International Orthodontics 2023; 21: 100717

Websites:
www.em-consulte.com
www.sciencedirect.com

Case Report

Long term stability of a high-angle skeletal Class II open bite treated with high-pull headgear and modified transpalatal arch: A case report

Roy Sabri

Available online: 13 December 2022

Department of Orthodontics, American University of Beirut Medical Center and private practice, Independence St, Sodeco, Freij Bldg, 16-6006, Beirut, Lebanon

roysabri@gmail.com

Keywords
Thumb sucking habit
High-angle open bite
Skeletal Class II
High-pull headgear
Modified transpalatal arch

Summary

This case report describes the treatment of an adolescent patient with an Angle Class II malocclusion, severe open bite and overjet, proclined incisors, skeletal Class II anteroposterior dysplasia, high mandibular plane angle and convex profile. The importance of stopping of a prolonged thumb sucking habit, which was a major causative factor of the open bite is discussed. A combination of a high-pull headgear and a modified transpalatal arch with a loop embedded with resin, at a distance from the palate, were used along with an Edgewise appliance. Treatment timing, favourable growth and good patient response led to an optimal outcome with excellent stability of the treatment results five years and five months post-treatment.

Introduction

The anterior open bite is considered to be one of the most challenging malocclusion to treat in orthodontics. It can impair masticatory function and phonetics and also causes considerable aesthetic concerns to the affected patients [1]. The aetiology of open bite is multifactorial. Unfavourable growth patterns as well as mouth breathing, tongue thrusting, thumb sucking habits and prolonged use of pacifiers have been considered causative or worsening factors [2]. This article describes the treatment of an 11 years and 9 months old boy with a chronic thumb sucking habit and vertical skeletal dysplasia as major causative factors of his malocclusion [3]. Such hyperdivergent retrognathic open bite malocclusions have a high relapse rate and a lack of strong scientific evidence with some of the available treatment modalities [4–6]. Thus, the importance of addressing the underlying anteroposterior and vertical skeletal discrepancies with appropriate orthodontic mechanics to achieve optimal facial and smile

https://doi.org/10.1016/j.ortho.2022.100717

aesthetics and good occlusion. This case report challenges the common belief that severe skeletal open bite malocclusions are prone to relapse by showing how an orthopaedic approach with proper mechanics can take advantage of growth to achieve a stable long term outcome.

Case presentation

Diagnosis and aetiology

A boy was seen for the first time at 9 years of age with a chief complaint of unpleasant teeth and smile. He was in the mid mixed dentition stage and had a severe open bite. His medical history was non-contributory and his dental history revealed a chronic thumb sucking habit. A thumb sucking appliance with bands on the first maxillary molars and an anterior palatal crib was initiated one year earlier by his pedodontist for a duration of 7 months and helped reduce the severity of the open bite (*figure 1* A). Unfortunately, it did not succeed in breaking the habit which resumed, apparently with equal intensity, right after appliance removal. He now had a severe open bite and overjet with no incisor show at rest and upon full smile (*figure 1* B-E). With guardians' consent, it was decided that another thumb sucking appliance would fail again if he is not ready to stop the habit. He therefore needed to take a decision to do so and stick to it before we can start any orthodontic correction of his malocclusion. The motivation of the patient was judged as fair and the disposition of the parents fully supportive and encouraging for the child. He was put on regular recall control appointments but did not show up until 2 years and 9 months later, at the age of 11 years and 9 months, in his early permanent dentition. The thumb sucking habit had recently and spontaneously stopped and his open bite appeared less severe since his initial visit at 9 years of age. He had no restorations and his oral hygiene was rather poor.

Clinical examination and facial photographs revealed a convex profile with mandibular and lower lip retrusion. From a frontal view, the face appeared well balanced and symmetrical. The lips met with a slight muscular contraction of the chin muscles and a mild labio-mental fold was noted. There was a low lip line with only 1 to 2 mm of incisal display upon smiling (*figure 2*).

Intraorally, he had a full Class II molar and canine relationship and an overjet of 11 mm. The open bite extended from first premolar to first premolar and was 7 mm at the midline. Dental midlines were aligned and coincident with the facial midline. Arch forms were normal with a flat curve of Spee in the mandibular arch and a severe curve of Spee in the maxillary arch. There was no tooth size-arch length discrepancy in both arches and the maxillary canines were slightly blocked out. Second molars were erupted (*figures 2 and 3*).

The panoramic radiograph revealed the presence of a mesiodens in an everted upward position with its root apex at the mid-root level between the maxillary central incisors. There was a full complement of teeth, including normally developing third molars. The overall bone level was within normal limits (*figure 4*).

