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CASE REPORT

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Treatment of severe anterior open bite by using tongue crib and teeth extraction: a case report

Jingmei Zhang[1,2], Yinuo Zhao[1,2], Dongsheng Song[1,2], Xinyu Liu[1,2], Chenmeng Lu[2,3], Jingzheng Yi[2,4], Yi Zhang[1,2*] and Min Hu[1,2*]

Abstract

Background Anterior open bite is a kind of malocclusion that can affect the oral function, aesthetics and even mental health of adolescents. Breaking harmful habits plays an important role in the orthodontic treatment of patients during the growth and development period.

Case presentation This case focuses on a 13-year-old adolescent male with anterior open bite of 6 mm, Class II malocclusion, and finger sucking, tongue thrusting habits, and abnormal swallowing pattern. Based on the etiology and the patient's condition, a treatment plan involving extraction of second premolars and use of an adhesive tongue crib was implemented. After 35 months of active treatment and 12 months of retention, results showed improved occlusion, normal overbite and overjet, proper molar relationships, and enhanced facial aesthetics. The study highlights addressing etiological factors and using appropriate treatments. A modified Hawley retainer and a retainer with a welded tongue crib at night helped maintain results due to the patient's history and potential for recurrence.

Conclusions For adolescent patients with anterior open bite, clear diagnosis and elimination of causative factors are key to favorable treatment results. Combining multiple mechanisms can effectively restore and establish a good occlusal relationship. Throughout the treatment, it is also necessary to pay attention to patients' growth and development.

Clinical trial number Not applicable.

Keywords Anterior open bite, Tongue crib, Extraction, Orthodontic treatment

*Correspondence:
Yi Zhang
zhangyi0519@jlu.edu.cn
Min Hu
humin@jlu.edu.cn
[1]Department of Orthodontics, Hospital of Stomatolog, Stomatology School of Jilin University, No. 1500 Qinghua Road, Chaoyang Area, Changchun City, Jilin Province, P.R. China
[2]Jilin Provincial Clinical Medicine Research Center of Orthodontics, Changchun, Jilin, P.R. China
[3]Qingdao Stomatological Hospital Affiliated to Qingdao University, Qingdao, Shandong, P.R. China
[4]Western Dental, CA, USA

Background

Anterior open bite (AOB) is a malocclusion, with a prevalence of approximately 16.52% [1] in children and adolescents, characterized by insufficient normal vertical overlap between the edges of the antagonist incisors when the posterior teeth are in occlusion [2]. AOB is one of the most challenging malocclusions, with complex etiology, including oral habit components, dental problems, and skeletal abnormalities [3]. Among them, sucking habits and hyperdivergency are important risk factors for anterior open bite [4]. From what we know, we need to develop different treatment regimens based on the specific etiology of these patients. For children and adolescents, early preventive dental correction, such as blocking harmful oral habits, is very important so as not to affect the normal growth and development of the masticatory system [5]. If harmful habits such as tongue thrusting are not eliminated during orthodontic treatment, anterior open bite will be very difficult to resolve. It may even be prone to recurrence during the retention stage [6].

Deleterious oral habits are an important risk factor for AOB [3, 7]. One study points out that among patients with non-nutritive sucking habits, the prevalence rate of anterior open bite is 41.15% [1], which is about three times the prevalence rate of open bite among adolescents. At present, orthodontic appliances commonly used in the management of deleterious oral habits in clinic include adhesive bonded spurs, fixed and removable tongue crib [8], and crib therapy has shown good therapeutic effect [9]. More importantly, a tongue crib designed according to the position of the tongue, the eruption status of teeth, and the depth of the maxillary and mandibular curves can exert the best effect in orthodontic treatment.

This case reports the diagnosis and treatment of an adolescent male patient with anterior open bite, slightly convex lateral profile, Class II malocclusion, accompanied by many years of finger sucking and tongue thrusting habits, and no family history of similar conditions. His tongue was placed between the upper and lower incisors in relaxing state. Treatment plan was based on the etiology, patient complaints, risk prediction and prevention. The second premolars were extracted, and the adhesive tongue crib was used to assist orthodontic treatment to establish a normal overbite and achieve a Class I occlusal relationship.

