

Case report



INTERDISCIPLINARY MANAGEMENT OF ORTHODONTIC AND RESTORATIVE TREATMENT: A CLINICAL CASE REPORT

Karina Dobрева¹, Iliyana Atanasova², Tsvetelina Borisova-Papancheva³

1) Student, Faculty of Dental Medicine, Medical University – Varna, Bulgaria.

2) Department of Orthodontics, Faculty of Dental Medicine, Medical University – Varna, Bulgaria.

3) Department of Conservative Dentistry and Oral Pathology, Faculty of Dental Medicine, Medical University – Varna, Bulgaria.

ABSTRACT

Purpose: This case report describes a multidisciplinary, growth-centered, and patient-focused strategy in managing a complex malocclusion with bilateral posterior crossbite compounded by Molar-Incisor Hypomineralization (MIH), deleterious oral habits, tonsillar and adenoidal hypertrophy, mouth breathing, open-mouth sleeping, and snoring.

Case report: The patient presented with a caries-prone early mixed dentition and multiple restorations, and underwent adenoidectomy and tonsillectomy before Phase I orthodontic treatment. Rapid maxillary expansion (RME) corrected maxillary transverse deficiency and posterior crossbite, followed by retention with a lingual plate. Noncompliance in the retention phase with the removable plate led to relapse.

Preformed stainless-steel crowns were placed on the MIH-affected maxillary first permanent molars because of post-eruptive hard-tissue breakdown. Their improper cementation and overcontoured morphology interfered with the eruption of the maxillary second molars. Compromised endodontic treatment of the mandibular left first permanent molar exacerbated periapical pathology, requiring additional restorative and endodontic management. Treatment included crown removal, endodontic retreatment, definitive restorations, and strategic primary tooth extractions to facilitate eruption of the permanent successors.

Relapse of maxillary transverse correction and an impacted maxillary canine necessitated Phase II orthodontics during the pubertal growth spurt, combining repeat RME and fixed appliance therapy. Subsequent diastema closure and space management facilitated alignment of the blocked-out canine. Myofunctional therapy complemented the orthodontic treatment and addressed persistent functional disturbances.

Conclusions: The interdisciplinary approach corrected the transverse discrepancy, aligned the permanent dentition, restored functional occlusal relationships, and preserved MIH-affected first permanent molars, illustrating the value of coordinated orthodontic, restorative, endodontic, otorhinolaryngological, and functional management in growing patients.

Keywords: Molar Hypomineralization, Palatal Expansion Technique, Malocclusion, Orthodontics, Endodontics, Mouth Breathing, Adenoidectomy, Myofunctional Therapy,

BACKGROUND

Molar-Incisor Hypomineralization (MIH) is a prevalent qualitative enamel defect affecting first permanent molars and often incisors, associated with hypersensitivity, post-eruptive breakdown, increased caries susceptibility, and complex restorative and behavioral challenges. [1] First permanent molars (FPMs) are key determinants of occlusal development, arch coordination, and anchorage, and become strategically critical in the presence of MIH. The updated European Academy of Pediatric Dentistry (EAPD) guidance emphasizes the importance of structured, individualized decisions regarding MIH molars, balancing preservation and extraction based on the severity of the condition, its long-term prognosis, and anticipated orthodontic implications, within an interdisciplinary framework. [1]

Management of compromised FPMs should not be approached in isolation. Interdisciplinary decision-making for poor-prognosis first permanent molars integrates restorative feasibility, endodontic prognosis, skeletal pattern, and space management to prevent compromise of future occlusal stability. [2] Early extraction of first permanent molars must be reserved for well-selected cases in which spontaneous or orthodontically guided space closure can be predictably achieved without adverse long-term effects on facial growth and occlusion. [3]

Preformed stainless-steel crowns (SSCs) and other full-coverage restorations are recognized as evidence-based options for severely compromised molars, including MIH-affected teeth, due to their durability, protective coverage, and cost-effectiveness when properly adapted. The success of stainless-steel crowns critically depends on appropriate occlusal morphology, proximal contact, and marginal adaptation, while inadequate contouring may predispose to plaque retention, periodontal inflammation, occlusal interference, and disturbance of eruptive pathways. [4, 5]

Maxillary constriction, high palatal vault, and bilateral posterior crossbite in growing patients, particularly when combined with adenotonsillar hypertrophy and oral breathing, have been associated with altered craniofacial growth and increased upper airway vulnerability. [6, 7, 8, 9] Rapid maxillary expansion (RME) in selected pediatric patients can increase nasal cavity volume, improve nasal airflow, and, as part of a combined approach with adenotonsillectomy and myofunctional rehabilitation, contribute to enhanced indices in sleep-disordered breathing. [7, 8, 9, 10, 11] Significant airway volume and oxygen saturation improvements have been demonstrated following RME in growing patients with posterior crossbite, supporting its role beyond purely dental correction. [9]

Robust adult data indicate that reduced maxillary intermolar distance and increased palatal height are strongly associated with greater obstructive sleep apnoea severity, and a multivariable model explains a substantial proportion of the variability in AHI. [6] These findings reinforce the concept that a constricted, deep palatal morphology is not only an orthodontic problem but also a potential structural risk factor for airway compromise. While direct extrapolation from adult data is limited, the morphological correlations reported reinforce the biological rationale for early orthopedic intervention in growing patients with marked maxillary constriction and airway compromise.

Long-term stability after RME remains highly dependent on patient compliance, neuromuscular reprogramming, and proper retention protocols. [12] Relapse of transverse correction, often associated with unresolved oral dysfunction or inconsistent retainer wear, underscores the need for continuous interdisciplinary follow-up involving orthodontic, functional, and behavioral management. [13] This aspect is particularly critical in growing patients with complex aetiologies such as MIH and airway obstruction, where treatment success extends beyond morphologic correction to encompass sustained functional adaptation and preventive care. [12, 13]

The present case report aims to describe an integrated diagnostic and therapeutic approach in a growing patient with MIH, maxillary constriction, upper-airway obstruction, restorative complications associated with overcontoured SSCs, and the clinical sequence of eruptive and endodontic complications, and to illustrate the staged integration of RPE, endodontic and restorative care, comprehensive orthodontic treatment, and myofunctional therapy.

CASE DESCRIPTION

1. Initial diagnosis and interdisciplinary assessment

A 9-year-old girl in the early mixed dentition presented with parental concerns regarding chronic mouth breathing, open-mouth sleeping, sleep bruxism, nightly

snoring, and difficulty chewing. The general medical history revealed recurrent illnesses, overweight status, and thyroid-related endocrine dysfunction. No relevant family or psychosocial history was reported by the patient or her parent.

Extraoral examination revealed a habitual open-mouth posture, lips that met only with muscular effort, and a mildly convex facial profile. Facial asymmetry was evident, with the maxillary incisal point deviating to the left due to early unilateral loss of the primary maxillary left canine. The mandible and chin were displaced to the right relative to the facial midline. The overall facial appearance was adenoid, characterized by a narrow nasal base and reduced tone of the perioral muscles. The smile arc was uneven, with pronounced buccal corridors reflecting the underlying transverse maxillary constriction. Postural evaluation demonstrated a subtle forward head inclination and altered cervical alignment, consistent with compensatory adaptation to chronic oral breathing.

Intraoral examination revealed a caries-prone dentition with multiple restorations and early mixed dentition with anterior crowding, accompanied by a significant lack of space for the eruption of the permanent canines. The first permanent molars exhibited MIH TNI 2, characterized by enamel breakdown, which complicated occlusal function and the long-term prognosis.

