Biological parking concept: proposal of a modular approach for the prevention of upper impacted canine in paediatric patients

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Abstract

Aim The aim of this paper is to propose a new concept of "biological parking" for the prevention of upper impacted canine in the early mixed dentition, illustrating the management of palatal expansion, followed by serial extraction of first deciduous molar and than deciduous canine.
Study Design The risk of impacted canine is detected by clinical examination, analysis of the intraoral scans and the panorex, in association with the presence of family history or other dental anomalies. In patients aged between 6 to 8 years old with maxillary transverse deficiency the treatment plan starts from palatal expansion, that can be performed with different type of expander. After the expansion and retention (9 to 12 months) a new panoramic x-ray is performed, in order to define the maturation stage of the upper first premolar, that has to be at least 50%, to carry out the extraction of the first deciduous molars. Before the extraction, the palatal expander can be substituted by a transpalatal arch or a Nance plate, to maintain the space and first molar position. When the early eruption of the first premolars is observed, the extraction of the deciduous canines can be performed. All subjects are periodically observed till the eruption of the maxillary permanent canines is clinically or radiologically assessed.
Results This approach, applied in the early mixed dentition, can obtain an important improving of the infrabony path of the canines, either in case of vestibular or palatal risk of impaction, because it promotes a guided acceleration of the eruption of the first premolar avoiding o reducing the risk of its mesial eruption and frees up space for the eruption of the canine, improving its inclination, better if associated with an open root apex. If pretreatment variables regarding the possible success of treatment on the eruption of canine are more severe, this approach can make easier the next surgical-orthodontic threrapy.
Conclusion Early maxillary expansion followed by the extraction first of the first milk molar and then of the deciduous canine, after the initial eruption of first premolars, in this exact sequence, can be effective in treating patients in early mixed dentition with risk of impacted canines.

KEYWORDS prevention of impacted canine, rapid palatal expander, leaf expander, RME, SME, Zeroexpander, first deciduous molar extraction, deciduous canine extraction, interceptive treatment, relative analgesia.

Introduction

Impacted maxillary canines are a relatively common condition, also associated with risks for the lateral incisors root resorption, longer treatment times and higher biological costs, to the detriment of quality of life. Prevention is typically based on early diagnosis (history, vestibular palpation at 9–10 years of age and radiological examination) and targeted interceptive interventions: selective extraction of deciduous teeth, transverse expansion, space management and long-term monitoring [Schindel et al., 2007 and 2013; Benson et al., 2021]. The aetiology is multifactorial with a genetic predisposition, but also other factors are implicated such as missing laterals and dental-skeletal discrepancy [Artmann et al., 2010; Becker et al., 2015]. A panoramic radiograph in early mixed dentition allows a first evaluation of the spaces and the possible eruption path of the canines with definition of sector, angulation and position of the canine cusp with respect to the lateral and central teeth [Eriksson and Kurol, 1988; Sambataro et al., 2004]. In cases with a not particularly unfavorable eruption path and adequate potential space, extraction of the deciduous canine alone between the ages of 10 and 11 can increase the likelihood of autonomous eruption of the permanent tooth, reducing the need for surgery and subsequent traction. An RCT in Angle Orthodontist showed significant improvements in eruption parameters after canine extraction [Bazargani et al., 2014]. The impact on pain and daily functioning in children is generally mild. When the risk of contact and root resorption is high, a CBCT of the affected area may be indicated to better define the three-dimensional position, while indiscriminate use should be avoided in low-risk cases [Pakbaznejad et al., 2020]. The literature describes associations with other dental anomalies (e.g., agenesis of the lateral incisors, microdontic lateral incisors with reduced eruptive vis, distal eruption path of the lower second premolars) and a higher incidence of ectopic canine teeth in females as early as 6 to 8 years of age, supporting the need for an earlier initial radiographic examination in mixed dentition and targeted follow-up [Diaz Gonzales et al., 2022]. This means that at 9-10 years of age, it may be too late for interceptive and preventive therapy for impaction risk. Maxillary transverse deficit is a key and contributing factor to the risk of maxillary canine impaction. A randomised trial [Baccetti et al., 2009] documented that early rapid maxillary expansion (RME) increases the eruption rate of canines at risk of palatal impaction as well as the use of the headgear [Baccetti et al., 2008]. An EJPD study [De Stefani et al., 2021] summarised, in a systematic review, the rationale and interventional protocols for RME in this context. On the other hand a study i reported that slow/controlled expansion at an early age improves developmental conditions of the "canine sector" and may reduce the need for more complex interventions in the long term [Willems et al.,

