ALIGNER CORNER

This JCO column is compiled by Contributing Editor William V. Gierie, DDS, MS. Every few months, Dr. Gierie will introduce a pertinent article related to clear aligner therapy. Your suggestions for future topics or authors are welcome.

This edition of the Aligner Corner presents two cases using Invisalign with mandibular advancement. Drs. Giancotti, Cozza, and Mampieri convey the challenges of managing young Class II patients with mandibular deficiency and maxillary dental protrusion. Their detailed description of the Invisalign* mandibular advancement (MA) appliance—essentially a Twin Block** crossed with an aligner—makes this complex device seem simple. The main advantage is that a mandibular protrusion appliance can straighten teeth effectively at the same time.

The two cases reported here are both 10-year-olds in the mixed dentition. It is easy to see the appeal of such an appliance to this patient population. It is more failsafe than a fixed functional appliance, has fewer hygiene issues than braces, and is much more comfortable for the patient than a Twin Block. The authors acknowledge previous work by Lysle Johnston and others and are cognizant that we are not going to grow mandibles 10mm with this therapy. Since their cases provide only initial clinical results, a randomized controlled trial to determine the effectiveness of the Invisalign mandibular advancement protocol would be a welcome addition to our literature.

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Aligners and Mandibular Advancement: A Comprehensive Option for Phase I Treatment of Class II, Division 1 Cases

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Treatment planning for Class II cases generally depends on the patient's age, growth potential, severity of malocclusion, and anticipated compliance.[1,2] Growth-modification procedures can be used in skeletal Class II cases during the mixed or early permanent dentition, before the cessation of active growth.

According to McNamara, mandibular retrusion is the most common feature of Class II, division 1 malocclusions in growing patients.[3] Mandibular advancement appliances such as the activator, bionator, Twin Block, and Fränkel are designed to encourage functional downward and forward displacement of the mandible.[4-11] Adaptive remodeling occurs on the articular surface of the TMJ, thus improving the position of the mandible relative to the maxilla.[2,12,13] Align Technology has recently introduced a new MA feature for treatment of skeletal mandibular retrusion with its Invisalign system, using the same orthopedic approach based on forward positioning of the mandible.[14,15]

Mandibular Advancement with Invisalign

Because a Class II patient with mandibular retrusion generally presents with a narrow upper arch, the first step in treatment is to resolve the transverse discrepancy by maxillary expansion. Torque control of the anterior teeth is crucial in coordinating the upper and lower archforms. The next step involves mandibular advancement to correct the skeletal discrepancy and balance the profile. Both stages can now be accomplished using the Invisalign MA protocol.

After the first series of aligners has addressed the arch coordination, if needed, the MA feature is introduced by integrating bilateral customized wings into the aligners as buccal extensions (Fig. 1). Changing the shape of the aligners improves the structural integrity of the precision wings. The wings cannot be manually adjusted, but are automatically placed to maintain the jaw position during every treatment stage. The consistency and precision of the wings have been improved since their introduction by extending the vertical overlap to facilitate reciprocal engagement, stabilize the aligner fit, and avoid asymmetrical movements.

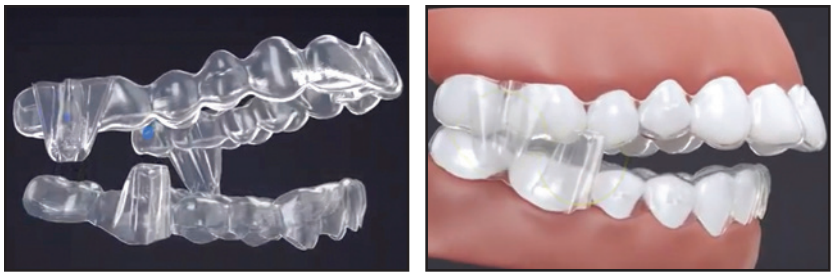

Fig. 1 Invisalign* mandibular advancement (MA) feature incorporates bilateral customized wings.

