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CASE REPORT

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Combined use of molar distalization and leeway space for class II division 1 malocclusion with odontoma-induced impacted maxillary right lateral incisor in the mixed dentition: a case report

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Abstract

Background Treatment for Angle's Class II division 1 involves both extraction and non-extraction orthodontic therapy. Managing Class II division 1 malocclusion accompanied by maxillary anterior tooth impaction and anterior crowding in mixed dentition poses a therapeutic dilemma. Premolar extraction may face traction failure in the impacted tooth, resulting in excessive tooth loss, while extracting impacted teeth may compromise occlusion and anterior aesthetics, necessitating future restoration. Molar distalization as a non-extraction approach often face challenges in providing sufficient space for aligning impacted teeth and simultaneously retracting proclined anterior teeth and improving the facial profile. This study describes a non-extraction orthodontic treatment plan for Class II division 1 malocclusion accompanied by maxillary anterior tooth impaction and anterior crowding in mixed dentition.

Case presentation An 11-year-old girl was diagnosed with Class II division 1 malocclusion and impaction of the maxillary right lateral incisor caused by an odontoma. A non-extraction treatment plan was implemented, involving first the distalization of the maxillary molars and utilization of the leeway space to create an eruption space, followed by surgical exposure and orthodontic traction, and finally, anterior teeth retraction and mandibular advancement guided by Class II elastics. After 39 months, the impacted maxillary right lateral incisor was successfully aligned, achieving Class I molar and canine relationship with a normal overbite and overjet and an improved facial profile.

Conclusions Molar distalization and use of the leeway space can avoid the need for tooth extraction during orthodontic treatment. Molar distalization and use of the leeway space can provide sufficient space to correct Class II molar relationship, align impacted teeth, and retract the maxillary anterior teeth. Retraction of the maxillary anterior tooth and guidance for mandibular advancement can improve the lateral facial profile.

Keywords Molar distalization, Leeway space, Class II malocclusion, Impacted incisor, Non-extraction, Odontoma

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Background

The prevalence of Angle Class II malocclusion among children and adolescents was 23.8%, with a prevalence of 16.7% in Angle Class II division 1 [1]. Treatment for Angle Class II malocclusion includes extraction and non-extraction therapy. In extraction therapy, the removal of the premolars is a common approach for treating Class II malocclusion. In non-extraction therapy, distalization of the maxillary molars is frequently used to treat Class II malocclusion.

Malocclusion is commonly associated with impacted teeth. The prevalence of impacted teeth in children and adolescents is approximately 4.9% [1]. Among the impacted maxillary anterior teeth, the canines are the most frequently affected, followed by the incisors [2]. Impacted maxillary incisors are the most commonly caused by supernumerary teeth, accounting for 47% of cases, whereas odontomas are responsible for only 9% of cases [3].

In the mixed dentition stage, when Angle Class II malocclusion is accompanied by impaction of the maxillary anterior teeth and anterior crowding, both extraction and non-extraction therapies present dilemmas. Some authors have addressed this issue by extracting the first premolars and using orthodontic traction to align the impacted teeth, thereby achieving a distal molar relationship [4, 5]. Although this approach provides sufficient space, there is a risk of traction failure in impacted teeth [6]. In a 27-year retrospective study on treatment modalities for maxillary impacted canines in children and adolescents, the failure rate of surgical exposure combined with orthodontic traction was 28.6% [7]. Another study reported a failure rate of 10% for surgical exposure combined with orthodontic traction of impacted maxillary incisors [8]. Additionally, some studies have discussed direct extraction of the impacted incisor, followed by orthodontic space closure or maintenance of the space until the patient reaches adulthood for subsequent implant or restorative treatment [5, 8]. While this approach addressed the issue of impacted teeth and shortened the orthodontic treatment duration, it also implied that any restorative solutions would only be temporary until around the age of 18 years, when growth ceased and more permanent solutions could be implemented [8]. Furthermore, the extraction of impacted teeth may result in significant alveolar bone loss, thereby compromising future implant sites [8]. Some authors adopted the "molar distalization" approach to treat such patients [9]. This approach aligns impacted teeth and preserves dentition integrity. However, there is a risk of relapse of the molar position and space loss [10], and this approach encounters challenges when the patients have the need for retracting their proclined maxillary anterior teeth. The use of miniscrews for en masse retraction of the maxillary dentition to correct Class II division 1 malocclusions has been reported previously [11]. However, this approach is more suitable for cases with well-aligned dental arches and no associated impacted teeth.

In mixed dentition space management, the leeway space—generated after the replacement of deciduous canines and molars by their permanent successors, particularly when the second deciduous molar is replaced by the second premolar—is often utilized to address anterior crowding [12]. Clinical studies on the utilization of leeway spaces to resolve crowding have primarily focused on preventive and interceptive treatments. Space maintainers, including the lingual arch, lip bumper, transpalatal arch, and Nance button, are commonly used to preserve arch length and passively utilize the leeway space to alleviate crowding [13–15]. There have been no reports on the use of the maxillary leeway space in the treatment of Class II malocclusion.

This case report describes a patient with mixed dentition and Angle Class II division 1 malocclusion complicated by an impacted maxillary right lateral incisor and anterior crowding. The patient was treated using a combined approach of molar distalization and utilization of the leeway space. This treatment successfully aligned the impacted teeth, restored Class I molar and canine relationship, and retracted the maxillary anterior teeth, resulting in an ideal occlusion and profile.

Diagnosis and etiology

An 11-year-old girl presented to the orthodontic department of The Second Hospital of Hebei Medical University with a complaint of non-eruption of the maxillary right anterior tooth. Four months prior, the patient underwent surgical intervention for odontoma in the maxillary right anterior region at the Department of Oral and Maxillofacial Surgery. Preoperative cone-beam computed tomography (CBCT) revealed a well-defined high-density radiopacity beneath the impacted maxillary right lateral incisor (Fig. 1). Postoperatively, the maxillary right lateral incisor has not erupted. The patient denied a history of trauma, systemic disease, family history, or orthodontic treatment.

