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Precision Finishing in Lingual Orthodontics

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One major reason for the current unpopularity of lingual orthodontic therapy is the difficulty in finishing the occlusion to a desirable esthetic and functional result. There are many factors unique to lingual orthodontics that contribute to the challenge of finishing, including:

1. Variation in tooth anatomy. The considerable variability in the lingual anatomy of the teeth has a significant impact on the placement of the brackets and thus on their relative positions. The larger the buccolingual dimension of the tooth, the greater the difficulty (Fig. 1). Another problem is the lack of well-defined anatomical markers that are found on the facial surfaces.

Toward the end of orthodontic treatment, any discrepancies in bracket placement will be reflected in misalignments of the dentition. Correction of these misalignments then requires precise bending of finishing archwires. Although techniques have been developed for modifying bracket base thicknesses to resolve 1st- and 3rdorder problems, such methods remain relatively inexact.

2. Evaluating the nature of misalignments. The difficulty of distinguishing between 3rd-order torque problems and 2nd-order vertical problems from the lingual makes finishing even more complicated.1

3. Wire bending with short interbracket distances. The short interbracket span encountered lingually, combined with indirect visualization, adds to the difficulty of accurate placement and positioning of the complex bends required for lingual finishing (Fig. 2). Imprecise placement of bends over short interbracket distances has a significant influence on the force system generated by an orthodontic archwire.

4. Psychological factors. Ironically, the lack of bracket coverage on the facial surfaces of the teeth allows patients to better evaluate the progress of orthodontic treatment, and therefore they are more demanding of the finished result. The added cost of lingual orthodontics further intensifies patients' demand for excellence.

In view of these factors, it is apparent that consistent excellence in finishing lingual orthodontic treatment requires the coupling of precise bracket placement with accurate archwire bending.

Archwire Bending with Orthomate

CAD/CAM technology has recently been applied in the development of instrumentation to accurately bend prescription orthodontic archwires. This system, called Orthomate (formerly Bending Art), consists of a scanner, a CAD program, and a robot for automated archwire bending (Fig. 3).

There are two ways of entering data into the computer. In the first method, the three-dimensional bracket positions are scanned using the 3D Orthomate camera (Fig. 4). The second approach uses measurements derived from a diagnostic setup, called Transfer Optimized Positioning (TOP). The two values required for each tooth are the mesiodistal tooth dimension and the positioning thickness, as in the DALI system developed by Fillion2 (Fig. 5).

The lingual mushroom archform is calculated by the computer (Fig. 6). In the finishing stage, additional 1st-, 2nd-, and 3rd-order bends can be programmed for further customization of the archwire (Fig. 7). The bending robot is able to fabricate wires of various cross-sections and materials (Fig. 8)–called Preprogrammed Target Archwires (PTAs).

This article will describe three finishing approaches that we have developed, using the Orthomate system to achieve more reliable and consistent treatment results with lingual orthodontics.

Type I Finishing: Clinical Corrections with Orthomate

We use this type of finishing when minimal bends need to be placed in the finishing archwire to achieve optimal alignment and intercuspation in the anterior region. The necessary corrections are clinically defined by the orthodontist, and the changes in bracket placement are entered directly into the computer (Fig. 7).

The clinician must be aware of the difference between 3rd-order torque problems and 2nd-order vertical problems. It is important to note that complete torque expression is only achieved by the use of full-size archwires. If undersized wires are used, overcorrection must be built into the archwire.

Case 1

This 55-year-old patient presented with severe lower crowding and a crossbite in the right canine area (Fig. 9A). The mandibular anterior teeth were retroclined and supra-erupted. Despite the crossbite, there was perfect intercuspation on the right side. During the crossbite correction, a vertical malposition of the mandibular right central incisor bracket became evident (Fig. 9B). Corrections were entered using Orthomate (Fig. 9C), and an .017" × .025" stainless steel PTA was placed (Fig. 9D). Post-treatment results: (Fig. 9E).

