

CASE REPORT

Julia Haubrich, Werner Schupp, Wolfgang Boisserée

Interdisciplinary treatment with aligner orthodontics followed by minimally invasive restorations



Julia Haubrich

KEYWORDS aligner orthodontics, attachments, composite, in-office aligners, interdisciplinary dentistry, Invisalign, minimally invasive restorations, OnyxCeph Aligner 3D software

Aligner therapy offers a valuable alternative to fixed appliance treatment in young and adult patients, making it possible to reduce potential side effects and providing an aesthetic therapeutic option. In some patients, abrasions, changes of tooth shape or loss of tooth substance require an additional tooth restoration to obtain an optimal outcome that satisfies the patient. Instead of reducing healthy tooth substance for the preparation of a crown or veneer, the development of composite in the past few years has led to improved results in terms of both longevity and aesthetics. The present article outlines different patient examples of interdisciplinary treatment with aligner orthodontics followed by minimally invasive restorations with composites on anterior teeth.

Introduction

As digitisation has progressed, aligner therapy has increasingly established itself as an indispensable treatment option in orthodontics over the past 20 years. Increased ex-

perience and improved understanding of biomechanics have seen the range of indications expand from mild crowding and spacing to more complex cases.¹⁻²⁶ The further development of orthodontic software regarding the processing of 3D data has made it possible for the orthodontist to decide whether the workflow should take place entirely in the office and in the in-office laboratory, or whether parts of the treatment planning and aligner manufacturing processes should be outsourced to external service providers.²⁷

In-office aligner therapy represents a decisive innovation and a valuable addition to orthodontic practices.²⁸⁻³² Planning treatment from beginning to end allows the practitioner not only to include all their biomechanical knowledge with attachments and staging for each individual treatment plan, but also to choose the aligner material, its quality and thickness, the length of the aligner margin and torque elements. This is not predefined by artificial intelligence and algorithms but is rather the responsibility of the orthodontic practitioner from the outset; with their experience and knowledge of biomechanics, they can assess the tooth movements and adapt the plan to the patient's individual situation.

Interdisciplinary treatment is a sine qua non to achieve optimal outcomes in any medical field. The possibility to virtually simulate the potential result in aligner orthodontics allows professionals across all dental fields to work closely together to perform interdisciplinary planning to

Julia Haubrich, Dr med dent
Private practice, Cologne, Germany

Werner Schupp, Dr med dent
Private practice, Cologne, Germany

Wolfgang Boisserée, Dr med dent
Private practice, Cologne, Germany

Correspondence to: Dr Werner Schupp, Hauptstrasse 50, 50996 Cologne, Germany. Email: schupp@schupp-ortho.de

obtain an optimal starting position for subsequent restorative treatment. Any potential need for adjustments to achieve an optimal tooth position for restorative treatment can be discussed and planned virtually from the beginning of therapy; this cannot be done in such detail with any other orthodontic technique.

In the event of dental abrasion, the maxillary anterior teeth are often particularly affected. Restoring such teeth in a conventional manner (i.e., using crowns) could lead to significant additional loss of tooth structure. The current therapeutic approaches for the treatment of patients with severe tooth wear derived from minimally interventionist dentistry base their clinical application on the excellent biomimetics and optimal mechanical and optical properties of both silica-based glass-ceramics and composite resin-based restorations. Due to their physical characteristics, these materials achieve adequate adhesive strength when combined with different contemporary adhesive systems.³³⁻⁴³

The following examples demonstrate interdisciplinary treatment with aligner orthodontics followed by minimally invasive composite restorations in a young patient and two adult patients.

Patient 1

A 9-year-old girl attended the present authors' office with a maxillary diastema, maxillary midline shift to the right, and a complete lack of space for potential eruption of the maxillary right lateral incisor (Fig 1). The panoramic radiograph revealed the maxillary lateral incisors were missing, with the maxillary canines moving into their former positions (Fig 1i). Treatment options, such as opening of spaces for later placement of implants in the maxillary lateral incisor region or complete space closure with the canines in the position of the missing maxillary lateral incisors, were discussed in detail with the patient and her parents. The option selected was to perform space closure and build up the canines to substitute for the lateral incisors after orthodontic treatment. Initially, to close the diastema and fulfil the patient's aesthetic goals, brackets (Damon System, Ormco, Orange, CA, USA) were bonded on the maxillary central incisors and the diastema was corrected with a sectional archwire, and the midline was corrected within sev-

eral months. Figure 2 demonstrates the extra- and intraoral situation after fixed sectional appliance treatment and prior to aligner treatment (Invisalign system, Align Technology, San Jose, CA, USA). The maxillary lateral incisors were missing, and total mesialisation of the maxillary dentition was planned to close the spaces and end with the canines in the position where the lateral incisors would have been. As the canines and lateral incisors differ in shape, minimally invasive composite restorations were planned after treatment and discussed with the treating dental practitioner.

Figure 3a to e shows the intraoral situation transferred into the ClinCheck software (Align Technology), including direct bonded attachments on the maxillary canines and central incisors, and mandibular canines to second premolars. Additional vertical rectangular attachments were placed virtually on the maxillary first premolars and left first molar. The virtual simulation of the end of treatment included intrusion of the maxillary central incisors to achieve improved gingival levelling of the anterior teeth and mesialisation of the maxillary posterior teeth into a full Class II molar relationship, as demonstrated in Fig 3f to j. Interproximal reduction (IPR) of 0.3 mm was necessary on all mandibular teeth from mesial to the mandibular left first molar to the right first molar due to the Bolton discrepancy with the missing maxillary lateral incisors. The Bolton analysis is presented in Fig 3k. Figure 4 shows the intraoral situation after the first phase of aligner treatment. The maxillary left second molar exhibited a crossbite situation, for which a transparent buccal hook was placed on the mandibular left first molar and on the palatal aspect of the maxillary left second molar, and the patient was advised to wear criss-cross elastics. Slight crowding persisted in the mandible. The panoramic radiograph revealed a retained mandibular left second molar, and the patient was advised to undergo extraction of the mandibular left third molar and attend further follow-up appointments to monitor the eruption of the mandibular left second molar. Figure 5 shows the ClinCheck simulation in the second phase of treatment transferred into the scan and steep maxillary incisors and missing occlusal contacts of the first molars (Fig 5a to e). The final planned outcome after 15 aligners with an additional horizontal attachment on the mandibular right first molar is presented in Fig 5f to j. Power ridges (Align Technology) were planned on the maxillary central incisors to obtain torque in the maxillary anterior teeth, and additional IPR



Fig 1a to j Extra- and intraoral situation at the age of 9 years in the late mixed dentition, with agenesis of the maxillary lateral incisors and a Class II relationship. The panoramic radiograph reveals the absence of the permanent lateral incisors.

was planned mesial of the maxillary central incisors to close the black triangle with three aligners for overcorrection and mesialisation of the maxillary central incisors. Figure 6 demonstrates the course of restorative treatment with the initial situation after aligner therapy (Fig 6a), and preparation of the maxillary first premolars and canines with composite buildup of the incisal margins (Fig 6b). In the first step, the shape of the maxillary canines is changed so they have the appearance of incisors. For this purpose, the tapered incisal area is built up with composite. The tip of the

canine tooth must often be reduced so that the length ratio from the middle to the lateral incisor appears harmonious. Since the canine tooth is much wider than the lateral incisor, the distal curvature is reduced. As the first premolar is usually smaller than the canine, it is widened mesially by the same amount so that it becomes correspondingly more voluminous and characteristic of a canine. This is achieved by lengthening the vestibular cusp. In addition, it is often necessary to build up the entire buccal surface to give the premolar the appearance of a canine in frontal view.



Fig 2a to h Extra- and intraoral situation after fixed sectional appliance treatment on the maxillary central incisors and prior to aligner treatment with the Invisalign system (Align Technology, San Jose, CA, USA). The maxillary lateral incisors were missing, and mesialisation of the maxillary posterior teeth and retraction of the maxillary anterior teeth were planned to close anterior spaces and end with the canines in the position where the lateral incisors would have been. As the canines and lateral incisors differ in shape, minimally invasive composite restorations were planned after orthodontic treatment.