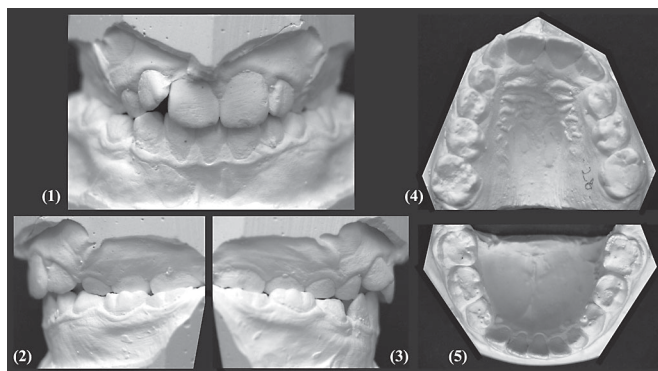
Sagittal discrepancies in occlusion were identified. In the anterior region, an overjet of 1.5 mm was observed. In the posterior segments, a mild Class II tendency was noted, more pronounced on the left side. On the right, a mesial step molar relationship was present, indicating a favorable growth and occlusal prognosis. On the left, the distal plane exhibited an edge-to-edge relationship between the second primary molars, resulting from mesial migration of the posterior teeth in the second quadrant by approximately 4 mm.

Transverse occlusal discrepancies were also present. In the frontal region, the mandibular midline was displaced 4 mm to the right relative to the maxillary midline. In the posterior region, a bilateral crossbite was evident. The maxillary arch was markedly constricted, exhibiting a high, gothic-shaped palatal vault, and clinical functional testing confirmed a right-sided mandibular laterodeviation, producing a visible discrepancy between the incisal and facial midlines.

Despite a normal overbite of 3 mm (upper incisors covering one-third of the lower incisors), the absence of multiple occlusal balanced contacts in the posterior segments indicated a vertical imbalance and functional instability.

Impressions of both arches and the interocclusal record were taken. Based on these, diagnostic models were fabricated to document the baseline condition and enable detailed orthodontic analysis of the upper and lower arches and their intercuspatation. (Fig. 1)

Fig. 1. Initial diagnostic orthodontic models: (1) frontal view in occlusion; (2) left lateral view in occlusion; (3) right lateral view in occlusion; (4) occlusal view of the maxillary arch; (5) occlusal view of the mandibular arch.

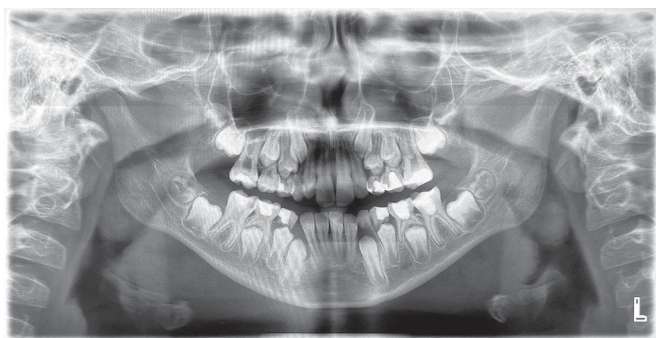


All clinical findings were confirmed by detailed biometric model analysis. Marginal rotations and axial inclinations of the permanent teeth were noted, including mesio-palatal axial rotation (MPAR) of the maxillary first permanent molars. Arch compression, assessed by Pont's index, measured -12 mm in the maxilla and -8 mm in the mandible. Space analysis, according to Moyers, revealed a deficiency of 3.1 mm in Quadrant 1, 6.3 mm in Quadrant 2, 1.0 mm in Quadrant 3, and 4.3 mm in Quadrant 4 for the eruption of permanent teeth.

Pre-treatment measurements on early mixed dentition models demonstrated a markedly constricted maxillary arch (IMD = 28.0 mm) and increased palatal height (PH = 34.5 mm). These measurements overlap with unfavorable morphological ranges reported in adult OSA cohorts by Mahony et al. [6]

Baseline panoramic and lateral cephalometric radiographs were obtained for comprehensive radiographic assessment. (Fig. 2, Fig. 3)

Fig. 2. Baseline panoramic radiograph (before treatment).



Baseline panoramic radiographic analysis revealed all permanent tooth germs, including developing third molars.

Both maxillary canines were diagnosed as ectopically positioned, corresponding to sector 4 according to the modified Ericson and Kurol method described by

Arnautska H. [14]. The crown of the maxillary right canine intersected the nasal floor line (apertura piriformis - p. NL) by more than one-third of its height, indicating a high risk of impaction during the so-called "ugly duckling" stage and necessitating early interceptive intervention. Radiographic assessment suggested a potential tendency toward mandibular canine impaction, particularly on the right side, although its overall prevalence was lower.

The condylar heads exhibit a slight right-sided reduction in height and flattening compared to the contralateral side, consistent with functional mandibular deviation and adaptive remodeling. The cortical outlines are continuous without signs of erosive or degenerative changes, as evaluated according to the standardized morphometric criteria described by Habets LL, et al. [15] and Pullinger A, et al. [16]

Based on the clinical, biometric, and radiographic findings, the initial orthodontic assessment identified marked maxillary transverse deficiency with bilateral posterior crossbite and functional right-sided mandibular laterodeviation, associated space deficiency in the mixed dentition, and ectopic positioning of the maxillary canines. The first permanent molars were affected by MIH, with post-eruptive enamel breakdown. The accompanying history of chronic mouth breathing, open-mouth sleeping, and nightly snoring warranted further otorhinolaryngological assessment of the upper airway.

2. ENT management and Phase I RME

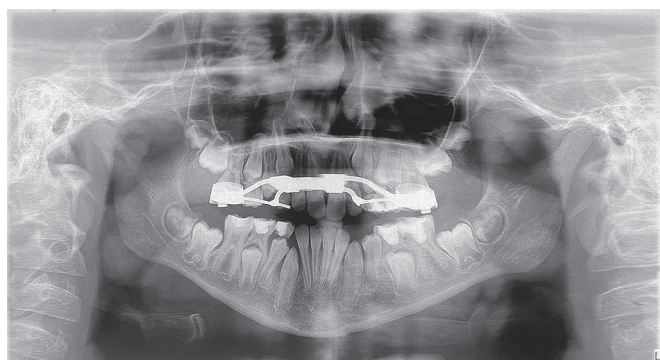
The patient was referred to an otorhinolaryngologist as part of the multidisciplinary diagnostic protocol to evaluate upper airway patency, adenotonsillar hypertrophy, and functional breathing patterns. An ENT assessment confirmed significant adenoidal and tonsillar hypertrophy. To address the primary etiologic factor of upper airway obstruction and associated mouth breathing, adenoidectomy and tonsillectomy were performed as the first stage of management. Postoperatively, improvement in nasal breathing and reduction in snoring were reported.

Before Phase I orthodontic treatment, preformed SSCs were placed on the maxillary first permanent molars to reinforce the structurally compromised enamel affected by MIH and to provide stable anchorage for the planned expansion appliance. Following recovery, Phase I orthodontic treatment was initiated with a tooth-borne rapid palatal expander constructed on bands cemented to the maxillary first permanent molars, extending with lateral supporting arms positioned in the premolar regions to ensure optimal force distribution and appliance stability. To achieve occlusal disarticulation, composite bite-raising buttons were placed on the preformed SSCs on maxillary first molars. The expansion protocol was performed according to established clinical standards, involving gradual activation during the early growth spurt to achieve skeletal correction of the maxillary transverse deficiency and to create sufficient space for the eruption of permanent teeth. Guided extraction of

selected primary teeth was indicated to facilitate controlled and sequential eruption of the permanent teeth.

