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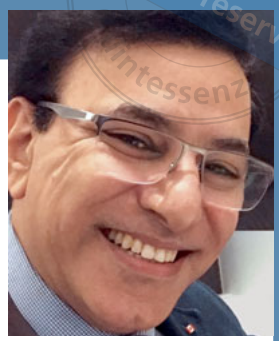
Rethinking the bioprogressive technique for Class II correction with clear aligners



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The traditional bioprogressive philosophy has been reported to treat growing Class II malocclusion cases. The traditional technique involves the use of cervical headgear to extrude maxillary molars and to restrain maxillary growth while allowing forward arcial growth of the mandible. This case report utilises the same philosophy but using clear aligners. A 12-year-old girl presented with a skeletal Class II relationship due to mandibular retrognathism. The patient also presented full-step Class II, division 1 malocclusion with an increased overjet and deep overbite in addition to a spaced mandibular arch. Treatment included restraining maxillary forward growth while allowing maximum forward mandibular growth and correction of both skeletal and dental malocclusion/malrelationship using clear aligners. Detailed setup of the treatment plan using clear aligners utilising the bioprogressive philosophy is presented. Treatment was completed in 1 year. The treatment achieved improvement in skeletal and dental relationships. Critical evaluation of the case is also presented and the future management of similar cases of Class II malocclusion with a skeletal Class II relationship is discussed.

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Introduction

There have been many reports on the treatment of Class II malocclusion cases solely by clear aligners, showing correction of buccal occlusion as well as improvement of the overbite and overjet[1-3]. In many of these reports, proclination of the mandibular incisors was a common treatment outcome, specifically when Class II elastics were used to distalise maxillary molars or to correct the buccal occlusion to Class I[2,3]. The only exceptions were the cases reported by Boyd[1], who reported that mandibular incisor inclination improved after Class II treatment; however, the manner of this improvement was unclear. In cases where mandibular incisors are initially retroclined, it is known that Class II elastics can move mandibular incisors forward to a normal position or sometimes beyond a normal position. The challenge is usually when mandibular incisors are initially proclined, normally seen in a skeletal Class II relationship and known as dental compensation. The mandibles of growing patients can grow forward or backward according to their mandibular structure shape, in particular the mandibular condylar heads[4,5].

The bioprogressive philosophy was first discussed by Ricketts, who suggested that Class II correction in cases with mandibular retrognathism should include maxillary molar distalisation and extrusion using cervical headgear, which triggers faster forward mandibular projection/growth in growing patients[6-9]. However, detailed clinical trials and

Fig 1a to h Initial clinical extraoral and intraoral photographs.

meta-analysis of the proposed technique have not been published.

Case presentation

A 12-year-old girl presented for a third opinion to correct her overbite and overjet with possible improvement of her convex profile, and the hope to avoid any extraction, headgear use or future surgical intervention.

Clinical records including cone beam computed tomography (CBCT) scans and cephalometric radiographs confirmed a skeletal Class II relationship and Class II, division 1 malocclusion (full-step Class II buccal occlusion), 80% overbite and 6-mm overjet (Figs 1 and 2). In addition, CBCT-generated digital models (Anatomodels, Anatomage, San Jose, CA, USA) showed spacing in the maxilla (4 mm) and mandible (5 mm) (Fig 3). The patient was classed as cervical vertebral maturation index (CVMI) stage 3[10].

Ricketts cephalometric analysis (Table 1) showed initial Class II skeletal relationship as confirmed by increased facial convexity (A-NPo) (mm) measurement due to prognathic maxilla and slightly retrognathic mandible (decreased ramus position). The patient also showed a forward-growing

Fig 2a to c **(a)** Initial cephalometric radiograph. **(b)** Initial panoramic radiograph. **(c)** Pretreatment tomograms showing the head of the condyles is directed forward indicating normal forward growth.