2023]. Timing is crucial: the effectiveness of deciduous tooth extraction and expansion decreases when the canine cusp is already beyond the axis of the lateral or when the angulation exceeds critical thresholds or in association with other dental anomalies. In such scenarios, interceptive intervention has a lower probability of success and it is recommended to subsequently plan surgical exposure with traction. Since the literature suggests "minimally invasive" approaches and paediatric radiation protection guidelines and standards recommend a judicious use of CBCT limited to cases with radiographic markers or clinical signs of increased risk [Kühnisch J. et al., 2019; Kalavritinos et al., 2020], it is essential to identify as early as possible a potential risk of impaction, even associated with other issues affecting the patient's development and growth during childhood [Topkara et al., 2012; Pavoni et al., 2014], in order to implement predictable treatment protocols that considerably improve the prognosis and simplify the subsequent surgical-orthodontic approach in the most complex cases, improving the relative prognosis and the patient's quality of life.

The classic preventive pillars (summary):

- Extraction of the deciduous canine in selected cases, increasing the likelihood of autonomous eruption and reducing the need for complex corrective treatments.
- Maxillary expansion when transverse discrepancy coexists, improving space conditions in the canine sector and the eruption rate.
- Headgear has also been considered as a viable approach, but its use is preferred for Class 2 cases with a predominantly maxillary component and requires a high level of collaboration [Armi et al., 2011].

Typical Practical Implications (summary)

- Screening at 8–10 years with palpation and panoramic imaging; use CBCT only if indicated by risk markers.
- If palatal displacement and potential space preserved: extraction of the deciduous tooth and follow-up at 6–12 months.
- If transverse deficit coexists: expansion (RME/SME) during growth [Ugolini et al., 2024].
- In case of an unfavorable prognosis (advanced sector, severe angulation, contact with the lateral aspect): plan the corrective treatment (exposure + traction) with the corrective timing, minimising iatrogenic risks.

A very interesting 2011 study [Alessandri Bonetti et al., 2011] compared the efficacy of single (one deciduous canine) and double simultaneous (deciduous canine and first molar) extractions in subjects aged 8 to 13 years with maxillary permanent canines positioned palatally or centrally in the alveolar ridge, at risk of impaction and root resorption of adjacent permanent teeth. The double extraction group showed significant improvements in the success rate and intraosseous position of the permanent canine, in terms of straightening the canine's long axis with distal crown movement, compared to the canine extraction group alone. Clinical and radiographic follow-ups are indicated 12 to 18 months (or even more, depending on the patient's age at the initial observation) after removal of deciduous teeth to follow permanent canine eruption tendency over time. The suggested observation period can be even different from the literature. Baccetti et al. in 2009 reported a follow-up of 4.4 years for the treatment group, Armi et al. [2011] reported a followup of 18 months while Koutzoglou & Kostaki [2013] considered the observation period concluded with a complete maturation of the canine root.

Aim

Starting from these considerations and according to an integrated approach between Paediatric Dentistry and Interceptive Orthodontics [Beretta et al., 2022], in diagnosis and treatment plan for every child (i.e. if I treated with a restoration a decayed deciduous tooth and then shortly after I took it out, I wouldn't be making a good treatment plan), the aim of this paper is to propose the new concept of "biological parking" for the prevention of upper impacted canine in the early mixed dentition, illustrating the management of palatal dimension, followed by serial extraction of first deciduous molar and than deciduous canine.

