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# Comprehensive space management and treatment of a patient with an early traumatic missing maxillary central incisor: a case report

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## Abstract

**Background** For patients missing the maxillary central incisor in childhood, resorption of the alveolar bone in the area of the missing teeth over time can increase the difficulty of performing later prosthodontic treatments. Early loss of permanent teeth is also one of the main causes of malocclusion. Early and effective space management will have a positive effect on the child's psychological and facial development. Moving the adjacent teeth to the central incisors may help to maintain the alveolar bone in the space of missing teeth, thereby preventing the development or complication of malocclusion. In the present report, we describe a case in which orthodontic treatment was performed for space management due to early missing teeth, leading to successful profile restoration of the missing teeth when she reached adulthood.

**Case presentation** The patient was an 11-year-old girl who underwent replacement dentition due to the loss of her maxillary right central incisor arising from trauma. Her maxillary right lateral incisor was moved to the position of the maxillary right central incisor, necessitating a secondary orthodontic treatment by clear aligner in the permanent dentition. In adulthood, the lateral incisor was reshaped into a central incisor to match the shape of the contralateral central incisor. Early orthodontic treatment took 15 months and the secondary orthodontic treatment took 30 months. The results of one-year follow-up observation confirmed good periodontal condition and occlusion of the anterior teeth.

**Conclusions** This case illustrates the need for early and effective space management through sequential orthodontic treatment and combined prosthodontic treatment to ensure favorable outcomes for patients with missing maxillary central incisors during the mixed dentition period.

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**Keywords** Dental trauma, Bone preservation, Space closure, Multidisciplinary

## Background

Missing maxillary central incisors are caused by several factors including avulsion, dental impaction, dental developmental anomalies, or the need for extraction due to poor treatment prognosis [1]. In childhood, the prevalence of dental trauma is estimated to be 25%, with trauma to the maxillary central incisors being the most common with an incidence of 66.7%, followed by the maxillary lateral incisors with an incidence of 17.4% [2]. Early loss of anterior teeth results in various forms of malocclusion such as incline moving of neighboring teeth, midline deviation, eruption of the opposing teeth, resorption of the alveolar bone in the space of missing teeth, reduced length of the dental arch, among others [3–5]. Premature loss of maxillary central incisors also alters the aesthetics of the patient's face, thus influencing the psychological health of patients. This calls for timely treatment of premature loss of anterior teeth to enhance the patient's physical and mental health.

The available treatments for premature loss of maxillary central incisor during the mixed dentition period include orthodontic relocation of the adjacent teeth to the site of the missing teeth to be retained for reshaping and restoration in adulthood, or maintenance of the missing tooth space for implant treatment in adulthood [6–9]. The success and long-term results of implant treatment in adulthood depend on good alveolar bone and periodontal conditions. Another aim of early treatment is to maintain adequate bone volume in the missing tooth area for later implant treatment [7, 8]. Complete treatment requires the collaboration of a multidisciplinary team, which often includes orthodontic, pediatric dentistry, and prosthodontic experts [6].

In this report, we present a patient with a trauma-induced missing maxillary right central incisor, who received an eight-year-long serial treatment. The treatment process included early orthodontic treatment during the mixed dentition period, a secondary treatment during the permanent dentition, and prosthodontic treatment in adulthood. Due to the effective treatment in the early stage, resorption of the alveolar bone was avoided in the later stage. The patient was satisfied with the treatment results and the orthodontic outcomes were stable during the regular follow-up.

## Case presentation

### Diagnosis and etiology

An 11-year-old girl presented to our hospital a one-month traumatic loss of the maxillary central incisor because of its negative aesthetic effect. Medical history: she underwent root canal treatment of tooth #21 in the pediatric dentistry department of our hospital due to trauma one month ago. The patient was referred to the orthodontic department for consultation to resolve her aesthetic problems arising from the missing central incisor.