The cephalometric analysis showed a severe skeletal Class II anteroposterior relationship evidenced by an ANB angle of 11° and a Wits appraisal of 6 mm. There was a hyperdivergent facial growth pattern with a Frankfort-mandibular plane angle of 32° and an SN-GoGn angle of 40°. The maxillary and mandibular incisors were proclined. Soft tissue analysis showed rather

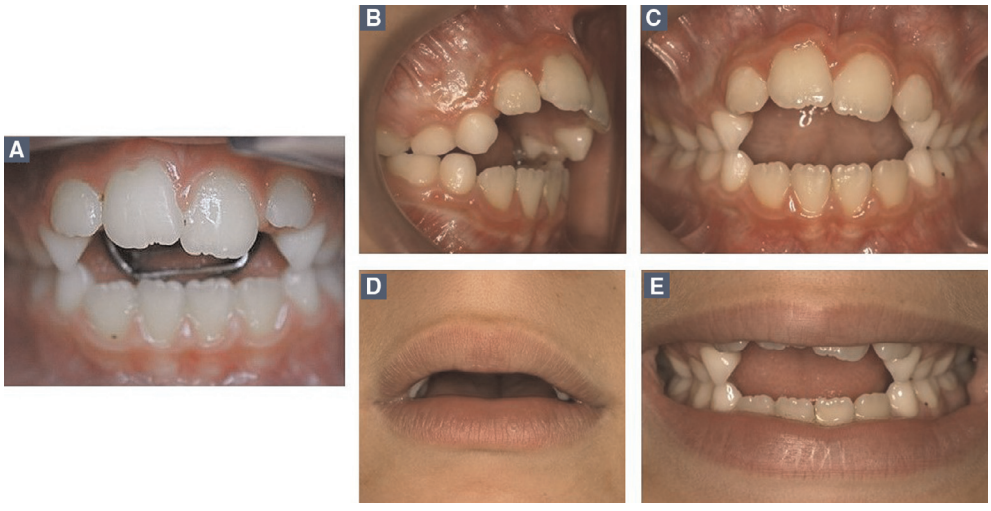

FIGURE 1

Intraoral photographs. A: with thumb sucking appliance (age: 8 years); B, C: (age: 9 years); D-E: rest and smile close-up views photographs (age: 9 years)

FIGURE 2

Pre-treatment facial and intraoral photographs (age: 11 years 9 months)