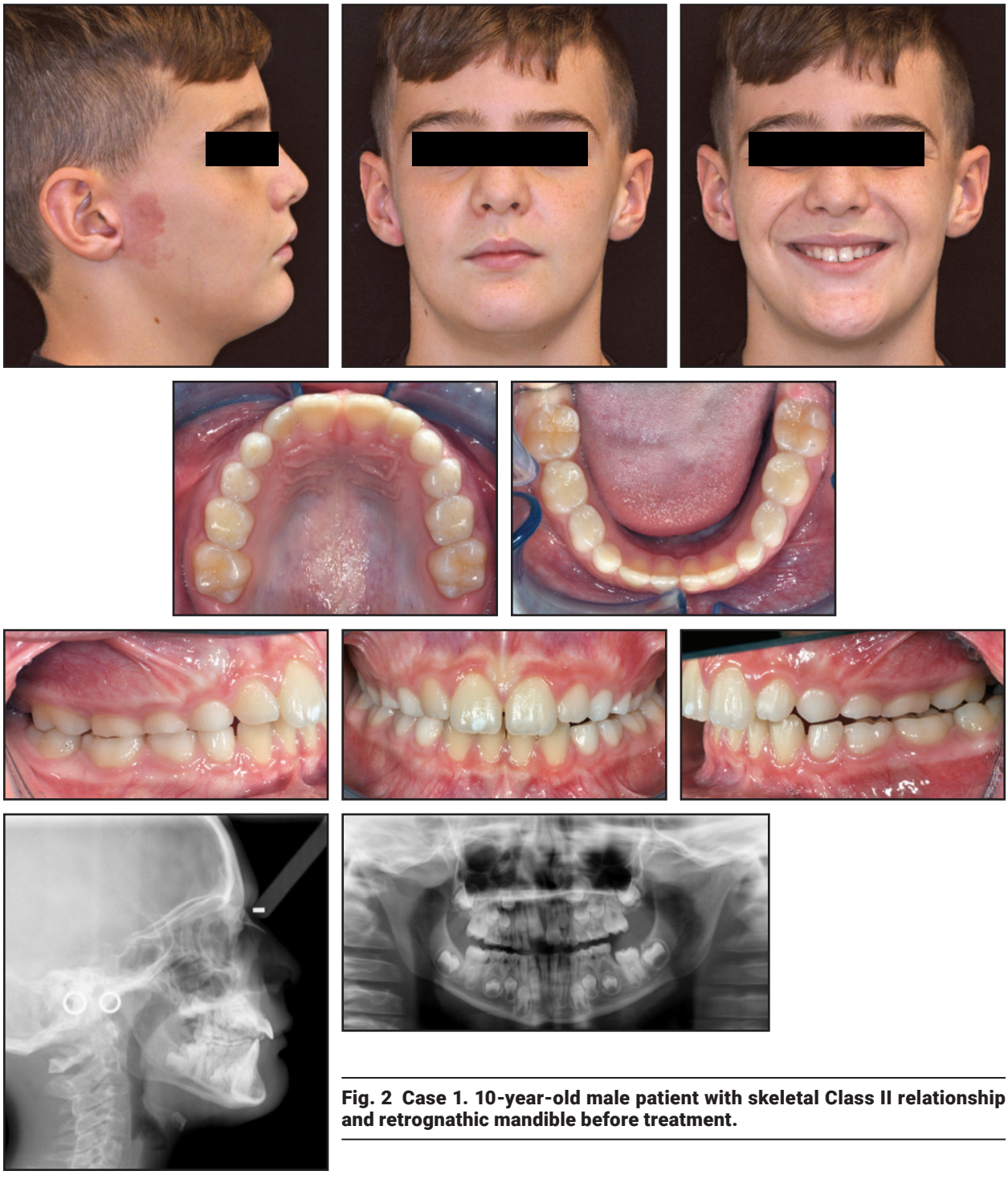

Fig. 2 Case 1. 10-year-old male patient with skeletal Class II relationship and retrognathic mandible before treatment.

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Clinical requirements for using the MA protocol in Class II patients with mandibular retrusion include:

- Overjet of at least 6mm.
- Permanent first molars and two or more incisors at least two-thirds erupted.
- Teeth beneath and adjacent to the precision wings present and stable during the active phase of MA.
- Sufficient crown size and interarch space for the buccal wings.

The progressive mandibular advancement amounts to 2mm every eight aligners; in other words, with weekly aligner changes, 2mm of mandibular advancement can be achieved in two months. Eruption compensation for the premolars can be requested in transitional aligners to allow patients to continue their MA treatment during exfoliation of the primary dentition. The final position of the sagittal plane can be planned as edge-to-edge (the default position) or as a 1mm or 2mm overcorrection.