Study Design

We know that canine inclination to the midline increases mesially until the maximum angle is reached at approximately 9 years of age; then it straightens again with horizontal movement of the cusp in a distal direction [Fernandez et al., 1998; Alessandri Bonetti et al., 2009]. The risk of impacted canine is detected by clinical examination, analysis of the intraoral scans and the panorex, in association with the presence of family history or other dental anomalies [Baccetti et al., 2010; Cardoso et al., 2014; Fabiani et al., 2017]. Regarding age, it was found that at the age from 8 years to 10 years there is a higher percentage of ectopic eruption than a younger age group [Diaz et al., 2022]. The data obtained show a greater predisposition to ectopic eruption of the permanent maxillary canine in the oldest group of patients (8 years 6 months to 10 years). So it can be assumed that an earlier approach could be better for the prognosis and treatment results. If we do not need to proceed with serial extraction of the permanent teeth, there is the possibility of space loss after extraction of the deciduous teeth, if done alone, especially when there is not enough space in the upper arch or in case of maxillary deficiency, so can be better to start the treatment to create space for the canine with expansion and to correct indirectly its position in the dental arch, once the clinician has taken into proper account canine inclination, mesiodistal position, and their potential effect on incisor root resorption [Amlani et al., 2007]. Authors suggest to associate maxillary expansion with deciduous canine extraction or prevention of mesial movement of the upper first molars [De Stefani et al., 2021]. It can be suggested that the best outcome can be obtained when expansion is associated with extraction of deciduous teeth and an appliance that prevents the mesial movement of the first molars [McNamara 2003]. Mesial diplacement of the premolars can be considered a dental anomaly associated to maxillary canine displacement and risk of impaction [Mucedero et al., 2015] The clinical relevance of the current investigation is that early diagnosis of mesial displacement of the upper first premolar may reveal a potential risk of subsequent malposition and eruption anomaly of the adjacent permanent canine. Early detection of a mesially displaced premolar associated to a malposed maxillary canine provides to the clinician the possibility to perform the treatment of choice to prevent canine impaction and root resorption of the adjacent teeth.

Biological Parking concept

The removal of the deciduous first molar, if at least half of the premolar's root is formed, accelerates eruption and promotes uprighting of the first premolar [Dale, 1976; Dale, 2000]. This frees up space for the eruption of the canine, improving the inclination of its crown in a distal direction into alveolar bone, avoiding the possible further mesial eruption of the premolar