Fig 3 Initial Anatomodels (cone beam computed tomography-driven digital models) (Anatomage, San Jose, CA, USA).

mandible (within normal range facial axis of Ricketts [Na-Ba-PtGn]) and Frankfort-mandibular plane angle (FMA) of 16.6 degrees. Maxillary and mandibular incisors were slightly proclined, as indicated from maxillary and mandibular incisor protrusion and decreased interincisal angle.

Treatment planning and methods

The patient was previously treatment planned by an orthodontist to have two maxillary premolars extracted. Another orthodontist offered her a headgear and full fixed appliance orthodontic treatment for 2 years, with the possibility of extraction of two maxillary first premolars. The patient was not interested in headgear or extraction treatment plans. Hence, the patient was provided with the following options:

- full fixed orthodontic treatment
- treatment with Invisalign (Align Technologies, San Jose, CA, USA).

The patient and her parents chose Invisalign treatment. To trigger mandibular growth, treatment planning involved slight distalisation of maxillary molars utilising Class II elastics (3/16" delivering force of 4.5 ounces [Rockey Mountain Orthodontics, Denver, CO, USA]) between maxillary canine cutouts and buttons bonded to the mandibular first molars (Fig 4a). At the same time, because of the recessive chin and the forward growth potential of the mandible, an attempt to maximise forward mandibular growth potential was planned by closing all mandibular spaces by retraction of mandibular incisors (7 mm) (Figs 4b and 4c), allowing a temporary increased overjet to maximise forward mandibular growth/repositioning. The patient was fitted with 46 aligners. The patient was instructed to wear aligners for 22 hours per day and to change/advance the aligners every week if she felt that the aligners were loose. Cephalometric analyses including Ricketts growth prediction was performed using Dolphin Imaging software (Dolphin Imaging & Management Solutions, Chatsworth, CA, USA).

Treatment progress

At stage 20 out of 46 aligners, ClinCheck (Invisalign) showed and edge-to-edge canine relationships (Fig 4c); however, clinical photographs showed a full-step Class I molar relationship on both sides (Fig 5). In addition, the profile showed improvement, with chin projection moved forward compared to initial records (Fig 5).

Table 1 Pre- and post-treatment cephalometric analyses

Analysis		T1	T2	Norm	SD
Craniofacial relation: cranial structure	Cranial length (mm)	57.1	57.0	57.7	2.5
	Posterior facial height (Go-CF) (mm)	60.4	67.5	54.8	3.3
	Cranial deflection (degrees)	30.5	30.5	27.3	3.0
	Porion location (mm)	−43.3	−42.6	−38.6	2.2
	Ramus position (degrees)	72.6	78.1	76.0	3.0
Craniofacial relation: Max. position (degrees)	Maxillary depth (FH-NA)	97.8	97.1	90.0	3.0
	Maxillary height (N-CF-A)	57.5	59.1	54.4	3.0
	SN-palatal plane	9.9	10.2	7.3	3.5
Craniofacial relation: Mand. position (degrees)	Facial angle (FH-NPo)	92.7	93.9	87.6	3.0
	Facial axis of Ricketts (NaBa-PtGn)	93.4	92.3	90.0	3.5
	FMA (MP-FH)	16.6	16.4	24.9	4.5
	Total facial height (NaBa-PmXi)	50.2	52.8	60.0	3.0
	Facial taper	70.7	69.7	68.0	3.5
Maxillomandibular relationships	Convexity (A-NPo) (mm)	5.1	3.2	1.3	2.0
	Corpus length (Go-Gn) (mm)	81.4	80.7	70.5	4.4
	Mandibular arc (degrees)	41.1	43.1	28.7	4.0
	Lower facial height (ANS-Xi-Pm) (degrees)	34.5	40.3	45.0	4.0
Dental relationships: Max. dentition	U-incisor protrusion (U1-APo) (mm)	7.6	2.0	3.5	2.3
	U1-FH (degrees)	119.9	105.0	111.0	6.0
	U-Incisor Inclination (U1-APo) (degrees)	34.0	14.9	28.0	4.0
	U6 - PT Vertical (mm)	17.3	18.2	15.0	3.0
Dental relationships: Mand. dentition	L1 protrusion (L1-APo) (mm)	0.9	−1.4	1.0	2.3
	L1 to A-Po (degrees)	27.7	18.1	22.0	4.0
	Mand. incisor extrusion (mm)	2.5	2.0	1.2	2.0
	Hinge axis angle (degrees)	100.5	82.9	90.0	4.0
Dental relationships: Max./Mand. dentition	Interincisal angle (U1-L1) (degrees)	118.3	147.0	130.0	6.0
	Molar relation (mm)	1.9	−2.3	−3.0	1.0
	Overjet (mm)	6.4	3.4	2.5	2.5
	Overbite (mm)	5.1	4.0	2.5	2.0
	Occlusal plane to FH (degrees)	0.1	0.9	8.9	5.0
Aesthetic	Lower lip to E-plane (mm)	−3.0	−4.3	−2.0	2.0