The patient denied systemic and family history and did not engage in poor oral habits. Functional examination showed normal opening type and opening degree, as well as revealed no abnormalities in the temporomandibular joint and masticatory muscles. There were no contraindications to orthodontic treatment. Intraoral examination showed an empty alveolar socket at the site of tooth #11, dark red gingival margins at the site of the missing tooth, and no gingival avulsion injuries (Fig. 1). The maxillary left central incisor had a crown fracture with pulp exposure (Fig. 1). The panoramic radiograph showed that the alveolar socket at the site of the maxillary right central incisor was empty, and no alveolar cleft was seen (Fig. 2b). The patient's lateral profile was slightly convex (Fig. 2a), and the facial surface was basically symmetrical on the front photo (Fig. 1). Moreover, the patient was in the mixed dentition period, had bilateral Class I occlusion without crowding, and had a 5 mm overjet, 50% deep overbite, and exhibited gentle curves of Spee (Fig. 1).

### Treatment alternatives

After consultation with the prosthodontist, the following four treatment alternatives were developed while considering the child's aesthetic requirements for the anterior region and bone maintenance in the missing tooth region. The first option was to place a temporary denture or wear an invisible denture at the site of tooth #11. The second option was to bond a Maryland Bridge restoration to reconstruct the profile of the missing central incisor. The third option was to implant a micro-implant at the site of the maxillary right central incisor and the shape of the tooth through resin core buildup. The fourth option involved early orthodontic treatment of mesial displacement of the maxillary right lateral incisor to the position of the maxillary right central incisor. The second phase of orthodontic treatment was performed at the time of permanent dentition. In adulthood, tooth #12 and tooth #21 were restored.

The patient and her family chose the fourth option and signed an informed consent form.

### Treatment progress

To avoid premature absorption of the deciduous teeth roots and to reduce unnecessary tooth movement, we placed the centroid positions of the bracket grooves of

**Fig. 1** Pretreatment facial and intraoral photographs

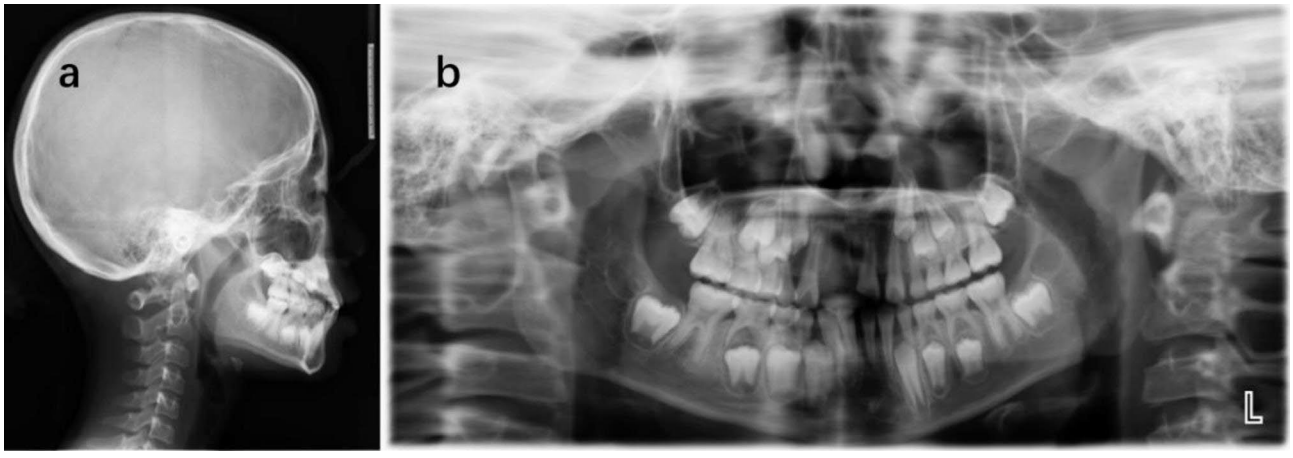


**Fig. 2** Pretreatment radiographs: **a** lateral cephalogram. **b** panoramic radiograph

teeth #12, #54, #16, #21, #22, #64, and #26 at a uniform horizontal height to ensure that the 0.018-inch stainless steel wire was fitted into the bracket grooves, and nickel-titanium push springs were placed between teeth #12 and #54 to initiate the mesial movement of tooth #12, to maintain the maxillary midline and the normal growth of the arch length in the developing child. Bracket bonding did not involve teeth #53 and #63 (Fig. 3a). Monthly follow-up visits were made during which the length of the push springs was increased to continue the proximal displacement of tooth #12 and to observe the replacement of the succeeding permanent teeth. The appliance was removed after 15 months when tooth #12 had essentially moved to the area of the missing tooth #11, the brackets on teeth #12 and #21 were retained, and a ligature wire was employed to connect the brackets on teeth #12 and #21 to prevent tooth #12 from being reset (Fig. 3b and c). Regular follow-up visits were conducted after all the permanent teeth had erupted and the second phase of orthodontic treatment was scheduled at a later date.