Figure 6c shows the final restorations with composite on the maxillary first premolars and canines. Retention was performed with a removable aligner worn at night and a fixed lingual retainer in the mandible from the left first premolar to the right first premolar. Figure 7 presents the

extra- and intraoral situation after composite restorations on the maxillary canines and first premolars (Enamel Plus HFO, GDF, Rosbach, Germany) (Dr Wolfgang Boisserée, Cologne) and Fig 8 demonstrates the course of treatment.

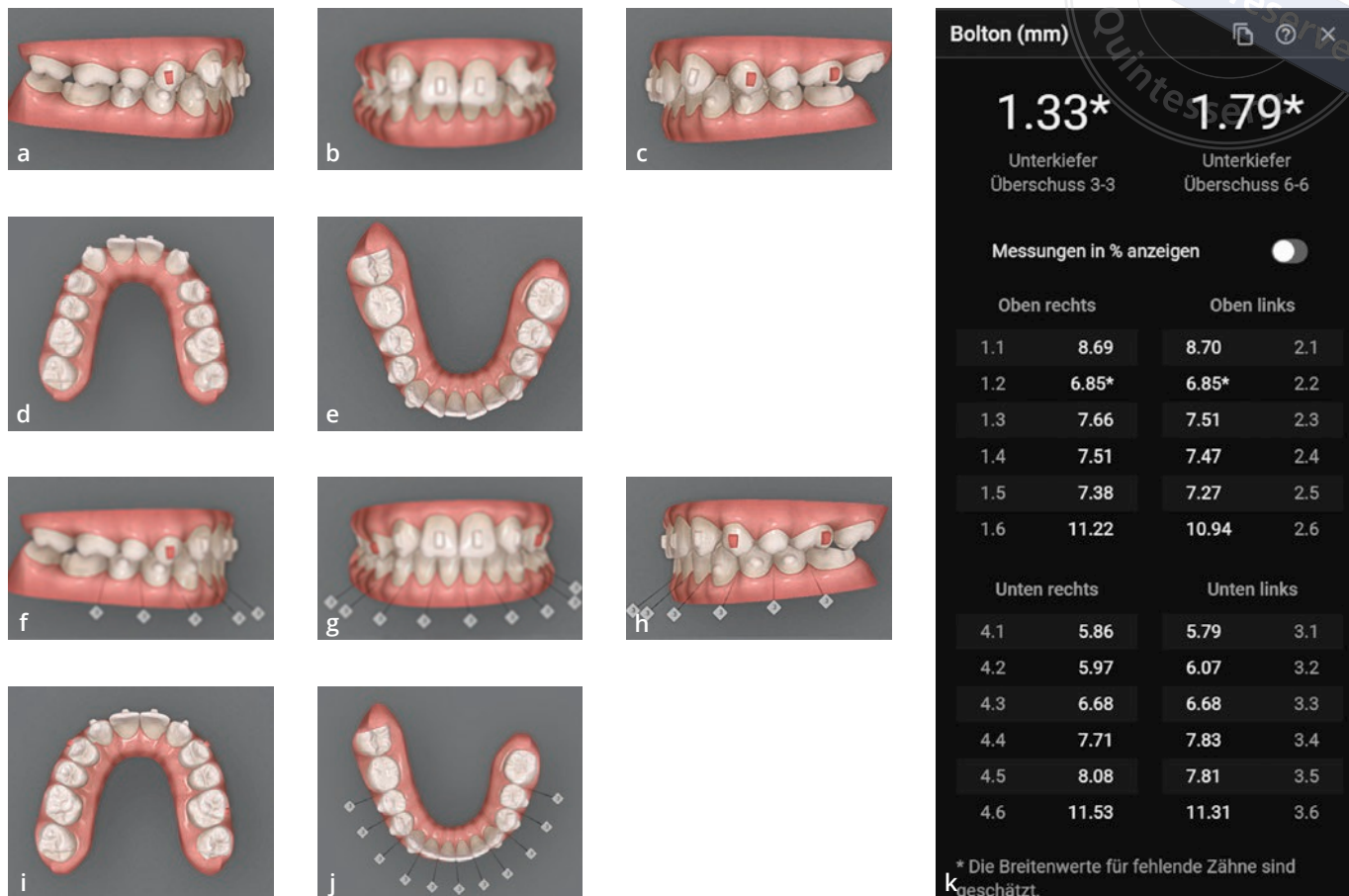


Fig 3a to k Virtual treatment simulation in the ClinCheck software (Align Technology), showing the direct bonded attachments on the maxillary canines and central incisors, and mandibular canines to second premolars. Additional vertical rectangular attachments were placed on the maxillary first premolars and left first molar (a to e). Virtual simulation of the end of treatment with intrusion of the maxillary central incisors and mesialisation of the maxillary posterior teeth into a full Class II molar relationship. Interproximal reduction (IPR) of 0.3 mm was necessary on all mandibular teeth from mesial to the mandibular left first molar to the right first molar due to the Bolton discrepancy with the missing maxillary lateral incisors (f to j). Bolton analysis (k).

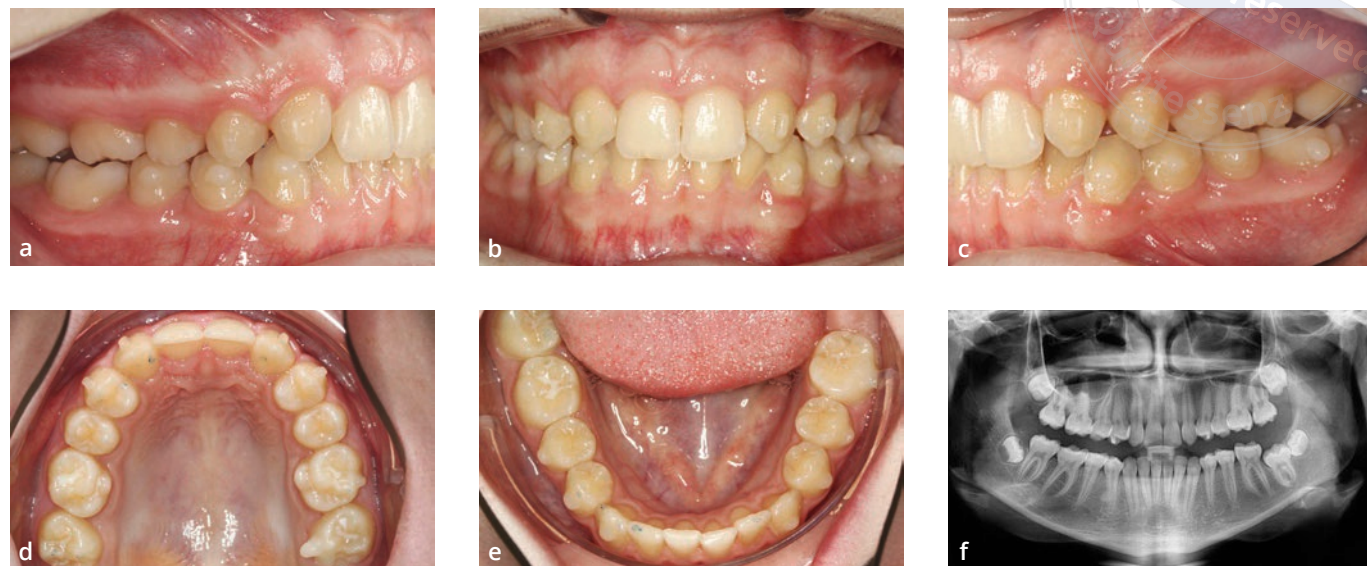


Fig 4a to f Intraoral situation after the first phase of treatment. The maxillary left second molar exhibited a crossbite situation, for which a transparent buccal hook was bonded on the mandibular left first molar and on the palatal aspect of the maxillary left second molar, and the patient was advised to wear criss-cross elastics. Slight crowding persisted in the anterior mandible. The panoramic radiograph revealed a retained mandibular left second molar, and the patient was advised to undergo extraction of the mandibular left third molar and attend further follow-up appointments to monitor the eruption of the mandibular left second molar.