FMA, Frankfort-mandibular plane angle; mand, mandibular; max, maxillary.

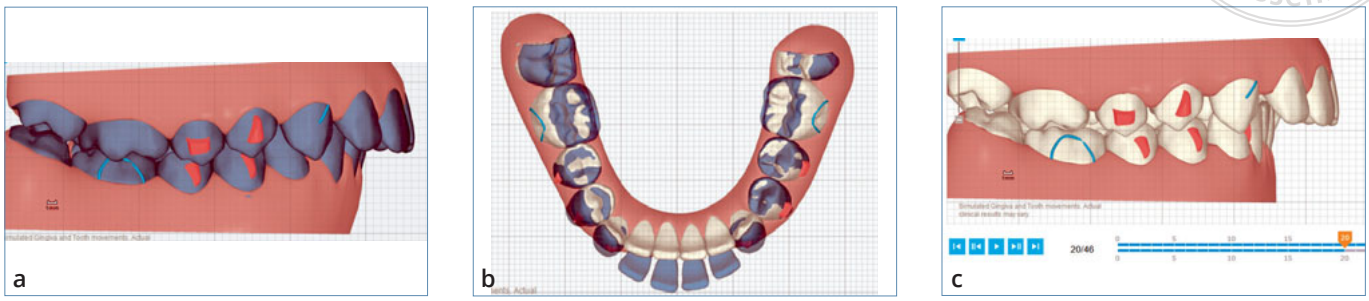

Fig 4a to c **(a)** Lateral side of the digital treatment plan by Invisalign ClinCheck. **(b)** Mandibular occlusal photo showing initial mandibular incisors position (blue) and final position (white). **(c)** Retraction of mandibular incisors to maximise forward mandibular growth.