Extraoral examination revealed balanced facial symmetry, harmonious facial thirds, and a convex profile (Fig. 2). No abnormalities were detected on temporomandibular joint examination.

Intraoral examination revealed a maxillary midline deviation of 1.5 mm to the right side. The maxillary right lateral incisor was unerupted, with a space of approximately 2.5 mm, and both maxillary second primary molars were retained. Neither the maxillary second premolars nor the second molars erupted bilaterally. The molars and canines on both sides exhibited Class II relationship with an anterior deep overjet of 5.6 mm.

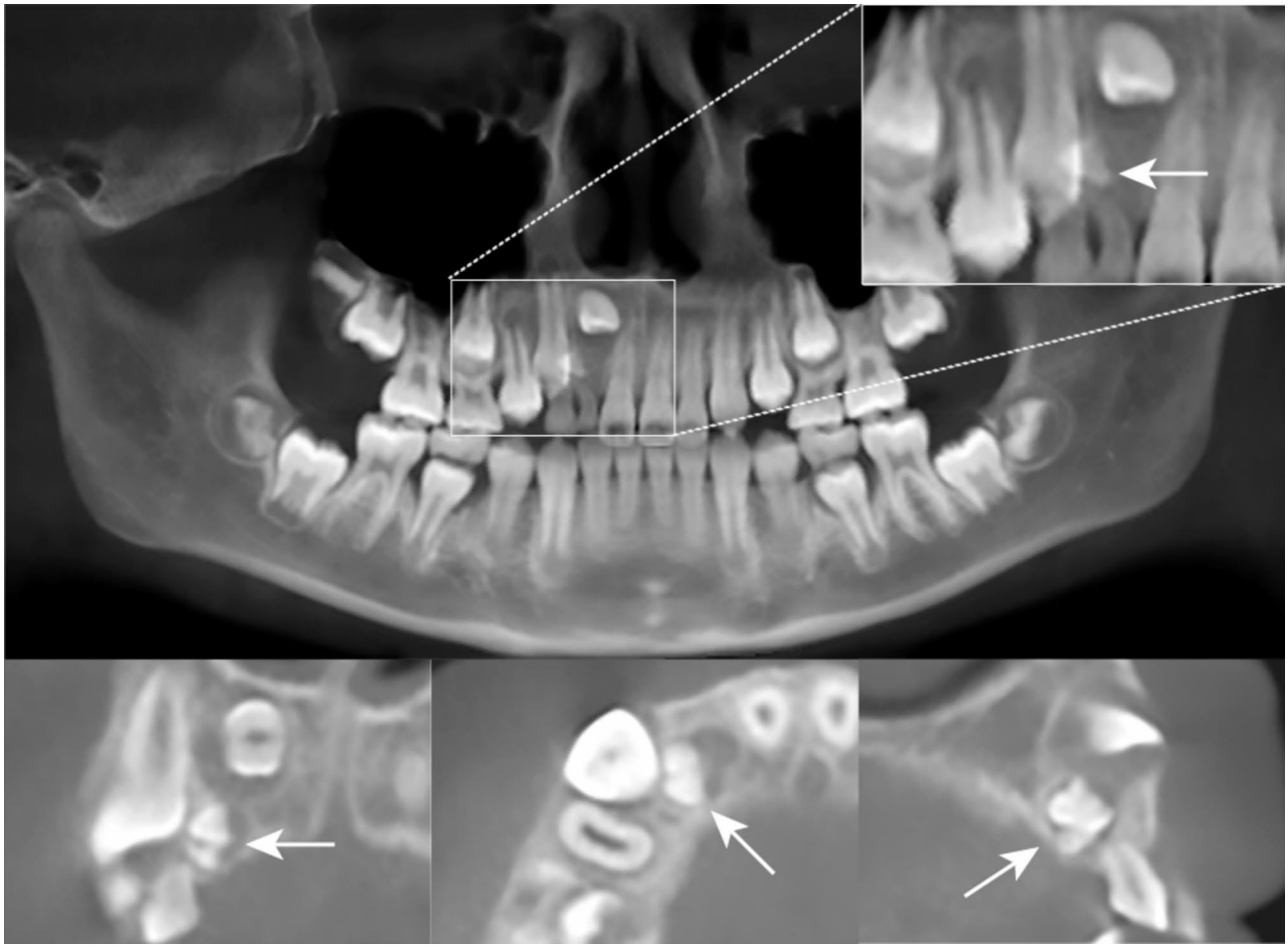

Fig. 1 CBCT images of the odontoma (white arrow) before surgical removal

Mandibular dentition was permanent with no crowding (Figs. 2 and 3). A lateral cephalogram revealed a Class II skeletal pattern, and the inclination of the maxillary incisors was within normal limits (Fig. 4A; Table 1).

The patient was diagnosed with Class II division 1 malocclusion and impaction of the right maxillary lateral incisor.

Treatment objectives

The main treatment objectives were to (1) align the impacted maxillary right lateral incisor into the arch, (2) achieve a normal anterior overbite, overjet, and Class I occlusal relationship, and (3) enhance the facial profile for a more favorable esthetic outcome.

Treatment alternatives

Here are the three treatment options as follows:

The first option was a non-extraction plan that involved distalizing the maxillary molars and utilizing the maxillary leeway space resulting from the replacement of the deciduous molars, combined with orthodontic traction to align the impacted maxillary right lateral incisor and retracting the anterior maxillary teeth. This approach avoids extractions but might pose risks such as limited anterior retraction, minor profile improvement, and possible failure of impacted tooth traction.