Case 1

A 10-year-old male presented in the mixed dentition (Fig. 2). Intraoral examination found a bilateral dental Class II malocclusion, a crossbite on the left side, mesially rotated upper molars, proclined upper incisors, retroclined lower incisors, and excessive overjet. Cephalometric analysis (Table 1) confirmed a skeletal Class II malocclusion with mandibular retrusion (ANB = 5°, SNB = 75°). The gonial angle was slightly excessive, indicating backward mandibular rotation. The diagnosis was a skeletal Class II relationship with a retrognathic mandible; a dental Class II, division 1 malocclusion; and a slight vertical growth pattern.

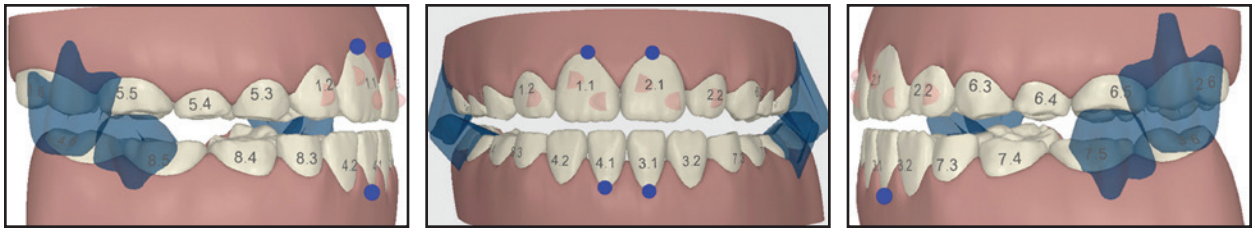

Fig. 3 Case 1. ClinCheck* plan for 2mm of mandibular advancement to reach edge-to-edge position.

Fig. 4 Case 1. A. After four months of transverse correction. B. First set of aligners with MA feature.

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TABLE 1
CASE 1 CEPHALOMETRIC ANALYSIS

	Norm	Pretreatment	Post-Treatment
Sagittal skeletal			
SNA	82° ± 2°	80°	80°
SNB	80° ± 2°	75°	79°
ANB	2° ± 2°	5°	1°
Vertical skeletal			
SN/ANS-PNS	8° ± 3°	4°	3°
SN/GoGn	32° ± 3°	35°	31°
ANS-PNS/GoGn	26° ± 1°	31°	28°
Mandibular growth			
Co-Gn	–	101mm	103mm
Dentobasal			
Maxillary incisor inclination (1/ANS-PNS)	115° ± 4°	110°	105°
Mandibular incisor inclination (1/GoGn)	95° ± 5°	88°	89°
Dental			
Overjet	2mm ± 2mm	6mm	2mm
Overbite	2mm ± 2mm	2mm	4mm
Interincisal angle (U1-L1)	130° ± 5°	135°	132°