Case presentation

Diagnosis and etiology

The patient, a 13-year-old male, sought orthodontic treatment at the Hospital of Stomatology, Jilin University in Changchun, China because he couldn't bite with his front teeth. During the process of taking the medical history, we learned that the patient had a relatively frequent habit of sucking his thumb, placing it between the upper and lower jaws. In the resting state, the tongue habitually protruded forward, with the front part of the tongue placed between the upper and lower jaws (Fig. 1). Moreover, when swallowing, the patient adopted the infantile swallowing pattern, that is, placing the tongue between the anterior teeth of the upper and lower jaws to seal the oral cavity and complete the swallowing process. However, his parents' facial profile and occlusal status are acceptable, without similar manifestations of anterior open bite.

The frontal photos before treatment showed basic symmetry of the face and a homofacial type. The side view was a basically straight face type, and the lips were slightly convex. The frenulum labialis, frenulum lingualis and the temporomandibular joint were normal.

Intraoral examination showed poor oral hygiene, with a small amount of materia alba and dental calculus, but the periodontal condition was fine. We could see the tongue was placed between the upper and lower incisors, with a low resting posture. His anterior overbite was −6 mm, the upper and lower midlines were basically aligned which were coincident with facial midline. Molars on both sides showed Class II relationships. The upper dental arch as a whole presented a cuspate oval shape, with stenosis in the middle section. Local crossbite could be seen on both sides. Teeth #11, #12, #15, #21, #22, #36, #37, #46 and #47 (FDI World Dental Federation, ISO-3950) were decayed. Tooth #15 was displaced palatally, #25 was not visible, and developmental lobes in the lower anterior teeth were observed.

Dental casts (Fig. 2) confirmed the Class II relationships and anterior open bite of degree III. Maxillary congestion was 5.15 mm, mandibular congestion was 2.55 mm, and the depth of the Spee curve was 1 mm. The Bolton ratio of anterior teeth was 78.6%, and the whole tooth ratio was 99.6%. The measurement of the arch width (Table 1) showed that there was insufficient width in the middle and posterior segments of the maxilla.

The panoramic radiograph (Fig. 3) showed that a supernumerary tooth was present near the root of #44, and #25 was impacted, located between the roots of #24 and #26. The periapical radiograph indicated that the root of #25 was not fully formed, and no root resorption was observed in #24 or #26. According to the panoramic radiograph, the four third molars of this patient were visible, and the condylar morphology was within normal limits. Meanwhile, it could be seen that the morphology of the anterior open bite was consistent with that of the anterior part of the tongue.

Cephalometric analysis (Table 2) showed that the patient had a skeletal Class II relationship (ANB: 5.2°, Wits: 3.2 mm), a hyperdivergent growth pattern (MP-FH: 29.3°), with no obvious skeletal open bite tendency

