



**Figure 7.** Facial and intraoral photographs at the end of treatment.

thin gingival biotype with Miller Class I defects on the maxillary left lateral incisor, canine and first premolar, and also on maxillary right lateral incisor and canine (Figure 1). Bleeding on probing (BOP) and probing pocket depth (PPD) were evaluated using a UNC 15 probe (Hu-Friedy, Chicago, IL, USA) and were measured using a standardized force probe (about 0.25 N) at the mesiobuccal, midbuccal, distobuccal, distolingual, midlingual, and mesiolingual aspects in both the arches from the left first molar to the right first molar. The BOP and PPD measurements were recorded, for each jaw, before oral surgery (T0), at 4 months (T1), at the end of treatment (T2), and at the 2-year retention follow-up (T3). Each measurement was repeated twice by the same operator, and the values were averaged. Oral health-related quality of life (OHRQoL) was assessed using the Italian version of the short-form oral health impact profile with 14 questions (OHIP-14), which represents the following seven dimensions of OHRQoL: functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap.<sup>5</sup> The patient was instructed in the use of the questionnaire, which was filled out preoperatively (T0), 3 days after surgery, 7 days after surgery, at the end of orthodontic treatment (T2), and at the 2-year retention follow-up (T3). Responses were

based on an ordinal 5-point adjectival scale (0 = never; 1 = rarely; 2 = occasionally; 3 = fairly often; and 4 = very often). OHRQoL was characterized by the summary scores of the OHIP-14, with higher scores indicating a stronger negative influence on OHRQoL. The initial (T0) OHIP-14 score was compared with the 3- and 7-day postoperative scores in order to determine the influence of this surgical technique on OHRQoL. The (T0) OHIP-14 score was then compared with the score at the end of therapy (T2) and at the 2-year retention follow-up (T3) to evaluate the influence of the present combined treatment on OHRQoL.

### TREATMENT OBJECTIVES

The primary treatment objective was to solve the crowding within a short time by using clear aligners. The complementary treatment objectives were to establish a good, functional, and stable occlusion and to improve the dental esthetics. The correction of the midline, overjet, and overbite was not a treatment objective.

### TREATMENT ALTERNATIVES

The following three treatment options to solve crowding were presented:

- The first option was orthodontic treatment with conventional brackets. However, the patient declined this because she wanted a more esthetic appliance. Furthermore, she requested a short orthodontic treatment time.
- The second alternative was lingual brackets. However, since lingual appliances tend to cause difficulties with oral hygiene and proper speech, and have poor accessibility from the lingual side, this treatment alternative was also excluded.

**Table 2.** Post-treatment cephalometric analysis

Measurement	Value	Normal	Standard deviation
Vertical skeletal	43.3	34.0	3.0
SN-MP (°)	29.3	26.0	3.0
FMA (MP-FH) (°)	36.1	24.0	3.0
PP-MP (°)	14.3	10.0	4.0
PP-OP (°)	21.9	20.0	3.0
OP-MP(°)			
Horizontal skeletal	74.7	82.0	2.0
SNA (°)	69.5	80.0	2.0
SNB (°)	5.2	2.0	2.0
ANB (°)	-1.6	-1.0	1.6
A-FH (A-Na perp) (mm)	-10.5	-3.6	3.9
Pg-FH (Pg-Na perp) (mm)	5.6	0.0	2.0
Withs appraisal (mm)			
Anterior dental	98.9	110.0	4.0
U1-PP (°)	6.1	5.0	2.0
U1-APg (mm)	0.2	0.0	2.0
L1-Apg (mm)	66.8	57.5	7.0
U1-OP (°)	68.6	72.0	5.0
L1-OP (°)	135.3	130.0	6.0
Interincisal angle (U1-L1) (°)	61.2	64.8	8.5
FMIA (L1-FH) (°)	89.6	95.0	7.0
IMPA (L1-MP) (°)	5.7	2.5	2.0
Overbite (mm)	5.7	2.5	2.5
Overjet (mm)			
Aesthetic	-4.6	-2.0	2.0
Lower lip to E-plane (mm)	-5.1	-6.0	2.0
Upper lip to E-plane (mm)	-5.1	-6.0	2.0

SN-MP, Sella-Nasion to mandibular plane angle; FMA, Frankfort mandibular plane angle; PP-MP (basal plane angle), angle between palatal plane (ANS-PNS) and GoMe plane; PP-OP, angle between the palatal plane and occlusal plane; OP-MP, angle between occlusal plane and mandibular plane; SNA, Sella-nasion-A point; SNB, Sella-nasion-B point; ANB, sagittal jaw relationship; A-Na perp, distance from A point to the perpendicular line to Frankfurt plane passing from Na point; Pg-Na perp, distance from Pg to the perpendicular line to Frankfurt plane passing from Na point; Wits value, indicator of anteroposterior disharmony between the maxilla and the mandible; U1-PP, maxillary incisor angle to palatal plane; U1-APg, the distance from the incisal edge of the maxillary incisor to the A-Pg line; L1-APg, the distance from the incisal edge of the mandibular incisor to the A-Pg line; U1-OP, angle between the maxillary incisor axis and the occlusal plane; L1-OP, angle between the mandibular incisor axis and the occlusal plane; U1-L1, angle between the mandibular and maxillary incisors; FMIA, Frankfort-mandibular incisor angle; IMPA, lower incisor mandibular plane angle; Overbite, distance between maxillary incisor and mandibular incisor, perpendicular to the static occlusal plane; Overjet, distance between maxillary incisor and mandibular incisor (parallel to the static occlusal plane); Lower lip to E-plane, distance from the lower lip to the E line; Upper lip to E-plane, distance from the upper lip to the E line.

