

A Simple and Effective Interceptive Approach in Mixed Dentition: The Two by Four Appliance

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Abstract

Early interceptive orthodontic treatment aims to guide the harmonious development of the dento-maxillofacial complex, reducing the severity of malocclusions and potentially preventing the need for more extensive treatment in the permanent dentition. Among interceptive strategies, the 2x4 fixed appliance represents a versatile and minimally invasive option, particularly suitable for the mixed dentition stage. It allows three-dimensional control of anterior tooth movement with limited reliance on patient compliance and has been reported as effective in managing anterior crossbites, crowding, open bites, increased overjet, and eruption disturbances. Despite its widespread clinical use, detailed documentation of its versatility through comprehensive case series remains limited. This article presents a series of 11 clinical cases treated between 2020 and 2025 at the Roberto Ferro Practical School of Orthodontics (Cittadella, Italy), illustrating the broad applicability of the 2x4 appliance in interceptive orthodontics. The cases included patients aged 4 to 11 years in deciduous or mixed dentition

stages, presenting with various malocclusions such as crossbite, crowding, reduced arch perimeter, open bite, increased overjet, Class II and Class III tendencies, and incisor–canine eruption interference. Treatment protocols involved the use of 2x4 appliances alone or in combination with adjunctive devices. The 2x4 appliance involves bands on the first permanent molars and brackets on the erupted maxillary incisors, connected by a continuous archwire for controlled tooth movement. Alignment was typically initiated with light nickel–titanium archwires, followed by stabilization or torque control as required. In most cases, correction of the primary malocclusion was achieved within a few weeks to several months. Radiographic monitoring was performed when eruption conflicts or root proximity were suspected. The presented case series confirms the 2x4 appliance as a simple, efficient, and highly versatile interceptive orthodontic tool for the management of a wide range of malocclusions during the mixed dentition stage. When appropriately indicated and carefully monitored, it enables rapid correction of anterior dental

discrepancies, supports proper eruption patterns, and improves esthetics and psychosocial well-being at an early developmental stage. Although its effects are primarily dentoalveolar, the appliance can be successfully combined with orthopedic or functional devices to expand its therapeutic scope. Given its ease of use, patient acceptance, and clinical effectiveness, the 2x4 appliance should be considered an essential component of contemporary interceptive orthodontic treatment.

Keywords: 2x4 appliance, early treatment, interceptive orthodontics, mixed dentition, pediatric malocclusion

Introduction

The primary aim of early orthodontic treatment is to harmonize the development of the dento-maxillofacial complex with that of the dentition and the neuromuscular system, thereby simplifying or even avoiding the need for extensive treatment in the permanent dentition stage ¹.

Interceptive treatment plays a critical role in reducing the severity of developing malocclusions, particularly those detectable in the early stages, even during the deciduous dentition ².

Leighton identified six early indicators of severe malocclusions in deciduous dentition, conditions that are often associated with a poor prognosis if left untreated in the mixed or permanent dentition. These include Class II and III dento-skeletal relationships, anterior crowding in the lower arch, skeletal open bite, and deep bite in Class II Division 2 malocclusion ¹.

While most interceptive therapies are implemented during the mixed dentition stage, early intervention in Class III malocclusion is typically more effective when initiated during the deciduous dentition phase ^{2,3}.

Several appliances and strategies are available for interceptive orthodontic treatment. Among these, the 2x4

fixed appliance has been recognized for its versatility, simplicity, comfort, and excellent patient tolerance ⁴⁻⁶.

This appliance allows for short-term, efficient correction of issues affecting the maxillary incisors, typically within a few months. It offers three-dimensional control of tooth movement and has proven effective in correcting anterior crossbites, aligning ectopic incisors, addressing rotations, closing diastemas, and correcting improper angulations and inclinations ⁷.

Additionally, the 2x4 appliance may be used in conjunction with other devices to correct dental Class II or III relationships or support orthopedic traction with a face mask. However, some concerns have been raised regarding the potential risk of root resorption, particularly in the maxillary lateral incisors. Amlani et al. emphasized the importance of careful case selection and canine eruption monitoring to minimize this risk ⁸.

The 2X4 Appliance

The 2x4 appliance is a fixed orthodontic system composed of four brackets bonded to the erupted permanent maxillary incisors and either two bands cemented or tubes bonded to the first permanent molars. A continuous archwire connects the components, maintaining or improving the arch form ⁷.

Depending on the treatment goals and clinician preferences, various auxiliary elements such as rubber tubing or nickel-titanium coil springs may be incorporated. The first one serve to enhance patient comfort and reduce the risk of archwire dislodgment or fracture.

The orthodontic archwires used in the 2x4 technique are intentionally thin in diameter to deliver light, continuous, and well-controlled forces to the anterior teeth and often, depending on the purpose of the treatment, only one arch could be sufficient.

Otherwise, the sequence begins with 0.012" to 0.016" NiTi (nickel–titanium alloy) or TMA (titanium–molybdenum alloy) wires. As alignment progresses, 0.016" stainless steel wires are employed, followed by rectangular wires measuring 0.017"x0.025" or 0.018"x0.025", which enable more precise control of torque and tooth angulation. Archwires could be generally replaced every two to four weeks⁹.