The clinically evident transverse widening and development of a marked midline diastema, which self-closed through the natural mesial migration of the incisors due to limited space for the eruption of permanent teeth in the lateral segments, were consistent with successful transverse expansion and opening of the mid-palatal suture. The rapid palatal expander was maintained for 6 months to consolidate the results. (Fig. 3)

Fig. 3 Panoramic radiograph after RME.



3. Early post-expansion assessment during Phase I consolidation

The maxillary expansion successfully created space for the eruption of the permanent teeth, with improvement in the axial inclination of the maxillary right canine (13). Improved vertical symmetry of the condylar processes was observed, with a reduction in the initial asymmetry index, but the right condyle remained slightly superiorly positioned. These radiographic changes were interpreted as possible ongoing adaptive remodeling during transverse orthopedic correction. [17]

4. Endodontic management during Phase I consolidation

During the Phase I consolidation period, the panoramic radiograph revealed a periapical radiolucency associated with the mandibular left first permanent molar (36), requiring endodontic treatment as part of the interdisciplinary management.

To manage the identified pathology and restore functional integrity, complete endodontic treatment of tooth 36 was carried out as part of the interdisciplinary therapeutic sequence. Local anesthesia was administered, followed by rubber dam isolation of the operative field. Under magnification and dental operating microscopy, the existing restoration and previously placed obturation extending into the pulp chamber were removed, and three canal orifices were exposed: mesiobuccal, mesiolingual, and distal. Canal patency was achieved using a No. 10 K-file, and working lengths were determined using an electronic apex locator. Chemomechanical preparation was performed with rotary nickel-titanium instruments to size 25/.06, with intermittent recapitulation and irrigation using saline, sodium hypochlorite, and EDTA

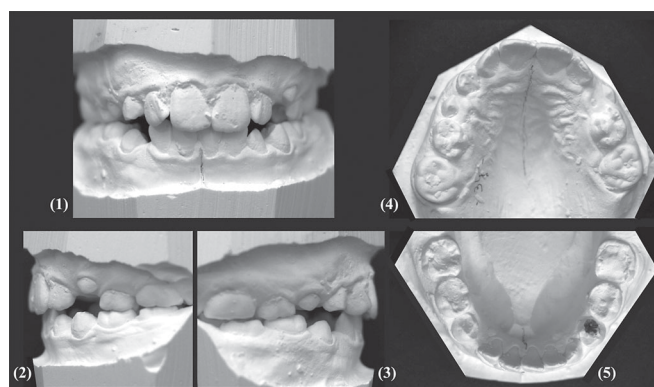
between instruments. Following rotary preparation, final irrigation with sodium hypochlorite was sonically activated, followed by saline neutralization and a concluding rinse with citric acid solution. Calcium hydroxide medication was placed, and the tooth was temporarily restored for 10 days.

At the follow-up visit, the patient reported no discomfort, and the tooth was asymptomatic. The final irrigation protocol was repeated with sonic activation, after which the canals were dried and obturated using cold lateral condensation with gutta-percha and a bioceramic sealer. Definitive adhesive composite restoration was subsequently completed.

5. Completion of Phase I, retention, and relapse

Following completion of the consolidation period, the RME appliance and occlusal bite-raising buttons were removed, and new impressions were taken to fabricate post-expansion diagnostic models for analysis. (Fig. 4)

Fig. 4 Post-expansion diagnostic orthodontic models following Phase I orthodontic treatment: (1) frontal view in occlusion; (2) left lateral view in occlusion; (3) right lateral view in occlusion; (4) occlusal view of the maxillary arch; (5) occlusal view of the mandibular arch.

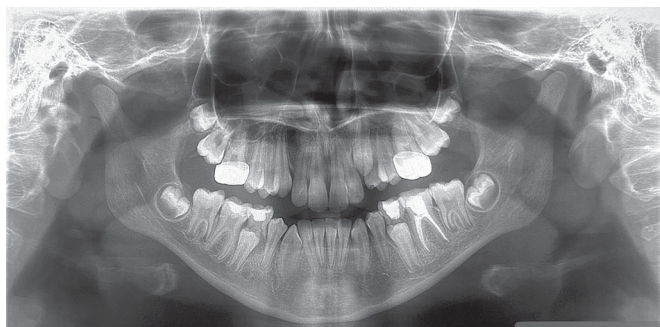


A dynamic pattern of transition to the late mixed dentition was observed, characterized by progressive improvement in eruption alignment and occlusal leveling. Transverse maxillary expansion and crossbite correction were achieved, with a measurable increase in maxillary intermolar width (IMW) to 45.3 mm compared to the mandibular width of 49.2 mm. However, the persistence of partial crossbite, bilateral cusp-to-cusp occlusal contact, and a residual transverse discrepancy of “4 mm indicated the need for continued monitoring of occlusal coordination.

Following removal of the RME appliance, removable lingual plates were prescribed in both arches for full-time retention, with removal only during meals.

For follow-up evaluation of the eruption sequence, particularly to assess the position of the impacted maxillary canine (23), a periodic panoramic radiograph was obtained. (Fig. 5)

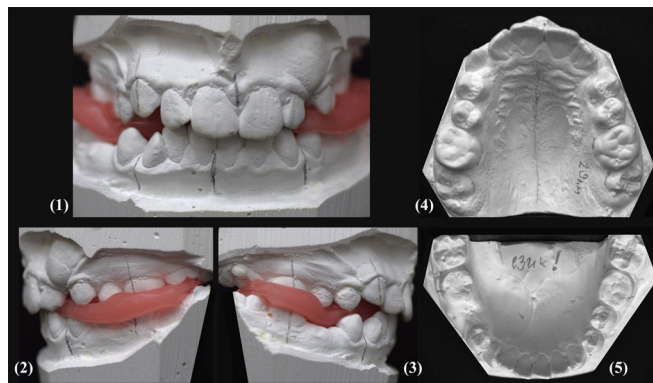
Fig. 5. Follow-up panoramic radiograph showing the eruption progress of the permanent dentition.



The panoramic radiograph demonstrates, in the maxillary arch, the eruption of all permanent posterior teeth except for the maxillary left canine (23), which remains intraosseously impacted. However, its axial inclination shows significant improvement, indicating more favorable eruptive potential. In the mandibular arch, improved eruption of the permanent dentition was observed following continued guided extraction of the primary teeth. Evidence of periapical healing and bone regeneration is observed in the region of the endodontically treated mandibular left first molar (36). The preformed SSCs on the maxillary first permanent molars appear overcontoured, mechanically impeding the eruption pathway of the maxillary second molars. The right condyle exhibits increased cortical density and marginal remodeling, which may reflect adaptive remodeling associated with altered occlusal loading. Despite these changes, no radiographic evidence of degenerative processes is observed, and the condylar height remains within physiological limits.

Thereafter, adherence to the prescribed full-time retention protocol was insufficient, as the removable appliances were not worn consistently, and the patient was subsequently lost to orthodontic follow-up. Consequently, the exact interval between discontinuation of adequate retainer wear and the onset of relapse could not be determined. When the patient later returned for reassessment, an almost complete relapse of the maxillary transverse correction was identified. No appliance-related cause of retention failure, such as documented breakage, loss, or poor fit, was recorded, so insufficient adherence to the prescribed wear protocol was the documented contributing factor. Following guided extraction of the remaining primary teeth and continued eruption of the permanent dentition, new impressions and bite registration were obtained for comprehensive case re-evaluation and detailed diagnostic analysis. (Fig. 6)

Fig. 6. Diagnostic orthodontic models following progression of the permanent dentition: (1) frontal view in occlusion; (2) left lateral view in occlusion; (3) right lateral view in occlusion; (4) occlusal view of the maxillary arch; (5) occlusal view of the mandibular arch.