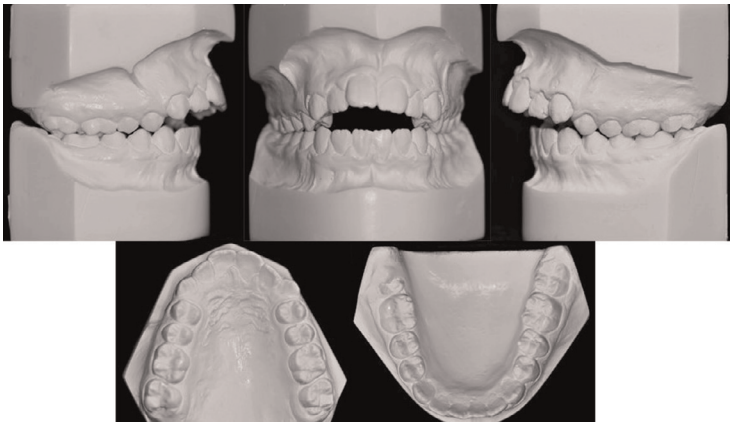

FIGURE 3

Pre-treatment dental casts

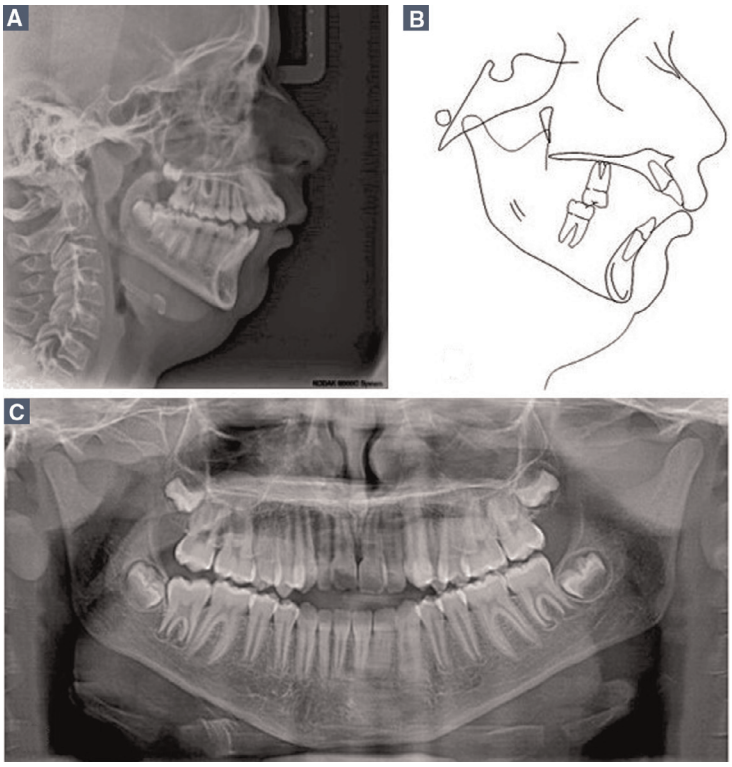

FIGURE 4

Pre-treatment radiographs and tracings. A: lateral X-ray; B: tracing; C: panoramic X-ray

protruded lips with a weak nasal projection. The oropharyngeal airway was narrow (*figure 4*).

Treatment objectives

The main objective in the treatment of this malocclusion was to correct the open bite and the lack of incisal exposure upon smiling which were the patient's chief complaints. The retruded mandible had to be addressed to improve facial aesthetics and help achieve a Class I occlusion with and optimal overjet and overbite relationship.

Treatment alternatives

A surgical approach at the end of growth was considered but dismissed. The reason for consideration was the severity of the anterior and vertical jaw discrepancies and an unfavourable vertical growth pattern. It was dismissed because parents did not want to leave him through his adolescent years with an aesthetically unpleasant malocclusion and give a chance to an orthopaedic and orthodontic approach, leaving orthognathic surgery or advancement genioplasty in case of poor mandibular response as a last resort.

The two basic orthodontic treatment options considered were premolar extractions or non-extraction and headgear:

- extraction of maxillary first premolars. Retract and extrude the maxillary anterior segment after reinforcing the posterior anchorage with a transpalatal arch or miniscrews. This treatment option has the advantage of not relying on patient cooperation. However, it does not take advantage of the growth potential to reduce the underlying anteroposterior and vertical skeletal discrepancies;
- non-extraction orthopaedic treatment with a high-pull headgear. The inner bow will be inserted on maxillary first molars bands connected by a transpalatal arch with an acrylic button 4 mm away from the palate. This would help correct facial convexity, the overjet and the open bite by favouring anteroposterior and vertical growth restriction of the maxilla and forward growth of the mandible.

The non-extraction/high-pull headgear option was adopted as it will favour differential growth and better address facial aesthetics. Growth potential, response to treatment and the importance of cooperation were discussed with the patient and parents.

Treatment progress

Bands were fitted on the maxillary first molars and an alginate impression was taken. A soldered transpalatal arch with a loop

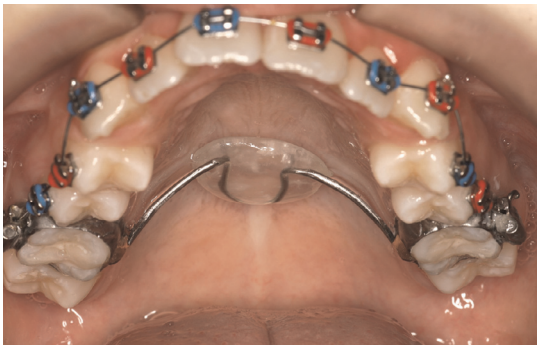

FIGURE 5
Intraoral photograph of transpalatal arch with acrylic button 4 mm away from the palate

4 mm away from the palate and embedded with an acrylic button was fabricated and inserted (*figure 5*). Standard edgewise brackets (0.022 × 0.028-inch slots) were bonded on the maxillary arch. A high-pull headgear was delivered on the next visit. The inner bow was inserted on the maxillary first molars bands and the outer bow bent upward to direct the forces (450 grams per side) through the centre of resistance of the maxillary first molars, generating a translatory distal movement of these teeth. The patient was instructed to wear his headgear after he gets home from school and during sleep for a total of 12 to 14 hours per day. His cooperation was not consistent which extended the duration of his headgear to 3 years. The mandibular arch was bonded 6 months after the maxillary arch. The mesiodens was extracted later as it would not interfere with initial tooth movement. A normal progression of archwires starting with 0.014-inch nickel-titanium alloy and working up to 0.018-inch stainless steel, was used to level, align and coordinate the arches. Class II elastics were initiated one year after treatment started. No anterior intermaxillary elastics were used to close the open bite. Active treatment duration was 4 years and fixed appliances were removed at age 15 years and 9 months. Retention consisted of a maxillary Hawley-type removable appliance worn full time for 12 months, followed by 12 months of night-time wear. Fixed retainers were made of 0.215-inch twisted wires bonded onto the lingual sides of the maxillary incisors and the mandibular incisors and canines. These fixed retainers could be kept permanently to maintain the long-term stability of the results.