Case 2

A 27-year-old patient presented with spacing due to proclination of the maxillary anterior teeth combined with a Class I molar relationship (Fig. 10A). An .017" × .025" stainless steel PTA was bent with corrections for rotation, torque, and angulation in the anterior area (Fig. 10B). After treatment (Fig. 10C, the program was used to produce an indirect-bonded prefabricated retainer.3

Case 3

This 23-year-old patient presented with a Class II, division 2 malocclusion (Fig. 11A). After space closure with sliding mechanics4 (Fig. 11B), an .017" × .025" stainless steel PTA (Fig. 11C) was used to optimize the alignment in the anterior region (Fig. 11D).

Case 4

This 25-year-old patient showed severe crowding in the maxillary and mandibular anterior regions and a reduced overbite. The mandibular right lateral incisor was completely blocked out (Fig. 12A). The anterior crowding was resolved with interproximal reduction in the lateral incisor area5 (Fig. 12B). An .016" × .022" stainless steel PTA (Fig. 12C) was used for final corrections (Fig. 12D).

Type II Finishing: Rapid Target Simulation with Orthomate

A number of clinical situations–especially those involving severe rotations or partially erupted teeth--require initial bracket positions to be offset. As treatment proceeds, brackets need to be repositioned, or moderate-to-complex bends have to be placed in the finishing archwire.

Rapid Target Simulation (RTS) with Orthomate allows for the fabrication of complex wire geometries to eliminate the need for rebonding of brackets and consequent stepping down in wire size. Although a laboratory procedure is required to fabricate a finishing PTA, the additional time needed in the laboratory is compensated for by the reduction in chairtime. RTS can easily be performed by a laboratory technician.

A new set of brackets is placed in the original bonding trays used for the indirect setup (Fig. 13A), and sectionally transferred to a duplicate of the original working cast (Fig. 13B). Next, each tooth is individually sectioned and placed along a full-dimension lingual archwire (Fig. 13C). The discrepancies in tooth position along the archwire are noted in terms of 1st-, 2nd-, and 3rd-order positions. The necessary adjustments are entered into the Orthomate program, and a new PTA is fabricated (Fig. 13D). This approach allows for direct visualization of the target occlusion in response to the bends placed in the archwire. The final intercuspation can be simulated by occluding the arches (Fig. 13E).

Case 5

In this case, both canines were improperly aligned, even though the .016" × .022" superelastic nickel titanium archwire was fully engaged (Fig. 14A). RTS was first used to simulate the occlusion on the unmodified archwire (Fig. 14B), then to produce a PTA (Fig. 14C). The corrections achieved by the PTA can easily be seen (Fig. 14D).

Case 6

This 22-year-old patient with a severe skeletal Class II malocclusion (Fig. 15A) was treated with a combination of orthodontics and orthognathic surgery.6 RTS was used to correct the angulation of the mandibular right molar (Fig. 15B), the torque of the mandibular left molar (Fig. 15C), and the rotation of the mandibular left canine (Fig. 15D). Note the close similarity between the target setup and the clinical photographs (Fig. 15E,F).

Type III Finishing: Setup Related Finishing with Orthomate

We use the Type III finishing approach in patients where complex three-dimensional corrections are necessary to finish the occlusion. Setup Related Finishing (SRF) is especially useful in unilateral treatment when the untreated arch is irregular. As in Type II finishing, a laboratory procedure is used to save chairtime in bracket repositioning and corrective archwire bending.

A second set of brackets is transferred to a duplicate of the original cast as described above, and individual teeth are reset in a diagnostic setup to reflect the target occlusal scheme (Fig. 16A). Identification markers are placed on the lingual brackets (Fig. 16B) for scanning with the Orthomate camera, and a three-dimensional image is captured of the target occlusion and brackets (Fig. 16C). Passive wires of various cross-sections and materials can be designed and fabricated with the system (Fig. 16D); their passivity can be verified on the setup model (Fig. 16E). The PTAs are used in sequence to correct the malocclusion and achieve the desired result.

Case 7

This 56-year-old patient presented with a frontal and lateral crossbite and several missing teeth, which were partly replaced by a removable prosthesis (Fig. 17A). After crossbite correction and preprosthetic space opening, the SRF procedure was carried out. Note the similarity between the target diagnostic setup and the clinical photographs (Fig. 17B). After orthodontic treatment, the patient was fitted with new prostheses (Fig. 17C).