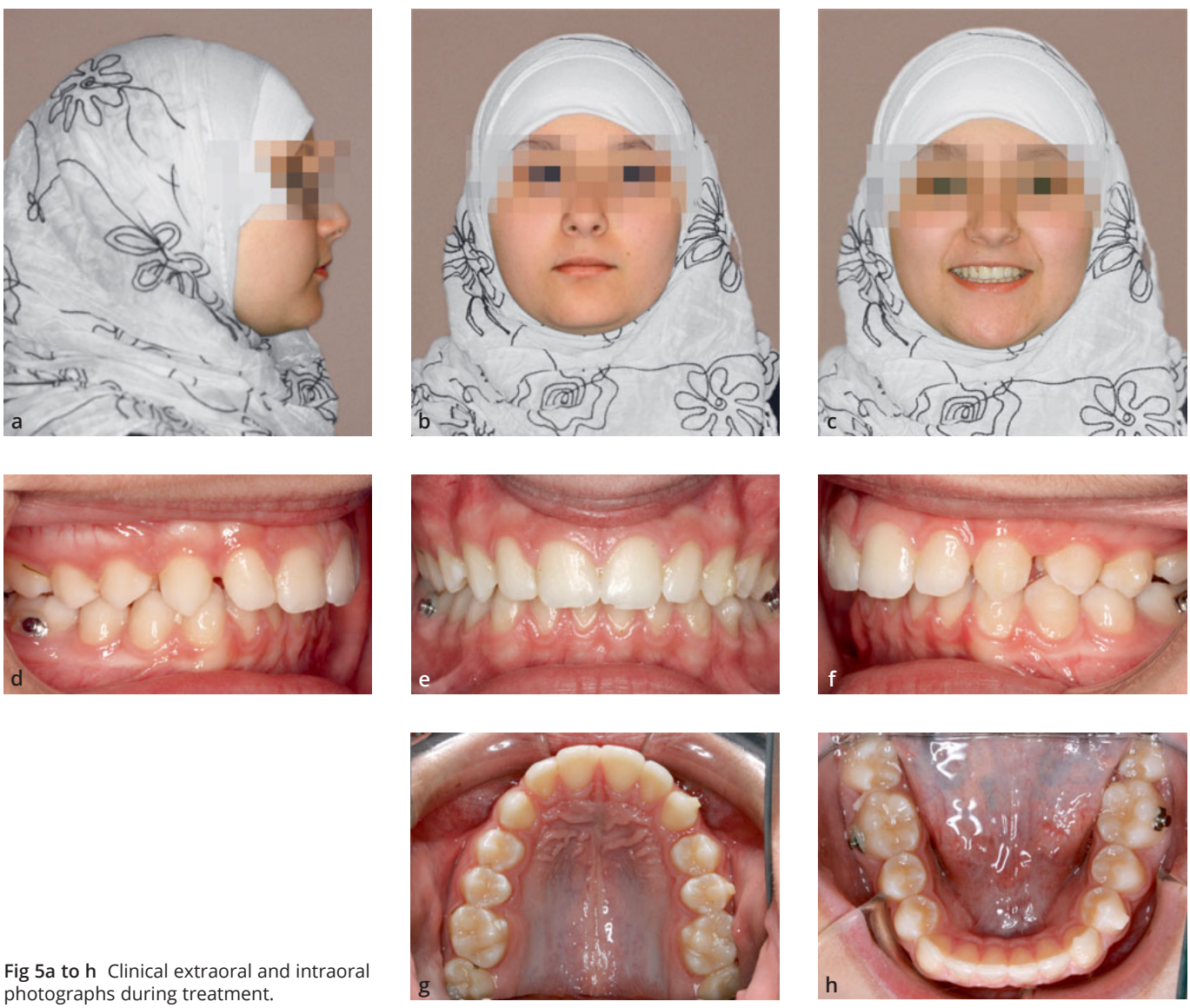

Fig 5a to h Clinical extraoral and intraoral photographs during treatment.