Sagittal discrepancies were identified, with an overjet of 3 mm in the anterior region and a posterior asymmetry characterized by a Class I relationship on the left and a Class II tendency on the right, attributed to mesial migration of the lateral teeth in the second quadrant. Transverse analysis revealed a 4 mm rightward deviation of the mandibular midline anteriorly and posteriorly, a cusp-to-cusp relationship on the left, and a crossbite on the right. IMW measured 42.3 mm, and interpremolar width (IPW) was 33.3 mm, compared with mandibular IMW of 53.3 mm and IPW of 39.2 mm, indicating a transverse discrepancy of -11 mm due to complete relapse. Vertical discrepancies included a 3 mm overbite in the anterior region and the absence of balanced multiple occlusal contacts in the posterior segments. Space analysis according to Moyers revealed an increased deficiency of 3.7 mm in Quadrant 1, 6.9 mm in Quadrant 2, 1.7 mm in Quadrant 3, and 4.2 mm in Quadrant 4 for the permanent teeth. These findings align with clinical evidence demonstrating that reduced retention compliance is strongly associated with higher rates of transverse relapse following RME. [12]

6. Restorative and endodontic management before Phase II

The interdisciplinary team elected to remove the improperly contoured stainless-steel crowns, which continued to impede the eruption of the maxillary second molars, to perform endodontic treatment of the more severely affected left maxillary first molar (26), and to provide anatomically precise definitive full-coverage restorations to support subsequent eruption, orthodontic treatment, and occlusal stability.

Following removal of the overcontoured stainless-steel crown, endodontic treatment of tooth 26 was undertaken to eliminate the persistent infection and re-establish appropriate coronal morphology before Phase II

orthodontic treatment. Local anesthesia was administered, followed by rubber dam isolation. The compromised restorative material and residual carious tissue were removed, and three canal orifices were identified: mesiobuccal, distobuccal, and palatal. Canal patency was achieved using a No. 10 K-file, and working lengths were determined using an electronic apex locator. Chemomechanical preparation was performed with rotary nickel-titanium instruments to size 25/.06, with intermittent recapitulation and irrigation using saline, sodium hypochlorite, and EDTA. Following rotary preparation, final irrigation with sodium hypochlorite was sonically activated, followed by saline neutralization and a concluding rinse with citric acid solution. The canals were subsequently obturated using warm vertical compaction with gutta-percha and an endodontic sealer. Definitive adhesive composite restoration was performed with careful reconstruction of the anatomical contour and occlusal morphology.

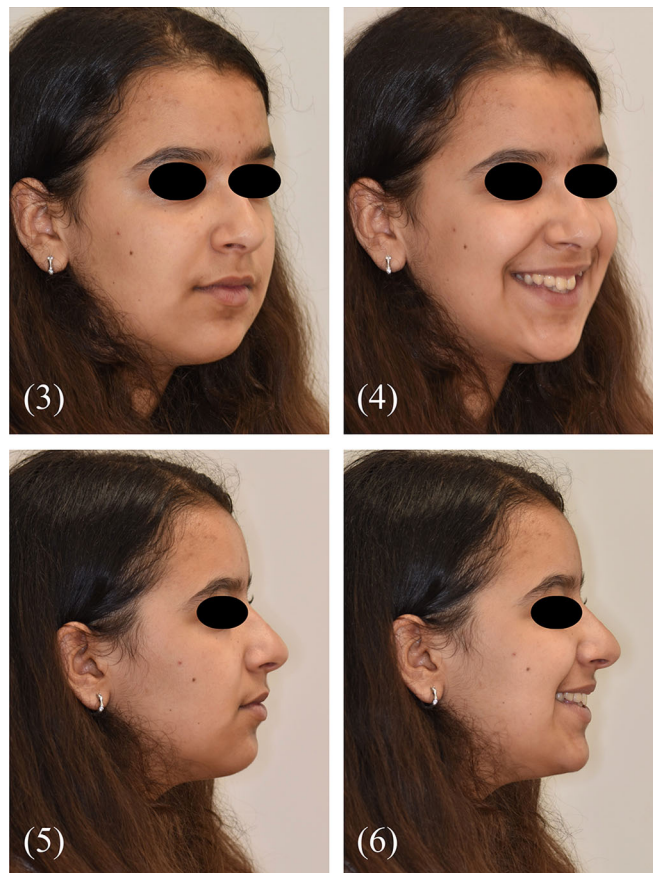
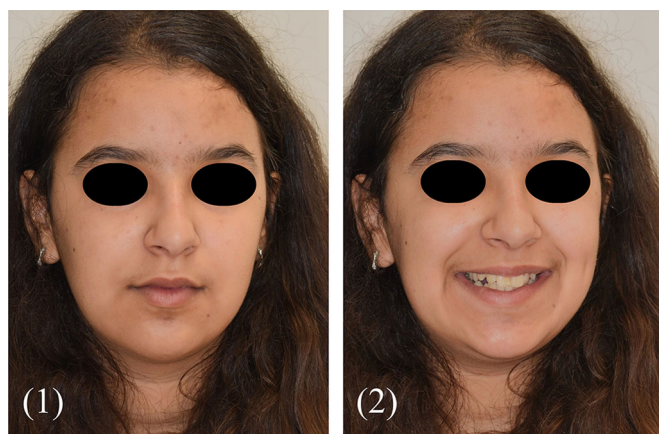
Endodontic therapy resulted in complete periapical healing, as confirmed on the final radiograph, while restorative treatment corrected the crown morphology, eliminating eruptive obstruction and occlusal interference.

7. Re-evaluation before Phase II

Following the documented relapse of maxillary transverse correction and persistence of the transverse discrepancy, a comprehensive diagnostic re-evaluation was performed before initiation of Phase II orthodontic treatment.

Standardized extraoral and intraoral photographs were obtained according to the orthodontic documentation protocol. (Fig. 7, Fig. 8)

Fig. 7. Pre-Phase II treatment extraoral orthodontic photographic documentation for diagnostic and analytical assessment: (1) frontal view at rest; (2) frontal view smiling; (3) three-quarter right view at rest ($\approx 45^\circ$); (4) three-quarter right view smiling ($\approx 45^\circ$); (5) profile view at rest ($\approx 90^\circ$); (6) profile view smiling ($\approx 90^\circ$).



The pre-Phase II extraoral photographs of the 13-year-old girl demonstrate balanced facial thirds and symmetrical orbital alignment. The chin is slightly deviated to the right relative to the facial midline, revealing mild facial asymmetry and reduced muscular balance in the lower third. The lips meet at rest without strain, representing improved lip competence following the ENT interventions compared with the baseline records. Upon smiling, approximately three-quarters of the clinical crowns of the maxillary incisors are displayed, but the smile line remains irregular, with visible buccal corridors consistent with a residual transverse maxillary deficiency.

In profile view, the soft-tissue contour appears straight, with a favorable relationship to the S-line, reflecting the improvement achieved during Phase I orthodontic treatment. The skeletal growth pattern corresponds to a hyperdivergent type. A slight forward head inclination remains evident and may represent residual postural adaptation associated with previous oral breathing and upper airway compensation. Smiling half-profile and profile views reveal a pronounced reverse curve of the Spee in the maxillary arch. Functional assessment also identified a low tongue-resting posture and an altered swallowing pattern, indicating a persistent neuromuscular imbalance that affects vertical stability and supporting a referral for myofunctional therapy.

Fig. 8. Pre-Phase II treatment intraoral orthodontic photographic documentation for diagnostic and analytical assessment: (1) frontal view in occlusion; (2) right lateral view in occlusion; (3) left lateral view in occlusion; (4) occlusal view of the maxillary arch; (5) occlusal view of the mandibular arch.