The second option involves extraction of the bilateral maxillary first and mandibular second premolars combined with orthodontic traction of the impacted maxillary right lateral incisor, which would be more favorable for occlusal adjustment and profile improvement. However, there is also a risk of traction failure.

The third option is to extract the impacted maxillary right lateral incisor, maxillary left first premolar, and bilateral mandibular second premolars. This approach avoids the risk of orthodontic traction but requires reshaping of the canine, with the potential need for crown restoration to simulate the morphology of the maxillary right lateral incisor. However, this option does not provide ideal intercuspation of the right maxillary or mandibular teeth.

The patient and her family rejected the extraction option and opted for the first treatment plan.

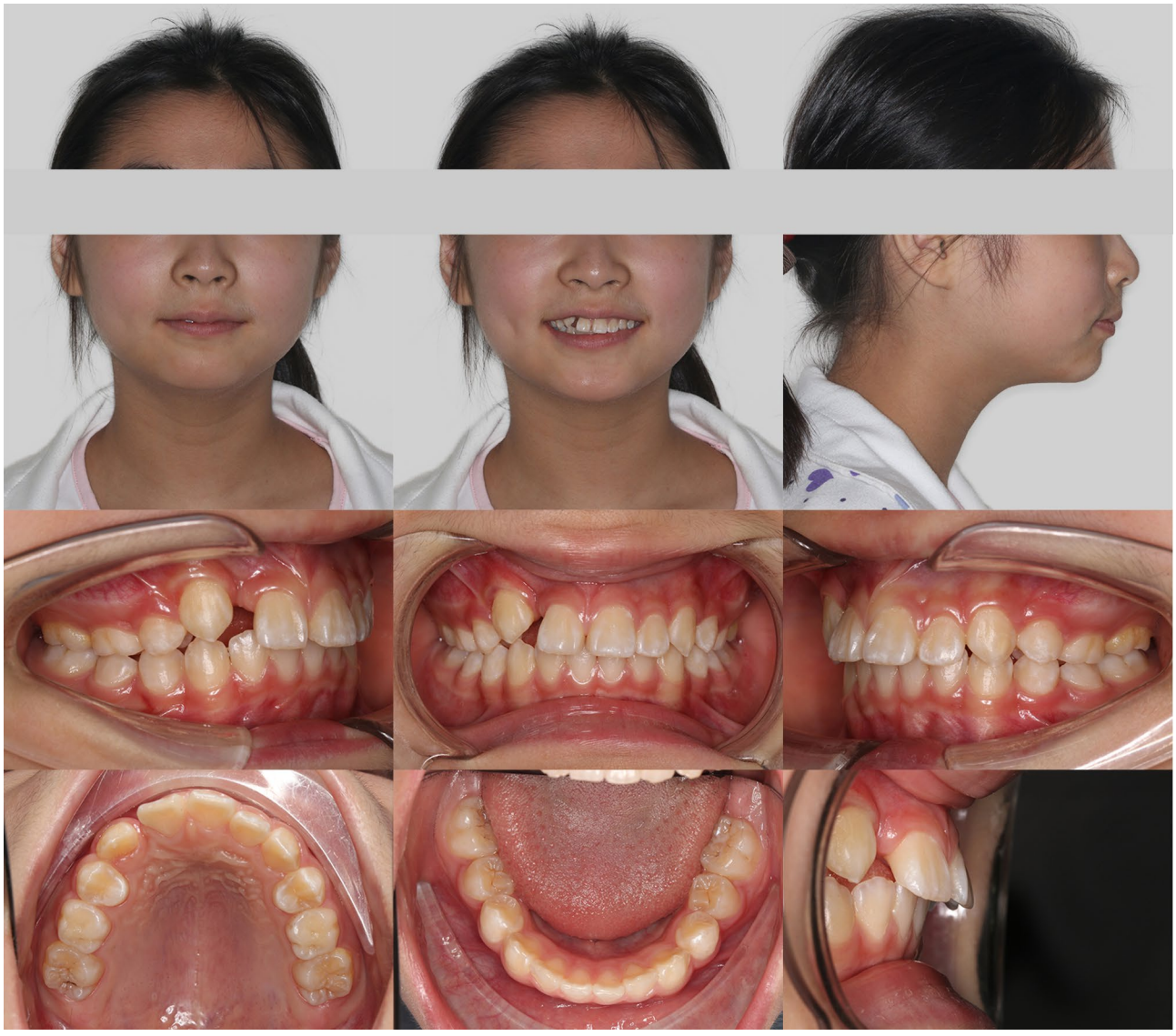

Fig. 2 Pre-treatment facial and intraoral photographs

Treatment progress

Pendulum and mandibular fixed appliances were initially used (Fig. 5A). Subsequently, fixed appliances were installed in the maxillary arch (3 weeks later). After 5 months of distalizing the maxillary first molars, sufficient space was created, with the maxillary second premolars mostly erupted (Fig. 5B). At this point, the pendulum was removed, and a 0.016-inch stainless-steel round archwire with stop bends was utilized to prevent anterior movement of the maxillary first molars (Fig. 5B). Class II elastics were used to distalize the maxillary canines, creating space for the eruption of the impacted maxillary right lateral incisor and retracting the upper anterior teeth (Fig. 5B). By the 10-month, the bilateral maxillary canines achieved a Class I relationship, and sufficient space was prepared for the eruption of the impacted maxillary right lateral incisor, with a mild deviation of the maxillary midline (Fig. 5C). Surgical exposure and orthodontic traction were applied to the impacted right maxillary lateral incisor (Fig. 6). Fully alignment of the impacted maxillary right lateral incisor with the arch took 24 months. At 39 months, the orthodontic treatment was completed, and clear vacuum-formed retainers were fabricated for the patient to maintain the treatment outcomes.