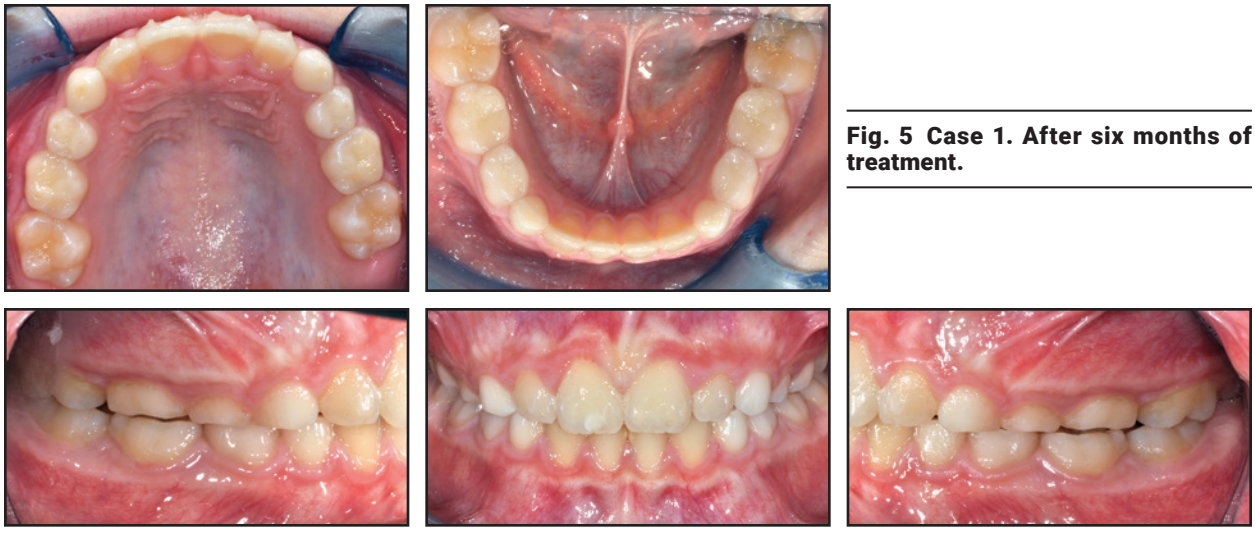

Fig. 5 Case 1. After six months of treatment.