Conclusion

The clinical experience of orthodontists over the last 30 years suggests that a true straight-archwire appliance does not presently exist. The use of PTAs fabricated with Orthomate allows a paradigm shift from correction built entirely into the brackets to correction built into a customized archwire.

All three types of finishing approaches using the Orthomate system provide more reliable and consistent results with lingual orthodontic treatment. Furthermore, the automated fabrication of true customized PTAs minimizes the chairtime associated with lingual orthodontic treatment, makes it more cost-effective for the practitioner, and has the potential to increase the usage of lingual therapy.7 □

FIGURES

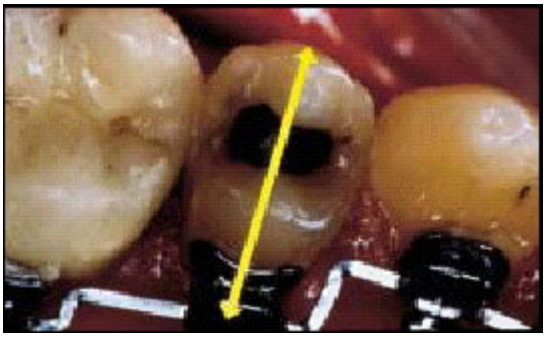

Fig. 1 Wide buccolingual dimension makes lingual bracket placement difficult.

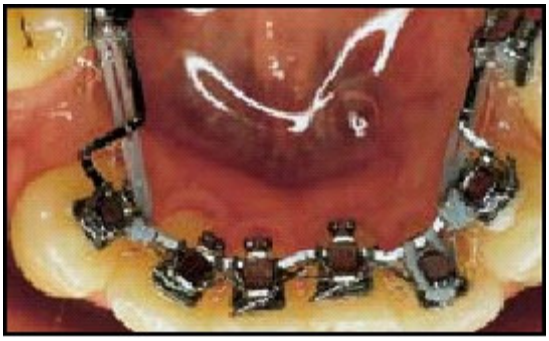

Fig. 2 Short interbracket span in lingual treatment.

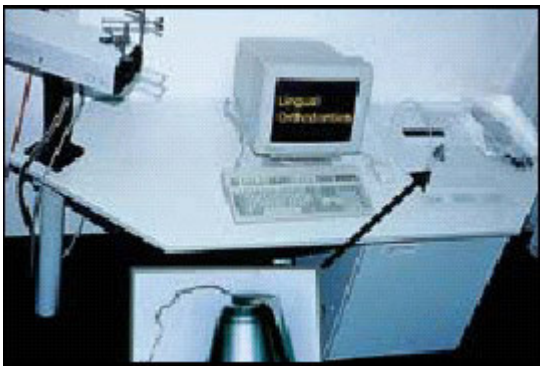

Fig. 3 Orthomate system.

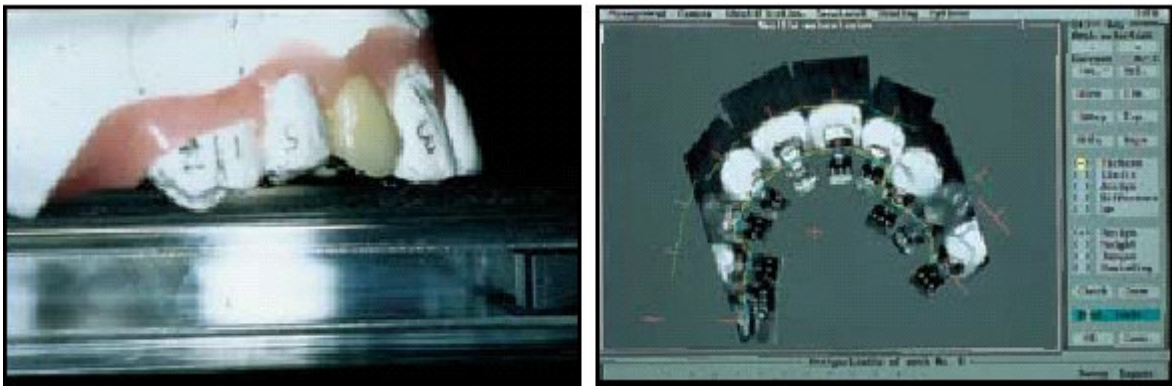

Fig. 4 Scanning three-dimensional bracket positions with Orthomate camera.