According to the literature^{10–16}, the primary clinical indications for the 2x4 appliance include:

- Management of anterior and posterior crossbites^{7,17,18}
- Correction of ectopic or impacted maxillary central incisors^{14,19}
- Closure of midline diastemas and abnormal interdental spacing
- Alignment of anterior crowding and mild rotations
- Increasing arch perimeter
- Vertical control of anterior teeth in open bite or deep bite cases
- Torque control of maxillary incisors
- Adjunctive support for other appliances (e.g., facemask, elastics)
- Correction of palatally displaced teeth
- Bodily movement of canines
- Management of pseudo-Class III malocclusion^{21–23}
- Creating space for the eruption of canines and premolars^{22,24}

The aim of this study is to demonstrate, through clinical cases, the versatility of this device, which is not widely documented in the literature but is commonly used by clinicians.

All treatments were carried out between 2020 and 2025 at Roberto Ferro's Practical School of Orthodontics in Cittadella, Italy.

Cases Report

A. Management of Anterior Crossbite

Case 1: Arnalda, 6 y.o., Female

Initially examined at age 6, the patient presented in full deciduous dentition, with significant occlusal attrition in both arches (Fig. 1). During the early mixed dentition phase, a single-tooth anterior crossbite involving tooth UL1 was diagnosed (Fig. 2).

Treatment involved a 2x4 fixed appliance along with occlusal turbos placed on the deciduous first molars. The crossbite was resolved within one month (Fig. 3). The appliance remained in place for a total of three months to ensure stabilization, after which spontaneous alignment continued.

The patient is currently under biannual follow-up.

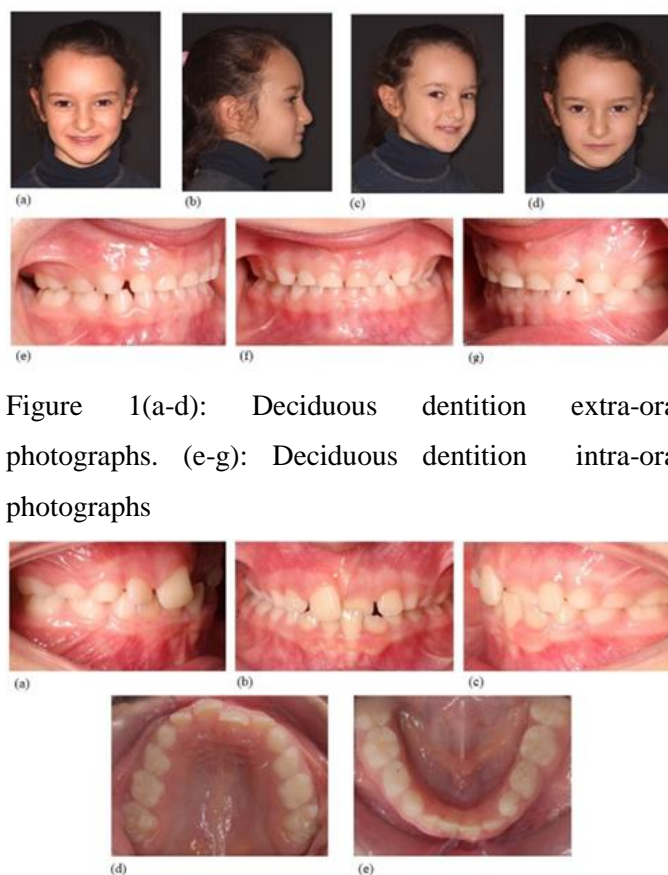


Figure 1(a-d): Deciduous dentition extra-oral photographs. (e-g): Deciduous dentition intra-oral photographs

Figure 2 (a-e): Early mixed dentition extra-oral photographs: anterior crossbite involving UL1



Figure 3: (a-c) Intra-oral photographs during treatment (d) Intra-oral photographs after 3 months of treatment: crossbite resolution (e) Post- treatment intraoral photograph after 18 months showing stable result

Case 2: Erika, 8 y.o., Female

At the age of 8, Erika presented with anterior dental crossbite affecting three maxillary incisors, within an otherwise favorable facial pattern (Fig. 4).

A 2x4 appliance with a 0.014" NiTi archwire was bonded, combined with lingual resin turbos on the mandibular central incisors to facilitate bite opening (Fig. 5). Complete resolution of the crossbite occurred within one month (Fig. 6).

The appliance and resin turbos were removed after two months. The patient continues with periodic observation.



Figure 4 (a-d): Pretreatment extra-oral photographs. (e-i) Pretreatment intra-oral photographs showing anterior crossbite



Figure 5 (a-c): Intra-oral photographs during treatment



Figure 6: (a-d) photographs post treatment: crossbite resolution (e) Post – treatment intraoral photograph after 6 months showing stable result

Case 3: Jacopo, 11 y.o., Male

Jacopo, in the third transitional phase of mixed dentition, presented with a dental anterior crossbite and a Class I molar relationship. His facial profile was normal, but mandibular retrusion resulted in an edge-to-edge incisal relationship (Fig. 7).

