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Research Article

Development of Dentofacial Anomalies Associated with Airway Obstruction and Low Tongue Posture

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Abstract

Aim: To assess the effect of low tongue posture on the development of Angle Class III dentoskeletal anomalies and to evaluate the effectiveness of combined myofunctional therapy and orthodontic appliance treatment in pediatric patients.

Materials and Methods: This prospective observational study enrolled 100 children (55 females, 45 males), aged 5–14 years. Diagnostic cephalometric analysis was used to classify participants into two groups: (1) functional anterior mandibular displacement (dentoalveolar Class III) and (2) skeletal Class III due to maxillary retrognathia. Group 1 received EF Line functional appliances with targeted myogymnastics and breathing exercises. Group 2 underwent rapid maxillary expansion, facemask therapy followed by myofunctional exercises. Clinical endpoints included nasal breathing restoration, craniofacial skeletal normalization by cephalometric indices, and relapse prevention. Outcomes were assessed at treatment completion and at six-month follow-up.

Results: Significant improvements were observed across clinical and cephalometric measures. Restoration of nasal breathing occurred in over 85 % of subjects. Mean maxillary width increased by 2.3 mm (±0.8) in Group 2, with corresponding improvement in maxillary position and reduction in mandibular prognathism. Group 1 achieved normalization of dental occlusion in 80 % of cases. Addition of myofunctional therapy was associated with a relapse rate below 10 % at six months posttreatment.

Conclusions: A multimodal intervention combining orthodontic appliance therapy and myofunctional exercises was effective in early correction of Class III dentofacial anomalies associated with low tongue posture and airway obstruction. The approach resulted in functional and skeletal improvements with low relapse incidence. Such interventions may be advisable in pediatric orthodontic practice to prevent progression of Class III malocclusion.

Keywords: Dentofacial Anomalies; Myofunctional Therapy; Low Tongue Posture; Airway Obstruction; Angle Class III

Introduction

The increasing prevalence of maxillofacial anomalies is well-documented globally, particularly among children and adolescents aged 3 to 16 years, with an estimated 75% of this population exhibiting some form of dento-maxillofacial irregularity. These anomalies rank third in prevalence among all dental conditions in this age group [1]. The continual rise in incidence highlights the necessity for focused prevention strategies and timely interventions aimed at minimizing the development of pathological occlusion [2].

Oral breathing is frequently observed in pediatric patients with malocclusions and is known to contribute to abnormal tongue posture, ultimately influencing the development of the craniofacial complex [3]. Causes of nasal obstruction include congenital anomalies of the head and neck, mucosal inflammation, nasal septum deviation, and upper airway obstruction, all of which can lead to craniofacial skeletal remodeling [4].

A low resting position of the tongue not only impairs upper airway patency but may also provoke compensatory postural adaptations, such as head extension and altered body alignment, in an attempt to facilitate breathing [5]. Children with chronic mouth breathing often present with a so-called "adenoid facies," characterized by narrow dental arches, inadequate space for permanent dentition, and a high-arched (Gothic) palate [6].

Altered breathing mechanics disrupt the equilibrium between agonist and antagonist muscles of the orofacial region [1]. Buccinator muscle hyperactivity exerts lateral pressure on the dentition, while the tongue, displaced from its ideal resting position against the palatal rugae, assumes a middle or low posture between the maxillary palate and mandibular floor [7]. When the oral cavity remains open, the tongue cannot counteract the lateral forces from the cheeks, further exacerbating malocclusion.

Physiological tongue posture is critical for the proper development of the maxillary arch and occlusion [8]. During nasal breathing with a closed mouth, the posterior third of the tongue exerts gentle upward pressure on the palate during swallowing, promoting transverse maxillary development and enhanced palatal vascularization [9]. Conversely, a low tongue position may result in the tongue tip resting against the anterior teeth during swallowing, diminishing the tonicity of orofacial muscles, including the orbicularis oris.

This dysfunction may lead to retrognathia of the maxilla, with sagittal overdevelopment and restricted transverse growth. Compensatory recruitment of accessory musculature—including facial, cervical, and even abdominal muscles—during swallowing is frequently observed in such cases. Moreover, the altered neuromuscular tone in muscles such as the geniohyoid, orbicularis oris, and mylohyoid contributes to the development of distal occlusions, often accompanied by deep overbite [1].