The patient was followed up and examined at the age of 15. Intraoral examination confirmed the maxillary right deciduous canine at the position of tooth #13. Teeth #15, #25, #35 were unerupted at this time whereas teeth #55, #65, and #75 exhibited grade II mobility (Fig. 4). Radiographs showed no resorption of tooth #53 root and vertical resorption of the roots of teeth #55, #65, and #75. Teeth #15, #25, and #35 were below the roots of teeth #55, #65, and #75, and about 2/3 of their roots had developed (Fig. 5). The patient was consulted about the need to undergo a second phase of orthodontic treatment with clear aligner (Align Technology Inc, Santa Clara, CA, USA). For the treatment, 48 steps of clear aligner treatment were designed to move the teeth by 0.2 mm per step. No movement of the maxillary right deciduous canine was designed. The maxillary and mandibular dentition were aligned. Specifically, the torque of tooth #12 was adjusted, axial inclination as well as the proximal and distal central gaps between tooth #12 and the neighboring teeth (approximately 0.5 mm each) were adjusted. At the end of the second stage of orthodontic treatment, a retainer was fabricated and the patient was advised to complete the restorative treatment of the maxillary left central incisor and the maxillary right lateral incisor in adulthood (Fig. 6).


**Fig. 3** Progress intraoral photographs. **a** The 0.018-inch stainless steel wire was fitted into the bracket grooves, and nickel-titanium push springs were placed between teeth #12 and #54. **b** Tooth #12 had essentially moved to the area of the missing tooth #11 after 15 months of treatment. **c** The brackets retained on the teeth #12 and #21 for approximately 22 months