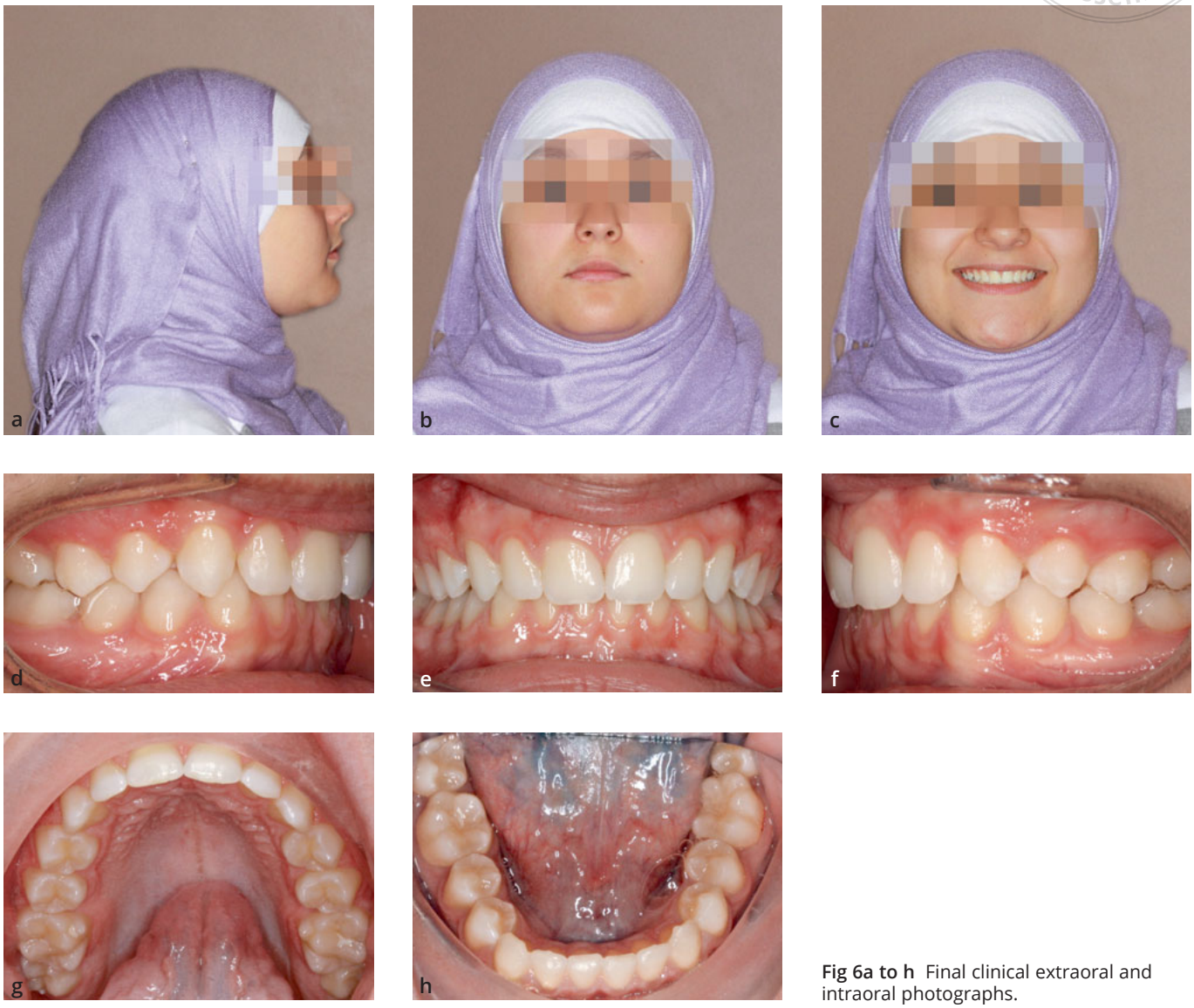

Fig 6a to h Final clinical extraoral and intraoral photographs.

At aligner 46 (week 46), the patient had Class I malocclusion for molars and canines, with a slight overbite (Fig 6). In addition, the patient's profile had improved to a straight profile. The patient and parent were satisfied at this point and they did not wish to continue to improve the overbite with additional aligners. Figures 7a and 7b show the post-treatment CBCT-driven cephalometric and panoramic digital radiographs. Figure 7c shows the post-treatment CBCT scan, illustrating the slight forward position of the condyle in the glenoid fossa. Table 1 reports the Ricketts cephalometric analyses before and after treatment. The post-treatment models (Fig 8) and patient's profile before, during and after treatment (Fig 9) are shown. Figure 10 depicts superimposition of the pre-and post-treatment cephalometric tracings. The mandible had grown forward 8 mm and maxillary and mandibular incisors had moved lingually by controlled tipping, while the maxillary molars were slightly distalised and extruded. Mandibular molars had slightly moved forward. Treatment was completed after 1 year.

Fig 7a to c **(a)** Final lateral cephalometric radiograph. **(b)** Final panoramic radiograph. **(c)** Post-treatment tomograms showing slight forward position of the condyles in the glenoid fossa.