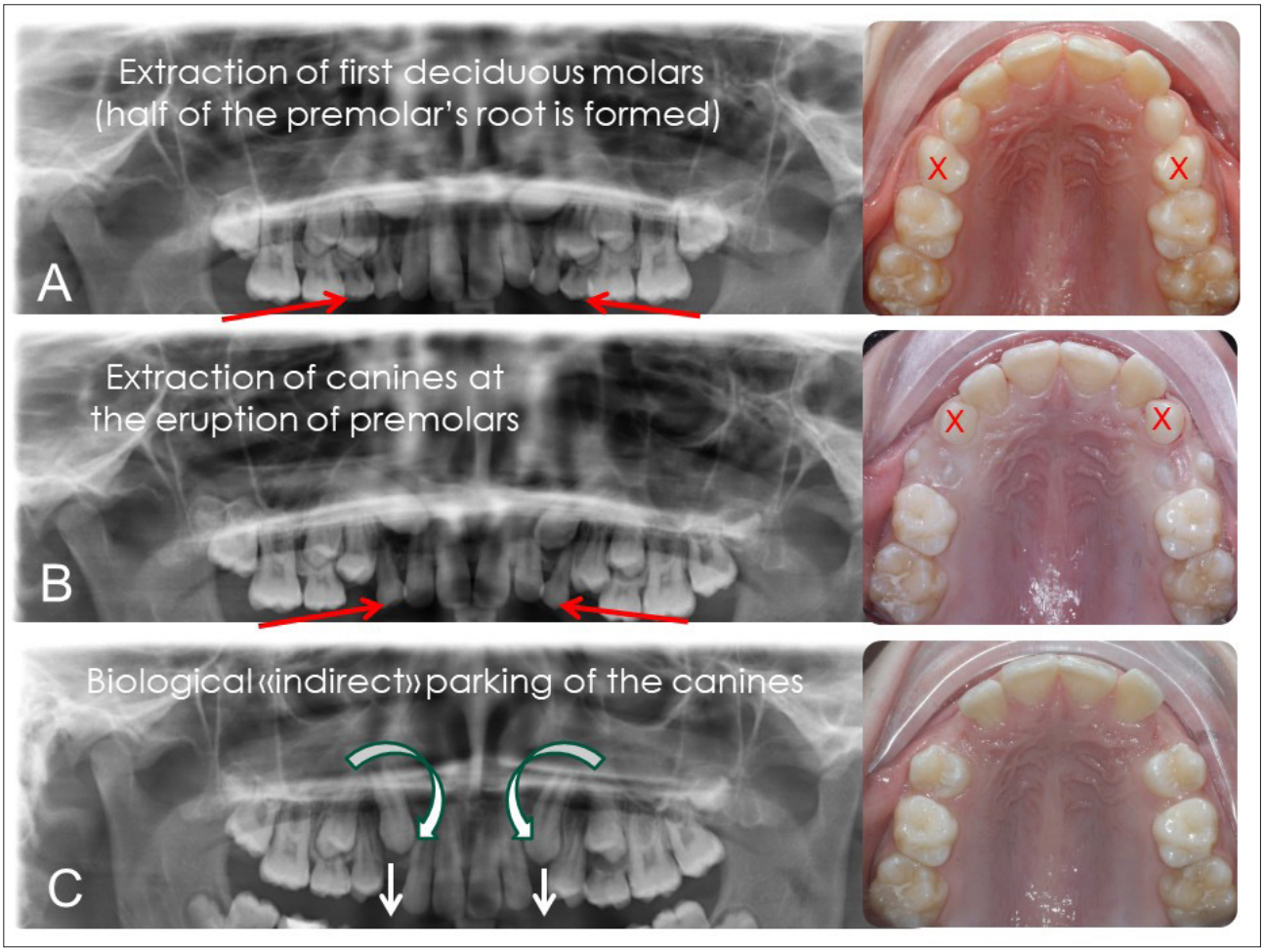

FIG. 1

which could occur by extracting the deciduous canine at the same time, especially in the presence of the mesial diplacement of the premolars. The eruption path of the canine can further improve with the subsequent extraction of the deciduous canine, performed at the first stage of eruption of the premolar (Fig.1 a, b, c: principles of biological "indirect" parking by means of sequential extraction of 5.4 and 6.4 and than of 5.3 and 6.3).

The literature indicates that rapid and slow maxillary expansion leads to comparable clinical outcomes [Agostino et al., 2014; Lo Giudice et al., 2017]. However, slow expansion has the advantage of being more gentle and more comfortable for the patient who experiences minor pain [Lagravère et al., 2005; Rutili et al., 2022] and it is possible to achieve it without collaboration from the family and the patient [Lanteri et al., 2018; Beretta et al., 2019; Beretta et al. 2021 and 2023; Tong et al., 2025]. In patients aged between 6 to 9 years old (depending on the individual time of the first phase of transition) with maxillary transverse deficiency, after the risk assessment of canine inclusion by clinical examination, analysis of the intraoral scans and the panorex, in association with an accurate medical history to search the presence of familiarity for other dental anomalies, the treatment plan starts from palatal expansion [Schneider-Moser, 2022], that can be performed with different type of expander anchored on deciduous teeth like RME [Rosa et al., 2016; Caprioglio et al., 2020], Leaf Expander [Lanteri et al., 2016; Beretta et al., 2019] or ZeroExpander [Beretta et al., 2021]. After the expansion and retention (9 to 12 months) a new panoramic x-ray is performed, in order to define the maturation stage of the upper first premolar, that has to be at least 50%, to carry out the extraction of the first deciduous molars, using local anesthesia in addition to the relative analgesia [Arcari et al., 2025] promote the best comfort for the little patient. Before the extraction, the palatal expander can be substituted by a transpalatal arch or a Nance plate, to maintain the space and first molars position. When the early eruption of the first premolars is observed, the extraction of the deciduous canines can be performed. All subjects are periodically observed, in the context of the interceptive treatment and with an informed dynamic involvement of families (especially when in complex cases the prognosis is reserved), till the eruption of the maxillary permanent canines is clinically or radiologically assessed.