Treatment targeted the lower arch using a 2x4 appliance (Fig. 8). Initial alignment was achieved with a 0.014" NiTi archwire, followed by a posted archwire with elastic tie-backs to reduce the lower arch perimeter.

The anterior crossbite was successfully corrected within four months (Fig. 9).



Figure 7: (a-b) Pretreatment extra oral photographs (c-g) Pretreatment intra-oral photographs showing anterior crossbite



Figure 8: (a-c) Intra-oral photographs during treatment

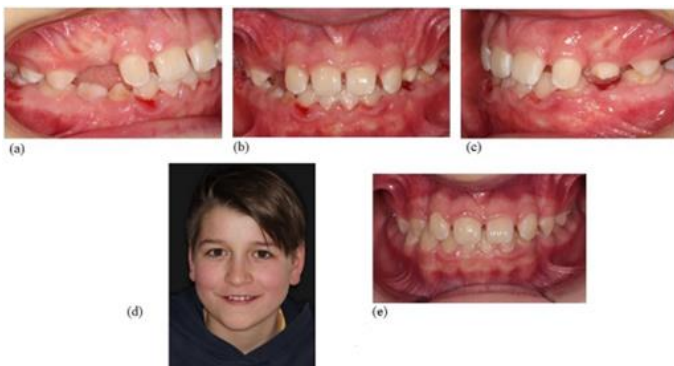


Figure 9: (a-d) photographs post treatment: crossbite resolution (e) Post-treatment intraoral photograph after 12 months showing stable result

B. Alignment of Anterior Crowding And Arch Perimeter Expansion

Case 4: Alessandro, 4 y.o., Male

Initially examined during the deciduous dentition phase, Alessandro exhibited a “Hollywood smile” with well-aligned teeth but no interdental spacing (Fig. 10). By the

early mixed dentition stage, mild anterior crowding became apparent (Fig. 11).

Treatment consisted of upper and lower 2x4 appliances, supplemented with coil springs and mesial slicing of the deciduous canines (Fig. 12). Long posterior turbos were placed to prevent mandibular retrusion during treatment. Crowding was resolved in 9 months. A bonded anterior splint was used to prevent relapse during the transition. The patient remains under regular follow-up.

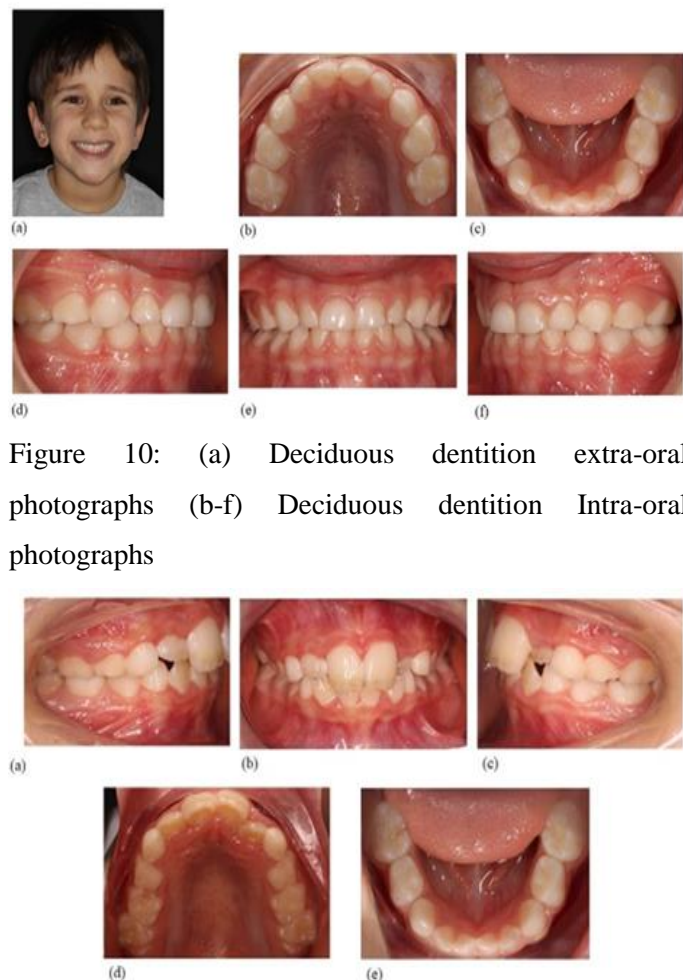


Figure 10: (a) Deciduous dentition extra-oral photographs (b-f) Deciduous dentition Intra-oral photographs