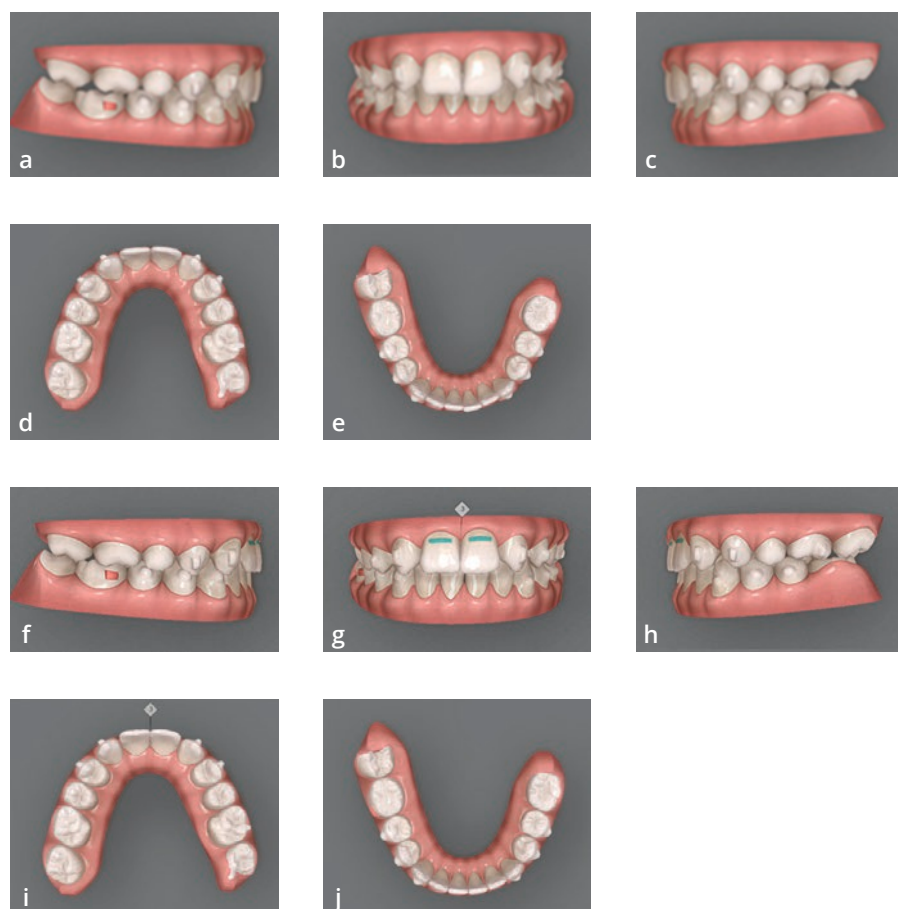


Fig 5a to j ClinCheck simulation in the second phase of treatment showing the situation transferred into the scan with steep maxillary incisors and missing occlusal contacts of the first molars (a to e). Final planned outcome after 15 aligners with an additional horizontal attachment on the mandibular right first molar. Power ridges (Align Technology) were planned on the maxillary central incisors to obtain torque in the maxillary anterior teeth, and additional IPR was planned mesial of the maxillary central incisors to close the black triangle with three aligners for overcorrection and mesialisation of the maxillary central incisors (f to j).



Fig 6a to c Preparation of the maxillary first premolars and canines with composite buildup of the incisal margins based on a wax-up. Situation after orthodontic treatment (a), changing the shape of the maxillary canines by building up the incisal area and widening the first premolars mesially with composite (b), and final restorations with composite on the maxillary first premolars and canines (Enamel Plus HFO, GDF, Rosbach, Germany) (Dr Wolfgang Boisserée, Cologne) (c).

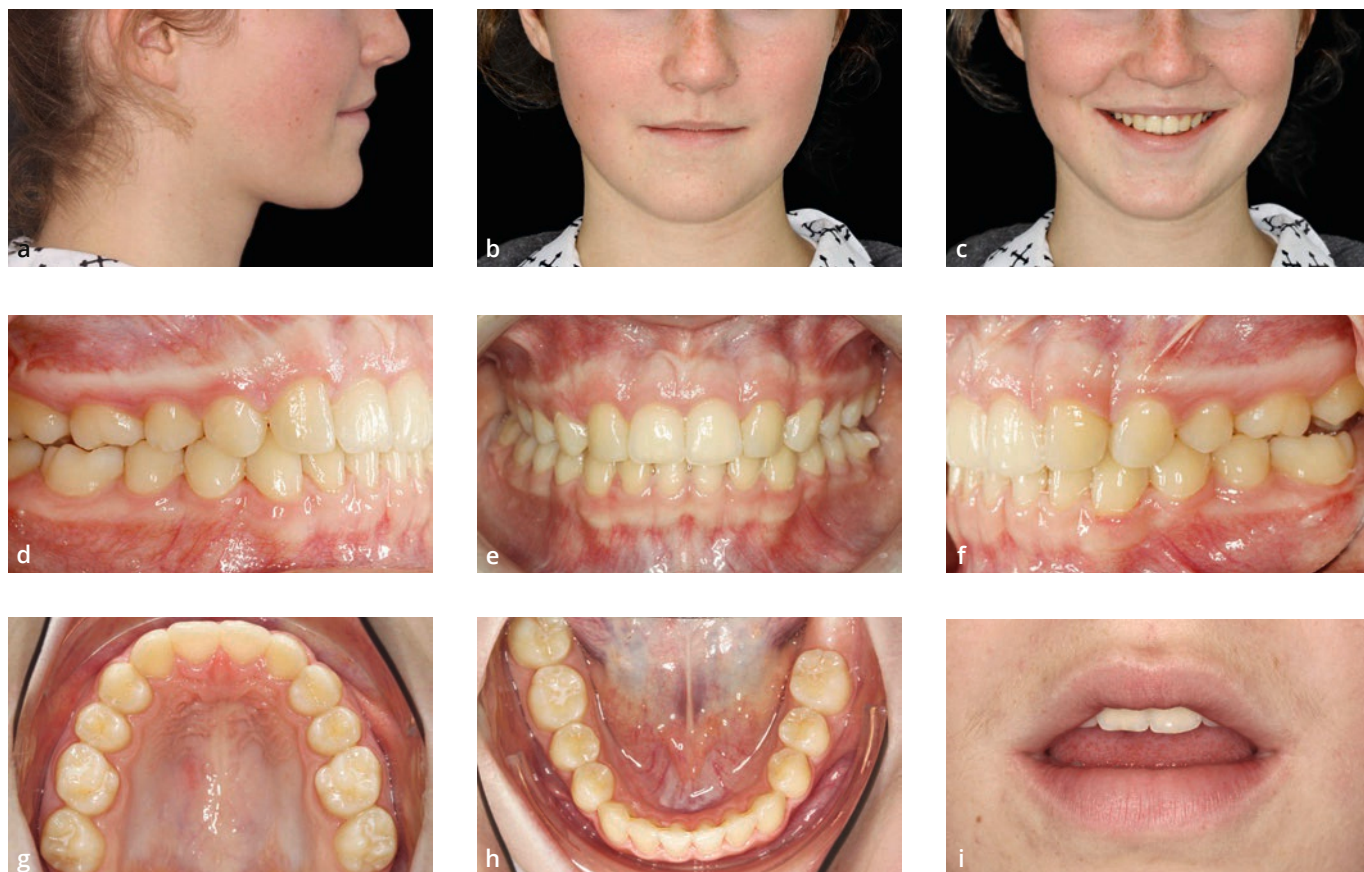


Fig 7a to k Extra- and intraoral situation after composite restorations on the maxillary canines and first premolars (Dr Wolfgang Boisserée, Cologne). For retention, a lingual retainer was placed on the mandibular left canine to the right canine. The button on the mandibular left first molar was removed after the photographs were taken, and the maxillary aligner was reduced distal of the maxillary right first molar to allow settling of the maxillary left second molar.



Fig 8a to g Course of treatment: before placement of a sectional fixed archwire on the maxillary central incisors, prior to aligner treatment, then after aligner treatment and minimally invasive restorations on the maxillary first premolars and canines.