Case reports

We present a summary of 5 case reports to illustrate the application of the "Biological Parking Concept" with different space management.

Case 1 (fig. 2): female of 7 years old with the risk of impaction of 1.3 and root resorption of 1.2, family history for upper lateral incisors agenesis and impacted canines, treated with RME, transpalatal bar and symmetric extraction of 5.4 and 6.4 and than of 5.3 and 6.3. Active treatment duration 20 months and follow up after 18 months with the complete eruption of both the canines.

FIG. 2

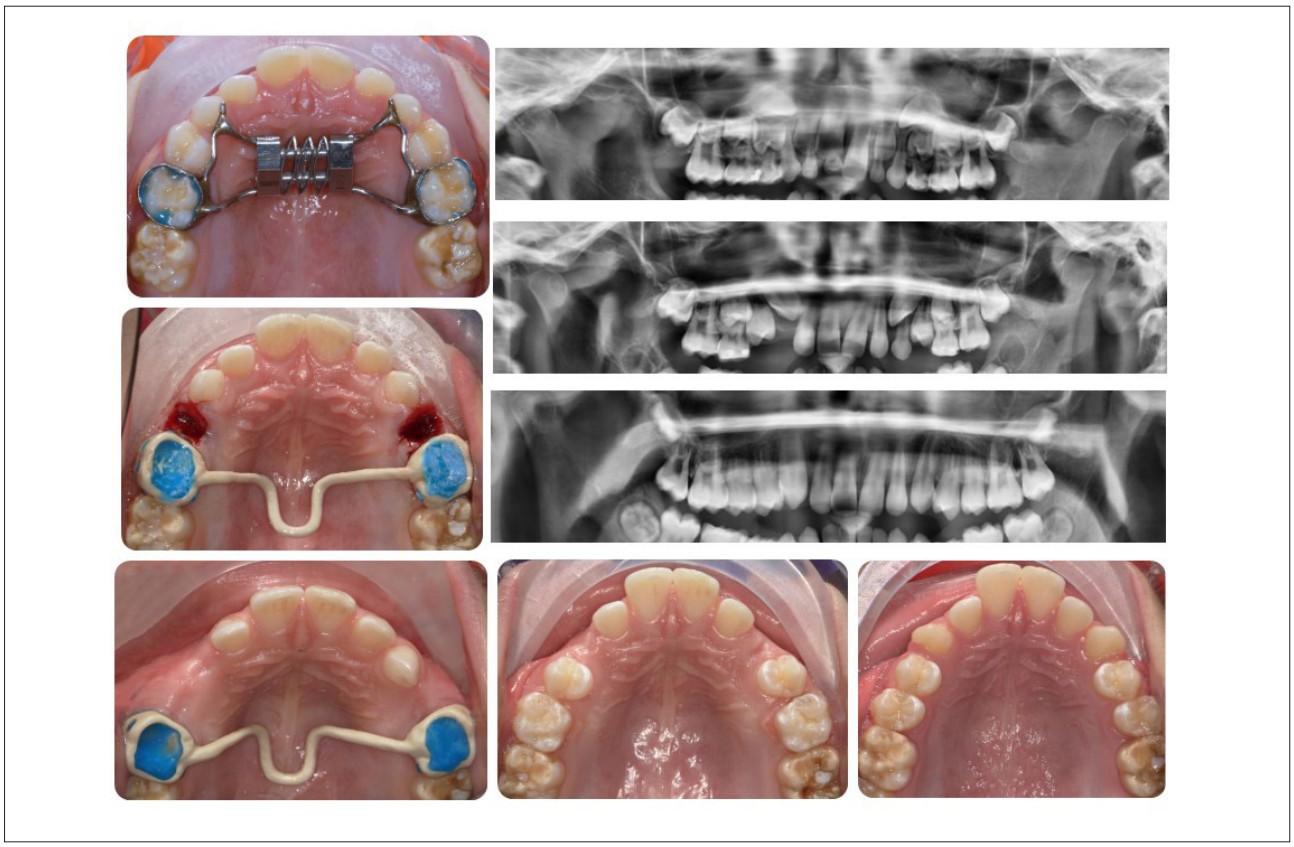

FIG. 3

FIG. 4

Case 2 (fig. 3): male of 6.8 years old, who lived abroad (clinical visits every 3 to 4 months) with a high risk of impaction of 1.3 and 2.3, family history for upper impacted canine, presence of MIH, treated with a Leaf Self Expander, peek transpalatal bar [Paglia et al., 2022] and extraction of 5.4 and 6.4 and than of 5.3 and 6.3. Active treatment duration 24 months and follow up after 20 months with the complete eruption of both the canines.

Case 3 (fig. 4): female of 8 years old with a high risk of impaction of 2.3 and the risk of root resorption of 2.2, nickel allergy and gag reflex, treated with ZeroExpander, active printed transpalatal bar in PA12 touching palatal vault [Campobasso et al., 2023], and simultaneous extraction of 5.4 and 6.4 and than of 5.3 and 6.3. Active treatment duration 18 months and follow up after 18 months with the complete eruption of both the canines.