Fig. 1 Pretreatment intraoral and extraoral photographs and radiographs

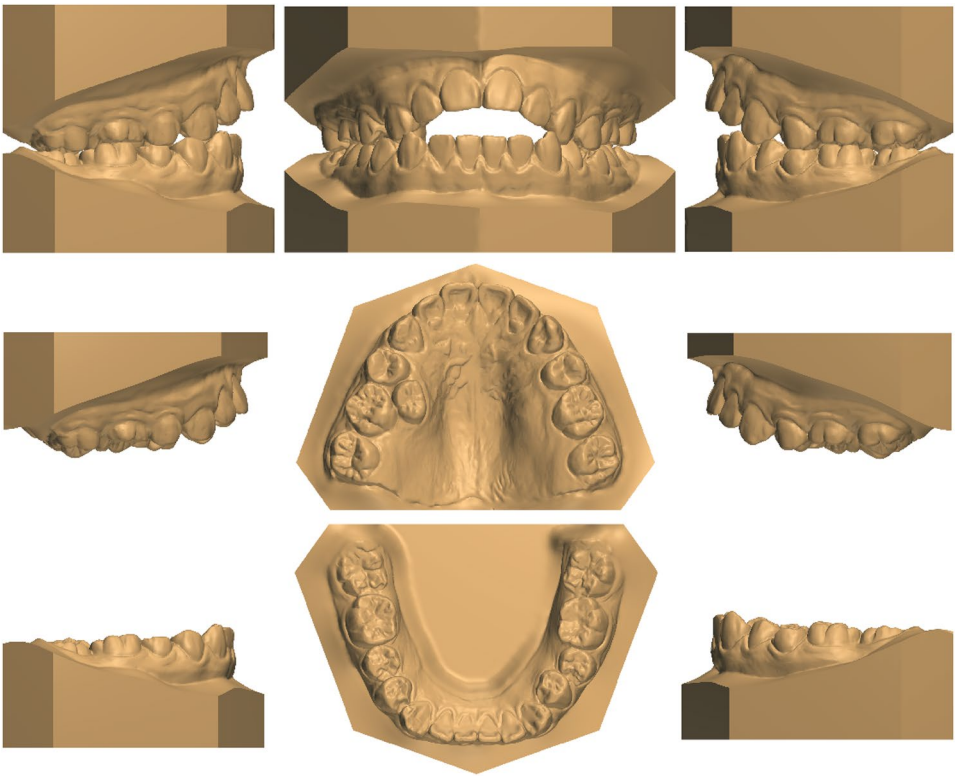

Fig. 2 Pretreatment dental casts

Table 1 Study cast analysis

Anterior Bolton Analysis		**Overall Bolton Analysis**	
Upper 3–3 width	50.26	Upper 6–6 width	96.92
Lower 3–3 width	39.48	Lower 6–6 width	96.54
Ratio	0.786	Ratio	0.996
Arch-width analysis	Pretretment		Post-Treatment
Upper 3–3	38.02		38.14
Lower 3–3	30.88		30.37
Upper 4–4	42.02		43.77
Lower 4–4	36.5		34.22
Upper 6–6	50.6		50.95
Lower 6–6	47.98		42.85

(S-Go/N-Me: 63.9%, LFH: 55.6%, and ODI: 70.5). The development of the posterior alveolar bone of both the maxilla and mandible was also within the normal value range, while the eruption height of the maxillary anterior teeth was insufficient (UADH: 24.9 mm, UPDH: 25.7 mm, LADH: 43.7 mm, LPDH: 35.2 mm). The normal upper articular angle (52.9°) and the large lower articular angle (78.2°) suggested that the mandibular body had a growth tendency of rotating backward and downward. At the same time, both the maxillary and mandibular anterior teeth were labially inclined (U1-SN: 108.8°, IMPA: 100.9°). The soft tissue measurement showed that both the upper and lower lips were protruded (Upper Lip to E-Plane: 1.6 mm, Lower Lip to E-Plane: 2.8 mm). In addition, based on lateral cephalogram, we could see that the tongue was closely attached to the lingual side of the mandibular incisors, and mandibular incisors displayed a pronounced protrusion. Lower arch leveling was changed, with mandibular incisors positioned below the occlusal level. Besides, we also observed that the patient's Cervical Vertebral Maturity Staging had already been at CVS V. However, considering that the adolescent male was only 13 years old and in combination with the height of his parents and the patient at that time (His height was 170 cm and his weight was 97 kg), we believed that he still had certain growth and development potential.

Treatment objectives

The treatment objectives were to achieve (1) appropriate anterior overbite in vertical dimension, restoration of masticatory function of the occlusal system; (2) appropriate overjet of Class I relations in the sagittal dimension; (3) coordination of transverse relations between the

Fig. 3 Pretreatment panoramic radiograph, periapical radiograph and lateral cephalogram

Table 2 Cephalometric measurements

Measurements	Pretretment	Post-treatment	Normal±SD
Skeletal			
SNA (°)	85.3	85.5	82±3.5
SNB (°)	80	81.9	80.9±3.4
ANB (°)	5.2	3.6	1.6±1.5
FMA (MP-FH) (°)	29.3	26.6	24.5±4.5
MP-SN (°)	37.3	34.3	33±6
Facial Plane to SN (SN-NPog) (°)	79.5	82	79.5±4
Mand Plane to Occ Plane (°)	24.2	20.7	16.6±5
Y-Axis (SGn-SN) (°)	71.6	69.1	67±5.5
Posterior Face Height (SGo) (mm)	81.7	82.2	77.7±5
Anterior Face Height (NaMe) (mm)	128	123.9	121.8±5
P-A Face Height (S-Go/N-Me) (%)	63.9	66.4	65±4
LFH (ANS-Me/N-Me) (%)	55.6	56	54±5
UFH (Na-ANS/N-Me) (%)	44.4	44	46±5
Gonial/Jaw Angle (Ar-Go-Me) (°)	131.1	129.6	124.2±6.7
Upper Gonial Angle (Ar-Go-Na) (°)	52.9	52.5	53.9±7
Lower Gonial Angle (Na-Go-Me) (°)	78.2	77.2	70.8±6
Overbite Depth Indicator (ODI)	70.5	70	74.5±5
Wits Appraisal (mm)	3.2	-0.5	-1±1
Anteroposterior Dysplasia (APDI)	81.4	86.1	81.4±5
Combination Factor (CF)	151.3	154.7	155.9±2
Dental			
U1-PP (UADH) (mm)	24.9	27.2	31±2
U6-PP (UPDH) (mm)	25.7	24.4	25±3
L1-MP (LADH) (mm)	43.7	44.9	44±3
L6-MP (LPDH) (mm)	35.2	34.8	34±3
U1-SN (°)	108.8	100.6	102.6±5.5
IMPA (L1-MP) (°)	100.9	91.1	95±7
L1 Protrusion (L1-APo) (mm)	6.4	4.3	2.7±1.7
Soft tissue			
Upper Lip to E-Plane (mm)	1.6	-0.4	-4.8±2
Lower Lip to E-Plane (mm)	2.8	0.1	-2±2
Convexity (A-NPo) (mm)	6	3.5	1.1±2
Lower Lip to H-Line (mm)	2	0.4	0.3±2
S.T. Facial Angle (FH-N'Pg') (°)	94.1	95.5	91.3±7