Treatment results

Remarkable facial changes were observed with a resolution of the mandibular retrusion and facial convexity. On full smile, there was an adequate vertical exposure of the maxillary incisors and an optimal amount of tooth display transversally. Intraorally, a well interdigitated Class I buccal occlusion was established with optimal overbite and overjet and tooth alignment (*figure 6*).

The post-treatment panoramic radiograph revealed good overall root parallelism except for the impacted mandibular third molars with oblique axial inclinations (*figure 7*).

The post-treatment cephalometric tracing and superimposition analysis made on Sella-Nasion at Sella, showed a significant downward and forward growth of the mandible relative to the maxilla. This differential growth with the correction of the skeletal and molar anteroposterior discrepancies have contributed to the 11 mm overjet correction. In addition to enhanced mandibular growth, favourable forward growth of the chin "button" at gnathion was also noticed. Maxillary incisors were extruded and uprighted and mandibular incisors slightly proclined. Soft tissue analysis showed adequate relationships to the Holdaway line of chin, lips and nose and an optimal correction of the facial convexity expressed by the facial contour angle reduction from 26° to 11° (*figure 7*, *table I*).

Post-treatment records taken 5 years and 5 months after fixed appliance removal revealed excellent long-term stability of the treatment results. The considerable improvement in facial and smile aesthetics has been preserved (*figure 8*). Intraorally, tooth alignment, well-interdigitated buccal occlusion and optimal overjet and overbite have been maintained, 3 years and 5 months after the removable maxillary retainer was discontinued. The maxillary fixed retainer was stopped one year earlier, after it has failed (*figures 8 and 9*). The panoramic radiograph showed healthy supporting tissues and extracted third molars (*figure 10*). The cephalometric radiograph and superimposed tracings at post-treatment (age 15 years 9 months) and 5 years and 5 months post-treatment (age 21 years 2 months) revealed some late mandibular forward growth (*figure 11*).

FIGURE 6

Post-treatment facial and intraoral photographs (age: 15 years 9 months)

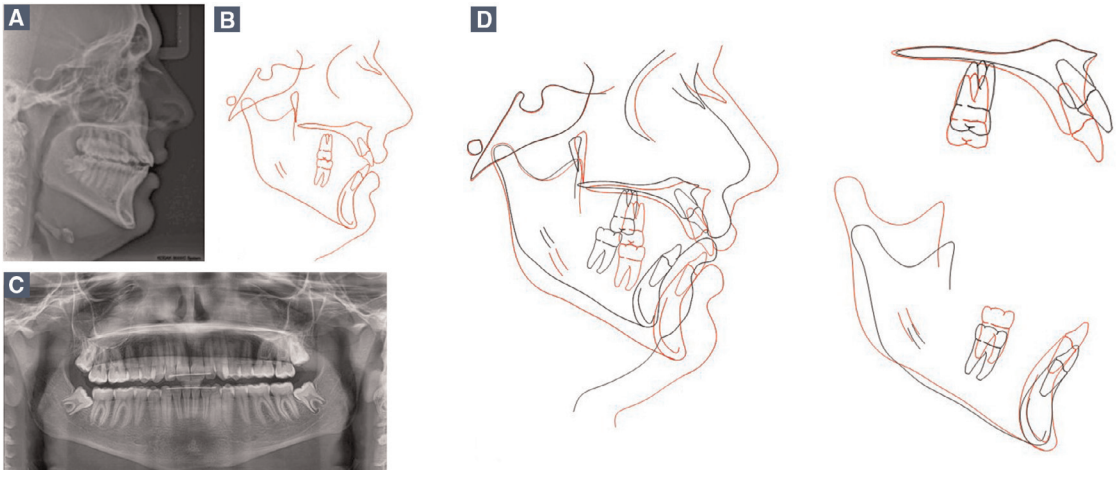

FIGURE 7

Post-treatment radiographs and tracings. A: lateral X-ray; B: tracing; C: panoramic X-ray; D: superimposed pre-treatment (black lines) and post-treatment (red lines) cephalometric tracing

TABLE I
Cephalometric measurements.