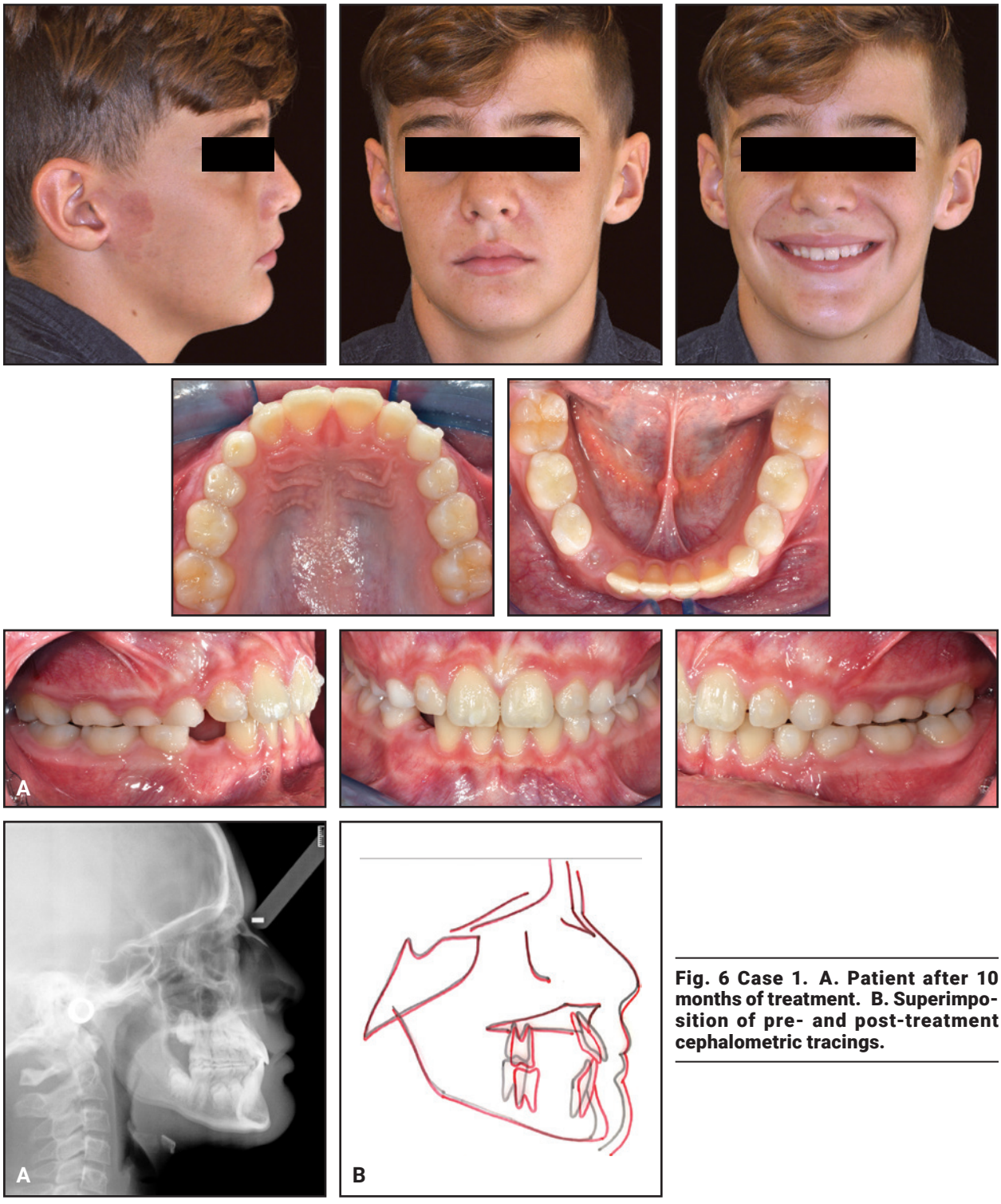

Fig. 6 Case 1. A. Patient after 10 months of treatment. B. Superimposition of pre- and post-treatment cephalometric tracings.

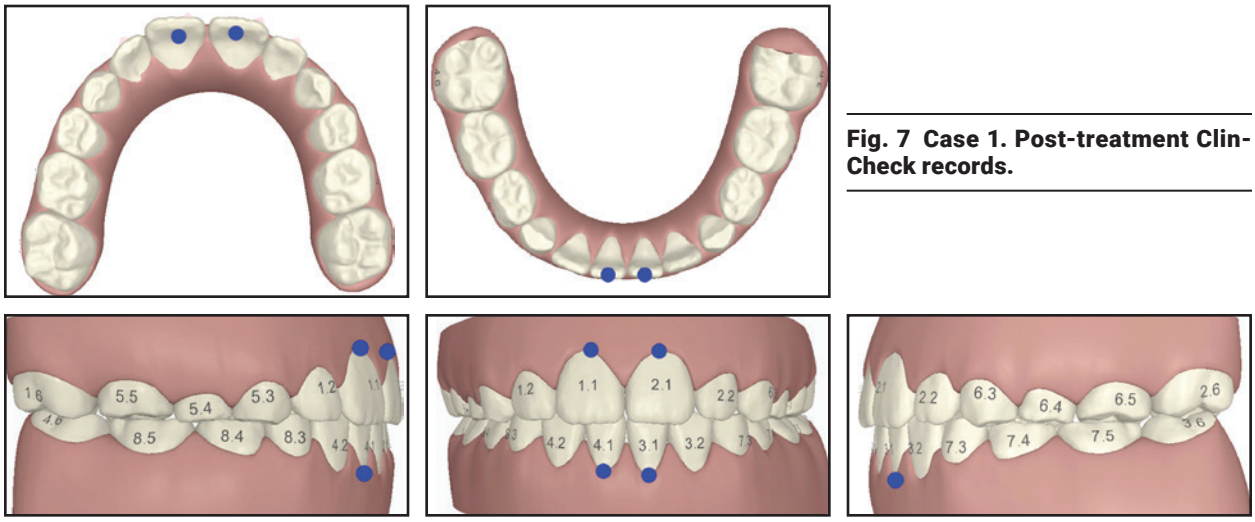

Fig. 7 Case 1. Post-treatment ClinCheck records.

Dental expansion was planned to correct the crossbite, with Invisalign MA used to provide torque control of the anterior teeth during mandibular advancement. The objectives of growth modification were to reduce the skeletal Class II pattern, achieve Class I skeletal and dental relationships, and establish normal overjet and overbite. Vertical control would be ensured by managing posterior extrusion with the aligners.

The patient was instructed to wear his aligners 20 hours per day. The ClinCheck* plan forecast a 2mm mandibular advancement from eight sets of aligners, with weekly changes (Fig. 3). Attachments were placed on the upper incisors to resolve tipping, and Power Ridges*** were used to correct lower incisor torque, thus avoiding an anterior stop to mandibular advancement.

After four months of transverse correction, the MA feature was initiated (Fig. 4). This stage required 26 sets of aligners, followed by six transitional sets (Fig. 5). During the transitional phase, the patient wore the MA aligners for eight to 10 hours at night to maintain the results until the late mixed dentition.

Active treatment time was 10 months (Fig. 6). The dental Class II relationship was corrected, the transverse dimensions of both arches were normalized, and the severe overjet was optimized (Fig. 7). Cephalometric analysis (Table 1) confirmed the sagittal correction, with ANB reduced by 4° and SNB increased by 4° as a result of the mandibular advancement therapy. The vertical skeletal relationship was also improved, as shown by a 4° reduction in SN/GoGn. The maxillary incisor inclination (1/ANS-PNS) decreased by 5°, while the mandibular incisor inclination (1/GoGn) was essentially maintained.