Case 4 (fig. 5): male of 7.6 years old with a high risk of impaction of 1.3 and 2.3, family history for dental anomalies, without space problems, treated with a passive peek transpalatal bar, and symmetric extraction of 5.4 and 6.4 and than of 5.3 and 6.3. Active treament duration and observation 24 months and follow up after 18 months with the complete eruption of both the canines.

Case 5 (fig. 6): female of 7.2 years old with a very high risk of impaction of 1.3 and 2.3, family history for severe upper impacted canine, dental trauma during vacation abroad on upper central incisors, endodontically treated with an open apex approach, expanded with RME, followed by transpalatal bar to derotate upper first molars, symmetric extraction of 5.4 and 6.4 followed by 5.3 and 6.3 and than stabilised with a Nance palatal arch. Active treatment duration 20 months and follow up after 18 months with the partial eruption of 1.3, associated to an improvement of 2.3, that promote an easier surgical-orthodontic approch with a better prognosis, also related to the management of 1.1 and 2.1.

Results

This approach, applied in the early mixed dentition, can obtain an important improving of the infrabony path of the canines, either in case of vestibular or palatal risk of impaction, because it promotes a guided acceleration of the eruption of the first premolar avoiding o reducing the risk of its mesial eruption and frees up space for the eruption of the canine, improving its inclination, better if associated with an open root apex. Assuming that a correct initial and dynamic informed consent for the families is essential regarding the diagnosis and the relative treatment goals, if pretreatment variables in terms of the possible success of treatment on the eruption of canine are more severe, this approach can make easier the next surgical-orthodontic threrapy.