**Fig. 4** Pre-second phase of orthodontic treatment records: facial and intraoral photographs

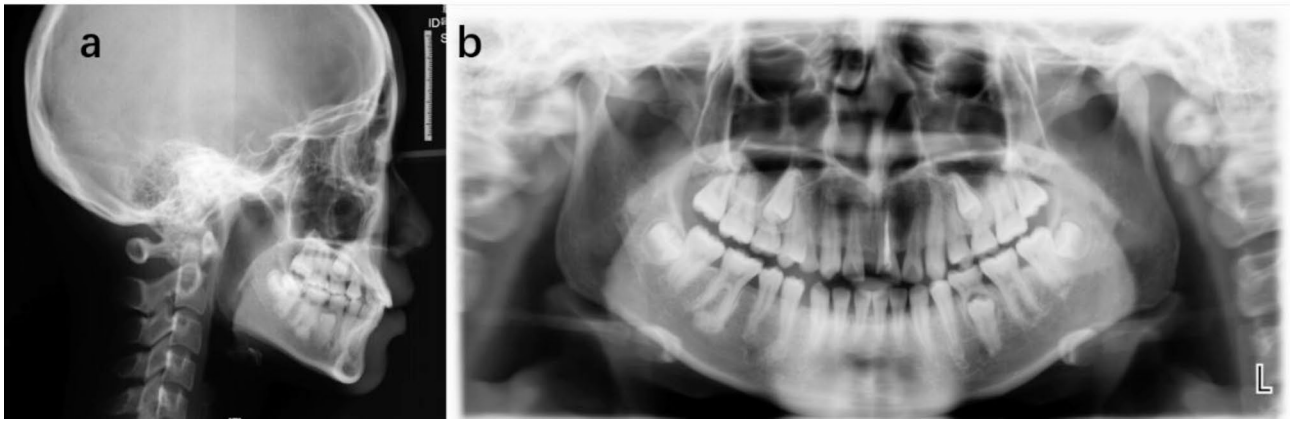


**Fig. 5** Pre-second phase of orthodontic treatment records: **a** lateral cephalogram. **b** panoramic radiograph

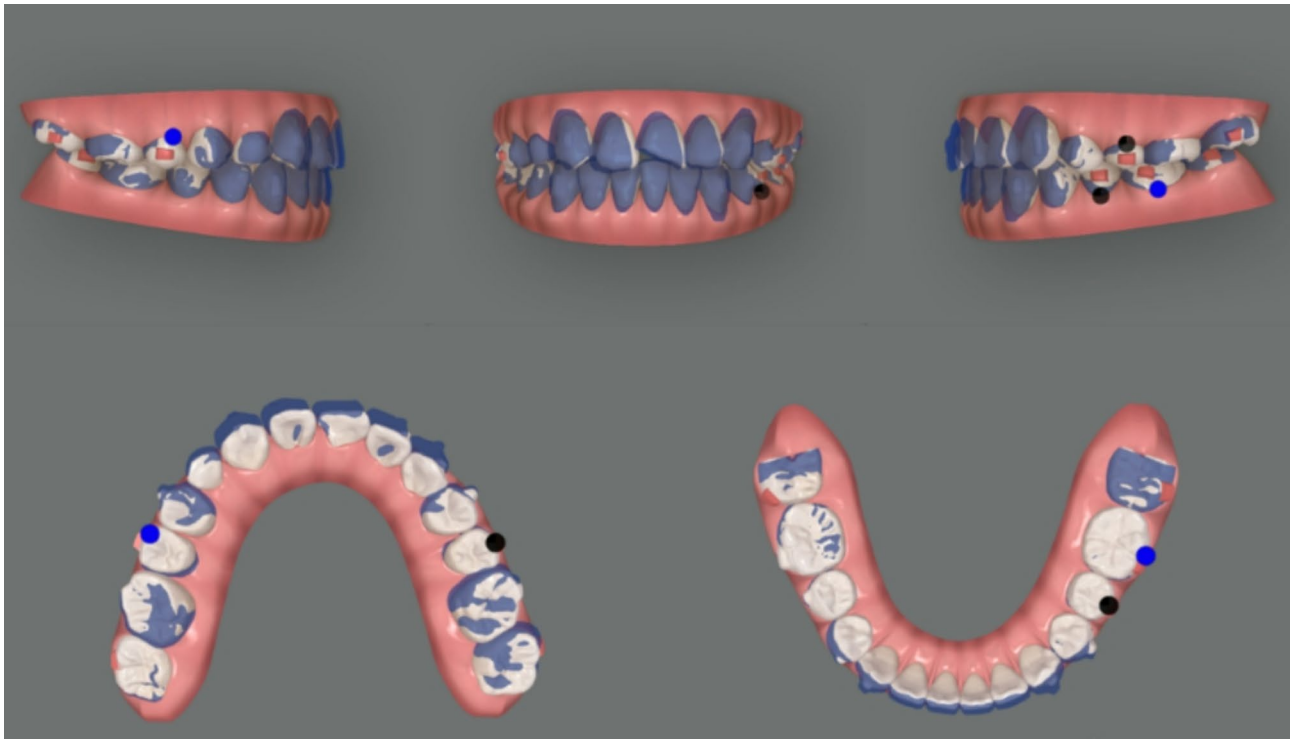

**Fig. 6** Clear aligner records: superimposition of pre- and post-treatment digital models by the ClinCheck

The patient was unable to attend regular follow-up appointments during the second phase of orthodontic treatment due to the COVID-19 pandemic and relocation for educational purposes, resulting in an extension of the treatment duration. The second phase of orthodontic treatment lasted about 2.5 years, and at the end of the treatment, the anterior overjet and overbite were normal, with bilateral molar and left cusp neutral relationships. A gap of about 0.5 mm was left on both the mesial and distal sides of tooth #53 (Fig. 7). Analysis of radiographs showed adequate root canal filling with no dark shadows seen at the tip of tooth #21, proper root parallelism and no significant apical resorption in teeth #12, #13, #21, and #22 (Fig. 8; Table 1). The patient was 17 years old at the end of orthodontic treatment. She was instructed to wear a retainer until the subsequent follow-up. The patient visited the prosthodontics department one year later for gingival revision and porcelain veneer restoration on tooth #12 and full crown restoration on tooth #21 (Fig. 9). The results showed that teeth #12 and #21 were symmetrical in shape and the gingival margins were of the same height. The retainer was replaced and the patient was regularly followed up.