Patient 2

A 68-year-old woman presented with severe gingival recession in the anterior region of both arches, along with crowding and rotations (Fig 9). She demonstrated severe incisor pre-contact, but no symptoms of craniomandibular dysfunction were noted. The CBCT examination revealed the condyles were in a retral position (Fig 9m and n). Intraorally, a Class I relationship with anterior crowding and pre-contact was observed. Due to the pre-contact, the maxillary anterior teeth showed severe enamel abrasion that was planned to be restored after orthodontic treatment. The treatment plan consisted of in-office aligner treatment with the OnyxCeph system (Image Instruments, Chemnitz, Germany), with the aim of creating sufficient space and horizontal overlap, to be followed by restorative treatment of the anterior teeth with composite. Gingival flap surgery was planned for after therapy to treat the recessions. Figure 10a presents the intraoral situation transferred into OnyxCeph, and Fig 10b shows the virtual treatment simulation with attachments planned on the maxillary lateral incisors and canines and the mandibular canines and first premolars buccally and lingually of the mandibular lateral and central incisors. A total of 16 steps were planned, each with two aligners (0.5 mm CA Pro [Scheu-Dental, Iserlohn, Germany] and 0.625 mm Biolon [Dentsply Sirona, Charlotte, NC, USA] to align the maxillary and mandibular anterior dentition. In addition, a torque element was planned on the maxillary

canines and first premolars to obtain palatal root torque. Up to 0.36 mm IPR was necessary in the mandible (Fig 10c), and the planned tooth movements are shown in Fig 10d. The planned resolution of the anterior pre-contact allowed anterior movement of the condyles. No movement of the posterior teeth was planned as interdigitation was good and anchorage could be increased, thus avoiding moving all the teeth and instead moving only those selected in the software. Figure 11 presents the extra- and intraoral situation after in-office aligner therapy and alignment of both arches following 32 weeks of treatment. No additional phase was required as all the tooth movements had been performed as planned. The patient was then advised to visit her dental practitioner for maxillary anterior restorations.

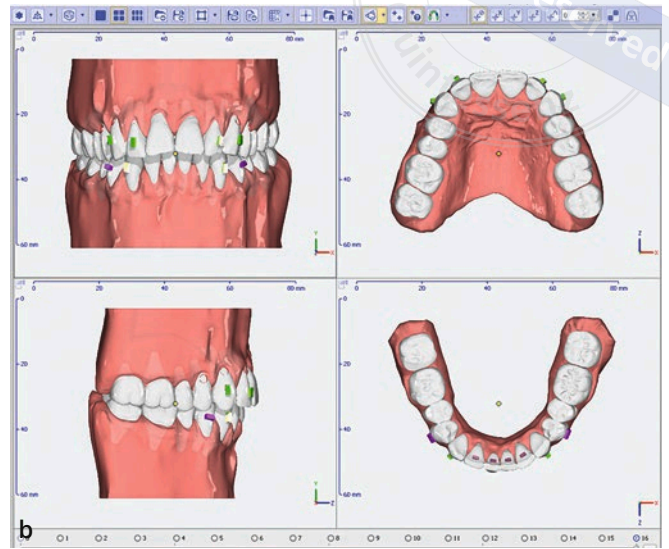
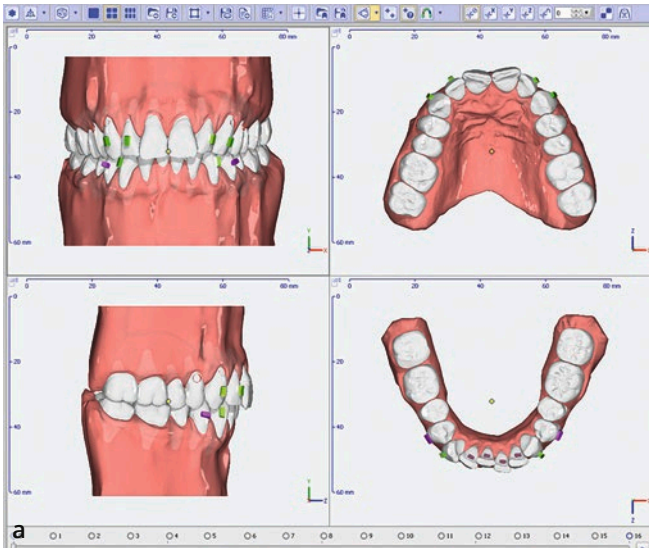
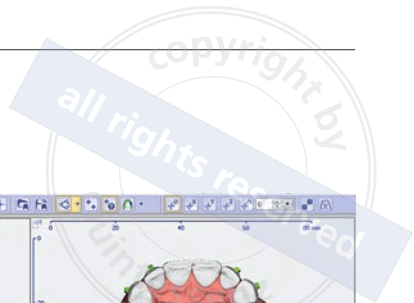
Figure 12 illustrates the extra- and intraoral situation directly after minimally invasive composite restorations on the maxillary central and lateral incisors and left canine (Enamel Plus HFO) (Dr Wolfgang Boisserée, Cologne). The incisal edges follow the lower lip line harmonically. Retention was performed with a removable aligner worn overnight in the maxilla and a lingual retainer in the mandible from the left first premolar to the right first premolar. Figure 13 shows the intraoral situation after 10 months, demonstrating a stable result and gingival healing.

Figure 14 presents the course of treatment with in-office aligners and the outcome after anterior composite restorations.

Copyright by
all rights reserved



Fig 9a to n Extra- and intraoral situation prior to treatment with the in-office aligner system, with crowding in the anterior region of both arches, along with abrasion of the anterior teeth, particularly the maxillary central incisors. The CBCT examination revealed the condyles were in a retral position.



Mandible														
Tooth*	47-46	46-45	45-44	44-43	43-42	42-41	41-31	31-32	32-33	33-34	34-35	35-36	36-37	Total
Amount of interproximal reduction (mm)	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00
Total (mm)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Distance (mm)	0.09	-0.36	-0.35	-0.24	-0.13	-0.16	-0.21	-0.12	-0.21	-0.32	-0.34	-0.32	0.17	-2.50

c *According to FDI notation.

Maxilla																
Tooth*	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
Mesial interproximal reduction (mm)																
Distal interproximal reduction (mm)																
Inclination (degrees)																
Inclination +/- (degrees)			-13.20	-23.70	-20.70	-14.20	-4.50	-1.60	10.50	14.70	2.50	-3.50	-15.40	-15.50	-14.20	-11.60
Angulation (degrees)																
Angulation +/- (degrees)			6.30	-5.90	7.70	6.10	1.90	7.70	1.00	2.40	11.30	29.10	1.00	10.00	-8.30	8.30
Rotation +/- (degrees)																
Rotation +/- (degrees)			0.10	0.10			1.20	-0.10	0.90	1.00	-0.70	-0.10			0.10	0.10
Mesial +/- (mm)																
Vestibular +/- (mm)			0.01	0.02	0.03	0.03	-0.02		-0.03	-0.02	-0.02					
Occlusal +/- (mm)			0.01	0.02	0.03	0.03	0.06	0.05	0.06	0.03	0.02	0.06	0.04	0.03	0.02	0.01

Mandible																
Tooth*	48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38
Mesial interproximal reduction (mm)																
Distal interproximal reduction (mm)																
Inclination (degrees)																
Inclination +/- (degrees)			-23.50	-42.20	-30.00	-34.90	-5.70	3.30	-11.90	3.20	3.50	-2.50	-29.20	-21.80	-35.40	-33.60
Angulation (degrees)																
Angulation +/- (degrees)			12.20	28.10	8.40	17.70	12.80	-4.90	1.40	-1.60	5.90	18.70	25.60	12.90	20.80	19.20
Rotation +/- (degrees)																
Rotation +/- (degrees)			0.10	0.10	0.10	0.10	-1.40	-0.80	-0.10	0.70	1.40	-0.50	0.10	0.10	0.10	0.10
Mesial +/- (mm)																
Vestibular +/- (mm)			0.01	0.03	0.04	0.05	0.02		0.05	-0.06	-0.02	0.02	-0.01	0.03	0.03	0.01
Occlusal +/- (mm)			0.02	0.03	0.03	-0.02	-0.02	-0.04	-0.05	-0.02	-0.06	-0.04	-0.02	0.01	0.03	0.03

d *According to FDI notation.