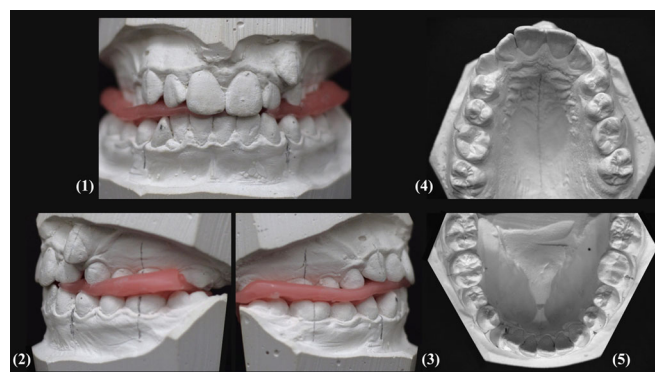
The pre-Phase II intraoral photographs reveal a permanent dentition stage with persistent transverse and space discrepancies. As a result of the previous RPE, all permanent teeth have erupted, including the left maxillary canine, although in a high vestibular position. Residual an-

terior crowding, dental rotations, and localized space deficiency remain evident, hindering complete leveling and alignment. The periodontal condition is compromised, with clinical signs of gingival inflammation consistent with plaque-induced gingivitis and limited oral hygiene. A constricted maxillary arch with a high, gothic-shaped palatal vault and the reappearance of a bilateral posterior crossbite indicate an established relapse of transverse deficiency. The overjet remains normalized, whereas a persistent asymmetric sagittal deviation with a Class II tendency, more pronounced on the left side, attributed to mesial migration of the lateral teeth in the second quadrant, is still present. The frontal view demonstrates a 3 mm midline deviation, with the mandibular dental midline shifted to the right relative to the maxillary midline. Clinical functional examination reconfirmed mandibular laterodeviation, supporting the need for transverse repositioning of the mandible to achieve balanced condylar seating within the glenoid fossae and improved occlusal coordination. The overbite in the anterior region remains normal at 2 mm, but posteriorly, loss of vertical stability is observed due to interference from crossbite.

These findings documented recurrence of the maxillary transverse deficiency in the context of insufficient retention and persistent functional disturbances, necessitating a comprehensive re-evaluation and initiation of Phase II orthodontic treatment aimed at stable skeletal expansion, crossbite correction, creation of space for the full incorporation, alignment of all permanent teeth within the dental arches, levelling and coordination of both arches, occlusal harmonization, and improved retention intended to support treatment stability.

Diagnostic study models were obtained to document the existing occlusal relationships, evaluate measurements, and perform a detailed biometric analysis of both arches. (Fig. 9)

Fig. 9. Diagnostic models before phase II complete orthodontic treatment: (1) frontal view in occlusion; (2) left lateral view in occlusion; (3) right lateral view in occlusion; (4) occlusal view of the maxillary arch; (5) occlusal view of the mandibular arch.



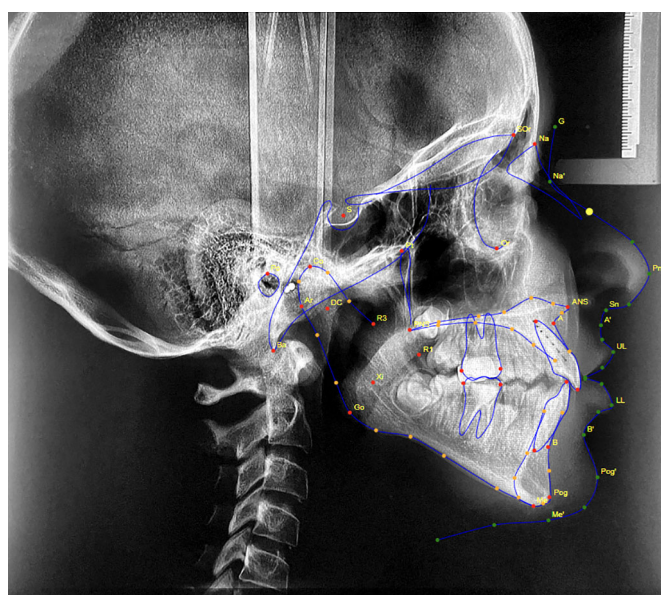
All clinical findings were confirmed by detailed biometric model analysis. Marginal rotations and axial inclinations of the permanent teeth were noted, including mesio-palatal axial rotation (MPAR) of the maxillary first

permanent molars. Measurements according to Tonn's analysis indicated a mild tendency toward deep bite, whereas Bolton's analysis demonstrated no tooth size discrepancies. Maxillary arch compression, assessed using Pont's index, yielded values of MM = -12.2 mm and PP = -7.9 mm, corroborating the presence of a severe transverse deficiency and a complete relapse.

Measurements on the pre-Phase II complete orthodontic treatment diagnostic models of the permanent dentition confirmed the persistence of a maxillary arch form that is morphologically closer to the OSA cohort than to normative controls, despite growth-related changes. The recorded values were: IMD = 30.0 mm and markedly increased palatal height, PH = 37 mm. Adult OSA patients demonstrated IMD values ranging from 28.96 to 35.01 mm and palatal height (PH) values ranging from 21.68 to 29.56 mm, whereas control subjects exhibited wider arches (IMD = 36.35–41.50 mm; PH = 18.57–23.51 mm). This clinical case falls well within the morphological range described for moderate-to-severe OSA phenotypes, reflecting a constricted, vertically deepened maxillary form associated with upper airway vulnerability. Although the predictive model proposed by Mahony et al. was developed for non-growing adults and cannot be directly applied for diagnostic purposes in adolescents, the consistent overlap in arch-form characteristics supports repeated orthopedic maxillary expansion within an interdisciplinary, airway-oriented treatment concept. Diagnostic models thus demonstrated reduced intermolar distance and increased palatal height, consistent with a morphologic pattern previously linked to impaired airway function. [6]

To evaluate skeletal relationships, dental compensations, airway dimensions after relapse, and growth patterns, a pre-Phase II lateral cephalogram was obtained for comprehensive cephalometric analysis. (Fig. 10)

Fig. 10. Pre-Phase II lateral cephalometric radiograph and digital tracing before complete orthodontic treatment.



The cephalometric evaluation performed before the initiation of complete Phase II orthodontic treatment demonstrates a skeletal configuration characteristic of bimaxillary retrognathism, with both jaws positioned posteriorly relative to the cranial base. The markedly reduced SNA (75.64°) and SNB (72.16°) angles confirm a retrusive maxillary-mandibular complex, a pattern frequently described in children with chronic oral breathing. Despite this global retrusion, the ANB value of 3.48° yields a mild apparent sagittal discrepancy. However, this does not reflect a genuine skeletal Class II relationship but rather a Class IV pattern, in which a retrusive maxilla is combined with a retrusive mandible and a preserved intermaxillary relationship. The Wits appraisal of -0.31 mm supports this interpretation and positions the patient near a neutral anteroposterior skeletal relation. This cephalometric constellation is consistent with functional mandibular displacement, vertical hyperdivergence, and the clinically documented history of mouth breathing.

The vertical skeletal parameters indicate a hyperdivergent facial pattern, characterized by an increased FMA of 31.88° , confirming a vertical growth tendency with clockwise mandibular rotation. These findings correspond to the clinically observed reduced posterior vertical stability and the history of crossbite interference. The mandibular plane angle remains elevated relative to normative values, reinforcing the diagnosis of increased lower facial height and diminished posterior facial support. The vertical disproportions are consistent with the patient's previously documented neuromuscular imbalance and soft-tissue adaptations, further justifying the need for precise vertical control during Phase II orthodontic treatment. Dentoalveolar relationships reveal moderate compensatory inclinations associated with prolonged transverse discrepancy and functional mandibular deviation. The upper incisor measurements showed increased proclination (U1-FH = 115.73° , U1-UOP = 48.54°), but normal upper incisor inclination relative to the cranial base (U1-SN = 101.52°), and the lower incisors are normal with good inclination (L1-LOP = 69.35° , IMPA = 89.42°). The interincisal angle of 122.96° indicates incomplete incisor decompensation relative to normative values and reflects the influence of chronic crossbite interference and asymmetrical occlusal contacts. The overjet is 1.36 mm, and the overbite is 0.72 mm, both within normal limits based on clinical and paraclinical measurements.