## Discussion

Patients with missing maxillary incisors have a variety of treatment options to choose from. The available treatments include adjacent tooth replacement, removable partial dentures, Maryland bridges and implant placement combined with resin restorations [6]. Removable partial dentures and Maryland bridges can restore the appearance of anterior teeth rapidly and are relatively simple to fabricate, making them widely applied to achieve temporary restoration of the appearance of missing teeth [6, 10, 11]. However, since the length of the dental arch changes with the remodeling of the alveolar bone in children, temporary restorations become loose or experience food impaction [11]. As a commonly used adjunct to orthodontic treatment, micro-implants can improve the efficacy of orthodontic treatment while effectively expanding the indications for orthodontic treatment [12]. However, the height of the alveolar bone of the healthy teeth around the implants grows in tandem with the growth of the child, while the alveolar bone around the implants does not grow significantly, which causes a vertical bone defect between the alveolar ridge area around the implants and the alveolar bone of the normal teeth. The younger the patient, the greater the potential for bone growth and the greater the likelihood of significant vertical bone defects forming around the implant placement area. This vertical bone defect has a negative impact on the aesthetic restoration of the anterior region [13]. Some scholars believe that the use of micro-implants as temporary restorations for missing anterior teeth has been suggested as feasible interventions [14]. It is beneficial for patients during the growth