Figure 11: (a-e) Mixed dentition extra oral photographs: anterior crowding

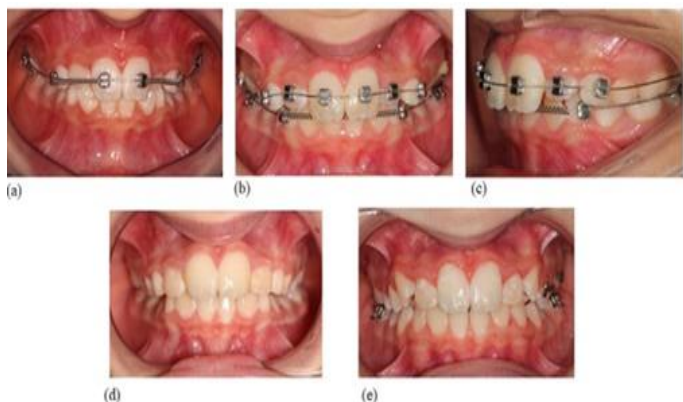


Figure 12: (a-c) Intra-oral photographs during treatment (d) Intra-oral photographs 9 months of treatment: crowding resolution (e) Post treatment intraoral photographs after 24 months

Case 5: Giorgio, 8 y.o., Male

At age 8, Giorgio presented during early mixed dentition with upper arch crowding and anterior crossbite (Fig.13). At age 9, a 2x4 appliance was bonded, leading to resolution of the malocclusion within two months (Fig. 14).

The appliance remained in place for 8 months and was followed by photographic documentation until the age of 17 (Fig. 15).

Due to aesthetic concerns, the incisal edge of tooth UL2 was later reshaped for improved symmetry.



Figure 13: (a-b) Pretreatment extra-oral photographs (c-g) Intra-oral photographs showing anterior crossbite and crowding



Figure 14(a): Intra-oral photograph during treatment (b) Intra-oral photograph after 2 months of treatment

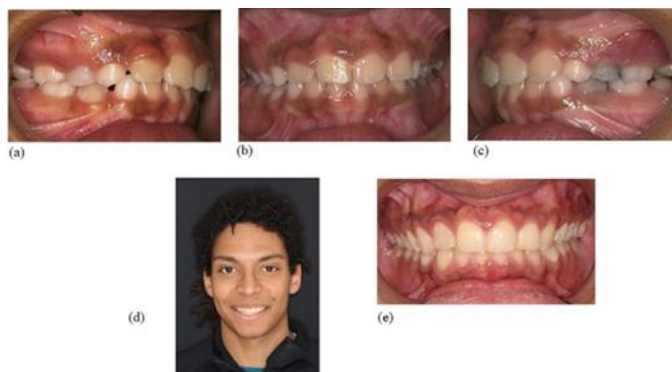


Figure 15: (a-d) Photographs post treatment: crossbite and crowding resolution (e) Post-treatment intraoral photographs after 9 years showing stable result

Vertical Control in Open Bite Management

Case 6: Elisabetta, 5.9 y.o., Female

First evaluated at 5 years and 9 months, Elisabetta exhibited a thumb-sucking habit. At the second phase of mixed dentition, she presented with bilateral Class II malocclusion, increased overjet, and occasional habit relapse (Fig. 16).

Initial treatment involved a 6 mm leaf expander (900 g force) with a tongue crib, followed by a 2x4 appliance for six months (Fig. 17). A functional elastodontic appliance was later used for one year, resulting in full resolution (Fig. 18).

Comparison of pre- and post-treatment cephalometric records demonstrated significant skeletal, dental, and facial improvements (Fig. 19).

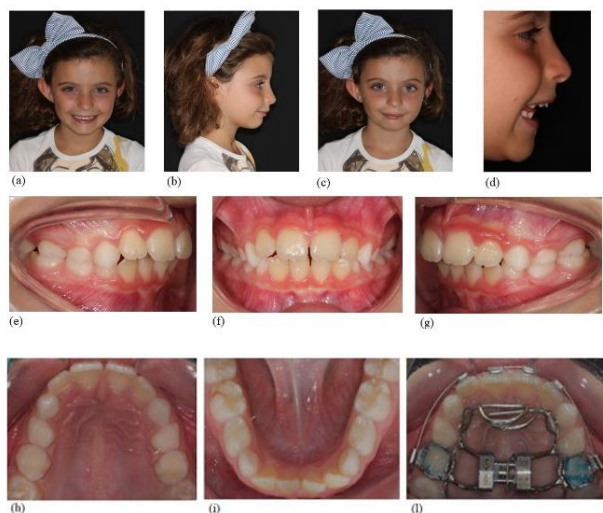


Figure 16: (a-d) Pretreatment extra-oral photographs (e-i) Pretreatment intra-oral photographs (j) Leaf-expander and 2x4

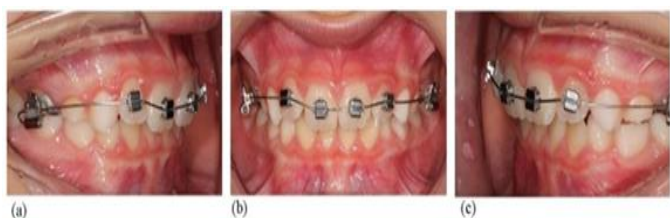


Figure 17(a-c): Intra oral photographs during treatment



Figure 18 (a-c): Intra oral photographs after six months of treatment



Figure 18 (a-c): Intra oral photographs after 1 Years of elastodontic therapy with full resolution