Fig 10a to d Intraoral situation transferred into OnyxCeph (a) and planned outcome in the software (b). Attachments were planned on the maxillary lateral incisors and canines and the mandibular canines and first premolars buccally and lingually of the mandibular lateral and central incisors. A total of 16 steps were planned, each with two aligners (aligner material 0.5-mm CA Pro [Scheu-Dental, Iserlohn, Germany] and 0.625-mm Biolon [Dentsply Sirona, Charlotte, NC, USA]) to align the maxillary and mandibular anterior dentition. A torque element was planned on the maxillary canines and first premolars to obtain additional palatal root torque. Overcorrection of the extrusive movement of the premolars and molars was planned, the initial anterior contact was resolved, and with this, the retrally guided mandibular position improved. Up to 0.36 mm IPR was necessary in the mandible (c) and the tooth movements were planned (d).



Fig 11a to m Extra- and intraoral situation after in-office aligner therapy with alignment of the maxilla and mandible following 32 weeks of treatment.





Fig 14a to l Comparison of the situation before and after treatment with in-office aligners (a to f) and the result after minimally invasive restorations on the maxillary central and lateral incisors and left canine (g to i) and several months after gingival healing (j to l).

Patient 3

A 48-year-old woman presented with a desire to resolve her anterior open bite. She had undergone orthodontic treatment *alio loco* and had an insufficient fixed lingual retainer from the maxillary right canine to the left lateral incisor. She demonstrated a visceral swallowing pattern and spaces had opened distally of the maxillary right canine and left lateral incisor, as well as distally of the mandibular canines and left central incisor. The old fixed lingual retainer was

removed and the patient was advised to undergo myofunctional therapy. The extra- and intraoral initial situation are presented in Fig 15, with anterior open bite from canine to canine, spaces in both arches and midline deviation. The panoramic radiograph revealed no pathologies, and the mandibular right third molar was *in situ* (Fig 15l). The lateral cephalometric radiograph and values demonstrate the open bite and protruding maxillary and mandibular anterior teeth with an increased interincisal angle with protruding incisors (Fig 15m to o). Figure 16a shows the intra-

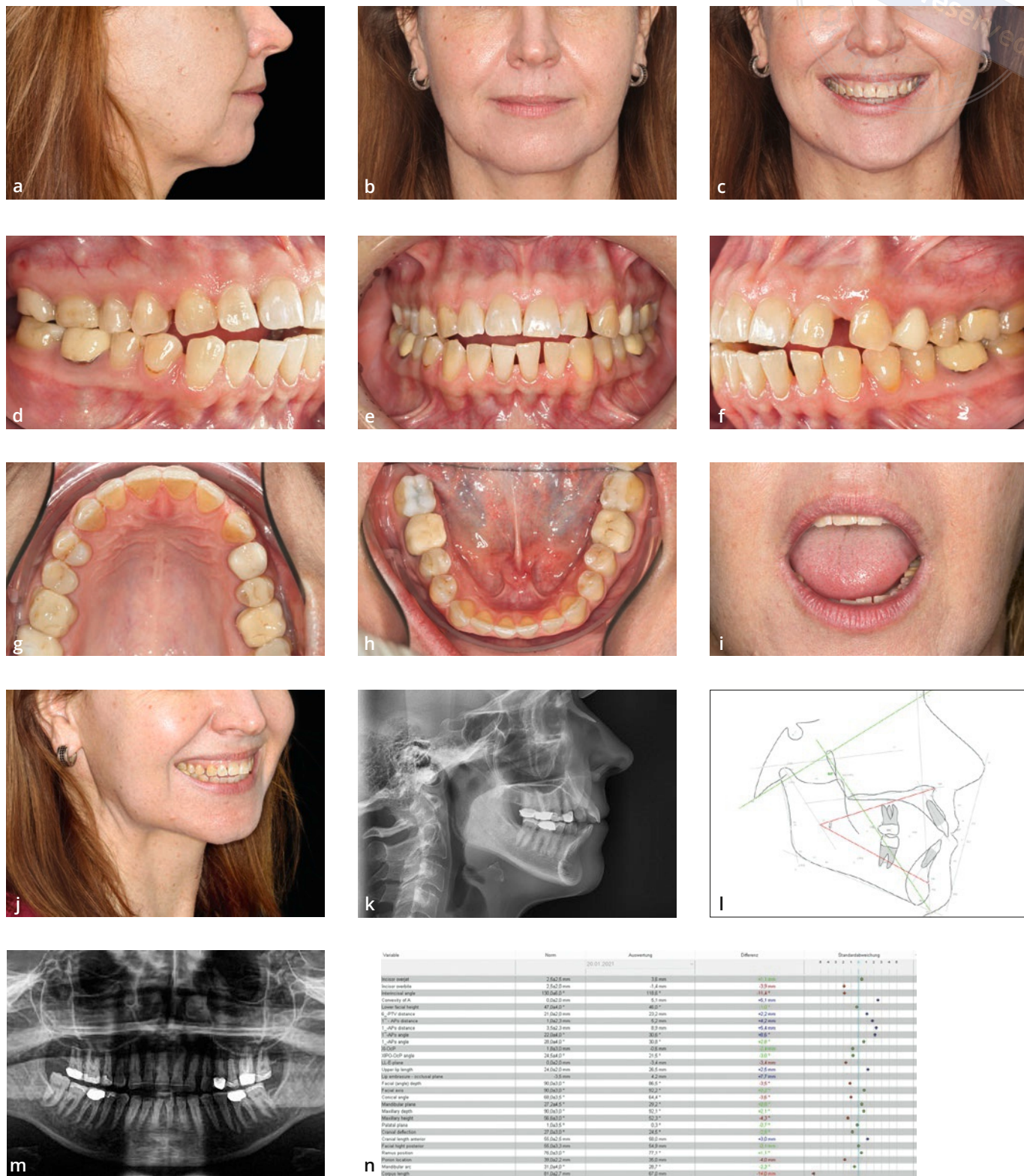
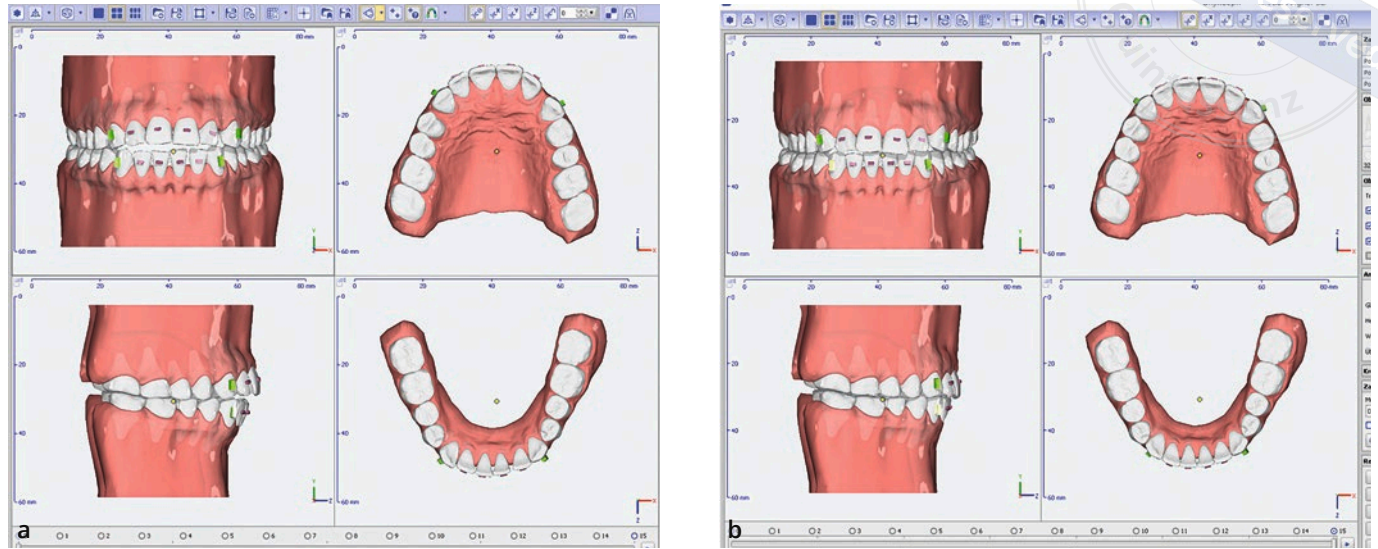


Fig 15a to n Extra- and intraoral situation prior to treatment with anterior open bite from canine to canine, spaces in both arches, midline deviation and a Class III tendency. The lip position at rest shows 2-mm maxillary incisal edges. The panoramic radiograph reveals insufficient restorations in both arches on the molars and premolars, which required new restorations after orthodontic treatment. The lateral cephalometric radiograph shows anterior open bite, an increased interincisal angle and protruding incisors.