Measurement	Norm	Before Treatment	After Treatment	5 years, 5 months After Treatment
Skeletal				
SNA (°)	82	85	82	82
SNB (°)	80	74	77	77
ANB (°)	2	11	5	5
FH-NA (Max depth) (°)	90	94	89	90
FH-NP (Facial angle) (°)	87	83	86	87
Wits (mm)	1	6	3	3
SN-MP (°)	32	40	39	39
FMA (°)	25	32	32	31
Dental				
U1-SN (°)	103	112	105	105
U1-NA (°)	22	27	25	24
U1-NA (mm)	4	5	6	5
L1-NB (°)	25	28	31	30
L1-NB (mm)	4	8	11	9
L1-MP (°)	87	95	97	95
L1-APo (mm)	1	0	6	4
U1-L1 (°)	131	112	120	122
Soft tissue				
Facial contour angle (°)	11	26	11	14
Holdaway line:				
Tip of nose (mm)	9	−4	12	7
Subnasal (mm)	5	8	5	5
Upper lip (mm)	0	0	0	0
Lower lip (mm)	0	0	1	0
Supramentale (mm)	5	6	6	6
Pogonion (mm)	0	0	0	0

FIGURE 8

Five years and five months post-treatment facial and intraoral photographs (age: 21 years 2 months)

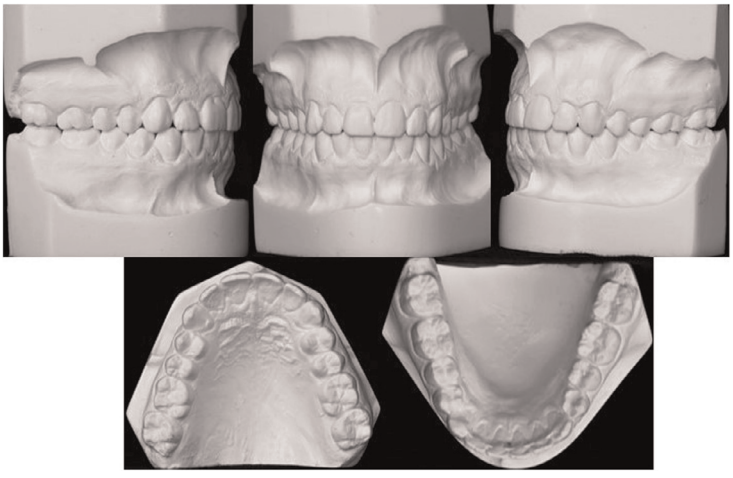

FIGURE 9

Five years and five months post-treatment dental casts

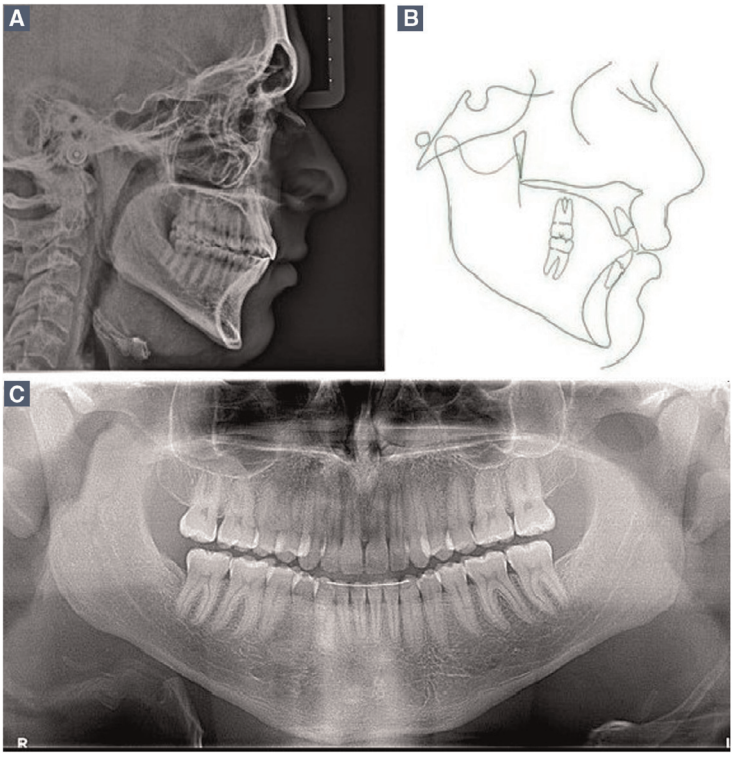

FIGURE 10

Five years and five months Post-treatment radiographs and tracings. A: lateral X-ray; B: tracing; C: panoramic X-ray