Table 3 Optional treatment plans

Options	Extraction	Advantages	Disadvantages
1	Supernumerary tooth; #15, #25, #35, #45	Multiple mechanisms to correct AOB; Matching tooth numbers in both arches; Facial profile improvement	Extracted more teeth;
2	Supernumerary tooth; #15, #25	Fewer teeth extracted;	Enlarge anterior tooth extrusion; Limit profile improvement

maxillary arch and the mandibular arch in the horizontal dimension; (4) improvement of facial aesthetics.

Treatment alternatives

Considering the pathogenic factors and mechanisms of this patient, we proposed two optional treatment plans (as shown in Table 3).

Since this patient had clear habits of thumb sucking, tongue thrusting, and abnormal swallowing, we were inclined to use a tongue crib as early as possible to eliminate the effect of harmful forces. Using implants to intrude the maxillary posterior teeth was an optional plan. However, the panoramic radiograph showed that the distance between the maxillary molars of this patient and the floor of the maxillary sinus was relatively short, so the degree of intrusion was limited, not to mention that the development of the patient's posterior alveolar ridge

was normal. In addition, considering that the patient was a 13-year-old boy, the stability of the implants was poor and there was a high risk of implant detachment. Moreover, implant placement required additional invasive procedures. Therefore, we ultimately did not adopt the method of using implants to intrude the maxillary posterior teeth. Furthermore, the severe AOB could hardly be resolved only by the elongation of the anterior teeth. The extraction of the two mandibular second premolars was beneficial for providing space to correct the axis of the anterior teeth, and the remaining space was used for the forward movement of the posterior teeth to lower the fulcrum. Consequently, we concluded that using a tongue crib and extracting four second premolars, integrating multiple mechanisms, was the most suitable plan for this patient.

Treatment plan

In order to remove possible pathogenic factors as soon as possible, we applied a tongue crib to help this patient break the finger sucking habit from the beginning of the treatment. We designed a bonded tongue crib as shown in Fig. 4. The anterior part of the tongue crib was located on the palatal side of the two maxillary canines. It vertically extended from the palatal plate and completely covered the anterior open bite area, preventing the tongue from protruding forward to touch the upper and lower incisors even in the resting state. When the posterior teeth were in occlusion, the tongue crib was closely attached to the gingival area on the lingual side of the mandibular incisors. In this position, it served as a complete mechanical barrier to the tongue, thumb, or fingers.

The tongue crib would be bonded to the maxillary molars together with the brackets at the initial stage of orthodontic treatment. The self-ligating brackets and archwires of the Damon system would be used to widen the maxillary dentition and match the widths of the maxillary and mandibular dental arches. The upper and lower anterior teeth would be appropriately retracted and elongated to their normal axial positions. Eventually, normal overbite, overjet, and a Class I canine and molar relationship would be established. On this basis, all third molars and the supernumerary tooth would be required to be extracted.

Treatment progress

Since the patient initially exhibited poor oral hygiene, we gave him detailed oral hygiene instructions and continued to reinforce his oral hygiene habits during orthodontic treatment.