Recent research highlights that certain craniofacial deformities may arise as a consequence of impaired airway patency [11]. Deviations of the nasal septum and chronic rhinitis have been implicated in the development of malocclusions such as prognathism and crossbite. Moreover, chronic rhinitis associated with hypertrophy of the palatine tonsils may contribute to the formation of a progenic (class III) occlusion [12].

Considering the significant variability in craniofacial structures due to individual anatomical and genetic differences, a standardized classification of malocclusion is essential for diagnostic and therapeutic purposes [13]. One of the most widely accepted classification systems is Angle's classification, which categorizes malocclusions based on the sagittal relationships of the dental arches, particularly the first permanent molars [14]. According to Angle, the first permanent molars—considered the "key to occlusion"—typically erupt in a stable, consistent position. Displacement of the lower first molars from this normative position is often a primary indicator of malocclusion [15].

In a normal (Class I) occlusion, the mesiobuccal cusp of the maxillary first permanent molar aligns with the buccal groove of the mandibular first permanent molar. Angle's classification includes three main classes:

- **Class I (Neutrocclusion):** Normal molar relationship with possible dental irregularities such as crowding or rotation.
- **Class II (Distocclusion):** The mandibular first molar is positioned distally relative to the maxillary first molar. This class is subdivided into:
- **Division 1:** Maxillary incisors are proclined with increased overjet and spacing.
- **Division 2:** Maxillary central incisors are retroclined and may cover the mandibular incisors completely [14].
- **Class III (Mesiocclusion):** The mandibular first molar is mesially positioned relative to the maxillary first molar, often leading to anterior crossbite and underbite appearance [8].

Transverse discrepancies, such as maxillary constriction in the posterior segments, may result in posterior crossbite. Clinically, this may present as crowding of the anterior teeth due to a reduced basal arch width and a mismatch between tooth and jaw dimensions. When a single tooth is involved, alveolar factors are

often responsible, whereas skeletal discrepancies are implicated when multiple teeth are affected [10].

Myofunctional disorders, particularly those involving aberrant tongue posture and orofacial musculature dysfunction, are recognized as major contributors to dentofacial anomalies. As such, early myofunctional intervention is considered crucial in preventive orthodontics [11]. The early use of functional appliances—such as myofunctional trainers—can aid in proper jaw development, correct tongue positioning, and guide teeth into a more physiologically appropriate alignment, potentially preventing the emergence of sagittal discrepancies [15].

The introduction of EF Line myofunctional appliances in the 1990s marked a significant advancement in interceptive orthodontics. These appliances are fabricated from soft, hypoallergenic materials and are often flavored with mint to reduce the gag reflex. They function by encouraging nasal breathing, repositioning the tongue, and strengthening the orbicularis oris muscle [16].

Fixed orthodontic expanders, including rapid palatal expanders, are commonly used to address transverse deficiencies and to correct lower jaw malpositions. These devices are most effective during periods of active growth, particularly during puberty and before the completion of skeletal maturation. Extraoral orthopedic appliances, such as the facemask (reverse-pull headgear), have also gained popularity in correcting Class III malocclusions [17]. These devices typically consist of a metal frame with forehead and chin supports connected to intraoral components via elastics or traction threads. The applied forces promote anterior maxillary growth and retraction of the mandible [18]. Optimal results are generally achieved when treatment is initiated during the mixed dentition phase, particularly before 9–10 years of age [2].

For cases involving transverse maxillary deficiency—often secondary to sagittal anomalies—orthodontic appliances designed to expand the palatal suture can be employed. These include Hyrax, Haas, Derichsweiler, McNamara, and fan-type appliances (e.g., Leone) [19].

In children aged 6–12 years, Class III mesial malocclusion is commonly managed through protraction of the maxilla using intraoral and extraoral orthopedic appliances. Extraoral devices, such as the facemask or chin cup, stimulate growth in the temporomandibular joint (TMJ) area and promote posterior repositioning of the mandible. This approach is particularly beneficial in addressing sagittal maxillary deficiencies, especially when combined with chronic oral breathing, as early intervention can reduce the risk of relapse.