Case 2

A 10-year-old female presented in the mixed dentition (Fig. 8). Intraoral examination showed a bilateral dental Class II malocclusion, mesially rotated upper molars, proclined upper incisors, and excessive overjet. Cephalometric analysis (Table 2) indicated a skeletal Class II malocclusion with mandibular retrusion (ANB = 5°, SNB = 72°). Both the upper and lower gonial angles were significantly increased, denoting a backward mandibular rotation. The diagnosis was a skeletal Class II relationship with a retrognathic mandible; a dental Class II, division 1 malocclusion; and a pronounced vertical growth pattern.

Maxillary dental expansion was planned to

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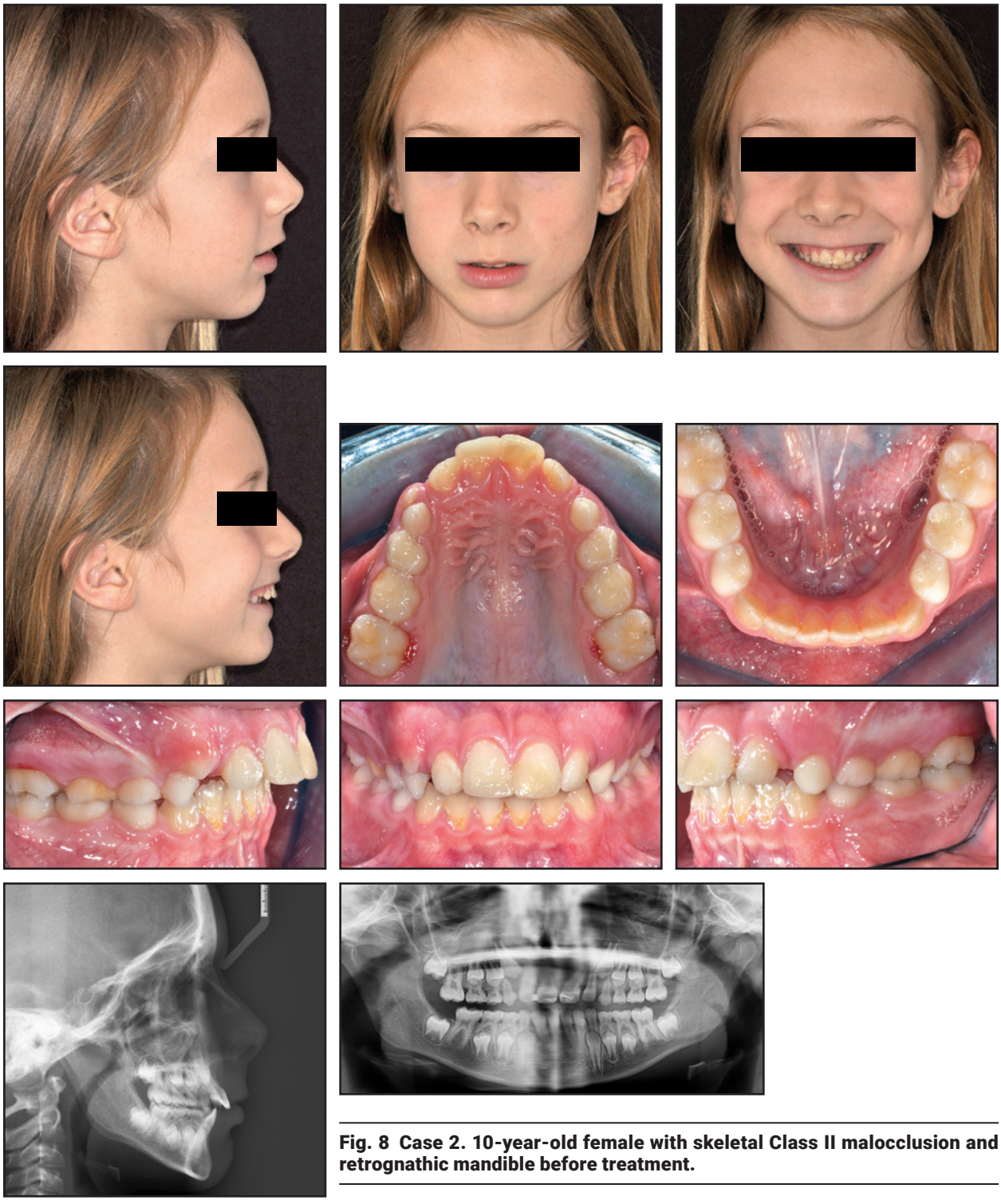

Fig. 8 Case 2. 10-year-old female with skeletal Class II malocclusion and retrognathic mandible before treatment.