Maxilla																
Tooth*	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
Mesial interproximal reduction (mm)																
Distal interproximal reduction (mm)																
Inclination (degrees)		3.40	-5.20	6.00	-2.90	4.10	16.00	14.10	13.70	14.90	0.90	-3.50	1.50	-7.80	8.20	
Inclination +/- (degrees)							1.20		-0.50	3.60	-0.60					
Angulation (degrees)		5.70	0.30	12.40	-6.80	-8.40	8.10	-1.00	7.60	15.70	-6.00	-0.20	8.50	-5.30	5.20	
Angulation +/- (degrees)							-0.10		-2.50	-2.10	1.90	-4.10	3.10			
Rotation +/- (degrees)					-0.20	2.10	-2.70	-2.80	4.00	-5.80	9.00					
Mesial +/- (mm)		-0.02	-0.02		0.15	-1.02	-0.83	-0.27	-0.30	-1.59	0.57	-0.04		-0.02	-0.04	
Vestibular +/- (mm)					0.04	-0.07	-1.37	-2.23	-2.81	-1.33	0.12					
Occlusal +/- (mm)		-0.20	-0.25	-0.25	0.01	-0.05	-0.10		-0.04	-0.35		-0.35		-0.25	-0.35	
Mandible																
Tooth*	48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38
Mesial interproximal reduction (mm)																
Distal interproximal reduction (mm)																
Inclination (degrees)		-33.20	-53.20	-10.30	-2.20	3.50	10.60	12.80	8.30	11.20	-0.40	-10.00	-12.70	-56.00	-33.70	
Inclination +/- (degrees)		0.20	0.10	0.10	-0.40	3.20	-0.30	0.80	0.10	-0.60	-0.10	-0.20			0.30	
Angulation (degrees)		6.80	11.30	17.40	18.80	15.70	7.60	1.40	3.40	3.90	15.20	25.10	3.30	6.10	11.30	
Angulation +/- (degrees)		0.10	0.10			-4.10	-1.60	-4.10	-1.00	0.70	-0.90			0.10		
Rotation +/- (degrees)		-1.90	-1.30	-0.60	0.40	-9.30	-0.60	-6.80	2.80	4.60	-0.10	0.30	-0.70	-1.30	-1.90	
Mesial +/- (mm)		-0.03	-0.10	0.05	0.12	-0.64	0.13	-0.70	0.02	-0.45	-0.05	0.01	-0.10	-0.04	-0.04	
Vestibular +/- (mm)		-0.17	-0.46	-0.60	-0.61	-1.43	-1.21	-1.80	-1.44	-1.29	-1.00	-0.63	-0.61	-0.45	-0.16	
Occlusal +/- (mm)		-0.17	-0.31	-0.26	-0.09	-0.34	-0.11		-0.10	-0.15	-0.27	-0.43	-0.13	-0.20	-0.32	

*According to FDI notation.

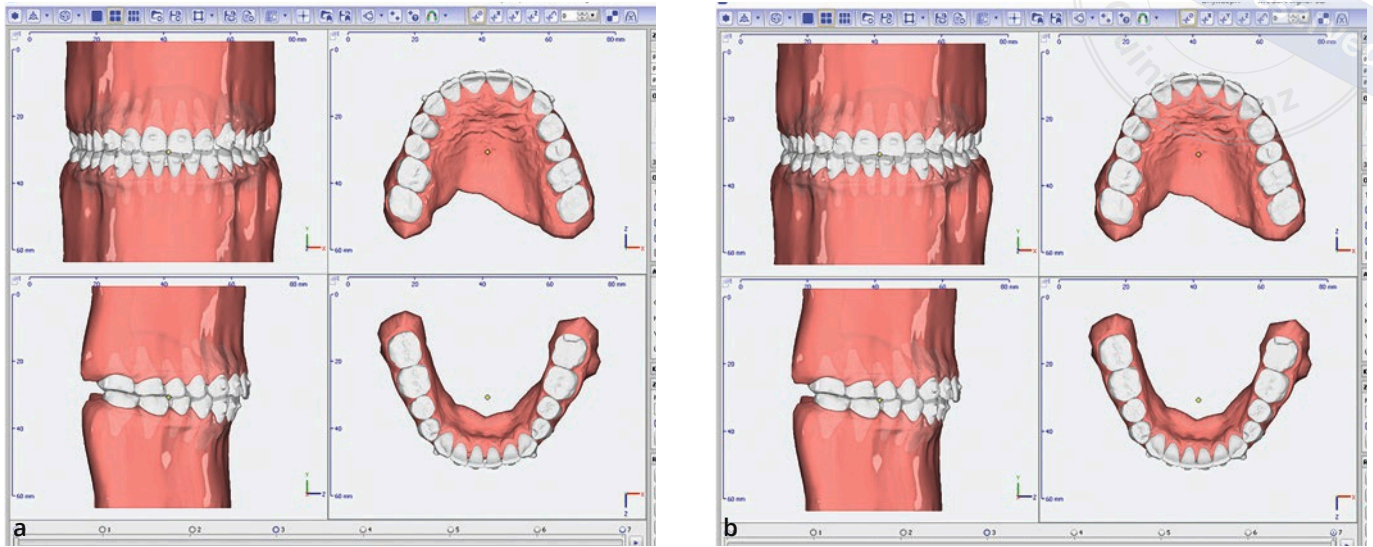
Fig 16a to c Intraoral situation transferred into OnyxCeph demonstrating the anterior open bite. Vertical and horizontal attachments were added on the maxillary and mandibular canines and lateral and central incisors for anchorage and extrusive movement. No IPR was planned. Tooth movement included intrusion of the posterior teeth up to 0.35 mm and extrusion of the anterior teeth up to 2.8 mm. The final planned outcome after 15 steps is shown in (b). Each step included two aligners (CA Pro 0.5 and 0.75 mm).



Fig 17a to h Intraoral situation after the first phase of treatment with in-office aligners and partial closure of the anterior open bite. To improve the anterior relation for the future restorations, further aligners were planned to increase the horizontal overlap and create additional space.

oral situation transferred into OnyxCeph, demonstrating the anterior open bite. Vertical and horizontal attachments were added on the maxillary and mandibular canines and lateral and central incisors for anchorage. No IPR was planned. The final planned outcome after 15 steps is shown in Fig 16b. Each step included two aligners (CA Pro 0.5 and 0.75 mm). Tooth movement involved intrusion of the posterior teeth up to 0.35 mm and extrusion of the anterior teeth up to 2.8 mm (Fig 16c). Figure 17 presents the intraoral situation after the first phase of treatment with in-office aligners and improvement of the anterior open bite. Figure 18 demonstrates the second phase planned in OnyxCeph with additional extrusion of the anterior teeth and eight steps of movements. No movement of the posterior teeth was planned in the second phase, and IPR was required on all the mandibular teeth mesially of the left first premolar to mesially of the right first premolar to increase retraction of the mandibular teeth as well as the horizontal

overlap. Figure 19 demonstrates the final intraoral situation after in-office aligner treatment with closure of the anterior open bite. Incisal tooth wear was present on the maxillary central and lateral incisors and canines, with reduced crown height. The patient was transferred to her dental practitioner for minimally invasive restorations on the maxillary anterior teeth and new crowns on the posterior teeth. Figure 20 shows the intraoral situation after the addition of composite restorations on the maxillary canines and central and lateral incisors (Enamel Plus HFO) and restorations on the posterior teeth (Prettau 3 Dispersive; Zirkonzahn, Gais, Italy) (Dr Wolfgang Boisserée, Cologne). A lingual retainer was inserted from the mandibular left first premolar to the right first premolar, and the patient continued to wear a removable aligner in the maxilla. Frequent follow-up appointments were recommended to control the retention and avoid reopening of the bite. Figure 21 shows the course of treatment.