Treatment results

The leeway space was approximately 1.4 mm. As per the measurement method described by Önçag et al. [16], the maxillary first molars were distalized by approximately 2.5 mm. The impacted maxillary right lateral incisor was successfully aligned into the arch, achieving Class I molar and canine relationship with normal overbite and overjet,

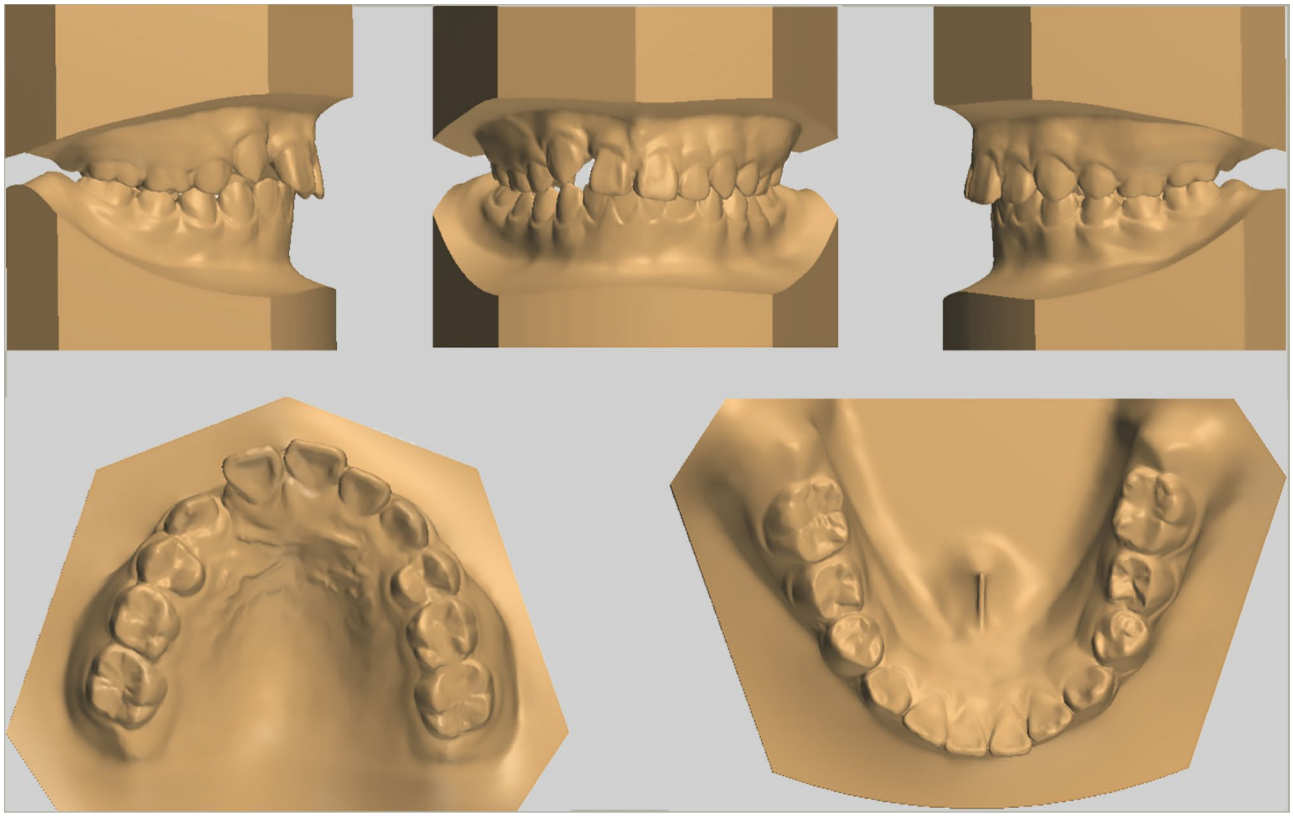

Fig. 3 Pre-treatment dental casts

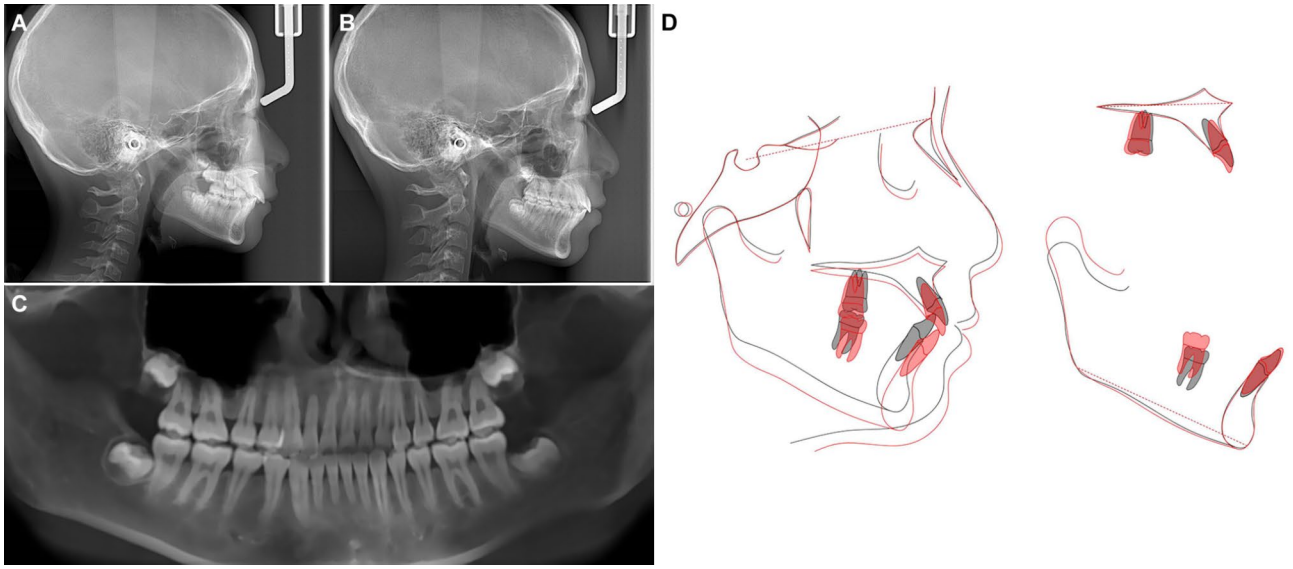

Fig. 4 **A**. Pre-treatment lateral cephalogram. **B**. Post-treatment lateral cephalogram. **C**. Post-treatment panoramic radiograph. **D**. Superimposition of cephalometric tracings before (black line) and after (red line) treatment