Preventive treatment is gaining increasing attention, with emphasis placed on restoring nasal breathing through respiratory therapy and on enhancing the tonus of orofacial muscles—including the orbicularis oris and masticatory muscles—via myofunctional therapy (myogymnastics) [16].

Clinical studies have demonstrated that the combination of myofunctional appliances and myogymnastics significantly improves treatment outcomes and contributes to long-term stability [12]. The primary muscles targeted during myogymnastics include the masseter, temporalis, pterygoid, and orbicularis oris muscles. For optimal effect, training should follow Rogers' principles, which emphasize the need for regular, low-amplitude muscle contractions with moderate intensity, interspersed with adequate rest intervals—typically a pause after each contraction [14].

In addition to muscle training, breathing exercises play a critical role in correcting dentofacial anomalies by addressing the underlying causes of oral breathing. Therefore, restoring nasal breathing should be a priority in therapeutic planning. However, diagnosing nasal obstruction can be challenging due to the subjectivity and variability of clinical findings. Some studies suggest no consistent relationship between mouth breathing and the presence of malocclusion, which may lead to incomplete or inadequate treatment approaches [18]. These limitations underscore the clinical relevance of our investigation [19].

The aim of this clinical study was to evaluate the influence of a low tongue posture associated with nasal breathing disorders on craniofacial development. Specifically, the aim was to assess changes in the transverse dimensions of the maxilla and cephalometric parameters, and to develop an appropriate orthodontic treatment plan for dentofacial anomalies resulting from such functional disturbances.

Materials and Methods

A clinical case involving a **7**-year-old male patient was analyzed. The child underwent a comprehensive otorhinolaryngological examination, which included oropharyngoscopy, rhinoscopy, otoscopy**,** and lateral skull radiography [7]. Airway patency was evaluated using a clinical inhalation–exhalation test, in which a paper napkin was applied as a passive flow indicator over the external nasal aperture. Inhalation through the middle nasal meatus typically draws the napkin inward, while exhalation through the inferior meatus pushes it outward. Abnormal movement patterns of the napkin suggest airflow obstruction [5,7]. Each nasal passage was evaluated separately.

An orthodontic assessment was conducted concurrently. Based on otolaryngological and functional breathing tests, the patient was confirmed to exhibit normal nasal breathing. No history of trauma or active inflammatory diseases of the upper respiratory tract was noted, and no exclusion criteria were met [14].

To assess craniofacial morphology, the sagittal and transverse dimensions of the maxilla were measured using the Moyers analysis. This method utilizes anatomical landmarks to evaluate the width of the dental arch at the level of the first permanent maxillary molars, allowing for the prediction of potential dentofacial anomalies [5]. Measurements were taken before and after the application of orthodontic treatment combined with myogymnastic exercises.

Cephalometric Evaluation and Treatment Protocol: The patient underwent lateral cephalometric radiography for detailed analysis of craniofacial relationships. During the procedure, radiation protection was ensured using a lead apron to minimize exposure to ionizing radiation.

Cephalometric landmarks were identified and marked on the radiograph as follows:

- **Nasion (N):** The junction of the frontal and nasal bones, serving as a reference point for assessing vertical facial height.
- **Sella (S):** The midpoint of the sella turcica, a critical reference in cranial base analysis.
- **Point A (A):** The most concave point on the anterior maxillary profile between the anterior nasal spine and the alveolar ridge.
- **Point B (B):** The most concave point on the anterior contour of the mandible, between the lower incisor region and the bony chin.
- **Pogonion (Pog):** The most anterior point on the bony contour of the chin.
- **Gnathion (Gn):** A midpoint between Menton and Pogonion, representing the most inferior-anterior point on the mandibular symphysis.
- **Menton (Me):** The lowest point on the mandibular symphysis.
- **Gonion (Go):** The posterior-inferior angle of the mandible where the body meets the ramus.
- **Anterior Nasal Spine (ANS):** The anterior tip of the maxillary nasal spine.
- **Posterior Nasal Spine (PNS):** The posterior tip of the maxillary nasal spine.