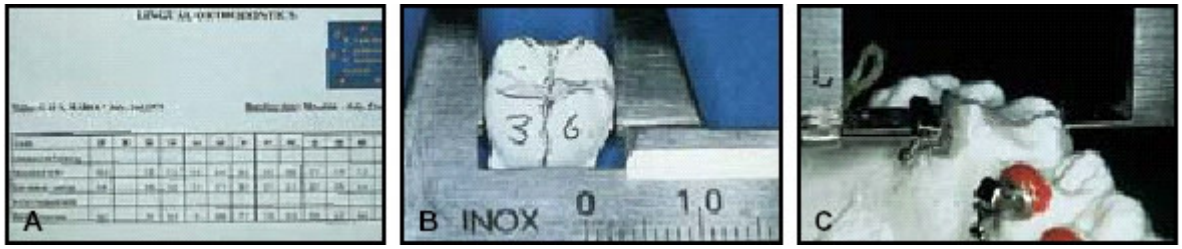

Fig. 5 A. TOP (Transfer Optimized Positioning) laboratory protocol. B. Measurement of mesiodistal tooth dimension. C. Measurement of positioning thickness [Ref. 2].

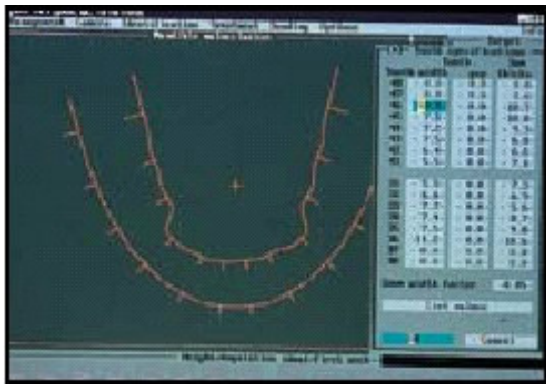

Fig. 6 Orthomate program calculates lingual archform.

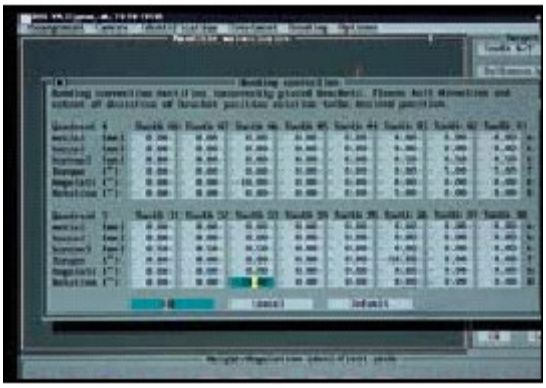

Fig. 7 Finishing corrections added with Orthomate.

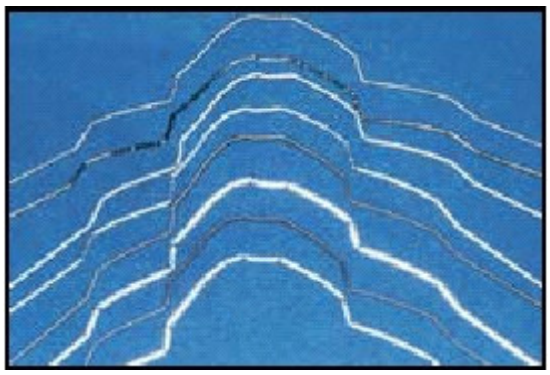

Fig. 8 Various archwires fabricated by Orthomate bending robot.

Fig. 9A Case 1: Type I finishing. A. Before treatment.

Fig. 9B Case 1: Type I finishing. B. Vertical malposition of mandibular right central incisor bracket evident during crossbite correction.

Fig. 9C Case 1: Type I finishing. C. Corrections entered in Orthomate program.

Fig. 9D Case 1: Type I finishing. D. .017" × .025" stainless steel PTA in place.

Fig. 9E Case 1: Type I finishing. E. After treatment.

Fig. 10A Case 2: Type I finishing. A. Before treatment.

Fig. 10B Case 2: Type I finishing. B. .017" × .025" stainless steel PTA in place.