midline alignment, and an improved facial profile (Figs. 7 and 8). Cephalometric analysis indicated a certain degree of forward growth of the mandible, accompanied by counterclockwise rotation (SNB increased from 71.9° to 72.9°, SNA changed from 77.9° to 78.1°, ANB decreased from 6.0° to 5.2°, SN-MP angle decreased from 37.3° to 36.3°, and Y-axis angle decreased from 61.2° to 59.8°) (Table 1; Fig. 4A, B, and D). The axial inclination of the upper incisors was significantly palatally upright after treatment (U1-SN decreased from 108.3° to 96.8°, and

Table 1 Cephalometric measurement

Measurement	Normal	Pretreatment	Posttreatment
SNA(°)	82.8 ± 4.0	77.9	78.1
SNB(°)	80.1 ± 3.9	71.9	72.9
ANB(°)	2.7 ± 2.0	6.0	5.2
FH-NP(°)	88.6 ± 3.0	82.9	84.9
NA-PA(°)	4.9 ± 3.0	13.8	11.0
U1-NA(°)	22.8 ± 5.7	30.4	18.7
L1-NB(°)	30.5 ± 5.8	33.4	34.7
U1-L1(°)	124.2 ± 8.2	110.2	121.5
U1-SN(°)	105.7 ± 6.3	108.3	96.8
SN-MP (°)	32.5 ± 5.2	37.3	36.3
L1-MP(°)	93.9 ± 6.2	104.2	105.4
Y-Axis(°)	60.3 ± 3.4	61.2	59.8

U1-L1 increased from 110.2° to 121.5°) (Table 1; Fig. 4A, B, and D).

The right maxillary lateral incisor demonstrated normal pulp vitality and no mobility; however, gingival recession was observed on the labial side (Fig. 7). Panoramic radiograph showed that the root length was acceptable (Fig. 4C). CBCT examination revealed varying degrees of labial, mesial, and distal alveolar bone resorption (Fig. 9).

The results remained unchanged at the 12-month follow-up. The right maxillary lateral incisor exhibited normal pulpal vitality, no mobility, and no further gingival recession on the labial side (Fig. 10).

Discussion

The treatment for Class II malocclusion with additional issues such as proclination of the maxillary incisors, crowding, and/or midline deviation often includes extraction of the premolars [17] or non-extraction, such as distalization of the maxillary molars [18]. In addition to the aforementioned conditions, the patient presented with an impacted maxillary right lateral incisor in this study. Extraction of the premolars risks traction failure of the impacted maxillary right lateral incisor, potentially necessitating prosthetic replacement. Alternatively, extraction of the impacted maxillary lateral incisor could compromise ideal occlusion and affect the anterior esthetics, which also requires prosthodontic methods to resolve. Given that the crowns of both maxillary second primary molars of the patient were intact and had not been exfoliated, the study aimed to distalize the maxillary molars and utilize the maxillary leeway space combined with surgical exposure for the traction of the impacted maxillary right lateral incisor, addressing issues such as insufficient space for the alignment of the impacted tooth, retraction of the proclined anterior teeth, adjustment of the maxillary midline, and improvement of the facial profile through Class II elastics to guide mandibular advancement.

Distalization of the maxillary molars is a non-extraction treatment option for Class II malocclusion. It typically utilizes either skeletal anchorage devices or conventional

Fig. 5 Progress intraoral photographs. **A**. Pendulum and mandibular fixed appliances were initially used. **B**. After 5 months of molar distalization, the pendulum was removed and a 0.016-inch stainless-steel round archwire with stop bends was utilized to prevent anterior movement of the maxillary first molars, and Class II elastics were used to distalize the maxillary canines. **C**. By the 10-month, sufficient space was prepared for eruption of the impacted maxilliary right lateral incisor

Fig. 6 Surgical exposure and orthodontic traction of the impacted maxillary lateral incisor