Before the orthodontic treatment started, we extracted four second premolars. At the same time as bonding the brackets, we bonded the tongue crib to the maxillary first molars (Fig. 5A). At the initial leveling stage, Damon system archwires and brackets of standard torque were used to widen the maxillary arch of the patient. As time passed, we could see that only with the archwire's action and the mechanical prevention of harmful habits, the degree of anterior open bite gradually reduced.

One year after the treatment, the patient and his parents stated that he had basically stopped sucking his thumb, and the tongue had gotten used to being placed in the correct position. Meanwhile, the patient's overbite had basically reached the normal level (Fig. 6A). Therefore, we removed the tongue crib and glued the buccal tubes to the maxillary molars. After that, to help maintain the overbite, we continuously used chair bow arch wires with vertical traction in the anterior teeth area (Fig. 6B). As the teeth were completely aligned and leveled, maxillary sliding and retraction of the upper anterior teeth were started, and the lower anterior teeth were bonded to move the posterior teeth forward to reduce the fulcrum and promote the reverse rotation of the mandible. To adjust the midline, oblique traction was applied (Fig. 6C).

After 35 months of active treatment, the patient finished orthodontic treatment. Since the patient underwent dental extraction, we designed a modified Hawley retainer (Fig. 7). Considering that the patient had many years of harmful tongue habits before treatment, we designed another set of retainer with welded tongue crib

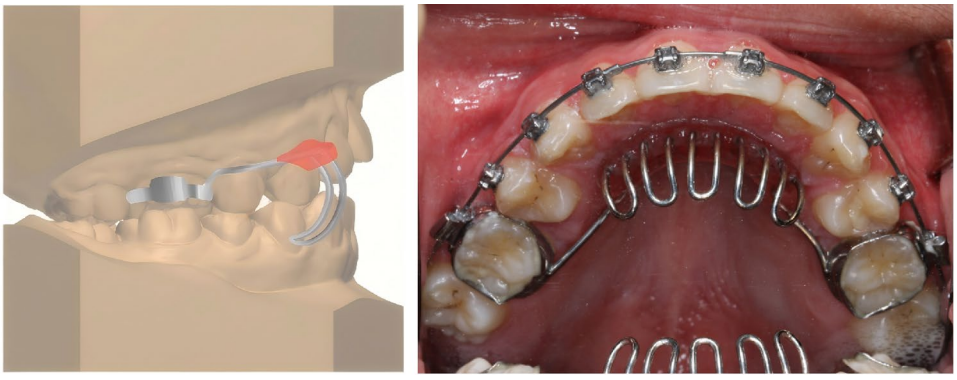

Fig. 4 Schematic diagram of the tongue crib and upper intraoral photography during treatment

Fig. 5 Treatment process 1: Tongue crib wearing stage. (**A**) The orthodontic treatment started. Self-ligating brackets were bonded, and the tongue crib was attached to the maxillary first molars. (**B**) A month later, there was a marked improvement in the open bite condition. (**C**) After five months, the vertical open bite was largely eliminated. (**D**) Ten months down the line, a positive overbite was achieved. Unfortunately, the bracket of the patient's 13# dislodged and went missing. As a substitute, we employed a non-self-ligating bracket with identical baseplate specifications

for the patient to use at night to avoid the recurrence caused by tongue habits to the greatest extent.

Treatment results

Post-treatment photographs (Fig. 8) confirmed satisfactory frontal and lateral aesthetics and lip-tooth relationship. Intraoral photographs and dental models (Fig. 9) showed a Class I molar relationship, a good interlacing relationship, normal overjet and overbite of anterior teeth, eligible teeth arrangement, and maxillary and mandibular arch widths and shapes were matched. The panoramic radiographs (Fig. 10) confirmed that the root parallelism was satisfactory, the extraction space was closed, there was no obvious root resorption, the alveolar ridge height was acceptable, and all the third molars and the supernumerary teeth were extracted.

The results of cephalometric measurement and overlapping map (Fig. 11) showed the forward movement of the maxillary and mandibular molar teeth, and the incisor teeth were extended and retracted, thus achieving mandible reverse rotation. Compared with the situation before treatment, the patient's lip convexity was improved, the lateral profile became better, and a normal growth and development direction was maintained.

The patient obtained satisfactory occlusion and facial aesthetics. These results remained stable after 17 months of retention (Fig. 12).