Cephalometric planes were drawn to facilitate angular and linear measurements:

- **NSL (Nasion–Sella Line):** Represents the anterior cranial base.
- **FH (Frankfort Horizontal Plane):** Connects the orbitale and porion, representing a horizontal cranial reference.
- **NL (Nasopalatal Plane):** Connects ANS and PNS, representing the orientation of the maxilla.
- Key angular measurements were assessed using cephalometric analysis software:
- **SeNA Angle:** Formed at the intersection of NSL and NA, this angle reflects the anteroposterior position of the maxilla relative to the cranial base.
- **SeNB Angle:** Formed by the intersection of NSL and NB, indicating the sagittal position of the mandible.
- **ANB Angle:** Formed by points A, N, and B, and indicates the skeletal relationship between the maxilla and mandible.
- **FMA (Frankfort Mandibular Plane Angle):** The angle between the mandibular plane and the Frankfort plane, indicating vertical growth pattern.
- **ILs/NL Angle:** Measures the inclination of the maxillary central incisors to the palatal plane.

- **ILi/ML Angle:** Evaluates the inclination of the mandibular incisors relative to the mandibular base.
- **Wits Appraisal:** The horizontal distance between the perpendicular projections of Points A and B onto the occlusal plane (SS and SM). A positive Wits value indicates maxillary prominence, while a negative value reflects mandibular prognathism [5,7].

Cephalometric analysis revealed significant deviations from normative values in the context of a progenic (Class III) malocclusion, characterized by distinct skeletal and dental discrepancies. These included forward positioning of the mandible, retrognathic maxilla, and altered incisor angulations. The changes in digital cephalometric indicators reflected the severity of the malocclusion and its morphological impact.

Treatment protocol

The patient was managed with a combination of EF Line functional appliances, myofunctional therapy, and respiratory exercises aimed at correcting orofacial muscular imbalance and promoting nasal breathing. This multimodal approach supports proper jaw growth and long-term skeletal alignment.

Data analysis was performed using descriptive statistics, including calculation of the mean, standard deviation, and standard error of the mean (SEM). Student's t-test was applied to assess statistical significance between pre- and post-treatment measurements.

Results

The outcomes of clinical and instrumental examinations by otolaryngologists and orthodontists, specifically related to oral breathing patterns and sagittal dysplasia, are summarized in Table 1-4, Figures 1-5.

Age	Number of patients	The presence of sagittal anomalies of the bite	Presence of mouth breathing	The presence of sagittal abnormalities of the bite in combination with mouth breathing
7	1	38 (38%)	7 (7%)	31 (31%)

Table 1: Analysis of clinical examination data.

Age	Boys (Total)	With a mesialbite	With retroposition of the upper jaw
7	1 (100%)	1 (100%)	0 (0%)

Table 2: Anomalies of bite taking into account age and gender.

Age	Type of nasal breathing disorder	With a mesial bite (n = 1)	With retroposition of the upper jaw
7	Notbroken	1 (100%)	-

Table 3: Distribution of Nasal Breathing Disorders by Malocclusion Type and Age.

Parameters	With mesial bite (Mean ± SD)
SNS corner	82.7 ± 1.8
Pn-SpPangle	82.9 ± 2.1
Kut N	88.4 ± 3.9
SNB corner	88.8 ± 3.4
Angle ANB	-3.1 ± 3.1
Pn-OcPangle	77.3 ± 3.6
N-MP corner	59.7 ± 3.9
SpP-MP angle (x)	24.8 ± 5.3
GoGn-SN angle	34.4° ± 1.03
ILs/NL angle	0.64 ± 0.01
AngleILi/ML	0.59 ± 0.03
Savvy	0.8 ± 0.04

Table 4: Results of cephalometric analysis.

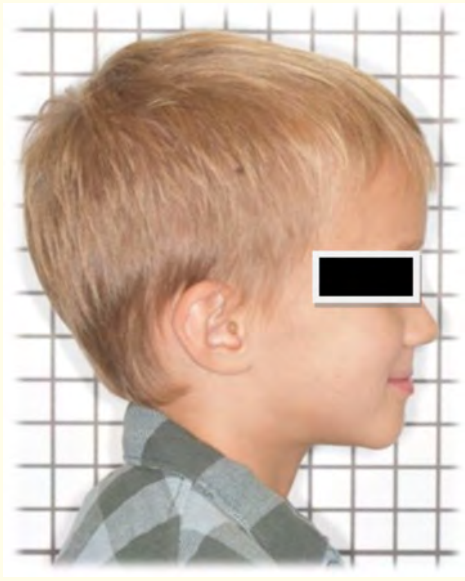

Figure 1: Child's bite before intervention.