Maxilla																	
Tooth*	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28	
Mesial interproximal reduction (mm)																	
Distal interproximal reduction (mm)																	
Inclination (degrees)		10.90	-2.70	11.50	3.30	7.80	16.80	13.70	13.10	12.10	8.80	-0.70	3.10	-2.20	10.60		
Inclination +/- (degrees)						0.10	0.20			-0.10							
Angulation (degrees)		5.10	4.60	16.90	1.00	-5.40	6.00	-0.80	6.20	8.60	21.00	3.20	15.60	-1.40	6.20		
Angulation +/- (degrees)						-0.40	-1.00			0.10							
Rotation +/- (degrees)						-1.00	-1.90	-0.60	0.60	1.10	-0.60						
Mesial +/- (mm)						0.05	0.05	0.20	-0.25	-0.39	0.23						
Vestibular +/- (mm)						-0.10	-0.20	-0.14	-0.21	-0.31	-0.80						
Occlusal +/- (mm)								-0.35	-0.03	-0.05	0.08						
Mandible																	
Tooth*	48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38	
Mesial interproximal reduction (mm)																	
Distal interproximal reduction (mm)																	
Inclination (degrees)		-32.40	-35.70	-9.10	-3.30	1.40	10.10	9.90	6.50	8.70	1.90	-7.10	-12.70	-42.00	-38.70		
Inclination +/- (degrees)						1.20	-0.70	-1.00	-0.80	-1.50	0.90						
Angulation (degrees)		13.10	15.10	19.90	20.80	16.30	7.90	-1.50	1.00	6.20	15.00	24.40	4.30	18.50	3.00		
Angulation +/- (degrees)						-1.20	-1.00	-2.70	-1.70	3.50	-1.10						
Rotation +/- (degrees)						-3.90	-1.80	0.80	-1.00	7.20	-3.70						
Mesial +/- (mm)						-0.03	-0.01	0.14	-0.14	0.01	-0.08						
Vestibular +/- (mm)						-0.40	-0.95	-0.75	-0.64	-0.80	-0.45						
Occlusal +/- (mm)							0.29		-0.11		-0.01						

*According to FDI notation.

Maxilla														
Tooth*	17-16	16-15	15-14	14-13	13-12	12-11	11-21	21-22	22-23	23-24	24-25	25-26	26-27	Total
Amount of interproximal reduction (mm)	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00
Total (mm)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Distance (mm)	0.00	0.00	0.00	0.05	-0.04	0.02	0.00	0.03	0.03	0.02	0.00	0.00	0.00	0.11
Mandible														
Tooth*	47-46	46-45	45-44	44-43	43-42	42-41	41-31	31-32	32-33	33-34	34-35	35-36	36-37	Total
Amount of interproximal reduction (mm)	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00 + 0.00	0.00
Total (mm)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Distance (mm)	0.00	0.00	0.00	0.00	-0.13	-0.29	-0.16	-0.24	-0.29	-0.21	0.00	0.00	0.00	-1.32

*According to FDI notation.

Fig 18a to d Second phase of treatment planned in OnyxCeph with additional extrusion of the anterior teeth and eight steps of movements. Based on the first phase, no movement of the posterior teeth was planned, and IPR was required on all the mandibular teeth mesially of the left first premolar to mesially of the right first premolar to retract the mandibular anterior teeth further and increase the horizontal overlap.

Copyright by
all rights reserved

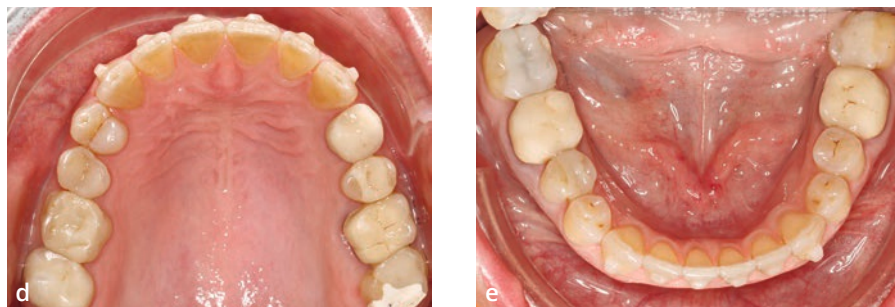


Fig 19a to e Final intraoral situation after in-office aligner treatment. The open bite had been closed and incisal wear was present on the maxillary central and lateral incisors and canines. The patient was transferred for minimally invasive restorations on the maxillary anterior teeth and canines and new crowns on the posterior teeth.

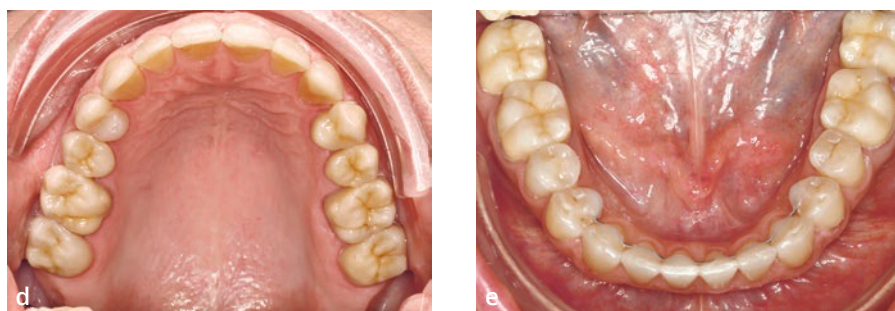


Fig 20a to e Intraoral situation after the addition of composite restorations on the maxillary canines and central and lateral incisors (Enamel Plus HFO) and restorations on the posterior teeth (Prettau 3 Dispersive; Zirkozahn, Gais, Italy) (Dr Wolfgang Boisserée, Cologne). A lingual retainer was inserted from the mandibular left first premolar to the right first premolar, and the patient continued to wear a removable aligner in the maxilla.



Fig 21a to i Course of treatment: initial situation with anterior open bite (a to c), the situation after in-office aligner treatment and 12 months of treatment time (d to f) and the final situation after composite restorations on the anterior teeth and new ceramic restorations on the posterior teeth (g to i).

Discussion

Anterior composite restorations have proven their worth in the long term; they offer aesthetic results that only rarely need to be followed by the use of veneers and come at a cost that is manageable for patients compared to that of indirect restorations.

Composite restorations have numerous areas of application, such as for aesthetic tooth correction in the anterior and posterior region, closure of anterior tooth gaps or diastemas, use in the case of a broken incisor, restoration after caries treatment or building up teeth after abrasion due to tooth grinding.

The anterior region is an important area of the dentition, especially in terms of aesthetics. Many different materials are available nowadays, and when selecting which one to use, it is important to consider criteria such as the

size of the restoration depending on the defect, parafunctional habits displayed by the patient, the geometry of the defect and the patient's aesthetic requirements and financial means.

Young patients with missing teeth, like the patient presented in case 1, pose a particular orthodontic challenge, as implants may not be placed immediately due to their age. Aesthetic, functional and long-term dental treatment for missing maxillary lateral incisors requires proper and forward-looking planning for young, adolescent and adult patients alike. The decision to close the gaps in case 1 was made after in-depth discussions with the patient and her parents, avoiding the need for follow-up treatments and further implants.

Case 2 presented a patient with posteriorly positioned TMJs and severe anterior pre-contact that had led to abrasion of the maxillary anterior teeth. With aligner treatment,

a functional relationship of the anterior teeth was achieved and no further improvement of tooth position was desired by the patient, as she was satisfied with the aesthetic outcome and pain-free. Further aligner treatment might have helped to improve the excessive mandibular curve of Spee or inclination of the premolar and canine roots in the maxilla.

Anterior open bites can be approached in several ways. The use of skeletal anchorage was not accepted by the patient in case 3, which led to the treatment option of maxillary and mandibular extrusion. With the addition of composites after orthodontic treatment, optimal function and aesthetics were achieved.

Conclusion

The present article provided three patient examples to illustrate various aspects of therapeutic options following orthodontic treatment. In all cases, the patient (and in young patients their parents) and the interdisciplinary cooperating dental practitioner performing the follow-up treatment should be involved in the decision-making process, whereby the advantages and disadvantages of different possibilities and materials for dental restorations (e.g. composite, veneers) should be weighed up carefully.