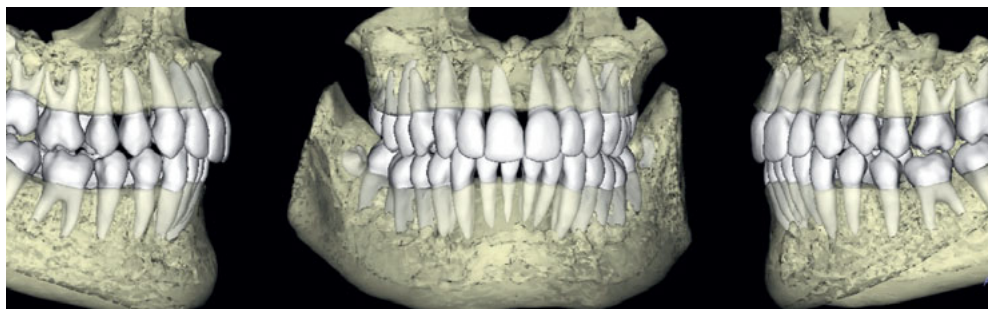

Fig 8 Final Anatomodels (cone beam computed tomography-driven digital models) (Anatomage, San Jose, CA, USA).

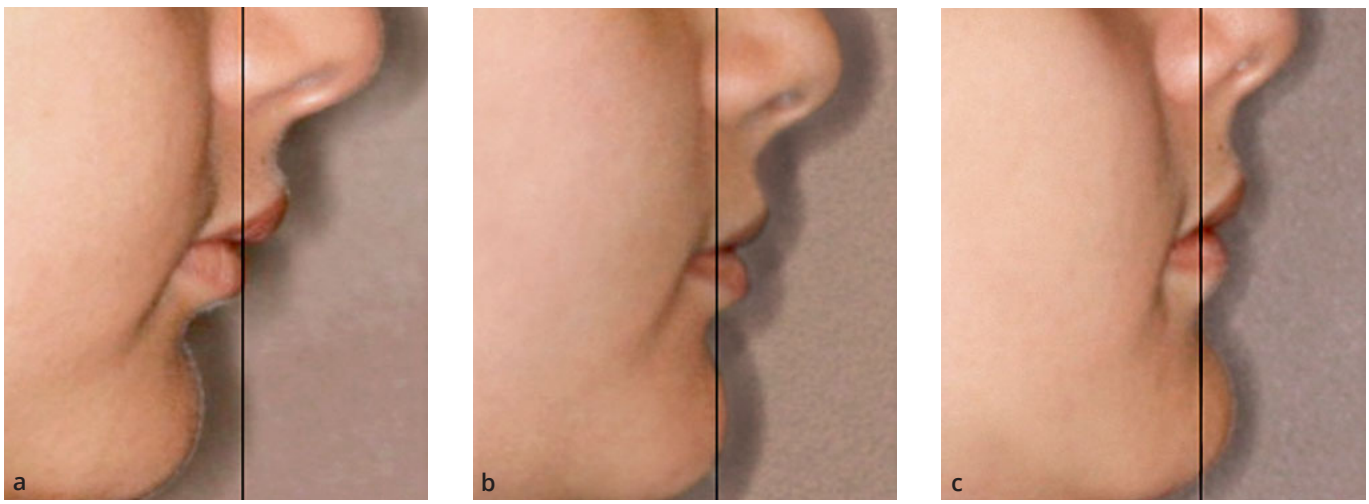

Fig 9a to c Lateral profile comparisons **(a)** before, **(b)** 9 months in treatment and **(c)** final profile (12 months in treatment).

Discussion

Class II malocclusion can be of many types depending on the underlying skeletal pattern[9]. Planning treatment of Class II, division 1 malocclusion with a skeletal Class II malrelationship should be considered in terms of which jaw should be allowed to grow or be repositioned in the anteroposterior plane. It is well known that facial growth continues forward after the adolescent growth period, including forward and downward growth of the nose and upper lip[11,12]. Retraction of the maxillary arch in cases with a normal nasolabial angle is not always a good idea or treatment plan, as this can lead to further retraction of the upper lip and consequently a more apparent forward position/projection of the nose. Allowing forward growth of the mandible in forward-growing children is key to achieving a bal-