- The third alternative consisted of an esthetic treatment plan using esthetic clear aligners combined with selective alveolar corticotomies to reduce the treatment time.

In each of the treatment options, the extraction of the mandibular right first premolar was planned. The patient also preferred to have the orthodontic treatment completed as soon as possible. By using corticotomies, the treatment time could be reduced by up to one-third of the time needed for conventional orthodontic treatment. The patient was informed of the risks, advantages, and disadvantages of each therapeutic approach before selecting for the combined use of corticotomy and clear aligners. She also provided her written informed consent for the procedures. The treatment plan involved the following comprehensive orthodontic treatment with clear appliances to align the maxillary and mandibular teeth and to correct the crowding, as well as a computer-guided piezocision procedure in both the arches to accelerate tooth movement.

## TREATMENT PROGRESS

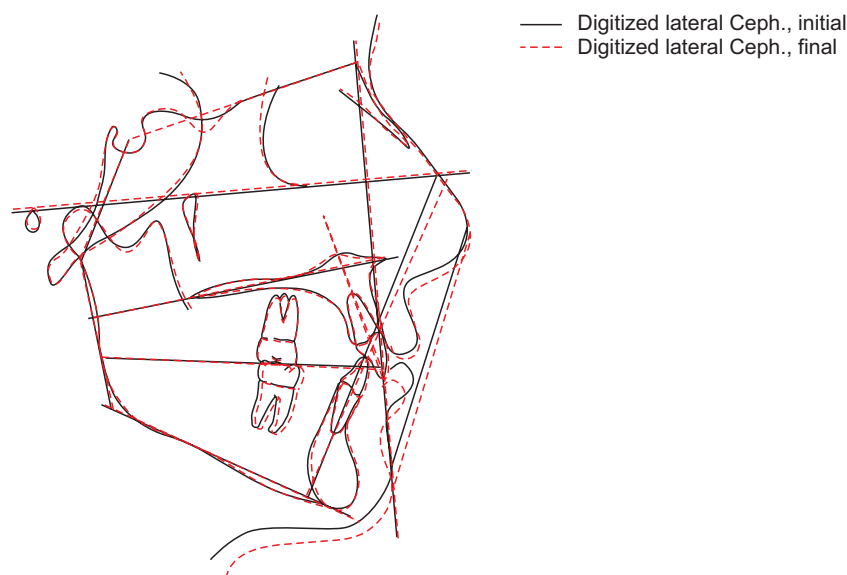
### Surgical procedure

To avoid a full-thickness flap reflection, a three-dimensionally (3D) printed surgical guide using computer aided design and computer aided manufacturing (CAD-CAM) was employed.<sup>6,7</sup> After positioning the surgical guide, its stability was checked by inviting the patient to bite. The guide presented an extension on the occlusal surface of the teeth, which allowed for its further stabilization in the maximum intercuspation. Vertical gingival incisions were made interproximally below the

interdental papilla by using a number-15 blade. The incisions crossed the periosteum, allowing the blade to contact the alveolar bone. The corticotomy cuts were performed through the gingival incisions 2 mm beyond the apices of the teeth. Interproximal corticotomy cuts were extended through the entire thickness of the cortical layer, barely penetrating the medullary bone. The design of the vertical cuts was aimed at maximizing marrow penetration and bleeding. The vertical cuts for the corticotomy were made using a piezosurgical device (Ultrasurgery; Carlo De Giorgi S.R.L., Milano, Italy). The procedure was then completed by suturing the vertical incisions. The orthodontic treatment began the same day by using clear aligners (Smiletech®; Ortodontica Italia, Rome, Italy) (Figure 4). At the end of surgery, the patient immediately underwent a CBCT examination in order to confirm the absence of damage to the anatomical structures (Figure 5).

### Orthodontic procedure

Before the surgical procedure, polyvinyl siloxane impressions of the maxillary and mandibular arches were taken and sent to a manufacturer who created 70 clear aligners—8 in the maxillary arch and 62 in the mandibular arch. The maxillary right second premolar and first molar were reduced at an interproximal location by means of diamond-coated finishing strips used for interproximal reduction (0.15 mm). Each aligner was used for 5 days (Figure 6). After the completion of treatment, the patient used retainers (Figure 7). Thermoformed templates of 0.6-mm thickness were used as retainers. The patient was instructed to wear them full-time for 1 year, followed by nighttime wear for an indefinite period.



**Figure 8.** Superimposition of pretreatment and post-treatment lateral cephalometric tracings (Ceph.).