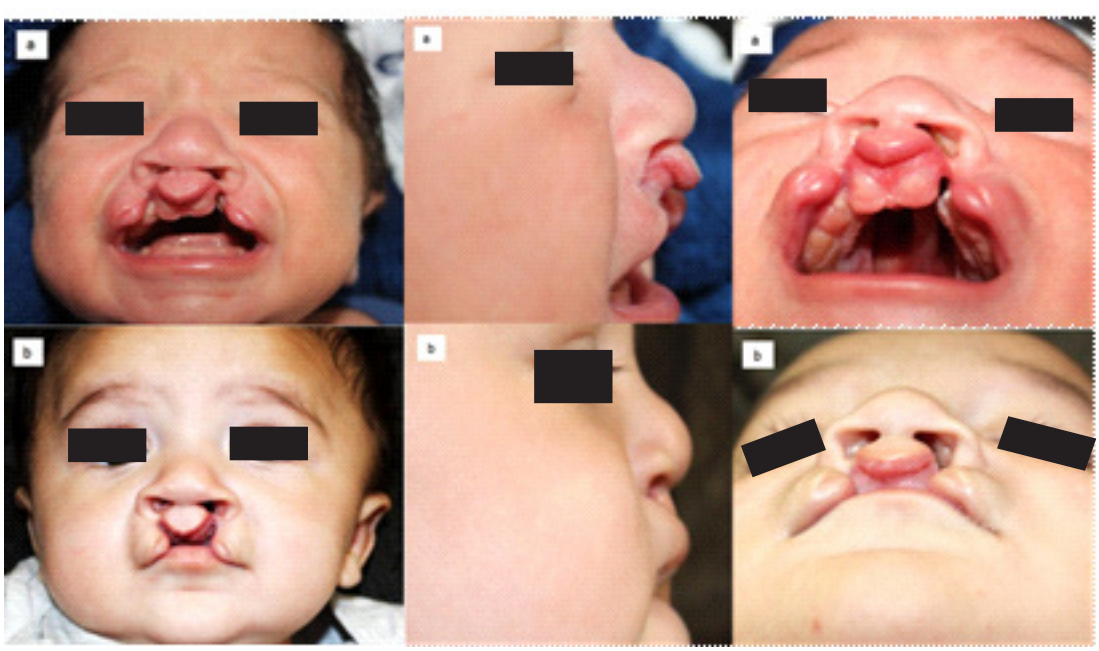

Figure 4. Comparison before the end of treatment. a) start of treatment; b) Twelve weeks of treatment.

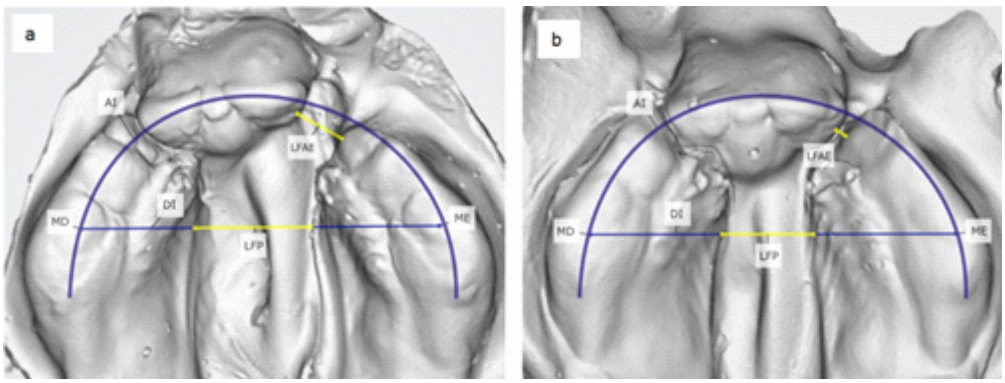

Figure 5. 3D models. a) First appointment. b) Twelve weeks of treatment.
Note: Markings for visual reference: MD/ME (Right/Left Molar) - corresponds to the highest point of the alveolar segment in the estimated region for the right/left molar; AI (Ideal Arch) - Alveolar arch achieved with treatment; ID (Intermolar Distance) - distance between MD and ME; LFP (Posterior Cleft Width) - distance from the most medial point of the right segment to the most medial point of the left segment, along the ID; LFAE (Left Anterior Cleft Width) - distance from the most medial and anterior point of the left segment to the most medial and posterior point of the right segment.

Figure 6. Patient after cheiloplasty and palatoplasty. a) Front view; b) Side view.