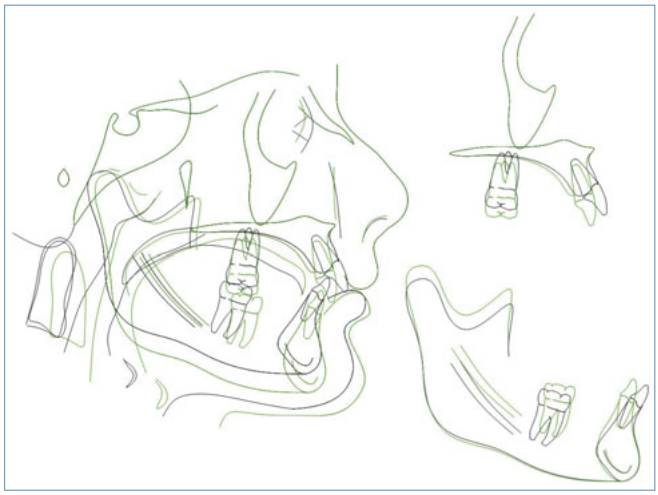

Fig 10 Initial cephalometric tracing (black) versus 1 year no treatment growth prediction (green).

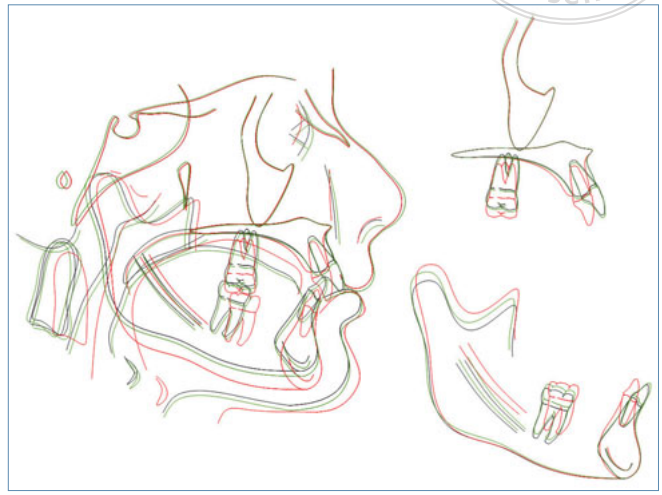

Fig 11 Superimposition of the initial cephalometric tracing (black), 1 year no treatment growth prediction (green) and final treatment (red).

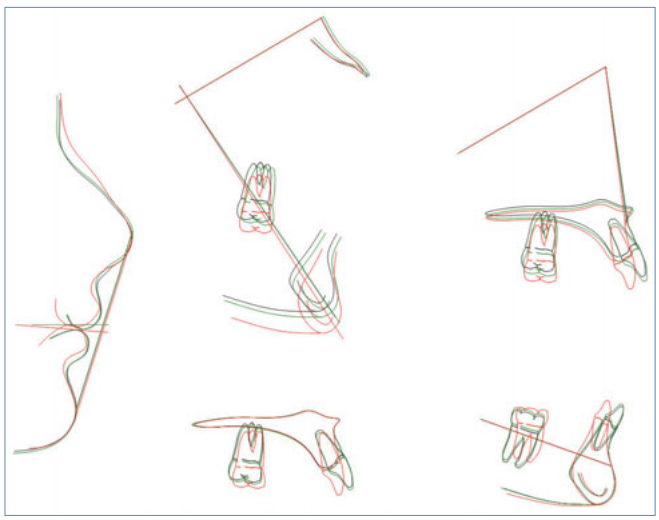

Fig 12 Ricketts 5 superimposition of the initial cephalometric tracing (black), 1 year no treatment growth prediction (green) and final treatment (red).

anced profile that will last in the long term. Decreased overjet could be a limiting factor in allowing forward growth of the mandible in a brachyfacial type. The presented treatment plan of retracting mandibular incisors to increase overjet that can maximise forward mandibular growth is a new idea that may be taken into consideration in treating similar cases in the future. Ricketts visualised treatment objective (VTO) growth prediction of this patient showed that little growth could have occurred without treatment intervention (green cephalometric tracing in the superimposition; Fig 10). This indicates that the treatment has a positive influence on the patient's mandibular forward growth. This forward growth could also have been due to mandibular molar intrusion (Fig 11). Growth prediction and treatment effect can be seen in the pre- and post-treatment superimposition (Fig 11).