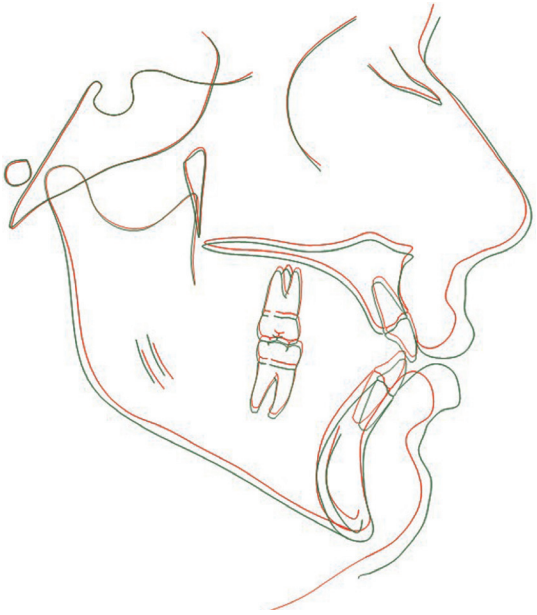

FIGURE 11

Superimposed post-treatment (red lines) and five years and five months post-treatment (green lines) cephalometric tracings

Discussion

Anterior open bite is widespread among young children, with a prevalence ranging between 17 to 18% in the mixed dentition [7,8]. A study on the relationship between sucking habits and malocclusion in the deciduous dentition found a higher prevalence of open bite in the thumb or finger sucking group compared with age matched controls without oral habits [8]. Likewise, about 1 of 4 subjects with hyperdivergent facial pattern develops anterior open bite [3]. This patient had a prolonged thumb sucking habit and hyperdivergent facial characteristics which are significant risk factors for anterior open bite in the mixed dentition with a prevalence rate of 36.3% [3]. The prolonged sucking habit has also created a mechanical obstacle for the eruption of anterior teeth resulting in a low lip line upon smiling [9].

Thumb sucking after age 5 could be in response to an emotional problem such as anxiety, family problems (marital discord) or a mean to attract parents' attention (e.g. if a baby is born in the family) [10]. When thumb sucking may be secondary to changes in the child's emotional environment, treatment should be directed at correcting the underlying problem. Thumb sucking may also be associated with fatigue, boredom, excitement, hunger, stress and insufficient satisfaction of sucking need in infancy and the key to successful elimination of the habit is motivation. The child and the parents must understand the harmful effects of thumb sucking on the dentition and why it is important to stop it. The duration, intensity and frequency of thumb sucking have to be assessed. The duration of the force is more critical than its magnitude, and the resting pressure has the greatest impact on the position of the teeth [11]. Treatment options proposed for thumb sucking can range from patient and parent counselling, oral appliances, behaviour modification techniques such as advice and incentives for changing behaviour, nasty tasting substance on the child thumb, wrapping the thumb in a bandage, placing gloves before bedtime, myofunctional therapy or combinations of these treatments [10,12]. The will and compliance to eliminate the habit should be evaluated and no treatment should be attempted with a child not willing to stop the habit. Thumb sucking appliances, like seen in this case report, will spontaneously reduce the severity of the open bite but should be proposed as an aid to a child who has been motivated previously and is willing to stop the habit. Otherwise, the appliance might be seen as a punishment and will fail to break the habit.

Open bites that include skeletal components have always been challenging malocclusions for orthodontists because of their multifactorial aetiology and their very high relapse rate [4]. Open bite correction is expected to be easier to achieve and maintain when the causative factor is identified and controlled. In the present case, besides recognizing the chronic thumb sucking habit as the major causative factor of the open bite, both the underlying vertical and anteroposterior skeletal discrepancies had to be addressed as well. The Kloehn cervical headgear has been widely used in the treatment of Class II, Division 1 malocclusions. The cervical pull, however, tends to extrude the molars which is undesirable in hyperdivergent Class II, Division 1 open bite patients who are more susceptible to dental extrusion and further bite opening during orthodontic mechanotherapy [13]. In such skeletal open bite malocclusions, vertical control of dentoalveolar height during orthodontic treatment with a possible counterclockwise mandibular rotation is essential. With good patient compliance and response, the use of the high-pull facebow headgear, along with fixed edgewise appliances, has been shown to correct Class II malocclusions in growing patients through restriction of horizontal maxillary growth with continued horizontal mandibular growth and vertical skeletal changes unaffected [14–16]. The conventional transpalatal arch was also shown to induce a slight inhibition of normal eruption of the maxillary first molars [17]. To better control the vertical dimension of high-angle patients without the benefit of compliance, modified transpalatal arches that would restrict further vertical growth or even intrude the posterior teeth have been advocated [18–20]. The transpalatal arch loop, embedded with resin and at a distance from the palate, uses upward tongue pressure during swallowing and speech to reduce the vertical dentoalveolar development and control maxillary first molars eruption [21].