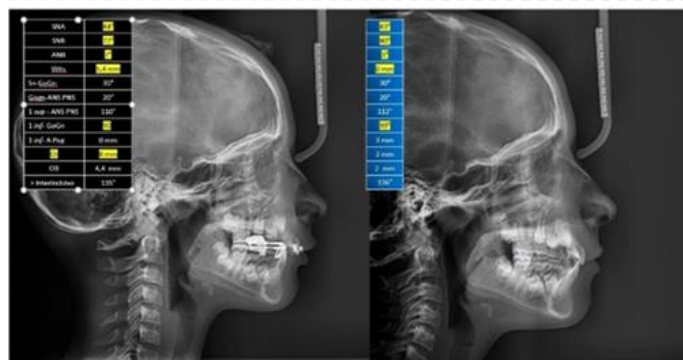


Figure 19: Comparison of cephalometric records during and after treatment

Case 7: Maggie, 7 y.o., Female

Maggie, an oral breather with thumb-sucking habit, presented with Class I malocclusion, posterior crossbite, and anterior open bite during early mixed dentition. She had a skeletal Class II pattern (Fig. 20).

An ERP (expandable rapid palatal expander) was combined with dual-arch 2x4 appliances and vertical elastics to close the anterior open bite (Fig. 21).

A screened Bionator was used during the transition phase for retention and functional stabilization (Fig. 22). Final finishing was completed with fixed appliances.

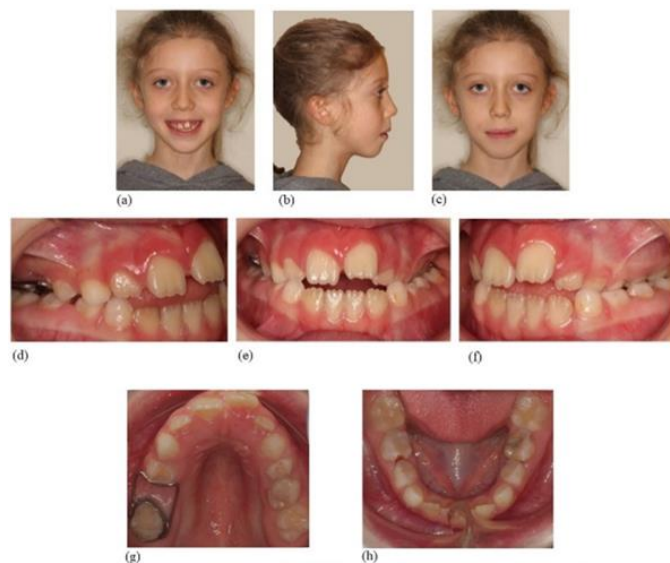


Figure 20 (a-c): Pretreatment extra oral photographs (d-h) Intra-oral photographs showing anterior crossbite and crowding



Figure 21: (a-c) Intra oral photograph during treatment



Figure 22(a-c): Photographs post treatment: anterior open bite resolution (d-e) post treatment intraoral photograph after bionator

D. Correction of Increased Overjet

Case 8: Alfredino, 8 y.o., Male

An 8-year-old boy with skeletal and dental Class I occlusion exhibited a pronounced overjet and a V-shaped upper arch (Fig. 23).

Due to delayed eruption of the first permanent molars, tubes were bonded on the second deciduous molars to initiate a 2x4 protocol. These were later replaced with tubes on the permanent molars to align the posterior segment (Fig. 24).

Initial alignment was completed in one year. During follow-up, a Class II malocclusion developed on the right side (Fig. 25), which was corrected using a TEO appliance.

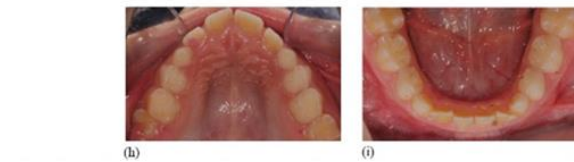
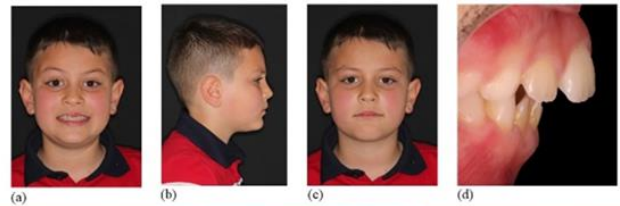


Figure 23: (a-c) Pretreatment extraoral photographs. (d-i) Intra Oral photographs showing overjet and V-shaped upper arch



Figure 24: (a-c) Intra oral photograph during treatment

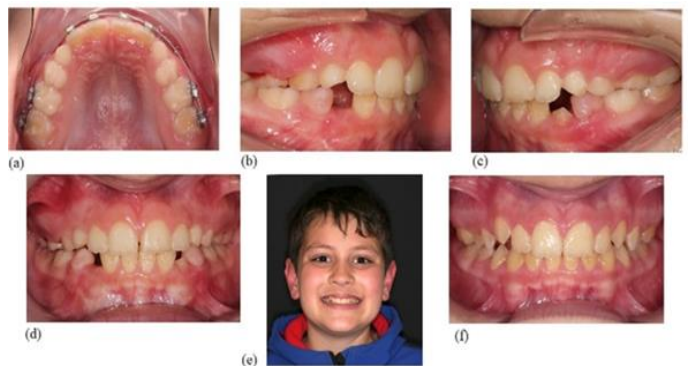


Figure 25 (a): Intraoral photographs showing the change of upper arch (b-d) Intraoral photographs after 12 months of treatment: overjet resolution (e-f) Post treatment photographs after 12 months of follow-up

E. Supportive Use with Other Orthodontic Devices

Case 9: Stefano, 11 y.o., Male

Stefano, in the late mixed dentition stage, presented with a skeletal and dental Class II hyperdivergent pattern and anterior crowding (Fig. 26).