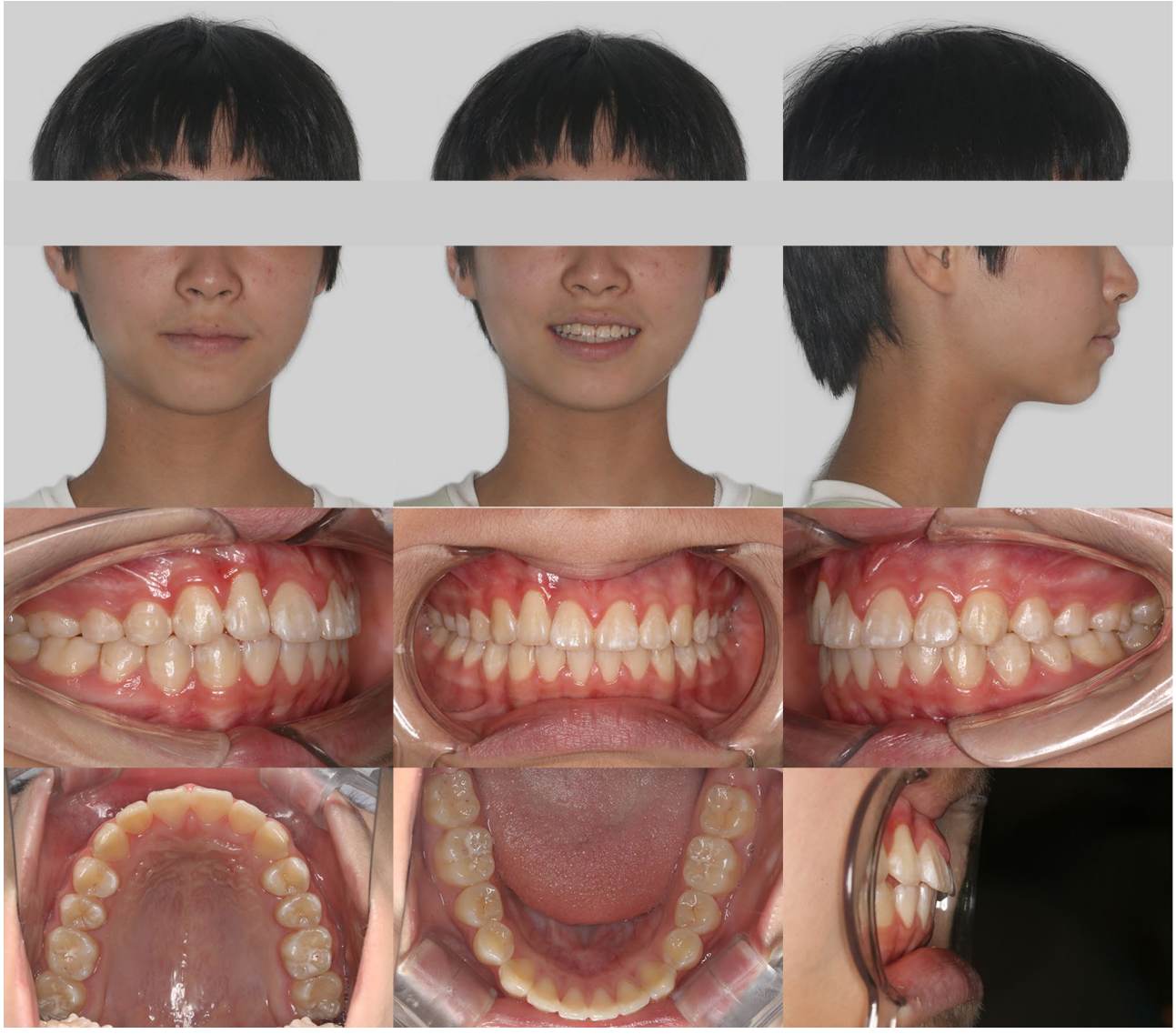

Fig. 7 Post-treatment facial and intraoral photographs

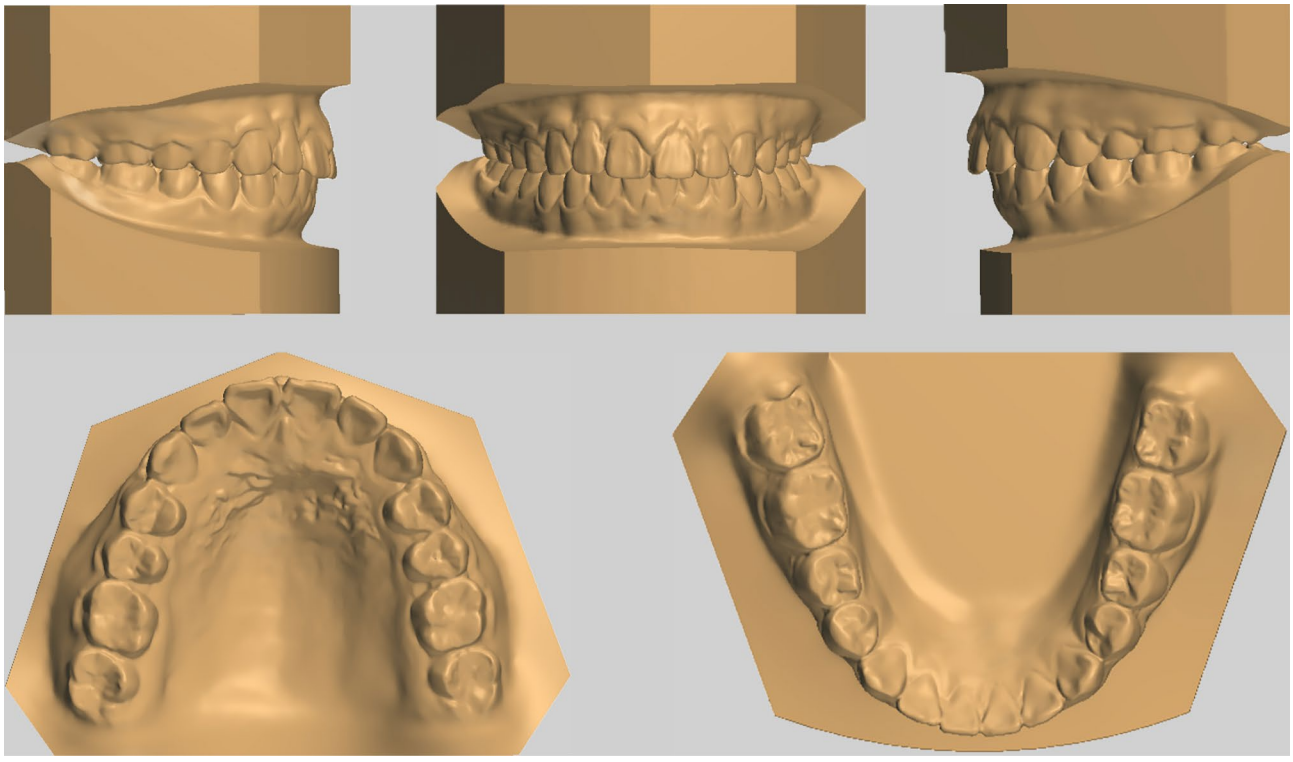

Fig. 8 Post-treatment dental casts

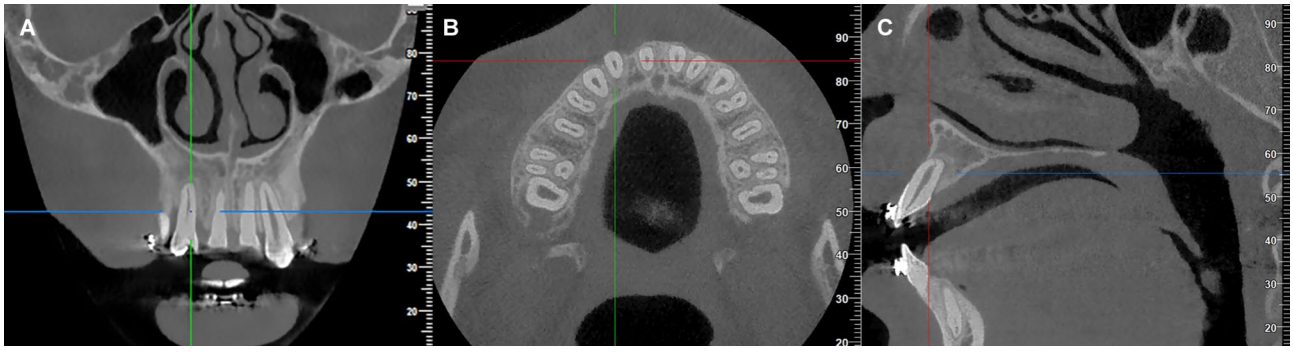

Fig. 9 CBCT examination of the maxillary right lateral incisor following alignment. **A**. Coronal plane shows mesial and distal alveolar bone resorption extended to the middle third of the root. **B** and **C**. Transversal and sagittal planes show labial alveolar bone resorption

anchorage systems, neither of which results in a significant difference in the amount of distal molar movement [19]. A pendulum was selected for this study. The pendulum can achieve distal movement of the maxillary first molars by approximately 2–6.4 mm with disadvantages, including distal tipping of the molars and loss of anterior anchorage [20]. The standard practice is to passively place a Nance button after removing the pendulum to stabilize the first molar that has been distalized for 4–5 months, allowing the premolars to drift distally before initiating fixed orthodontic treatment [10]. In this study, full-arch fixed appliances were placed shortly after installing the pendulum in the maxilla. This approach enabled the initial alignment and leveling of the dental arch, while the gradual replacement of larger-sized archwires prevented distal tipping of the molars during the distalization of the maxillary molars. Upon achieving a super Class I relationship and removing the pendulum appliance, the transition to thicker stainless-steel wires with stop bends was facilitated for both the maxillary and mandibular dental arches (Fig. 5B). The rationale behind this approach was that, in the maxilla, stop bends were incorporated into thicker arch wires to maintain arch length and prevent anterior movement of the molars while minimizing the loss of anchorage in the premolars. Additionally, in the mandible, thicker wires ensured that Class II elastics could be immediately applied after removal of the pendulum appliance, which served to distalize the maxillary