The soft-tissue profile evaluation reveals balanced perioral relationships, with the upper lip positioned -1.77 mm and the lower lip -0.31 mm relative to Ricketts' E-line. These values fall within acceptable aesthetic limits. The nasolabial angle of 99.78° is harmonious and compatible with the mild maxillary retrusion suggested by skeletal landmarks. Overall, the facial contour remains straight and well balanced, with soft-tissue compensation

masking the border-line sagittal disharmony.

The cephalometric findings confirm the presence of transverse maxillary deficiency accompanied by functional mandibular laterodeviation, dentoalveolar compensation, and mild sagittal imbalance. These parameters substantiate the clinical indication for repeated orthopedic maxillary expansion, dental decompensation, and comprehensive fixed-appliance treatment to re-establish sagittal, transverse, and vertical equilibrium. The cephalometric profile is entirely consistent with the photographic records and the diagnostic impressions derived from intraoral assessment, strengthening the rationale for the Phase II treatment strategy. Cervical vertebral maturation (CVM) assessment corresponded to CVM Stages 2-3, indicating the ascending Phase of the pubertal growth spurt and indicating a favorable growth period for orthopedic maxillary expansion and growth-modifying orthodontic interventions. [18]

Evaluation of the upper airway on the lateral cephalogram demonstrated favorable nasopharyngeal and oropharyngeal dimensions, consistent with restored nasal patency following completion of the ENT interventions during Phase I. The retropalatal and retroglossal spaces fall within the upper-normal range for age, with a well-maintained nasopharyngeal outline and absence of adenoidal encroachment. This pattern aligns with the clinically observed transition from oral to predominantly nasal breathing, underscoring the positive functional impact of early airway management. These findings were consistent with current evidence indicating that normalization of nasal airflow following ENT management can enhance upper-airway dynamics and promote harmonious craniofacial growth in children with prior airway compromise. However, cephalometric airway dimensions do not constitute an objective assessment of airway function or sleep-disordered breathing. [19, 20]

Evaluation of the temporomandibular region revealed bilaterally well-corticated condylar heads without radiographic evidence of erosive, osteophytic, or degenerative alterations. The slightly reduced vertical height and subtly flattened superior contour of the right condyle, observed on panoramic imaging, are compatible with functional adaptive remodeling associated with secondary to long-standing mandibular laterodeviation and asymmetric occlusal loading, rather than true temporomandibular joint degeneration. This pattern is consistent with the established literature on condylar adaptations in cases of transverse maxillary deficiency and unilateral occlusal interference, in which subsequent orthopedic correction and neuromuscular rebalancing lead to morphological stabilization without progression to osteoarthritis. Given the two-dimensional nature of the imaging, these findings should not be interpreted as a definitive three-dimensional assessment of condylar morphology or position. [21, 22]

8. Phase II RME and fixed appliance therapy

During the patient's pubertal growth spurt, Phase II orthodontic treatment was initiated with a second RME. A new tooth-borne RME appliance was bonded to the first permanent molars and first premolars. (Fig. 11)

Fig. 11. Intraoral view after the second RME.



RME was activated according to a standardized clinical protocol, resulting in a broader midline diastema of 7.5 mm and clinically evident transverse expansion.

Following full activation, the RME was locked and maintained in position for a 6-month retention period to allow consolidation of the skeletal expansion and stabilization of the maxillary transverse dimensions.

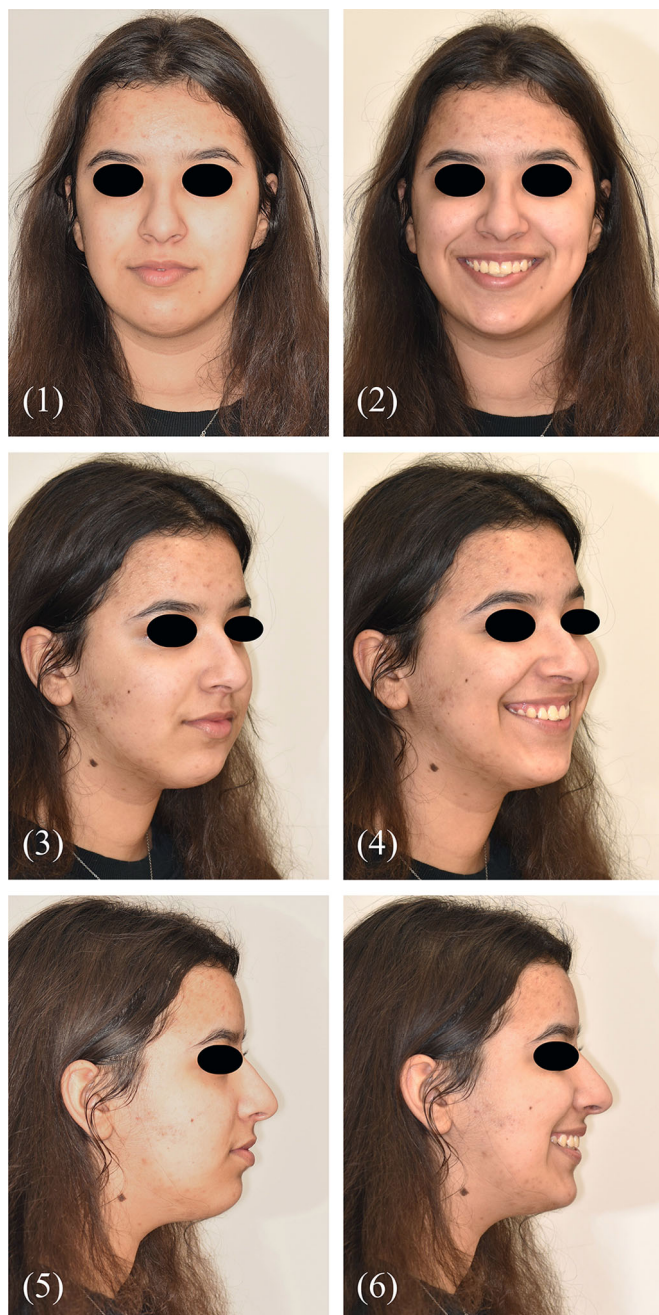
Subsequently, a fixed appliance was placed in both arches to align, level, distribute space, and guide the teeth into their optimal positions. The biomechanical strategy was carefully refined to achieve controlled tooth movement, proper root parallelism, and three-dimensional arch coordination, with an emphasis on precision, light, continuous forces, and preservation of periodontal health.

During Phase II, the patient was referred for myofunctional therapy under the supervision of a myofunctional therapist. The therapeutic goals were to promote predominantly nasal breathing, improve lip competence and resting tongue posture, establish a mature swallowing pattern, and eliminate tongue thrust. Therapy included supervised sessions and a home exercise program prescribed for 3–5 minutes, 3–5 times daily. The specific sequence of exercises, the frequency of specialist visits, and the total duration of therapy were not documented in the orthodontic record. Patient compliance with the prescribed program was partial. Clinical improvement was assessed by observation of the tongue's resting posture, swallowing pattern, lip seal, and predominance of nasal breathing.