Discussion

There are many causes of anterior open bite, and although genetic factors play an important role in the etiology of malocclusion development, acquired factors also have a great influence [3]. Studies have shown that if AOB persists during the peak of craniofacial adolescent growth, it hardly self-corrects or even worsens [5], which impedes the normal development of teeth and jaws, resulting in impaired facial aesthetics, and may even adversely affect the mental health of adolescents [10].Therefore, for adolescent patients in the growth stage, it is particularly important to clarify the cause of AOB for the diagnosis and the subsequent treatment design.

When there is a persistent habit of thumb sucking, it can lead to weakened lips, protrusion of maxillary incisors, and destruction of the lip seal required for

Fig. 6 Treatment process 2: Space closing and fine adjustment stage. (**A**) When the overbite reached the normal standard, we removed the tongue crib and bonded the buccal tubes to the maxillary first molars. (**B**) during the stage of closing the extraction space, we applied vertical traction in the anterior tooth area. While maintaining the overbite, it promoted the uprighting of the axes of posterior teeth. (**C**) In the adjustment stage, bilateral asymmetric intermaxillary traction was adopted to help correct the midline. (**D**) After 33 months of orthodontic treatment, the treatment goals were basically achieved

Fig. 7 Posttreatment intraoral photographs with retainer

Fig. 8 Posttreatment intraoral and extraoral photographs

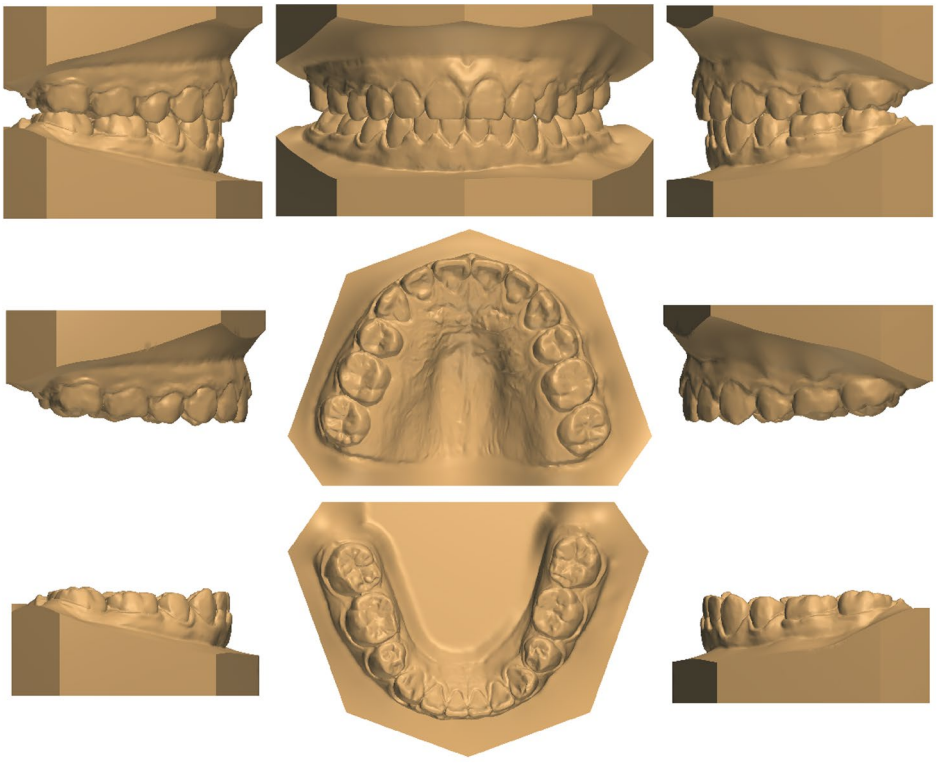

Fig. 9 Posttreatment dental casts

Fig. 10 Posttreatment panoramic radiograph, posteroanterior radiograph, and lateral cephalogram