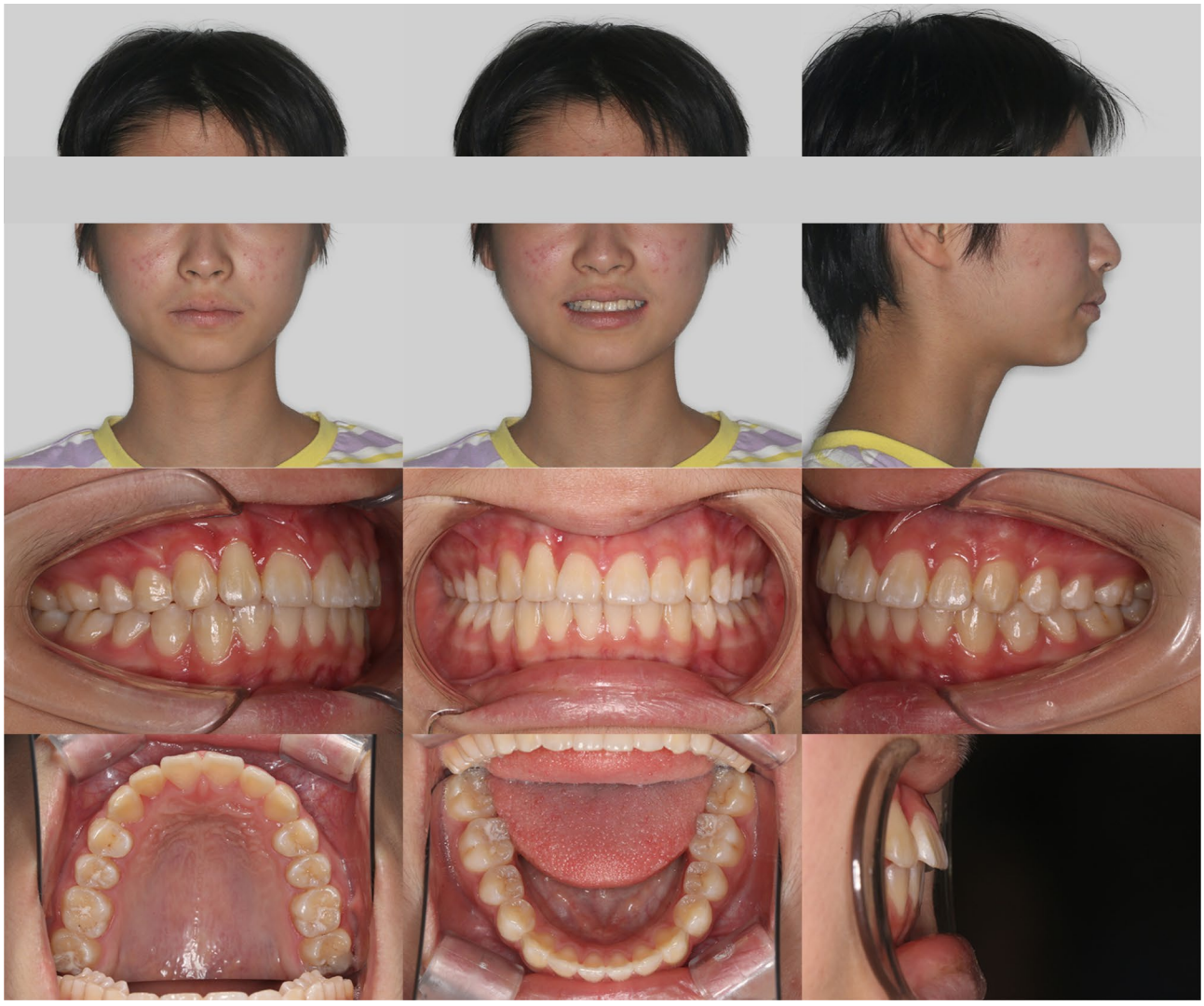

Fig. 10 Twelve-month follow-up facial and intraoral photographs

canines and premolars, prepare space for impacted tooth eruption, retract the upper anterior teeth, and guide mandibular advancement.

A slight clockwise mandibular rotation is generally observed after treatment with the pendulum appliance [21] and class II elastics [22]. However, in this study, counterclockwise rotation of the mandible was noted, as evidenced by a decrease in the Y-axis angle from 61.2° to 59.8° and a reduction in the SN-MP angle from 37.3° to 36.3°. In fact, a critical contributing factor to the observed changes in mandibular position is the growth and development of the mandible. In a longitudinal study on craniofacial growth of untreated Class II girls aged 9–18 years, Yoon et al. [23] noted that with growth, their faces became more flattened and ANB angles reduced, while the mandible exhibited forward rotation with decreased MP-SN and gonial angles. Kim et al. [24] also concluded that the mandible undergoes anterior or forward rotation during growth and development in a longitudinal study on condylar and mandibular rotation in untreated individuals with Class II malocclusion. The cephalometric superimposition images from pre- and post-treatment clearly demonstrate mandibular growth and development (Fig. 4D). Therefore, we speculate that the growth and development of the mandible rather than both the pendulum and the Class II elastics mainly contributed to the change of the post-treatment mandible position.

In mixed dentition space management, the leeway space is often used to address anterior crowding [12]. It is recommended to initiate treatment in the late mixed dentition stage, just before exfoliation of the second primary molars, to maximize growth potential and patient compliance while utilizing the leeway space [25]. Regarding the statistics on the size of leeway space in the maxilla, Imai et al. [26] reported that the average leeway space per side is approximately 1.46 mm, while Botero et al. [27]

stated a figure of approximately 1.556 mm. In the present study, the measured leeway space on each side of the maxilla was approximately 1.4 mm. This implies that the space created by distalizing the maxillary first molar, in conjunction with the leeway space in the maxilla, would be jointly used for the distal movement of the premolars and canines, alignment of the impacted right maxillary lateral incisor, and retraction of the upper anterior teeth.

The incidence of impacted maxillary incisors caused by odontomas is approximately 9% [3]. It has been reported that 32% of the impacted teeth erupt spontaneously following the removal of odontomas [28], and the eruption prevalence is even higher when orthodontic traction is applied after removing obstacles in the eruption path [29]. In this study, the impacted maxillary right lateral incisor did not erupt spontaneously after odontoma removal. Surgical exposure combined with orthodontic traction was performed in the 10th month of treatment, and it took 24 months to fully align the impacted teeth. However, the gingival recession was noted on the maxillary right lateral incisor following alignment (Fig. 7), and CBCT revealed loss of alveolar bone (Fig. 9). This might be related to the insufficient keratinized gingiva to the labial aspect, inadequate torque control of the maxillary right lateral incisor, and the open surgical procedure [5]. In a recent systematic review, Chambrone et al. noted that untreated buccal gingival recession defects in individuals with good oral hygiene are highly prone to an increase in recession depth on long-term follow-up [30]. Although no progression of the gingival recession was noted at the 12-month follow-up in our case, long-term monitoring remains necessary. If the patient perceives the gingival recession as aesthetically concerning or if it worsens in the future, periodontal surgical interventions, such as a free gingival graft, subepithelial connective tissue autograft, or guided tissue regeneration, may be required [31].

Conclusions

Molar distalization and use of the leeway space can avoid the need for tooth extraction during orthodontic treatment. Molar distalization and use of the leeway space can provide sufficient space to correct Class II molar relationship, align impacted teeth, and retract the maxillary anterior teeth. Retraction of the maxillary anterior tooth and guidance for mandibular advancement can improve the lateral facial profile.

Abbreviations

CBCT Cone-Beam computed tomography

Acknowledgements

Not applicable.

Author contributions

TX (corresponding author) contributed to designing the orthodontic treatment, played a pivotal role in its execution, and guided the drafting of the manuscript. KM summarized the case data, conceived the focus of the case report, and wrote this manuscript. LC, ZP, and TX contributed to the acquisition and analysis of case data. WZ and ZJ performed surgical procedures. All the authors have read and approved the final version of the manuscript.

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Data availability

All data supporting the findings of this study are included within the manuscript.

Declarations

Ethics approval and consent to participate

The study participant provided written informed consent.

Consent for publication

Written informed consent was obtained from the parents/legal guardians of the participants for publication of the case report and accompanying images.

Competing interests

The authors declare no competing interests.

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