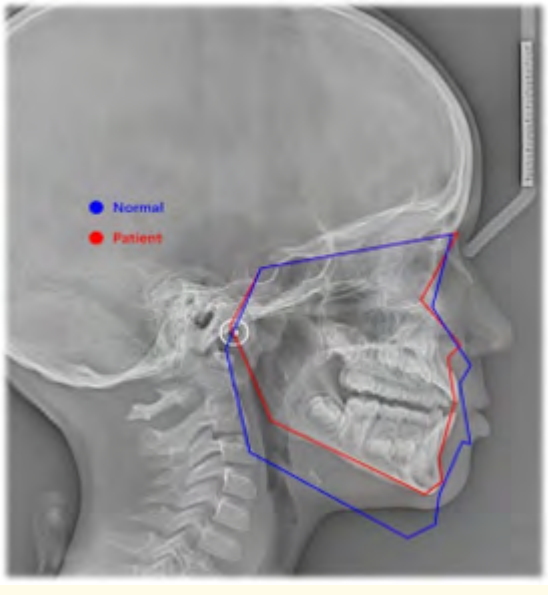

Figure 2: Cephalogram before treatment.

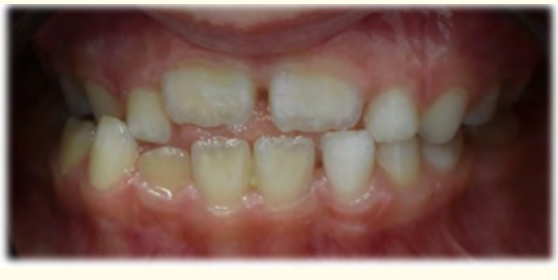

Figure 3: Child's bite before the intervention.

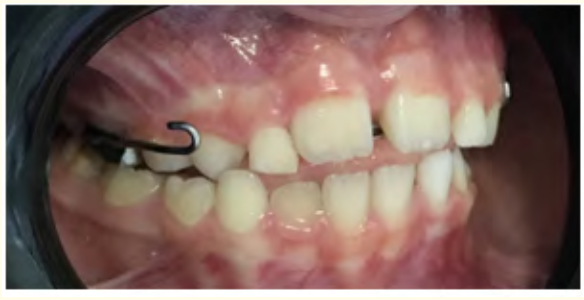

Figure 4: The patient's bite before the intervention.

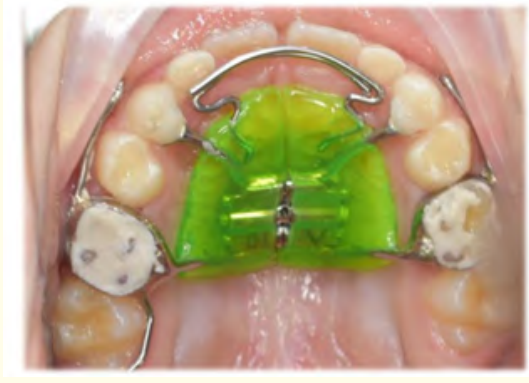

Figure 5: Carrying out the first manipulations.

The transverse dimension of the maxilla was assessed by measuring the distance from the incisive foramen (incisal canal) perpendicularly to the line connecting the mesiobuccal cusps of the first permanent maxillary molars. This measurement is essential for evaluating the transverse width of the maxillary arch and identifying any skeletal constriction, which may predispose the patient to dentoalveolar and maxillofacial anomalies. Accurate determination of maxillary dimensions is critical for developing an appropriate orthodontic treatment plan, particularly in cases requiring maxillary expansion.

The comparative data on maxillary width before and after treatment are presented in Table 5.

Measurements showed that orthodontic treatment and myogymnastics changed the sagittal dimensions of the upper jaw in a boy with mesial malocclusion and mandibular protrusion. After treatment, normalization of dimensions in the sagittal plane was observed (Table 6, Figures 6-8).