DISCUSSION

The application of the NAM protocol in the present case proved to be highly effective as a preparatory stage for primary surgery in a patient with bilateral transforamen cleft lip and palate. The results obtained throughout the presurgical treatment align with findings in the literature, which highlight the benefits of this approach in approximating the alveolar segments, correcting nasal deformities, and improving facial symmetry. This finding is especially relevant considering the complexity of cleft lip and palate, a congenital malformation involving significant functional and structural impairments. Condition directly affects vital functions such as breathing, feeding, and speech, as well as significantly impacting craniofacial growth

[5,21]. In the presented case, although the patient had a complete bilateral transforamen cleft, considered one of the most severe forms of the malformation, the early initiation of intervention and continuous follow-up through the NAM protocol until the performance of cheiloplasty and palatoplasty surgeries were crucial for the positive clinical outcomes observed. This result reinforces the importance of therapeutic strategies initiated within the first days of life, conducted by a multidisciplinary team focused on the patient's morphological, functional, and psychosocial rehabilitation.

In this context, early and well-conducted interventions, such as the use of NAM, play a central role in the morphological and functional rehabilitation of the patient, contributing not only to better surgical outcomes but also to the overall development of the child [22]. The presurgical approach with the NAM device primarily aims to reduce the cleft width, reshape the alveolar segments, improve nasal symmetry, and consequently facilitate surgical reconstruction [15,23]. As highlighted by Grayson and Maull [24], NAM promotes the alignment of intraoral alveolar segments and significantly contributes to the correction of the nasal tip, alar base, and columella, enabling better aesthetic and functional results.

In this case, a significant reduction of the alveolar cleft was observed, as well as a notable improvement in nasal contour and facial aesthetics after only seven weeks of treatment, which eliminated the need for a second molding phase and may have favored the family's adherence to the treatment. The centralization of the premaxilla provided a more adequate anatomical base for the surgical closure of the lips, reducing tissue tension and, consequently, the risk of postoperative complications. In cases like this, the use of presurgical orthopedic treatment can avoid the need for multiple interventions, as well as reduce hospitalization time and hospital costs [23]. The longitudinal evaluation of the case allows us to infer that the use of NAM resulted in favorable functional and aesthetic outcomes, corroborating findings previously described in the literature. The reduction of the alveolar cleft dimensions and the approximation of the maxillary segments prior to cheiloplasty not only facilitate the surgical procedure but also promote better tissue conformation and less tension on the scars [12]. In this regard, Kapadia et al. [25] emphasize that NAM effectively modulates anatomical structures, contributing to the improvement of surgical and postoperative parameters.

The evolution of nasal shape observed throughout the clinical follow-up reinforces the potential of NAM in the symmetrization of the alar cartilages, an aspect widely discussed by several authors. Grill et al. [26] investigated in their study the effectiveness of NAM in patients with bilateral cleft lip and palate and compared them with healthy babies of the same age, whose nasal development was normal. The results showed that, when comparing the two groups, cartilage remodeling was effective, and NAM significantly lengthened the columella and increased the height of the nostril. Such early aesthetic gain may have a positive psychological effect on caregivers, increasing their confidence in the interdisciplinary team and favoring adherence to treatment.

With technological advances in healthcare, new possibilities have emerged to enhance the traditional protocol for molding and fabricating NAM plates. In this context, the application of reverse engineering has stood out as a promising alternative. The reverse engineering technique has overcome a significant limitation of this therapy compared to conventional NAM therapy: by delivering all the appliances in a single appointment, allowing parents or caregivers to install the subsequent plates themselves, the patient avoids weekly visits for adjustments, which has always been a challenge for treatment adherence [27].

Although the results observed in this case report are promising, it is necessary to acknowledge the inherent limitations of descriptive studies with a single sample. Generalization of the findings requires

investigations with more robust methodological designs, including larger samples and control groups. Nonetheless, the presented data reinforce the applicability and clinical relevance of NAM as a complementary strategy in the interdisciplinary management of cleft lip and palate.

CONCLUSION

This case report highlights the benefits of the NAM protocol as a crucial step in the presurgical preparation of a patient with bilateral transforaminal cleft lip and palate, promoting approximation of the alveolar segments, improvement of nasal symmetry, and optimization of the anatomical conditions for corrective surgeries. The observed findings are consistent with the literature, which identifies NAM as an effective approach to reduce surgical complexity, enhance aesthetic and functional outcomes, and, in some cases, minimize the need for additional interventions. Treatment success depends on family adherence, continuous multidisciplinary follow-up, and individualized management.

Conflict of interest: The authors declare that there are no conflicts of interest.

Data availability: The research data are available in the body of the document.

Contributions

AVMV Silva, conceptualization, methodology, project administration, writing-proof editing, resources. EA Diniz, formal analysis, investigation, writing – original draft. KRJ Carvalho, conceptualization, formal analysis, project administration, writing – review & editing. PM Dario conceptualization, formal analysis, project administration, writing – review & editing. SM Paiva, supervision. S Macari, supervision.

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