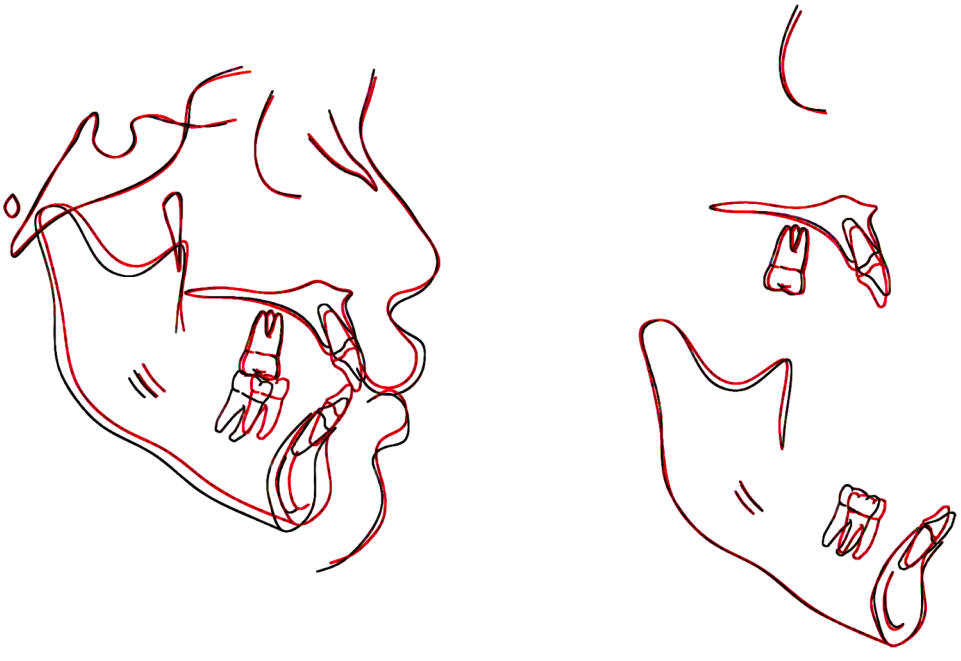

Fig. 11 Cephalometric superimpositions between pretreatment (black) and posttreatment (red)

Fig. 12 Intraoral and extraoral photographs at 17-month follow-up

swallowing, ultimately resulting in anterior open bite [11]. More seriously, an abnormal tongue position during swallowing or at rest combined with thumb-sucking behavior will exacerbate AOB [12]. In this case, we could see that the open bite area of this patient basically matched the shape of finger sucking and the tongue. There was no open bite in the posterior teeth area. According to the cephalometric analysis, this patient did not have a significant skeletal open bite tendency. The eruption height of the posterior teeth was also within the normal range, while the eruption height in the anterior tooth area was insufficient. Moreover, neither parent had similar intraoral manifestations. Therefore, we speculated that harmful oral habits might be an important cause of anterior open bite in this patient.

Tongue crib is a commonly used orthodontic appliance for breaking the finger sucking and tongue thrusting habits of adolescent patients [9]. Compared with the adhesive bonded spurs, the fixed tongue crib used in this case is less likely to fall off the teeth, and has a lower incidence of complications such as breakage and maladaptation [13]. Furthermore, it demonstrated better therapeutic efficacy and stability [14]. Compared with removable tongue crib, adhesive tongue crib can break the harmful habits while straightening the teeth, and on the one hand, shorten the time of orthodontic treatment, on the other hand, reduce the possibility of adolescent patients to give up treatment because of the less need of the cooperation of the patients.

It is very important to select an appropriate device for correcting tongue habits, and a full judgment should be made by combining the position of the patient's tongue body and the curvature of the sagittal curve of the maxillary and mandibular dentitions. Although a horizontally placed palatal plate also has a certain curative effect [15], it is obvious that a vertically placed tongue crib can better block thumb sucking behavior and forward protrusion of the tongue. In this case, the position of the patient's tongue body was very low. Therefore, a tongue crib extending to the floor of the mouth was selected, and good results could be obtained without the need for vertical short traction of the anterior teeth. When the length of the tongue crib is insufficient, some children will extend their tongues forward to the incisor area by passing the lower part of the tongue crib, further enhancing the strength of the tongue muscles and deviating from the treatment goal. If the length of the tongue crib is too long and it is too close to or even presses on the lingual mucosal tissue of the mandible, the comfort level will be reduced, and it may be difficult to ensure the patient's compliance. In response to the above problems, some researchers have made certain improvements to the tongue crib design. Some researchers have added an acrylic bead in the center of the crib to assist in correcting the position of the tongue [16]. There are

also scholars [12] who have designed an adjustable tongue crib that can adjust the height of the tongue crib according to needs, increasing the patient's comfort and cooperation.

In addition to passively blocking harmful habits through the tongue crib, during the orthodontic treatment process, active tongue muscle training can better eliminate the adverse effects of the tongue on the anterior teeth [11]. The tongue crib and myofunctional training showed excellent effectiveness in correcting anterior open bite and tongue function. During the orthodontic treatment, the extraction space closed spontaneously without the application of an active force by the orthodontic appliance, perhaps because blocking tongue pressure allowed the lips to press the anterior teeth lingually, similar to the findings of Sie et al. [17].