Conclusion

Early maxillary expansion followed by the extraction first of the first deciduous molar and then of the deciduous canine, only at the beginning of the eruption of first premolars, in this exact sequence, can be an effective alternative in treating patients in early mixed dentition with risk of impacted canines,

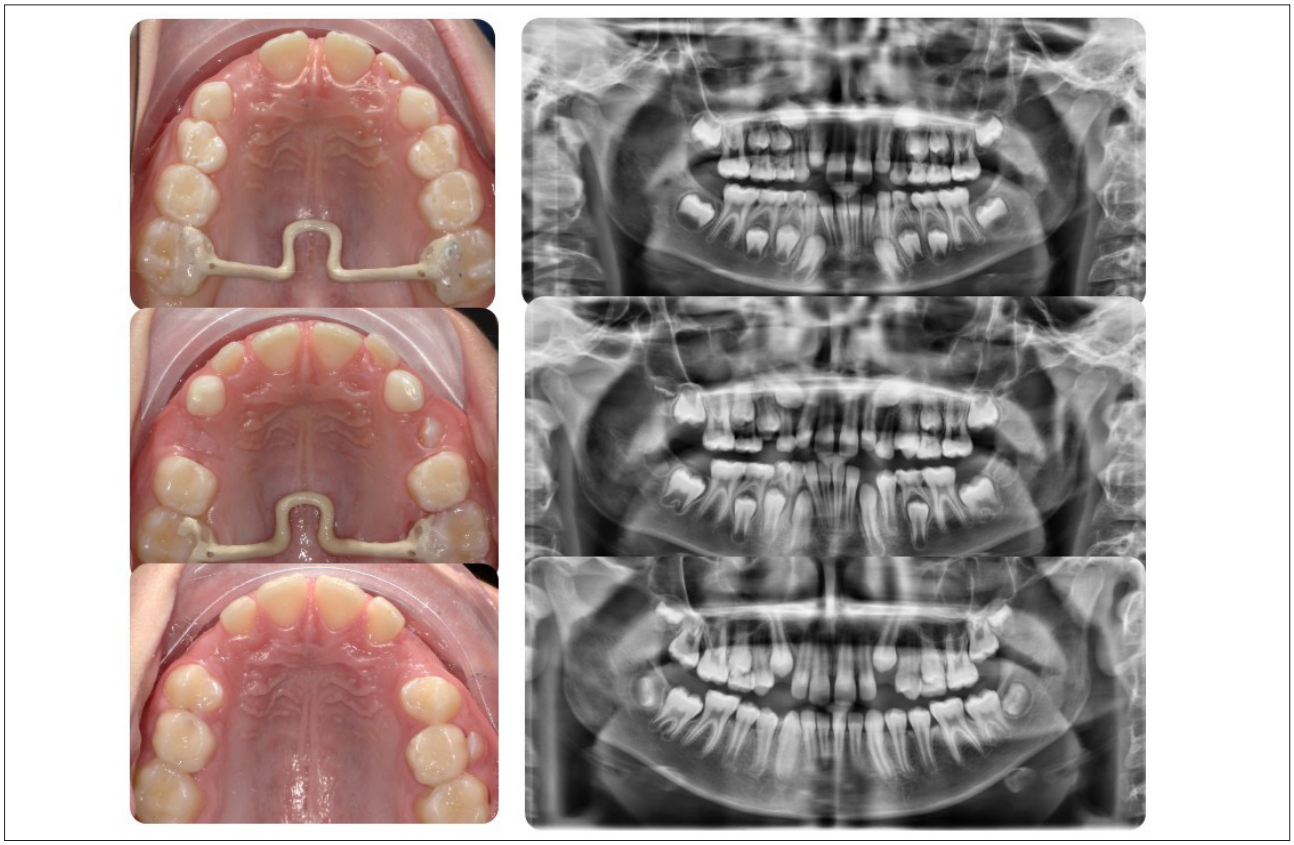

FIG. 5

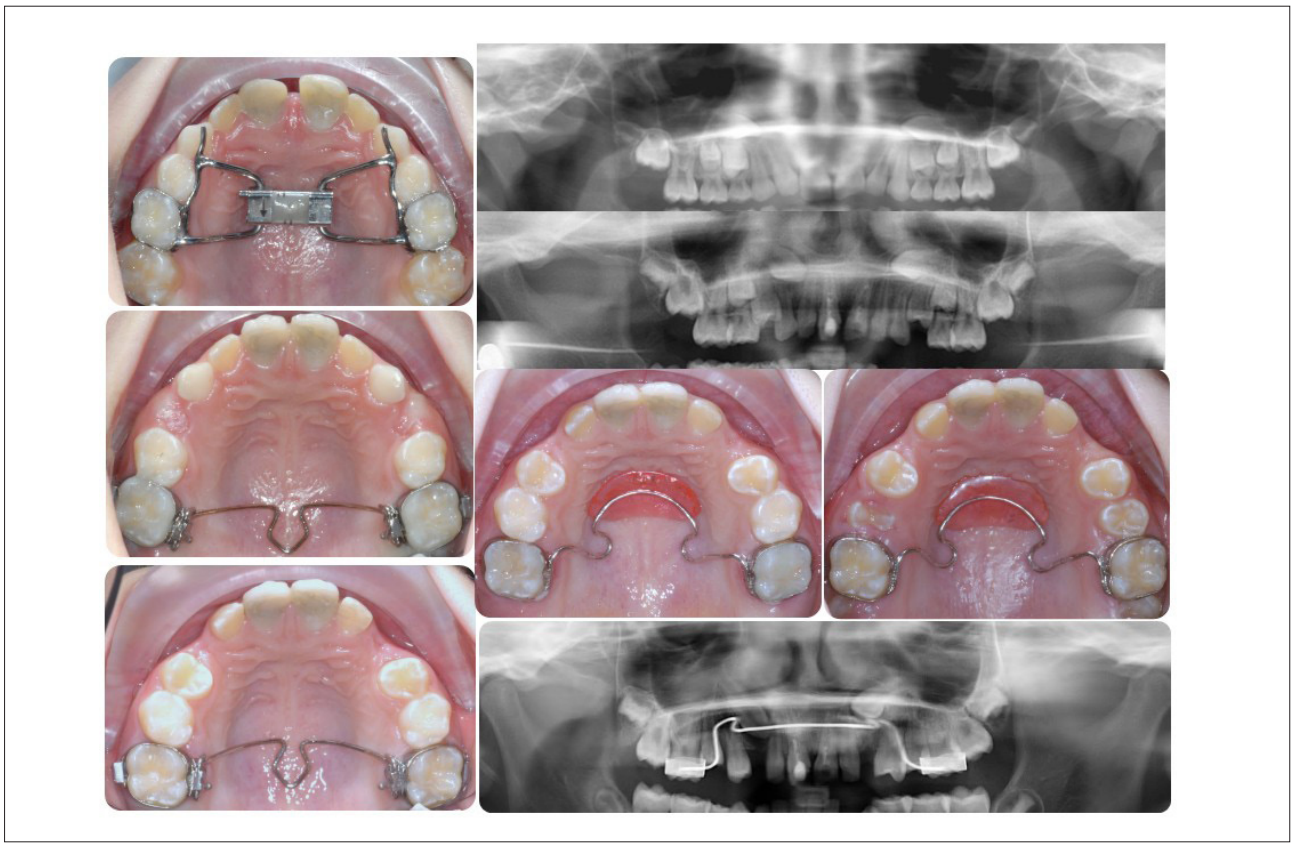

FIG. 6

because the permanent canine follows an indirect guide for its eruption path to the dental arch. This approach can be even useful in presence of dental caries of the deciduous teeth, where an integrated treatment can plan at the right time and in the right way the extraction of the decayed tooth, instead of restoration, which would be useless, and also in more complex cases with multiple ectopic eruption paths, where managing the correct time of extraction of deciduous teeth, maybe associated with a surgical-orthodontic approach for the permanents, guides the succes of the treatment. Authors highlight the need to conduct further high-quality resarch to better define the treatment protocols proposed and outcomes for the patients, using standardised measurements of the images to validate and improve the current findings.

Author Contributions

M.B., F.F.C and N.C.: Conceptualisation and Writing original draft; A.G. and L.Z.: Formal Analysis and Validation. All authors have read and agreed to the published version of the manuscript.

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