Fig. 9 Case 2. ClinCheck plan.

Fig. 10 Case 2. A. After three months of treatment, with MA aligners in place. B. After six months of treatment.

coordinate the arches. Invisalign MA would provide not only torque control of the anterior teeth, but vertical control to avoid molar extrusion during mandibular advancement. The objectives of growth modification were to ameliorate the skeletal Class II pattern, establish skeletal and dental Class I relationships, and improve the overjet and overbite.

The patient was instructed to wear the aligners 20 hours per day and to change aligners every two weeks. Rectangular attachments were prescribed on the upper incisors for torque control and mechanical retention (Fig. 9).

The MA treatment required 26 sets of aligners (Fig. 10). The active phase was followed by six transitional sets, which the patient wore for eight to 10 hours at night to maintain the results. Because the patient was close to the late mixed dentition, we expected to start Phase II treatment within eight to 10 months.

After 12 months of treatment with Invisalign

TABLE 2
CASE 2 CEPHALOMETRIC ANALYSIS

	Norm	Pretreatment	Post-Treatment
Sagittal skeletal			
SNA	82° ± 2°	77°	77°
SNB	80° ± 2°	72°	75°
ANB	2° ± 2°	5°	2°
Vertical skeletal			
SN/ANS-PNS	8° ± 3°	5°	4°
SN/GoMe	32° ± 3°	40°	41°
ANS-PNS/GoMe	26° ± 1°	35°	36°
Mandibular growth			
Co-Gn	–	98mm	101mm
Dentobasal			
Maxillary incisor inclination (1/ANS-PNS)	115° ± 4°	115°	113°
Mandibular incisor inclination (1/GoMe)	90° ± 5°	90°	85°
Dental			
Overjet	2mm ± 2mm	6mm	4mm
Overbite	2mm ± 2mm	1mm	4mm
Interincisal angle (U1-L1)	130° ± 5°	120°	122°

MA, the Class II relationship was corrected and the transverse dimensions of both arches were coordinated (Fig. 11). The severe overjet was reduced by the mandibular advancement. Cephalometric analysis (Table 2) highlighted the improved sagittal relationship, with ANB reduced by 3° and SNB increased by 3°. The vertical skeletal relationship was controlled, and SN/GoMe remained almost unchanged.

Discussion

Functional appliances have shown mixed results[15,16] for several reasons: the significant variation in individual responsiveness to functional treatment,[17] the effectiveness of the chosen intervention strategy,[18] and the biological timing of the treatment.[19] The pubertal growth phase is considered the optimal period for achieving skeletal effects.[20-22] A long-term controlled study found that prepubertal treatment with removable functional appliances produced mainly dentoalveolar changes.[23]

Since functional appliances deal primarily with gross changes in the intermaxillary relationships and arches, they usually need to be followed by traditional fixed appliances to achieve optimal results. The efficacy and efficiency of functional appliances also depend heavily on patient compliance. Esthetic considerations and dynamic lifestyles prevent many of today's patients from wearing functional appliances for the recommended number of hours every day.[24,25] Moreover, as