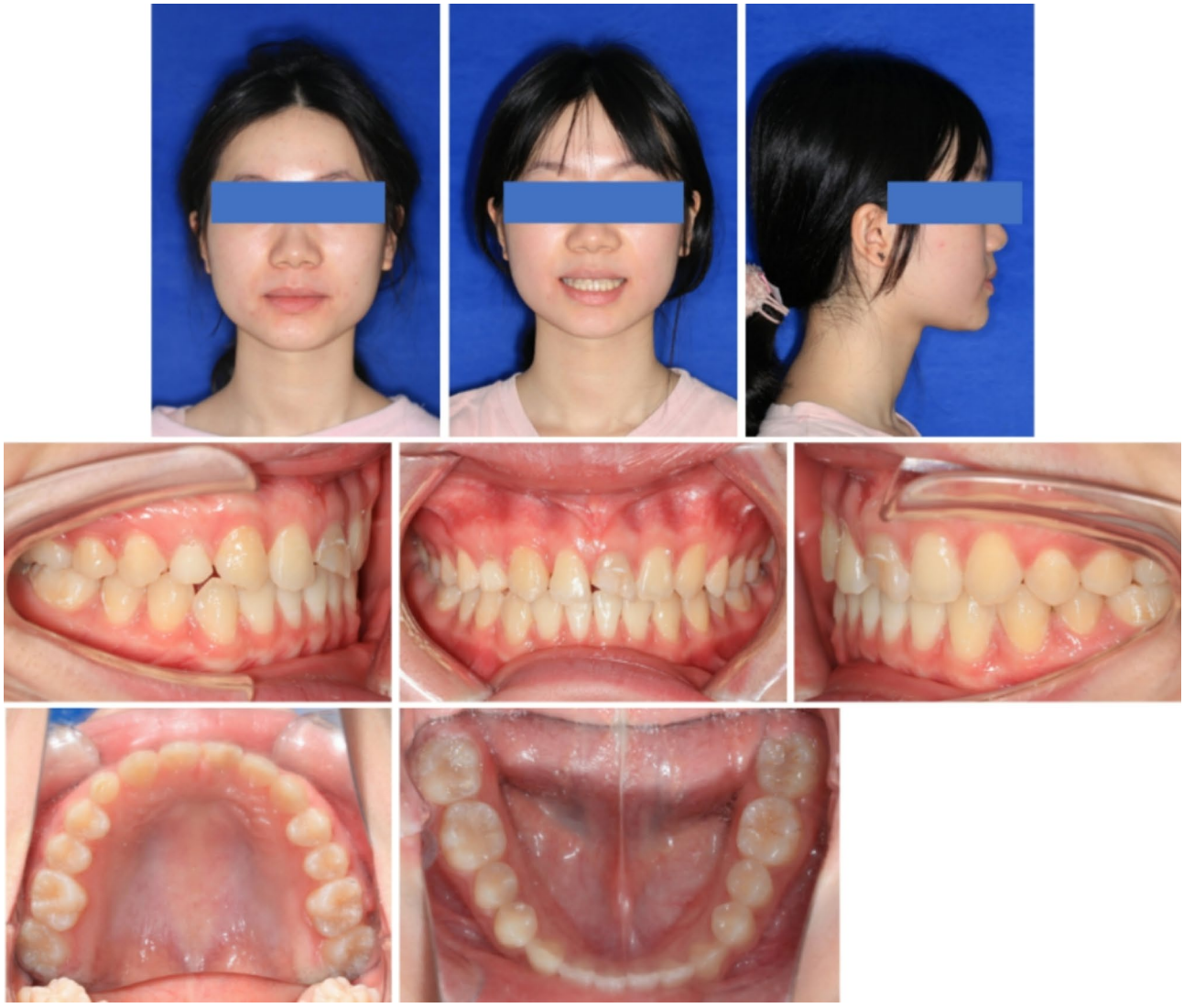

**Fig. 7** Posttreatment facial and intraoral photographs

period to preserve the buccolingual alveolar bone volume and soft tissues. However, long-term follow-up studies and reports on the use of this treatment modality in patients who are chronically edentulous and cannot be treated with permanent restorations within a short period of time are lacking [14].

For patients missing maxillary unilateral central incisors during childhood, aesthetic needs and long-term health need to be considered simultaneously. If an incisor is extracted or lost, the buccolingual width of the alveolar ridge in the corresponding area decreases by about 23% in the first 6 months, with a total resorption of about 34% over 5 years [15, 16]. Missing maxillary central teeth can cause displacement of neighboring teeth and midline deviation, creating several challenges to the subsequent aesthetic restoration approaches. Therefore, it is imperative to develop strategies for minimizing the resorption of the alveolar bone in the anterior region and reduce the difficulty of subsequent restorative procedures. In the available literature, no study has reported the lifetime prognosis of implant therapy.

As the tooth passes through the alveolar bone under orthodontic forces, the resorption and remodeling of the bone around the root effectively maintain the height and width of the alveolar bone [16, 17]. Orthodontic treatment also promotes the regeneration of damaged periodontal tissues. Defects in the buccolingual periodontal tissues may undergo morphological changes with the movement of orthodontic teeth. Orthodontic treatment can, therefore, be considered a form of periodontal treatment. This periodontal treatment is similar to "guided orthodontic regeneration techniques", which include "guided orthodontic soft tissue regeneration" and "guided orthodontic bone regeneration" [18]. Natural teeth