Parameter	With a mesial bite Earlier	With a mesial bite After
Norm	-	1 (100%)
Lengthening	-	-
Abbreviation	1 (100%)	-

Table 5: Sagittal dimensions of the upper jaw before and after orthodontic treatment in combination with myogymnastic exercises.

Parameter	With a mesial bite Earlier	With a mesial bite After
Norm	-	1 (100%)
Lengthening	-	-
Abbreviation	1 (100%)	-

Table 6: Transverse dimensions of the upper jaw before and after orthodontic treatment in combination with myogymnastic exercises.

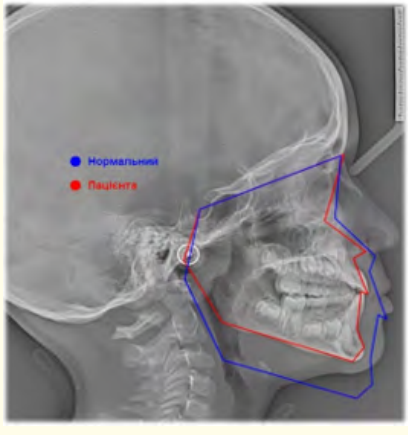

Figure 6: Cephalogramafterexpansion.

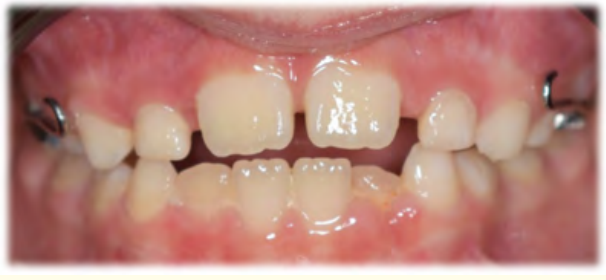

Figure 7: Bite after expansion.

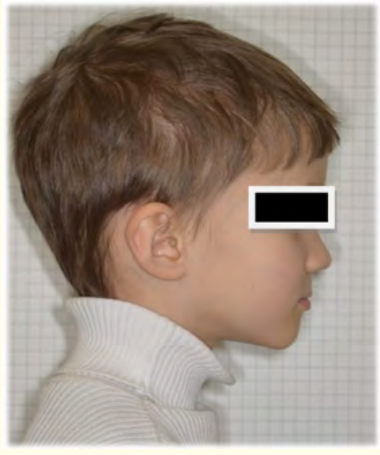

Figure 8: After 6 months after expansion.

The measurements showed that the boy with a mesial bite had a narrowing of the upper jaw and a decrease in transverse dimensions. After orthodontic treatment and myogymnastics, normalization of transverse dimensions was noted. A similar trend was observed in patients with retroposition of the upper jaw. Myofunctional therapy was performed, the results are shown in the photo (Figure 9-12).

Figure 9: After myofunctional therapy.

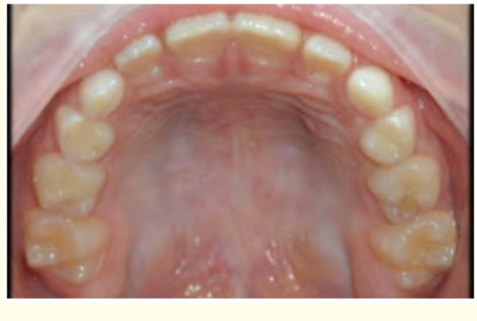

Figure 10: After myofunctional therapy.

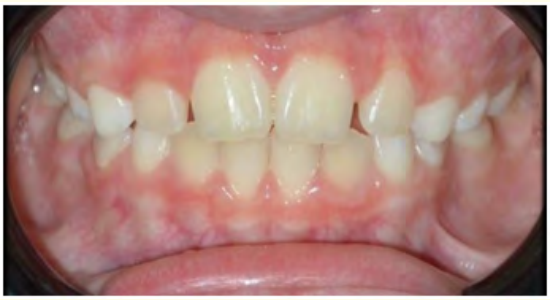

Figure 11: After myofunctional therapy.

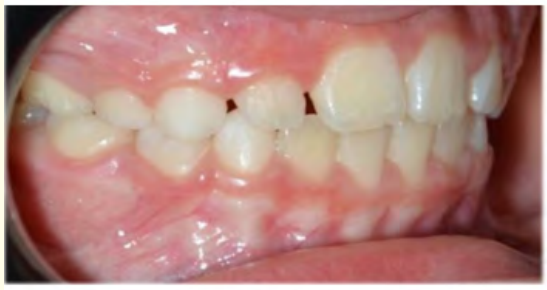

Figure 12: After myofunctional therapy.