9. Final outcome and follow-up

Final extraoral photographs documented improved facial symmetry and soft-tissue balance, as well as an aesthetic, harmonious smile. (Fig. 12)

Fig. 12. Final standardized extraoral orthodontic photographic documentation: (1) frontal view at rest; (2) frontal view smiling; (3) three-quarter right view at rest ($\approx 45^\circ$); (4) three-quarter right view smiling ($\approx 45^\circ$); (5) profile view at rest ($\approx 90^\circ$); (6) profile view smiling ($\approx 90^\circ$).



The final extraoral photographs after treatment demonstrate harmonized facial proportions and improved symmetry of the lower facial third, with notable refinement of the previously observed right-sided chin deviation. The mandibular midline is visually better centered relative to the facial midline, indicating im-

proved condylar seating and balanced transverse mandibular position following orthopedic expansion and comprehensive orthodontic treatment. At rest, the lips remain competent without strain, and the perioral muscle tone appears more balanced than in the pre-treatment records. The perinasal region exhibits improved contour and support, and a reduction in previously compensatory perioral activity, accompanied by improved lip competence and perioral muscular balance. Upon smiling, a more harmonious and symmetrical smile arc is evident, with increased visibility of maxillary incisors, gingiva, and markedly reduced buccal corridors, reflecting effective transverse correction of the maxilla. The smile line is more regular and balanced across the midline, with improved coordination between the upper and lower lips. In profile view, the soft-tissue silhouette maintains a straight and well-balanced contour, preserving a favorable relationship with established aesthetic reference lines. The soft-tissue profile maintained a favorable relationship to the S-line, confirming the stability of the maxillary-mandibular soft-tissue harmony achieved during treatment. The head posture appears more upright, and the previously observed forward head inclination was no longer evident in the final photographic records. This improvement suggests enhanced airway function and normalization of cervical-cranial posture following the elimination of oral breathing and correction of transverse and sagittal discrepancies. The smiling half-profile and profile records further demonstrate a more physiologic curve of Spee after complete orthodontic alignment, normalized upper-lip dynamics during smiling, and the absence of low tongue posture, infraposition, or tongue-based compensation, accompanied by visibly more coordinated circumoral muscular activity. These findings were consistent with improved soft-tissue balance, stable vertical control, and functional adaptation following the combined orthodontic and myofunctional management.

The final extraoral records document substantial improvement in soft-tissue balance, function, and facial aesthetics, reflecting the cumulative impact of transverse orthopedic correction, precise orthodontic biomechanics, enhanced airway efficiency, and targeted neuromuscular rehabilitation.

This favorable extraoral transformation is complemented by intraoral findings that provide a detailed view of the occlusal, transverse, and alignment improvements achieved at the end of treatment. (Fig. 13)

Fig. 13. Final standardized intraoral orthodontic photographic documentation: (1) frontal view in occlusion; (2) right lateral view in occlusion; (3) left lateral view in occlusion; (4) occlusal view of the maxillary arch; (5) occlusal view of the mandibular arch.



The final intraoral photographs demonstrate a fully established permanent dentition with markedly improved sagittal, transverse, and vertical relationships following comprehensive Phase II orthodontic treatment. Arch form coordination has been restored, and the maxillary transverse dimen-

sion exhibits correction, with complete resolution of the bilateral posterior crossbite and normalization of intercuspation bilaterally. The previously high-vestibular positioned maxillary canine has been successfully incorporated into the arch, contributing to harmonious anterior and posterior tooth alignment. Anterior alignment demonstrates full, stable correction of crowding and rotational discrepancies. The dental midlines were nearly coincident, with only a minimal, clinically insignificant residual deviation. Overjet and overbite are normalized and functionally stable, ensuring balanced anterior guidance. Sagittal relationships have been effectively harmonized, eliminating the previous asymmetry and establishing Class I molar, premolar, and canine relationships bilaterally. Transverse stability is evident through the coordination of arch forms and symmetric premolar-molar intercuspation. Vertical control has been achieved, with the restoration of multiple-point occlusal contacts in the posterior segments and the elimination of the functional interference that previously contributed to mandibular laterodeviation. A more physiologic tongue posture was observed clinically, with palatal adaptation facilitated by the normalized maxillary width, following the beneficial effects of combined orthodontic and myofunctional management. Periodontal evaluation reveals an overall improvement in gingival health compared with initial records, reflecting the benefit of orthodontic alignment and improved access for hygiene. Nevertheless, suboptimal oral hygiene during active treatment has resulted in superficial enamel decalcification, which appears as white spot lesions on the teeth. These findings necessitate structured remineralization therapy and reinforced preventive strategies. Occlusal views confirm coordinated arch symmetry, a broader coordinated maxillary arch form following successful skeletal expansion, and stable interarch relationships supported by bonded canine-to-canine lingual retainers in both arches.

The final intraoral records document the successful achievement of transverse orthopedic correction, complete incorporation and alignment of all permanent teeth, restoration of functional occlusal balance, and improvement in periodontal condition, with minor enamel decalcifications representing the primary residual clinical concern requiring post-treatment management.

To comprehensively evaluate the skeletal, dental, and endodontic outcomes following treatment completion, a final panoramic radiograph was obtained for comparative assessment. (Fig. 14)

Fig. 14. Final panoramic radiograph following completion of Phase II orthodontic treatment.



The final panoramic radiograph reveals a fully erupted and well-aligned permanent dentition, characterized by coordinated interarch relationships following completion of Phase II orthodontic treatment. The maxillary second molars and canines exhibit complete eruption with proper axial inclination and restored eruptive trajectory, confirming the resolution of the previous mechanical obstruction caused by overcontoured stainless-steel crowns.

The endodontically treated maxillary and mandibular left first permanent molars (26, 36) show complete periapical healing, with normalization of the lamina dura and absence of residual radiolucency, indicating successful resolution of the prior periapical pathology. The restorative margins of the definitive full-coverage restorations on the first molars (16, 26, 36, 46) appear anatomically appropriate, with no radiographic signs of proximal overcontouring or periodontal compromise.

The maxillary arch demonstrates a stable transverse dimension consistent with the achieved orthopedic expansion, while the mandibular arch maintains coordinated intermolar and intercanine widths. These changes represented a shift away from the constricted, high-vault configuration associated with increased OSA risk in adult data. [6]

The alignment of the anterior segments in both arches is harmonious, with balanced root parallelism and no root resorption, reflecting precise biomechanical control throughout treatment. Third molar development is consistent with chronologic age, showing full crown and residual root formation, without signs of ectopic positioning or eruptive disturbance.

The temporomandibular regions showed bilaterally preserved condylar cortical outlines without evident degenerative changes. The previously observed right-sided asymmetry appeared less pronounced on the final panoramic radiograph. These findings should be interpreted with caution because panoramic radiography does not permit a definitive assessment of three-dimensional condylar position or temporomandibular joint morphology.

The final panoramic radiograph confirms stable dental, skeletal, periodontal, and endodontic outcomes, reflecting the effectiveness of the interdisciplinary treatment protocol, including orthopedic expansion, controlled fixed-appliance biomechanics, endodontic treatment, restorative correction, and neuromuscular rehabilitation.

At the 12-month follow-up, the achieved occlusal relationships remained stable, while periodontal and oral hygiene status continued to improve. No clinical evidence of transverse or sagittal relapse was identified during this follow-up period. At the end of treatment, the patient reported increased self-confidence and a perceived improvement in her quality of life.

DISCUSSION

The case presents the clinical complexity of managing malocclusion in a growing patient with MIH,

marked maxillary transverse deficiency, upper-airway obstruction, functional disturbances, and restorative complications. These factors coexisted in a unified pathogenic mechanism in which impaired airway function, dysfunctional muscle patterns, and compromised dental structure interacted to shape craniofacial growth trajectories. The successful outcome underscores the necessity of an integrated, interdisciplinary, growth-responsive, and function-oriented approach rather than a purely mechanical orthodontic intervention.