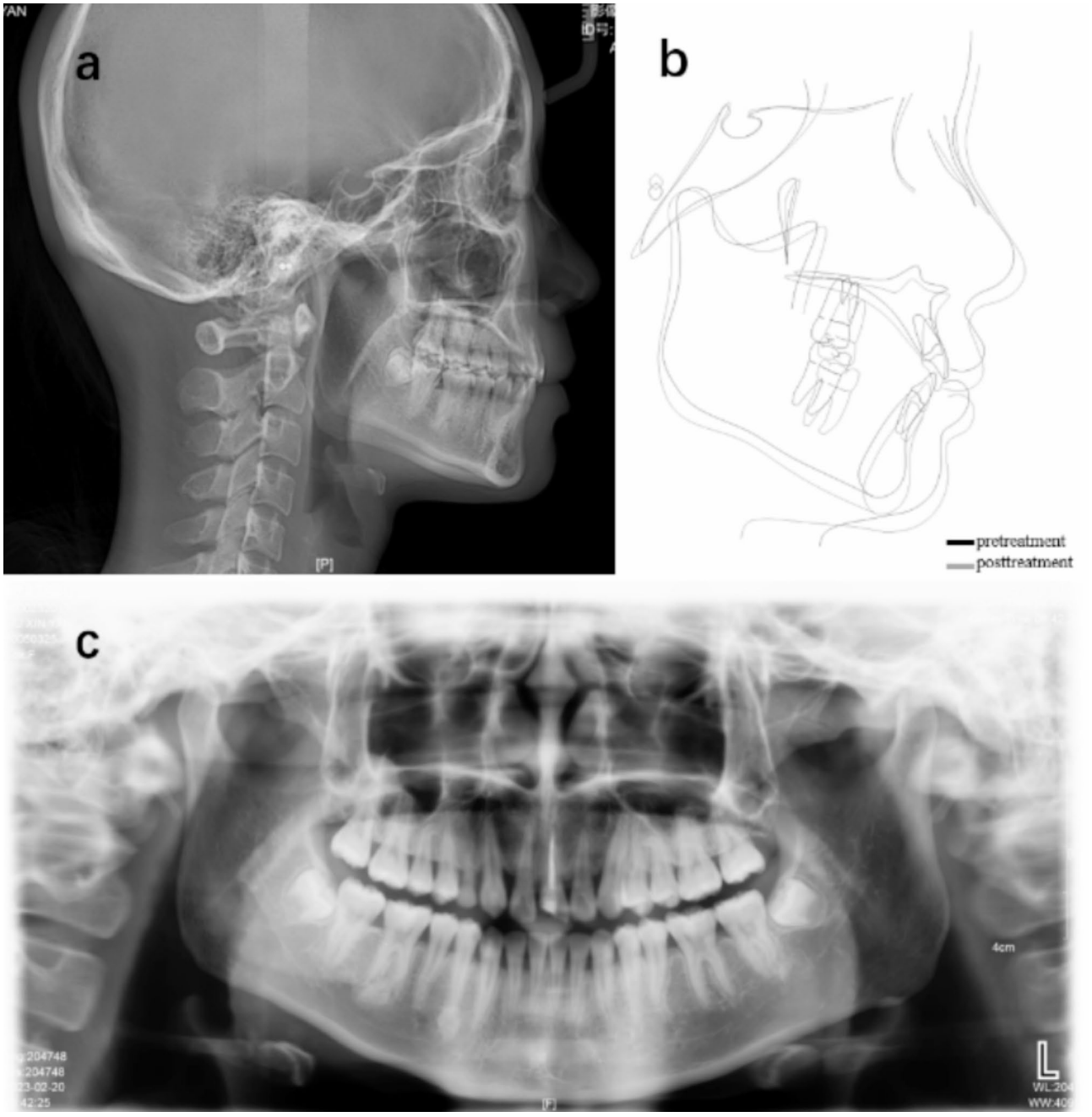


**Fig. 8** Posttreatment radiographs: **a** lateral cephalogram. **b** superimposition of pre- and post-treatment lateral cephalogram. **c** panoramic radiograph

**Table 1** Cephalometric analysis at Pre-phase II treatment and posttreatment

| Measurements | Norm (mean ± SD) | Pre-phase II treatment | Posttreatment |
|---|---|---|---|
| SNA (°) | 82.8 ± 4.0 | 83.0 | 82.5 |
| SNB(°) | 80.1 ± 3.9 | 80.6 | 79.9 |
| ANB(°) | 2.7 ± 2.0 | 2.4 | 2.6 |
| NP-FH(°) | 85.4 ± 3.7 | 85.2 | 87.4 |
| NA-PA(°) | 6.0 ± 4.4 | 4.3 | 4.6 |
| U1-NA (mm) | 5.1 ± 2.4 | 6.2 | 1.6 |
| U1-NA (°) | 22.8 ± 5.7 | 30.0 | 11.3 |
| L1-NB (mm) | 6.7 ± 2.1 | 6.0 | 2.5 |
| L1-NB (°) | 30.3 ± 5.8 | 25.0 | 15.3 |
| U1-LI (°) | 125.4 ± 7.9 | 122.1 | 150.8 |
| U1-SN (°) | 105.7 ± 6.3 | 113.5 | 93.7 |
| MP-SN (°) | 32.5 ± 5.2 | 30.0 | 29.9 |
| FH-MP (°) | 31.1 ± 5.6 | 25.8 | 22.8 |
| L1-MP (°) | 92.6 ± 7.0 | 94.4 | 85.5 |
| Y-Aix (°) | 66.3 ± 7.1 | 66.0 | 63.6 |
| Po-NB (mm) | 1.0 ± 1.5 | 0.7 | 0.8 |

preserve bone volume, and from the current literature, implants lack this property.