A combination of a 2x4 appliance with Tweed brackets, open-coil springs, and a TEO appliance was used (Fig. 27-28).

The treatment resulted in successful space recovery, alignment of the anterior teeth, and resolution of the Class II malocclusion (Fig. 28).

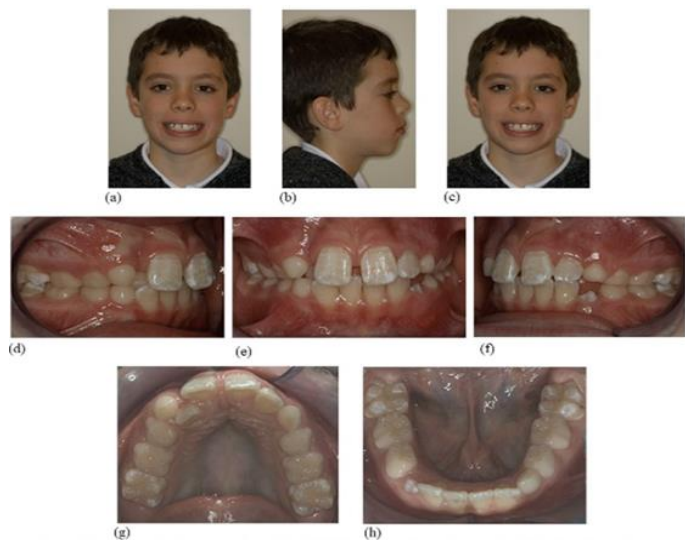


Figure 26 (a-c): Pretreatment extra oral photographs.(d-h) Intra oral photographs showing class II and crowding



Figure 27: Intra oral photographs during treatment with 2x4 in combination with TEO appliance



Figure 28 (a-c): Combination of a 2x4 appliance with open coil springs (d-f) Post Treatment intraoral photograph showing space recovery, alignment of the

anterior teeth, and resolution of the anterior teeth, and resolution of the class II malocclusion

Case 10: Riccardino, 7.9 y.o., Male

Riccardino, at 7 years and 9 months, presented with a full anterior crossbite and skeletal Class III pattern (Fig. 29).

Treatment combined a rapid palatal expander, a 2x4 appliance (Fig. 30), and a facemask with elastics attached to the hooks of a posted archwire (Fig. 31).

The crossbite was resolved in both transverse and sagittal planes (Fig. 31-32). The patient, satisfied with the results, declined further refinements.

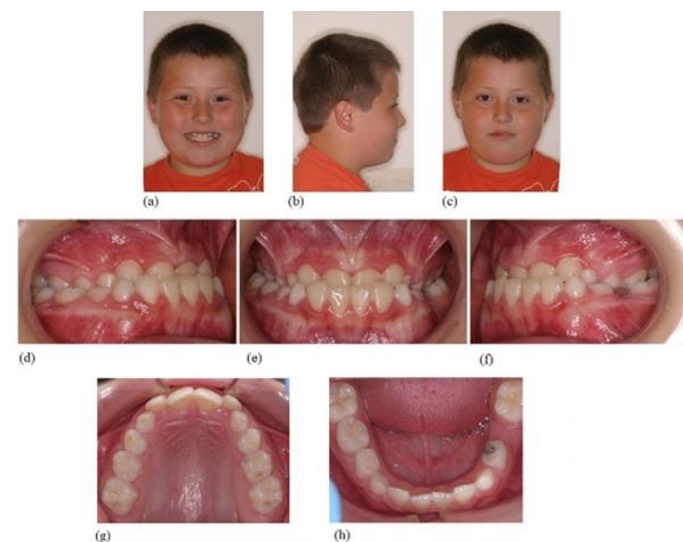


Figure 29(a-c): Pretreatment extra oral photographs (d-h) Intraoral photographs showing class III and anterior crossbite



Figure 30 (a-c): intra-oral photograph with 2x4 device, after 2 months of ERP treatment

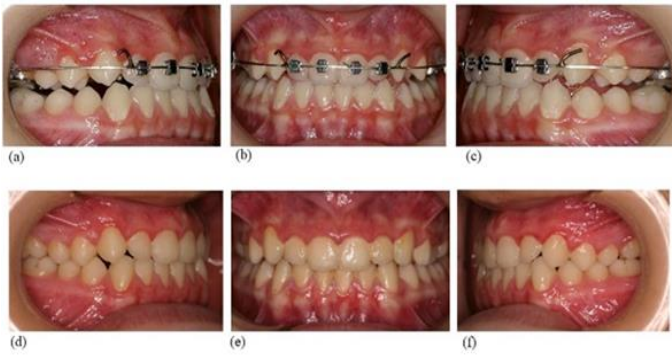


Figure 31(a-c): Combination of a 2x4 appliance and facemask (d-e) Post treatment intraoral photograph showing crossbite resolution