The initial craniofacial phenotype, including a high palatal vault, bilateral posterior crossbite, mandibular laterodeviation, forward head posture, and reduced perioral muscle tone, were observed in the context of chronic mouth breathing and adenotonsillar hypertrophy during growth, initiating a cascade of neuromuscular and skeletal adaptations. The association between mouth breathing and altered maxillofacial development is well documented in the literature, with evidence indicating that chronic oral respiration contributes to increased palatal height, diminished intermolar width, and clockwise mandibular rotation, thereby reinforcing vertical dysplasia and transverse collapse.

Superimposed on this airway-driven pattern, the presence of MIH introduced structurally compromised first permanent molars with post-eruptive breakdown, placing the patient at risk for impaired mastication, altered occlusal load distribution, and early restorative interventions. Improperly overcontoured preformed SSCs, although initially placed to protect compromised enamel and provide first RME anchorage, inadvertently exacerbated the eruptive disturbance of the maxillary second molars and contributed to occlusal imbalance, intensifying asymmetrical mandibular loading and functional condylar adaptation. MIH and altered airway physiology created a biologically amplified risk for malocclusion complexity.

One of the most critical determinants of success in this clinical case was the precise timing of the second Phase of orthopedic intervention. Cervical vertebral maturation assessment confirmed CVM Stage 2-3, representing the ascending Phase of the pubertal growth spurt, an optimal biological window for skeletal modification. RME performed during this Phase enabled stable sutural disjunction and orthopedic expansion rather than predominantly dentoalveolar tipping. The measurable skeletal gain, the pronounced midline diastema, and the stable correction of the bilateral crossbite substantiate the skeletal nature of the expansion. The favorable airway dimensions observed on the pre-Phase II cephalogram confirm that Phase I ENT interventions and early orthopedic expansion successfully removed the principal etiologic obstacles to healthy nasal breathing before the initiation of comprehensive fixed-appliance orthodontics.

Neuromuscular dysfunction represented an important component of the clinical presentation and was considered relevant to treatment stability. Pre-Phase II findings included a low tongue resting posture, an altered

swallowing pattern, reduced circumoral muscular balance, and forward head posture. The relapse of maxillary transverse correction following Phase I was attributable to insufficient adherence to the prescribed retention protocol and persistent functional disturbances. Although both factors may have contributed to the loss of correction, their individual effects cannot be determined from this single clinical case.

Myofunctional therapy complemented the Phase II orthodontic treatment by addressing persistent functional disturbances, including altered tongue resting posture, immature swallowing pattern, reduced lip competence, and mouth-breathing tendency. Clinical improvement in these parameters was observed during treatment. However, given the patient's partial compliance and the absence of standardized functional outcome measures, the independent contribution of myofunctional therapy to the final treatment stability cannot be determined.

The complications associated with the overcontoured SSCs represent an important interdisciplinary consideration. While stainless-steel crowns are evidence-based solutions for molars affected by MIH, their success fundamentally depends on anatomical contouring and harmonious integration into the occlusal scheme. In this case, mechanical interference of eruptive pathways transformed an initially protective intervention into an etiologic factor for delayed and deflected eruption of the maxillary second molars, resulting in subsequent occlusal disturbance. The removal of overcontoured crowns, endodontic treatment of compromised molars, and subsequent placement of anatomically precise definitive restorations enabled the spontaneous recovery of eruption dynamics and the restoration of functional occlusal relationships. This outcome aligns with contemporary recommendations advocating close coordination among pediatric dentists, endodontists, and orthodontists in the management of children with MIH.

Radiographic findings provided further insight into growth-mediated adaptation. The observed condylar remodeling, slight flattening, and height reduction on the right side represented a functional response to asymmetric occlusal loading rather than degenerative temporomandibular joint disease. The subsequent normalization of condylar height and cortical integrity following transverse correction and occlusal rebalancing confirms that young condyles possess robust adaptive capacity when occlusal interferences are eliminated, supporting the concept of functional remodeling as a largely reversible phenomenon in growing patients. Airway analysis reinforced the biological relevance of the staged, etiologic approach. The favorable retropalatal and retroglossal dimensions seen on the pre-Phase II cephalogram, in contrast to the initially compromised airway, reflect the compounded effect of adenotonsillectomy, early RME, and neuromuscular rehabilitation in restoring nasal airflow and stabilizing upper-airway function. This is consistent with mounting evidence that early normalization of nasal breathing can redirect craniofacial growth towards a more physiologi-

cal development.

The 12-month follow-up, reflected in maintained occlusal relationships, the absence of transverse or sagittal relapse, improved oral function, and normalized airway parameters, demonstrates that long-term success in such complex cases cannot be reduced to the selection of an appliance alone. It is the result of a biologically coherent sequence: correction of the primary etiology, skeletal alignment during the optimal growth phase, neuromuscular retraining, biomechanically controlled orthodontics, and anatomically precise restorative work. The persistence of superficial white spot lesions emphasizes the importance of rigorous hygiene protocols and remineralization strategies during fixed appliance therapy, especially in MIH patients who are inherently predisposed to demineralization. This residual finding doesn't detract from the overall functional and structural success but underscores the importance of continued preventive care, oral hygiene reinforcement, and remineralization strategies after fixed-appliance treatment.

Limitations

Several limitations should be considered when interpreting the findings of this case report. This report describes a single clinical case. Therefore, causal relationships cannot be established, and the findings cannot be generalized to broader patient populations. No objective sleep study was performed, and the reported improvement in airway-related symptoms was inferred from clinical observations and cephalometric findings rather than objective sleep assessment. In addition, the use of two-dimensional radiographic imaging limited the assessment of temporomandibular joint and airway morphology. Patient compliance, particularly with the prescribed retention and myofunctional therapy protocols, influenced the treatment course and should be considered when interpreting both the relapse and subsequent treatment response. The post-treatment follow-up period was limited to 12 months, precluding conclusions regarding longer-term stability. The reported improvements in self-confidence and perceived quality of life were based on the patient's subjective report and were not assessed using validated patient-reported outcome measures.

CONCLUSION

This case demonstrates that the successful management of complex malocclusion in a growing patient with MIH, transverse maxillary deficiency, airway impairment, neuromuscular dysfunction, and iatrogenic restorative complications requires a fully integrated, etiologically driven, and growth-responsive approach. Early correction of airway obstruction, followed by precisely timed orthopedic expansion during the pubertal growth spurt, enabled stable skeletal correction and restored functional balance. Comprehensive fixed-appliance treatment and anatomically accurate restorative rehabilitation, complemented by myofunctional therapy, contributed to improved occlusal function, neuromuscular ad-

aptation, and facial balance. The timely endodontic retreatment of compromised molars, combined with definitive full-coverage restorations, re-established dental integrity and prevented further occlusal and eruptive disturbances. The favorable functional, skeletal, periodontal, endodontic, and occlusal outcomes, maintained at during the 12-month follow-up, underscore the principle that stability in complex pediatric cases is achieved

not by appliances alone, but through coordinated interdisciplinary intervention that simultaneously addresses structure, function, growth, and behavior.

INFORMED CONSENT

Written informed consent was obtained from the patient's parents for the publication of this case report, including the accompanying clinical photographs and radiographic images.

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Address for correspondence:

Karina Dobрева
Faculty of Dental Medicine, Medical University of Varna;
84, Tsar Osvoboditel Blvd., 9002 Varna, Bulgaria.
E-mail: karina.dobрева@gmail.com,