Several case reports have also shown that, at least in the short term, skeletal anchorage with miniplates or miniscrews can intrude both maxillary and mandibular molars and improve the vertical and anteroposterior discrepancy by favouring counterclockwise rotation of the mandible [22–24]. In the present case, the favourable treatment response was due to the orthopaedic growth modification effect of the high-pull headgear through forward growth restriction of A-point and significant forward growth of the mandible rather than maxillary and mandibular molars intrusion [16]. Given the patient's narrow airways and low tongue position, orofacial myofunctional therapy (OMT) could have been considered. Orofacial dysfunctions often associated with skeletal open bite malocclusions increase the degree of difficulty of orthodontic treatment and can contribute to relapse. OMT has been advocated to allow satisfactory growth and development of the jaws and corresponding adaptation of the dentition. However, the effectiveness of OMT adjunct therapy to orthodontic treatment has been controversial. Smithpeter and Covell showed that the relapse of open bite treated with orthodontics and OMT was significantly less than that in patients treated with orthodontics alone [25]. In contrast, other authors concluded that OMT may not always be the right choice for patients with open bite and aberrant tongue behaviour but should be given serious consideration [26,27]. The findings of a systematic review reflected the scarcity of consistent studies and the lack of scientific evidence on the effectiveness of OMT as a complement to orthodontic treatment [28].

With this background, orthodontists have been reluctant to recommend OMT, particularly considering its crucial dependence on the motivation and compliance of both child and parents and the availability and expertise of OMT providers [29].
A possible criticism of the treatment of this malocclusion is the lengthy treatment time of four years. This could easily be blamed on the patient's several broken and cancelled appointments during treatment even though most of these appointments were rescheduled without delay. Missing appointments also affected his headgear cooperation which became inconsistent and prolonged treatment time.

Conclusions

In this case report, a combination of high-pull headgear and modified transpalatal arch proved to be effective mechanics for the treatment of a high-angle skeletal Class II open bite malocclusion in a growing patient. The optimal treatment outcome seems to be the result of good patient response to the right mechanics for the right patient at the right time. The excellent long-term stability was an additional challenge in the treatment of this malocclusion with a very high relapse tendency.

Informed consent: The patient has provided prior consent for inclusion of his information and images.

Acknowledgment: The author would like to acknowledge Dr. Kinan G. Zeno for his valuable contribution to the cephalometric assessments.

Disclosure of interest: The author declares that he has no competing interest.