Figure 12 shows Ricketts 5 superimposition of the initial cephalometric tracing. The treatment results are similar to those originally published by Ricketts[8] on the effect of headgear in extruding maxillary molars while stimulating forward growth of the mandible. The advantages of clear aligners over traditional fixed orthodontic treatment include but are not limited to that fact that clear aligners are more hygienic than traditional fixed braces, and that headgear is no longer accepted by patients. Setting up the treatment plan according to traditional concepts, but using clear aligners, allows rethinking of traditional methods such as the bioprogressive technique.

In the consideration of a similar treatment plan in the future, intrusion of the mandibular incisors should be part of the treatment plan to avoid deepening the bite. The use of Class II elastics or other Class II mechanics with aligners may be a safeguard if forward growth of the mandible does not occur during the treatment. Future prospective clinical trials or retrospective analysis of similar cases may provide supportive evidence of the presented idea or necessary modifications. The slightly forward position of the condyle

in the post-treatment CBCT scans may explain or contribute to the forward positioning/growth of the mandible/chin, which could also be due to forward posturing of the mandible. Another aspect that should be considered in the future, especially for similar cases, is evaluation of the patient's pre- and post-treatment circumoral muscle force and neuromuscular status. Evaluation of this aspect is important to ensure possible stability or relapse of the achieved results in similar cases.

Conclusions

The presented case shows that clear aligners can be used to treat Class II malocclusion due to mandibular retrognathism utilising the bioprogressive technique. Significant improvement in the patient's profile was observed. Providing or increasing overjet in forward-growing skeletal Class II cases can maximise forward mandibular growth in growing patients. The use of Class II mechanics is suggested as a safeguard to aid improvements in Class II malocclusion.

References

1. Boyd RL. Complex orthodontic treatment using a new protocol for the invisalign appliance. J Clin Orthod 2007;41;525–547.
2. Dahr S. Clinical tips and techniques. Dr. Sam Daher's techniques for Class II correction with Invisalign and elastics. San Jose: Align Technology, April 2011; N12610.
3. Schwartz A. Case study. Class II deep bite correction with Invisalign. San Jose: Align Technology, July 2010; M20139.
4. Björk A. Prediction of mandibular growth rotation. Am J Orthod 1969; 55:585–599.
5. Kinzinger G, Kober C, Diedrich P. Topography and morphology of the mandibular condyle during fixed functional orthopedic treatment: a magnetic resonance imaging study. J Orofac Orthop 2007;68:124–147.
6. Ricketts RM. Orthodontic treatment in the growing patient. Volume 4: Mechanics. Scottsdale: American Institute for Bioprogressive Education 1999:146–148.
7. Ricketts RM. Bioprogressive therapy as an answer to orthodontic needs. Part II. Am J Orthod 1976;70:359–397.
8. Ricketts RM. Bioprogressive therapy as an answer to orthodontic needs. Part I. Am J Orthod 1976;70:241–268.
9. Moyers RE, Riolo ML, Guire KE, Wainright RL, Bookstein FL. Differential diagnosis of Class II malocclusions. Part 1. Facial types associated with Class II malocclusions. Am J Orthod 1980;78:477–494.
10. Baccetti T, Franchi L, McNamara JA. The cervical vertebral maturation (CVM) method for the assessment of optimal treatment timing in dentofacial orthopedics. Semin Orthod 2005;11:119–129.
11. Bishara SE, Hession TJ, Peterson LC. Longitudinal soft-tissue profile changes: a study of three analyses. Am J Orthod 1985;88:209–223.
12. Bishara SE, Jakobsen JR, Hession TJ, Treder JE. Soft tissue profile changes from 5 to 45 years of age. Am J Orthod Dentofacial Orthop 1998;114:698–706.