Retention of the treatment result as well as close monitoring examinations for long-term maintenance of the restorations are basic prerequisites for the longevity of the results achieved.

Declaration

The authors declare there are no conflicts of interest relating to this study.

References

1. Schupp W, Haubrich J (eds). *Aligner Orthodontics and Orofacial Orthopedics*. Berlin: Quintessence Publishing, 2023.
2. Wilmes B. The new Benefit for Aligner Technique to overcome limitations of aligners. *J Aligner Orthod* 2023;7:25-38.
3. Sugawara J, Ojima K, Dan C, Nagasaki H. Application of aligners for detailing and finishing biomechanics in "surgery first" approach. *J Aligner Orthod* 2018;2:283-294.

4. Solano Mendoza B, Gómez García L, Pourhamid H, Solano E. Multidisciplinary treatment-increase of vertical dimension combined with Invisalign treatment. *J Aligner Orthod* 2018;2:101-107.
5. Simon M, Keilig L, Schwarze J, Jung BA, Bourauel C. Treatment outcome and efficacy of an aligner technique--regarding incisor torque, premolar derotation and molar distalization. *BMC Oral Health* 2014;14:68.
6. Schupp W, Haubrich J, Ojima K, Dan C, Kumagai Y, Otsuka S. Accelerated Invisalign treatment of patients with a skeletal Class III. *J Aligner Orthod* 2017;1:37-57.
7. Schupp W, Funke J, Haubrich J, Boisserée W. Follow-up treatment after initial splint therapy. *J Aligner Orthod* 2019;3:147-164.
8. Sayahpour B, Majdani A, Eslami S, Buehling S, Goteni M, Kopp S. Treatment of anterior open bite with the Invisalign First system: A case report. *J Aligner Orthod* 2022;6:189-197.
9. Rossini G, Parrini S, Deregibus A, Castroflorio T. Controlling orthodontic tooth movement with clear aligners. An updated systematic review regarding efficacy and efficiency. *J Aligner Orthod* 2017;1:7-20.
10. Robertson L, Lee D, Eimar H, El-Bialy T. Treatment of a challenging Class III malocclusion case using Invisalign clear aligners and microosteoperforation: a case report. *J Aligner Orthod* 2019;3:229-241.
11. Reistenhofer B, Triessnig F, Besser K. Correcting severe deep bite with the Invisalign appliance. *J Aligner Orthod* 2018;2:109-123.
12. Piergentili M, Sangiuolo C, Martina S, Levatè C, Verrone M, D'Antò V. Management of root displacement with clear aligners. *J Aligner Orthod* 2021;5:139-145.
13. Palikaraki G, Karamesinis K, Damanakis G. Orthodontic treatment in a periodontal patient with incisor extraction using Invisalign clear aligner system: a case report. *J Aligner Orthod* 2018;2:317-323.
14. Ojima K, Dan C, Watanabe H, Kumagai Y. Upper molar distalization with Invisalign treatment accelerated by photobiomodulation. *J Clin Orthod* 2018;52:675-683.
15. Malekian K, Parrini S, Garino F, Deregibus A, Castroflorio T. Mandibular molar distalization with clear aligners in Class III patients. *J Aligner Orthod* 2019;3:7-14.
16. Makino, M., Treatment of deep bite with 'gummy smile' using clear aligners and temporary anchorage devices: a case report. *J Aligner Orthod* 2021;5:39-46.
17. Ma H, Feng Y, Pu P, Ren Y, Gu Z. Angelalign treatment of an adult with excessive overjet and a missing mandibular premolar: a case report. *J Aligner Orthod* 2019;3:93-105.
18. Lumi M. Maxillary distalisation and mandibular mesialisation with horizontal attachments in molars during Class II treatment: A case report. *J Aligner Orthod* 2022;6:263-270.
19. Lione R, Pavoni C, Cozza P. Management of crowding in mixed dentition with Invisalign First: 10 steps to successful digital planning. *J Aligner Orthod* 2021;5:115-122.
20. La Valle MG, Iaracitano B, Basilico M. Use of aligners to treat buccal bone loss. *J Aligner Orthod* 2020;4:311-330.
21. Haubrich J, Schupp W. Invisalign treatment in early years to avoid potential extraction treatments - case reports. *J Aligner Orthod* 2018;2:39-52.
22. Haubrich J, Funke J, Schupp W, Wilmes B. Approaching complex orthodontic treatment cases using aligners in combination with skeletal anchorage. *J Aligner Orthod* 2022;6:103-120.
23. Greco M, Rossini G, Rombolà A. Simplifying the approach of open bite treatment with aligners and selective micro-osteoperforations: An adult case report. *Int Orthod* 2021;19:159-169.
24. Greco M, Migliori F. Digital approach in pre-prosthetic orthodontic treatment in adult patients. *J Aligner Orthod* 2020;4:219-226.
25. Giancotti A, Mampieri G. Unilateral canine crossbite correction in adults using the Invisalign method: a case report. *Orthodontics (Chic)* 2012;13:122-127.

26. Chang S, Schupp W, Haubrich J, Yeh WC, Tsai MS, Tabancis M. Aligner therapy in treating bimaxillary dentoalveolar protrusion. *J Aligner Orthod* 2019;3:277–301.
27. Krey KF, Hartmann M, Schicker P, Corteville F, Eigenwillig P. Complete digital in office workflow for aligner treatment with a fused filament fabrication (FFF) 3D printer: Technical considerations and report of cases. *J Aligner Orthod* 2019;3:195–204.
28. Salazar T. In-office thermoplastic aligner workflow. *J Aligner Orthod* 2021;5:123–130.
29. Elkholy F, Lapatki BG. Recommendation of a novel film-thickness sequence, 0.4, 0.5 and 0.75 mm, for aligner systems. *J Aligner Orthod* 2018;2:295–304.
30. Chaudhari PK, Turkyilmaz I, Zere E, Sokhi RK. In-house aligners for correction of relapse in mandibular incisor alignment. *J Aligner Orthod* 2021;5:217–223.
31. Bock HL, Bock JJ, Karbach F, et al. Material properties and first clinical applications of CA Pro, a novel aligner foil. *J Aligner Orthod* 2022;6:163–181.
32. Schupp W, Haubrich J. In-office aligner treatment. *IOK* 2020;52:289–300.
33. Loomans B, Opdam N, Attin T, et al. Severe tooth wear: European Consensus Statement on Management Guidelines. *J Adhes Dent* 2017;19:111–119.
34. Vailati F, Belser UC. Full-mouth adhesive rehabilitation of a severely eroded dentition: the three-step technique. Part 1. *Eur J Esthet Dent* 2008;3:30–44.
35. Vailati F, Gruetter L, Belser UC. Adhesively restored anterior maxillary dentitions affected by severe erosion: up to 6-year results of a prospective clinical study. *Eur J Esthet Dent* 2013;8:506–530.
36. Vailati F, Carciofo S., CAD/CAM monolithic restorations and full-mouth adhesive rehabilitation to restore a patient with a past history of bulimia: the modified three-step technique. *Int J Esthet Dent* 2016;11:36–56.
37. Attin T, Filli T, Imfeld C, Schmidlin PR. Composite vertical bite reconstructions in eroded dentitions after 5.5 years: a case series. *J Oral Rehabil* 2012;39:73–79.
38. Mehta SB, Banerji S, Millar BJ, Suarez-Feito JM. Current concepts on the management of tooth wear: part 4. An overview of the restorative techniques and dental materials commonly applied for the management of tooth wear. *Br Dent J* 2012;212:169–177.
39. Milosevic A, Burnside G. The survival of direct composite restorations in the management of severe tooth wear including attrition and erosion: A prospective 8-year study. *J Dent* 2016;44:13–19.
40. Manhart J. Ästhetische Restitution im Frontzahnbereich mit plastischen Füllungen. *Quintessenz* 2003;54:143–149.
41. Kühn M, Stelzle F. Minimal invasive esthetic construction of teeth with composite body shades. *Swiss Dent J* 2020;12:785–790.
42. Ernst CP. Schneidezähne in Form gebracht. *ZMK* 2014;10:636–647.
43. Frese C, Schiller P, Staehle HJ, Wolff D. Recontouring teeth and closing diastemas with direct composite buildups: a 5-year follow-up. *J Dent* 2013;41:979–985.