References

[1] Laudadio C, Inchingolo AD, Malcangi G, et al. Management of anterior open-bite in the deciduous, mixed and permanent dentition stage: a descriptive review. J Biol Regul Homeost Agents 2021;35:271–81.
[2] Rijpstra C, Lisson JA. Etiology of anterior open bite: a review. J Orofac Orthop 2016;77:281–6.
[3] Cozza P, Baccetti T, Franchi L, Mucedero M, Polimeni A. Sucking habits and facial hyperdivergency as risk factors for anterior open bite in the mixed dentition. Am J Orthod Dentofacial Orthop 2005;128:517–9.
[4] Greenlee GM, Huang GJ, Chen SS, Chen J, Koepsell T, Hujoel P. Stability of treatment for anterior open-bite malocclusion: a meta-analysis. Am J Orthod Dentofacial Orthop 2011;139:154–69.
[5] Salehi P, Pakshir HR, Hoseini SA. Evaluating the stability of open bite treatments and its predictive factors in the retention phase during permanent dentition. J Dent (Shiraz) 2015;16:22–9.
[6] Feres MF, Abreu LG, Insabralde NM, Almeida M, Flores-Mir C. Effectiveness of the open bite treatment in growing children and adolescents. A systematic review. Eur J Orthod 2016;38:237–50.
[7] Silvestrini-Biavati A, Salamone S, Silvestrini-Biavati F, Agostino P, Ugolini A. Anterior open-bite and sucking habits in Italian preschool children. Eur J Paediatric Dent 2016;1:43–6.
[8] Avrella MT, Zimmermann DR, Andriani JSP, Santos PS, Barasuol JC. Prevalence of anterior open bite in children and adolescents: a systematic review and meta-analysis. Eur Arch Paediatr Dent 2022;23:355–64.
[9] Urzal V, Braga AC, Ferreira AP. Oral habits as risk factors for anterior open bite in the deciduous and mixed dentition - cross-sectional study. Eur J Paediatr Dent 2013;14:299–302.
[10] Skinazi G. A psychological approach to thumbsucking. J Clin Orthod 2000;34:478–81.
[11] Tanny L, Huang B, Shaweesh A, Currie G. Characterization of anterior open bite in primary school-aged children: A preliminary study with artificial neural network analysis. Int J Paediatr Dent 2021;31:576–82.
[12] Shah R, Ashley P, Amlani M, Noar J. Non-nutritive sucking habits in a child: a clinical protocol to their prevention and management. J Orthod 2021;48:410–6.
[13] Henriques FP, Janson G, Henriques JF, Pupulim DC. Effects of cervical headgear appliance: a systematic review. Dental Press J Orthod 2015;20:76–81.
[14] Brown P. A cephalometric evaluation of high-pull molar headgear and face-bow neck strap therapy. Am J Orthod 1978;74:621–32.
[15] Firouz M, Zernik J, Nanda R. Dental and orthopedic effects of high-pull headgear in treatment of Class II, division 1 malocclusion. Am J Orthod Dentofacial Orthop 1992;102:197–205.
[16] Bilbo EE, Marshall SD, Southard KA, Allareddy V, Holton N, Thames AM, et al. Long-term skeletal effects of high-pull headgear followed by fixed appliances for the treatment of Class II malocclusions. Angle Orthod 2018;88:530–7.
[17] Mucedero M, Vitale M, Franchi L, Cozza P, Perillo L. Comparisons of two protocols for early treatment of anterior open bite. Eur J Orthod 2017;39:270–6.
[18] Deberardinis M, Stretesky T, Sinha P, Nanda RS. Evaluation of the vertical holding appliance in treatment of high-angle patients. Am J Orthod Dentofacial Orthop 2000;117:700–5.
[19] Salem OH, MacCarthy TS. Modified transpalatal bar for maxillary molar intrusion. J Clin Orthod 2005;39:668–71.
[20] Greco AM, Gavetti F, Severino M, Gatto R. Use of a modified vertical holding appliance for open bite interceptive treatment in growing patients. Eur J Paediatr Dent 2021;22:35–40.
[21] Xu K, Zeng J, Xu T. Effect of an intraoral appliance on tongue pressure measured by force exerted during swallowing. Am J Orthod Dentofacial Orthop 2016;149:55–61.
[22] Sherwood K. Correction of skeletal open bite with implant anchored molar/bicuspid intrusion. Oral Maxillofac Surg Clin North Am 2007;19:339–50.
[23] Kuroda S, Katayama A, Takano-Yamamoto T. Severe anterior open-bite case treated using titanium screw anchorage. Angle Orthod 2004;74:558–67.
[24] Estelita S, Janson G, Chiqueto K. Versatility and benefits of mini-implants for vertical and sagittal anchorage in a growing open bite Class II patient. J Orthod 2012;39:43–5.
[25] Smithpeter J, Covell DJr. Relapse of anterior open bites treated with orthodontic appliances with and without orofacial myofunctional therapy. Am J Orthod Dentofacial Orthop 2010;137:605–14.
[26] Van Dyck C, Dekeyser A, Vantricht E, Manders E, Goeleven A, Fieuws S, et al. The effect of orofacial myofunctional treatment in children with anterior open bite and tongue dysfunction: a pilot study. Eur J Orthod 2016;38:227–34.
[27] 3-Hong H, Zeng Y, Chen X, Peng C, Deng J, Zhang X, et al. Electromyographic features and efficacy of orofacial myofunctional treatment for skeletal anterior open bite in adolescents: an exploratory study. BMC Oral Health 2021;21:242.
[28] Homem MA, Vieira-Andrade RG, Falci SG, Ramos-Jorge ML, Marques LS. Effectiveness of orofacial myofunctional therapy in orthodontic patients: a systematic review. Dental Press J Orthod 2014;19:94–9.
[29] Jónsson T. Orofacial dysfunction, open bite, and myofunctional therapy. Eur J Orthod 2016;38:235–6.