For patients with AOB caused by deleterious oral habits, the key to correction is to break the habit of finger sucking and tongue thrusting, but also to vertical control [18]. The use of appropriate biomechanics is critical to achieving the desired outcome in this case. For the maxilla, by appropriately widening the maxillary dental arch and using the small amount of space provided by extracting two second premolars, the upper anterior teeth could be retracted and elongated to establish a good lip-tooth relationship [19]. During the process of tooth adduction, a rocking chair arch is used in both the maxilla and mandible, and vertical elastic traction is applied in the anterior tooth area. This not only promotes overbite maintenance but also has a depressing and uprighting effect on the molars. Since the eruption height of the posterior teeth was normal, we did not use implants to intrude the maxillary molars. Therefore, after appropriately retracting and elongating the mandibular anterior teeth, we moved the mandibular posterior teeth forward, lowered the occlusal fulcrum [20], thus promoting the counter-clockwise rotation of the mandible, ameliorating the class II bone relationship of the patient [21], and improving the lateral profile.

How to maintain the long-term stability of AOB patients is a problem that orthodontists need to address, but studies have shown that AOB patients can maintain stability for more than 10 years [22]. Previous studies have shown that compared with non-extraction orthodontic treatment, extraction orthodontic treatment has higher long-term stability for patients with AOB [23]. However, considering that patients who have had teeth extracted may experience recurrence of the extraction space during the retention period, we have designed and used a modified Hawley retainer (Fig. 7). This kind of retainer is easy to put on and take off, reducing the potential adverse effects of fixed retainers [24], and can also achieve relatively high levels of compliance [25]. Moreover, when a small recurrence of the gap occurs, the wrapping property can be increased and the teeth can be tightened by adjusting the retainer.

Furthermore, for patients with AOB, vertical retention is more important and difficult, considering that it is challenging for any type of retainer to maintain vertical stability. In this patient's treatment process, we repeatedly advised the patient to reduce the habits of finger-sucking and tongue-thrusting. After the overbite reached a positive value and the tongue crib was removed, we also had the patient cooperate with vertical intermaxillary traction to maintain the overbite. Moreover, we made an additional retainer with tongue crib for the patient to use at night. This was intended to prevent the tongue from exerting adverse forces on the anterior teeth at night when there is no conscious control, thus further assisting the patient in adapting to the correct tongue position and enhancing the stability of orthodontic treatment [26].

The study showed the highest prevalence of space reopening 1 year after treatment [27]. As expected, the patient showed good stability at 17 months of follow-up, and we hope that the patient can maintain the current good correction results over a longer period of time.

Conclusions

For adolescent patients with anterior open bite, clear diagnosis and elimination of causative factors are key to favorable treatment results. Combining multiple mechanisms can effectively restore and establish a good occlusal relationship. Throughout the treatment, it is also necessary to pay attention to patients' growth and development.

Abbreviations

AOB	Anterior open bite
FMA	Frankfort mandibular plane angle
LFH	Lower facial height
UFH	Upper facial height
APDI	Anteroposterior Dysplasia
ODI	Overbite Depth Indicator
CF	Combination Factor
UADH	Upper Anterior Dental Height
UPDH	Upper Posterior Dental Height
LADH	Lower Anterior Dental Height
LPDH	Lower Posterior Dental Height
CVS	Cervical vertebral stage

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Author contributions

Jingmei Zhang collected data and drafted the manuscript. Yinuo Zhao and Dongsheng Song participated in the orthodontic treatment of this patient, and drafted and critically revised the manuscript. Xinyu Liu and Chenmeng Lu contributed to data reanalysis. Jingzheng Yi critically revised the manuscript. Yi Zhang provided assistance and advice regarding the manuscript. Min Hu performed the final editing of the manuscript. All the authors have read and approved the final version of the manuscript.

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Data availability
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study was conducted in accordance with the Declaration of Helsinki and approved by the Medical Ethics Committee of The Bethune Hospital of Stomatology Jilin University (SJD-KQ-2024–087).

Consent for publication
Written informed consent for publication was obtained from the patient and his legal guardian to publish all clinical data and accompanying photographs.

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Competing interests
The authors declare no competing interests.

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