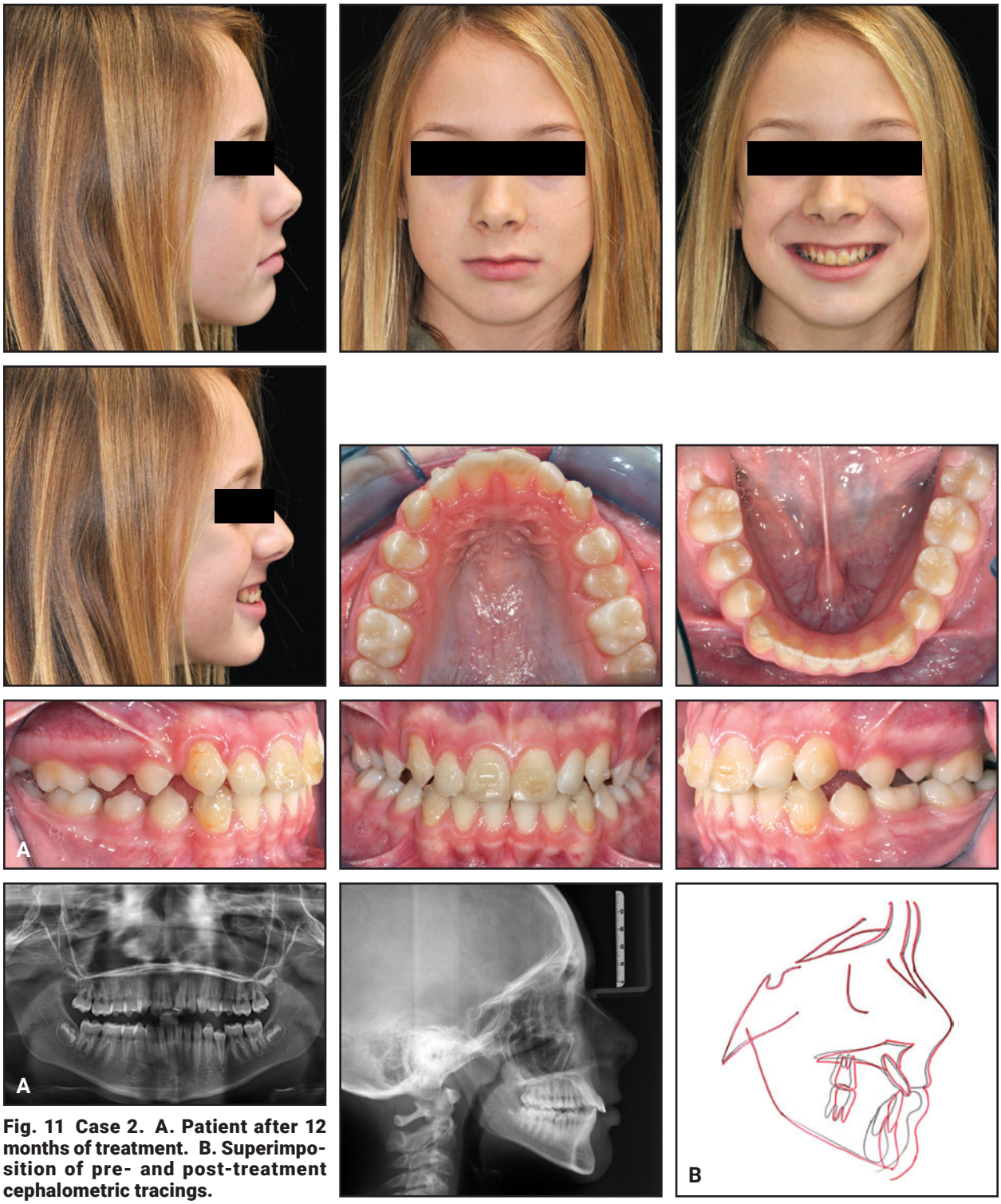

Fig. 11 Case 2. A. Patient after 12 months of treatment. B. Superimposition of pre- and post-treatment cephalometric tracings.

Johnston has observed, functional appliances work with the normal pattern of facial growth to correct a Class II molar relationship, rather than inducing a true mandibular "growth modification."[26] In the end, various one- and two-phase alternatives may produce similar effects. While orthodontists can diagnose and intercept specific developing problems in the early mixed dentition, many cases should be monitored, but not treated, until the permanent teeth are in place.[27]

Compared with functional appliances that have traditionally been used in the mixed dentition, the innovation of the Invisalign MA feature is to combine tooth movement and mandibular advancement in a single device. This protocol allows dentoalveolar expansion of the upper arch, derotation of the upper molars, coordination of both arches, and torque control of the anterior teeth—all likely to facilitate progressive forward mandibular movement. Invisalign MA can be used to treat a broad range of Class II patients in the mixed or permanent dentition, from ages 10 to 15. While early clinical experiences are encouraging, further research is needed to assess the efficacy and long-term effects of this new therapeutic system.

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