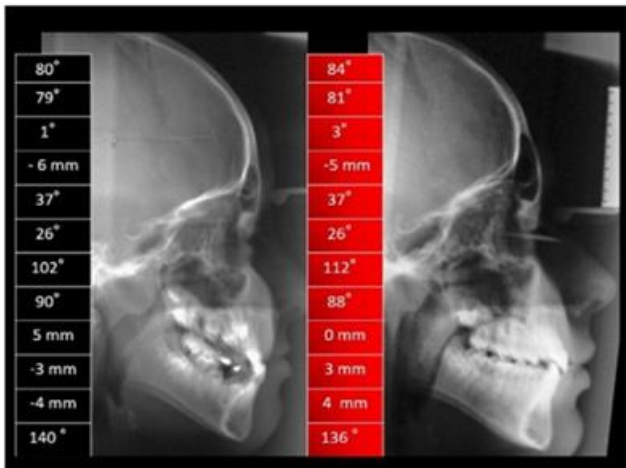


Figure 32: Comparison of cephalometric records before and after treatment

F. Management of Incisor–Canine Eruption Interference

Case 11: Gloria, 9.3 y.o., Female

She is a 9-year-old girl in the second transitional phase of mixed dentition, presenting with moderate crowding in both arches. The skeletal and dental framework is consistent with a hyperdivergent Class II pattern (Fig. 33).

Panoramic and CBCT imaging revealed an incisor–canine eruption conflict, particularly pronounced on the left side, where the erupting canine was in close proximity to the vestibular surface of the maxillary left lateral incisor root (Fig. 34).

The combined use of a 2x4 appliance and a rapid palatal expander (ERP) allowed for the physiological eruption of both maxillary canines (Fig. 35).

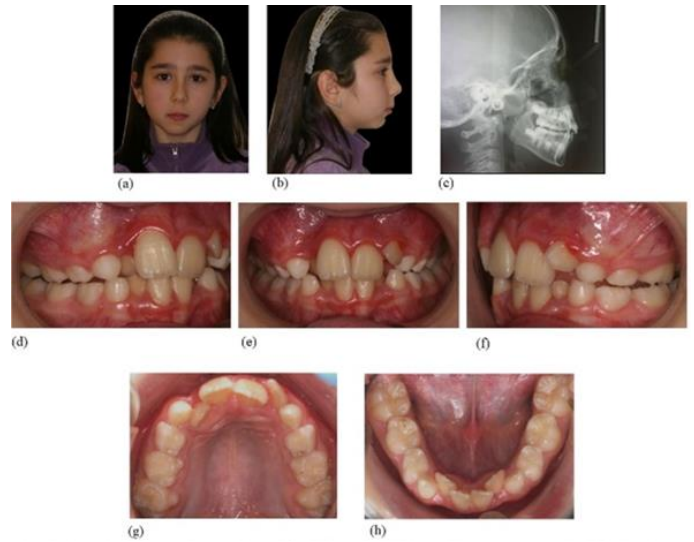


Figure 33: (a-c) Pretreatment extra oral photographs and tele-rx.(d-h) Intra oral photographs: crowding in both arches

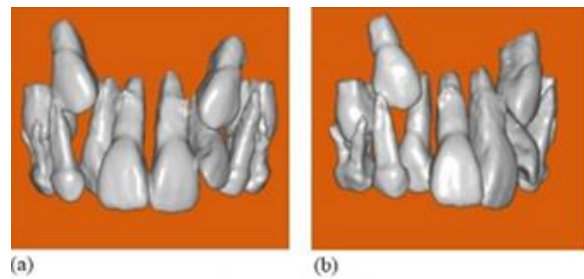


Figure 34(a-b): CBCT images showing incisor –canine eruption conflict



Figure 35: Intra oral photographs during and after treatment (d-e) Post Treatment intraoral photographs showing physiological eruption of both maxillary canines

Discussion

The case series presented highlights the clinical versatility and efficacy of the 2x4 appliance as an interceptive orthodontic tool in the mixed dentition stage. As demonstrated, it facilitates the correction of various malocclusions - such as anterior crossbites, crowding, open bites, and increased overjet - in a rapid and predictable manner, often within a single treatment phase^{2,25,26}.

A. Advantages of The 2X4 Appliance

This is a technique with numerous advantages, both in terms of clinical outcomes and patient acceptability amongst these:

- It is a cost-effective treatment:

The appliance is efficient in preventing malocclusion progression at an early developmental stage, reducing the need for future complex interventions^{14,7,27,28}.

- It has a high patient acceptance and is comfortable:

Its minimally invasive nature and low dependency on patient compliance make it well tolerated among children^{29,30}.