Developmental anomalies of the maxilla significantly influence the positioning of the mandibular dentition and the overall formation of the lower dental arch. Transverse constriction of the maxilla results in improper angulation and eruption of the mandibular molars, contributing to global malalignment of the dental arches. Restoration of a physiological occlusion requires normalization of the transverse dimensions of the maxilla, as maxillary constriction is a major etiological factor in the development of sagittal malocclusions.

Cephalometric analysis revealed a reduction in the SNB angle in children with nasal airway obstruction and Class III malocclusion (mesial bite). The mean SNB value in the affected group was 80.6° ± 1.9, compared to 82.5° ± 1.6 in the control group. This suggests horizontal underdevelopment of the maxilla, likely associated with a low tongue posture and subsequent reduction in upper airway volume. Posterior and inferior displacement of the hyoid bone was also noted, potentially affecting cervical posture and reducing the efficacy of nasal respiration.

In patients with Class III malocclusion, the mandible was positioned anteriorly relative to the maxilla. Cephalometric evaluation showed a mean ANB angle of -3.8**°, c**ompared to the normative value of +2°, confirming a skeletal discrepancy. The SNB angle was increased to 85.2° ± 2.5, relative to 83.6° ± 0.9 in controls, indicating anterior displacement of Point B and skeletal mandibular prognathism.

Analysis of the GoGn–SN angle demonstrated a decrease to 30.2° ± 1.04 in cases of horizontal growth, and an increase to 34.4° ± 1.03 in patients with vertical growth (reference value: 33.1° ± 1.02). These findings emphasize the importance of analyzing anterior-posterior facial height ratios and determining the vertical growth pattern of the craniofacial complex. Additional assessment of the SpP–MP (palatal to mandibular plane) angle facilitated evaluation of lower facial height, which is crucial for determining facial growth direction.

In patients with anterior open bite, a vertical gap between the anterior teeth was observed despite occlusion of the posterior teeth. Cephalometric analysis revealed an increased GoGn–SN angle of 34.4° ± 1.03, indicating vertical mandibular growth and associated elongation of the lower facial third.

Clinical signs of transverse maxillary deficiency included accentuated nasolabial folds, narrowing of the nasal base, and decreased inter-alar width, leading to nasal airway constriction and compromised nasal breathing. If left untreated, self-correction does not occur. As the child matures, the progression of maxillofacial growth with an established dentoalveolar anomaly contributes to lasting changes in the sagittal and vertical facial planes.

Treatment approach

The patient was managed using a comprehensive protocol that included EF Line functional appliances, myofunctional therapy, breathing exercises, a fixed rapid maxillary expander (RME), and a facemask. Post-treatment cephalometric analysis confirmed significant improvement in maxillary transverse dimensions and correction of skeletal discrepancies.

The combination of orthodontic appliances and myogymnastics played a critical role in achieving and maintaining proper occlusion. Specific exercises targeting the orbicularis oris—such as “Fish,” “Elephant,” and “Button” exercises—were prescribed to enhance muscle tone and prevent relapse. Each exercise was recommended twice daily, with 10 repetitions per session.

Clinical studies and our observations confirm that effective management of mesial occlusion in children aged 6–12 years can be achieved through the use of orthopedic appliances in combination with extraoral traction (e.g., facemask or chin cup). These devices act on the temporomandibular joint growth center, supporting mandibular repositioning and preventing progression of the malocclusion.

Management of malocclusions associated with nasal breathing dysfunction requires a preventive, multidisciplinary approach. Incorporating myofunctional therapy to address masticatory muscle imbalance proved effective in maintaining treatment results and reducing relapse rates.

Conclusions

The combination of EF Line functional appliances, fixed palatal expanders (RME), and facemask therapy resulted in the restoration of transverse maxillary dimensions and effective correction of dentofacial anomalies within a relatively short treatment period. The adjunct use of myogymnastic exercises played a crucial role in relapse prevention and stabilization of functional outcomes.

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