Compared to adult patients with missing anterior teeth, the treatment of children with missing anterior teeth is more difficult and time-consuming due to the growth and development considerations. At the beginning of the early orthodontic design, the doctor anticipated that by moving tooth #12 to tooth #11, tooth #13 and tooth #14 would move proximo-centrally on their own to erupt and establish an occlusion. However, the actual results showed that tooth #13 erupted on its own at the tooth #12 site, while tooth #14 did not erupt at the site of tooth #13. Tooth #53 was retained at the site of tooth #13 showed no significant root resorption. A gap of approximately 0.5 millimeters remained in the mesial and distal sides of tooth #53. The width and the mesial and distal gaps of tooth #53 matched those of the contralateral tooth. To improve its prognosis, the patient underwent composite resin restoration for the wedge-shaped defect on tooth #53 in the endodontics department. As the patient declined reshaping tooth #13 to resemble tooth #12, the final restorative treatment resulted in the right maxillary canine contacting with the right mandibular lateral incisor during lateral movements. This right-side canine-protected occlusion, unlike the left side, effectively minimized the lateral forces exerted on tooth #53, which is crucial for its long-term preservation. Tooth #53 experienced natural retention, and the patient was informed of the potential for poor prognosis and the possibility of future implant restoration. Prosthodontists have long been opposed to the proximo-central movement of maxillary canine into the lateral incisor area, due to the perception that it would prevent the establishment of a canine protected occlusion [19]. However, cusp movement to the lateral incisors leads to a stable occlusion with effective canine guidance [19, 20]. The outcome of treatment in this case is consistent with the results obtained from other studies. In addition, it has been reported that the presence or absence of a canine protected occlusion is not significantly correlated with the development of temporomandibular joint disorders [21–23]. The patient's follow-up results after one year indicated that the intercuspation of the teeth was in good relationship (Fig. 10). The stability of this treatment outcome will be tracked through a further follow-up to determine the long-term effects. One of the advantages of clear aligners over fixed orthodontic appliances is the ability to accurately preset and efficiently express anterior torque control, axial inclination adjustment, and precise tooth movement [24]. However, without additional assistance, the clear aligners demonstrate a suboptimal ability to exert lingual control over the root of the anterior teeth. Excessive labial displacement of the incisal roots increases the risk of complications such as root resorption and alveolar bone defects [24–26]. In future treatments, we will remind more about the necessity of controlling the torque of the anterior teeth. We can increase anterior torque control with the addition of the overcorrection design, the design of power ridges, and the assistance of micro-implants.

## Conclusion

Aggressive and effective early intervention for missing anterior teeth in early childhood can prevent aesthetic-related psychological issues in children and reduce the difficulty of restorative treatment later in life.

By moving the lateral incisors to the site of the missing central incisors for natural tooth preservation through


**Fig. 9** After restorative treatment: **a** facial photographs. **b** porcelain veneer restoration on tooth #12 and full crown restoration on tooth #21. **c** forward and lateral movement


**Fig. 10** Intraoral photos after 1 year of retention period: **a** The intercuspation of the teeth were in good relationship. **b** forward and lateral movement

orthodontic treatment, the integrity and arch length of the teeth can be satisfactorily preserved, reducing the rate of implant restoration at a later stage.

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**Author contributions**
LC performed the major patient clinical operations, analyzed and interpreted the patient data and was a major contribution writing the manuscript.
FY and ZO proposed and agreed with the patient clinical treatments and performed major patient clinical operations. Both of the two corresponding authors have made equally significant contributions to the work and share equal responsibility for it. All the authors have read and approved the final manuscript.

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**Data availability**
No datasets were generated or analysed during the current study.

## Declarations

**Ethics approval and consent to participate**
The study participant provided written informed consent.

**Consent for publication**
Written informed consent for the publication of clinical details and clinical images was obtained from the parents of the patient prior to the study. All authors have approved the manuscript for submission.

**Competing interests**
The authors declare no competing interests.

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