- It improves esthetics and has psychosocial impact:

Early correction of visible dental anomalies (e.g., anterior crossbite or diastema) has a significant positive influence on the child's self-perception and social interactions^{7,30}.

- It has three-dimensional control of tooth movement:

The appliance enables precise control over angulation, inclination, torque, and position of the anterior teeth while preserving the natural arch form^{4,6}.

- It requires minimal patient cooperation:

As a fixed appliance, it does not rely on the child or parents for activation or compliance²⁹.

- There is no need for laboratory fabrication:

The device can be fully prepared and placed chairside, which makes it time-efficient and economical²⁵.

- It is usually applied in a single visit:

The appliance can be bonded and activated in a single appointment, expediting treatment initiation³⁰.

- It can be used as a support for many auxiliaries and other appliances:

The 2x4 appliance can be combined with elastics, coil springs, or face masks to address a range of malocclusion types^{15,23,31}.

- It has no interference with speech or mastication:

The appliance is generally well tolerated in terms of oral function, especially compared to removable devices³.

- Usually its forces are light:

Compared to conventional full-arch appliances, the 2x4 system applies more controlled and physiologic forces, reducing risks associated with excessive pressure¹⁴.

Limitations and Considerations

Despite its many advantages, the 2x4 appliance presents some limitations and risks that must be carefully managed:

- Limited anchorage:

The anterior segment, especially maxillary incisors, may experience unwanted movement if posterior anchorage is insufficient¹⁵.

- Bracket debonding or discomfort from archwire extensions:

Long distal extensions of the archwire beyond the molar tubes can irritate soft tissues if not carefully adjusted.

- Oral hygiene management:

As with all fixed appliances, patients must maintain excellent oral hygiene to avoid decalcification, white spot lesions, or caries^{32,27}.

- Limited skeletal or muscular correction:

The 2x4 appliance primarily acts dentally. Unlike orthopedic removable appliances, it does not significantly modify jaw growth or muscle function³³.

- Not suitable for primary dentition:

It is contraindicated in cases where permanent incisors and molars have not erupted.

- Difficulty in band placement on unerupted molars: Partially erupted molars may not retain bands properly, potentially compromising anchorage or requiring bonded tubes.

Incisor Root Resorption

The real problem with using 2 x 4 is the potential conflict between the root of the lateral incisor and the crown of the canine during its intraosseous eruption. The canine has a serpentine descent that causes it to move mesially toward the root of the lateral tooth until age 9, then straightens^{34, 35}. Any distalization of the lateral root while the canine is mesializing could lead to root resorption.

Root resorption is a common consequence of orthodontic treatment and active tooth movement. However, it is important to note that root resorption can also occur in individuals who have not undergone orthodontic therapy³⁶.

Microscopic resorption is a necessary component of orthodontic tooth movement. Clinically, root resorption is considered significant only when there is a loss or shortening of 1–2 mm or approximately one-fourth of the root length³⁷.

Using radiographic assessments, Amlani demonstrated that appropriately selected cases treated with active orthodontic intervention during the early mixed dentition phase do not exhibit significant root resorption³⁸. Nevertheless, clinicians must carefully assess the inclination of the canines relative to the midline and the long axis of the lateral incisors when planning treatment.

Current literature provides limited scientific evidence regarding the adverse effects and complications associated with the use of 2x4 fixed orthodontic appliances during the mixed dentition phase in pediatric

patients. Further research is warranted to clarify these outcomes. The difficulty of conducting clinical trials that can provide operational guidelines does not, however, undermine the great versatility of a widely used device, which can be supported, if necessary, with intraoral radiographs.

Conclusion

Two-by-four appliance has been reported to be used commonly by orthodontists (93.94%) and about 50% of general dentists³⁹. Early active treatment resulting in increased patient self-esteem and parent satisfaction, improved and more stable results, and less extensive treatment needed later⁴⁰.

The 2x4 appliance represents a simple, well-accepted, efficient, and highly versatile interceptive orthodontic tool for addressing malocclusions during the mixed dentition stage. It enables the early correction of anterior dental discrepancies - such as crossbites, crowding, proclination, diastemas, and open bites - often in a matter of months and with minimal patient cooperation.

Given its ease of application, minimal reliance on laboratory support, and excellent tolerance among pediatric patients, the 2x4 appliance is particularly well-suited for use by pediatric dentists and general practitioners, provided they possess appropriate training in its biomechanics and clinical indications.

Importantly, early intervention using the 2x4 appliance has been shown to:

- Simplify or shorten later orthodontic treatment needs
- Improve facial and dental esthetics during a formative period in the child's psychosocial development
- Promote proper eruption patterns and arch form
- Avoid the worsening of malocclusion into the permanent dentition

While its dentally focused effects limit its use in cases requiring skeletal correction, it can be effectively combined with orthopedic or functional devices to broaden its therapeutic potential.

In conclusion, the 2x4 appliance offers a valuable clinical opportunity for early-phase intervention, especially when integrated into a broader interceptive strategy. Its use not only benefits the developing occlusion, but also contributes positively to the child's overall well-being and self-esteem. For these reasons, it should be considered an essential tool in the contemporary management of mixed dentition malocclusions.

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