Fig. 10C Case 2: Type I finishing. C. After treatment.

Fig. 11A Case 3: Type I finishing. A. Before treatment.

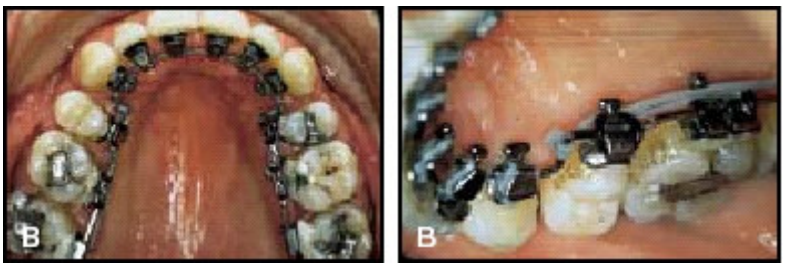

Fig. 11B Case 3: Type I finishing. B. En masse retraction with sliding mechanics.

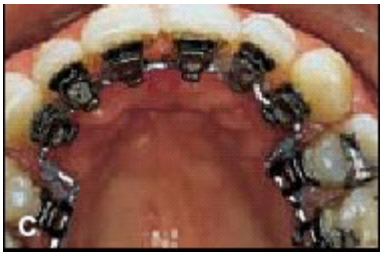

Fig. 11C Case 3: Type I finishing. C. .017" × .025" stainless steel PTA with lasso rotation elastic on maxillary left lateral incisor.

Fig. 11D Case 3: Type I finishing. D. After treatment.

Fig. 12ABC Case 4: Type I finishing. A. Before treatment. B. Derotation of mandibular right lateral incisor. C. Maxillary .016" × .022" stainless steel PTA in place.

Fig. 12D Case 4: Type I finishing. D. After treatment, showing lingual retainers.

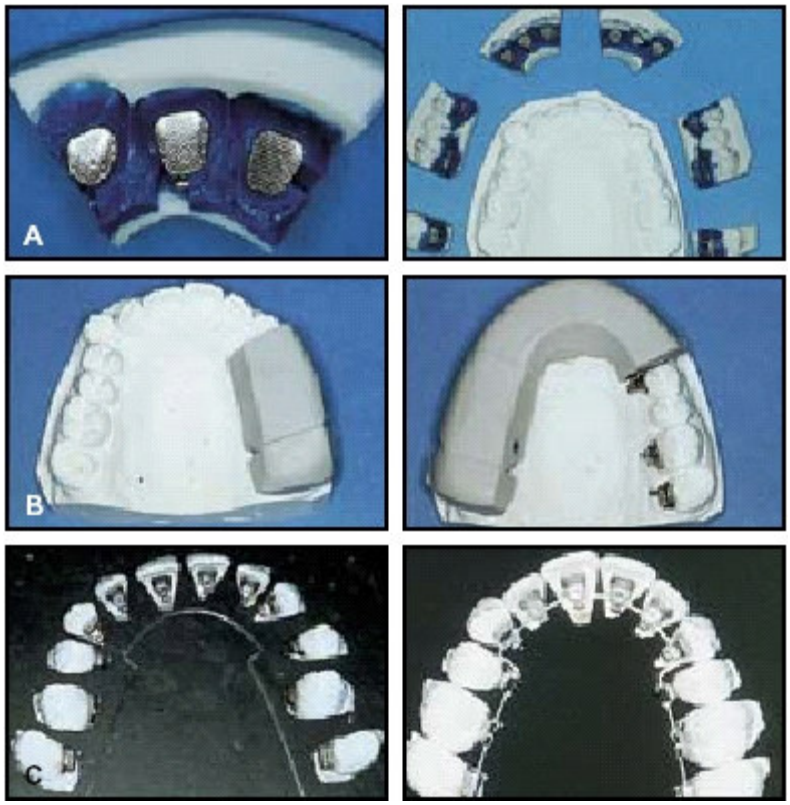

Fig. 13ABC Type II finishing with Orthomate: Laboratory procedure. A. New brackets placed in original transfer trays. B. Brackets transferred to duplicate of original cast. C. Teeth sectioned and positioned along full-size archwire.

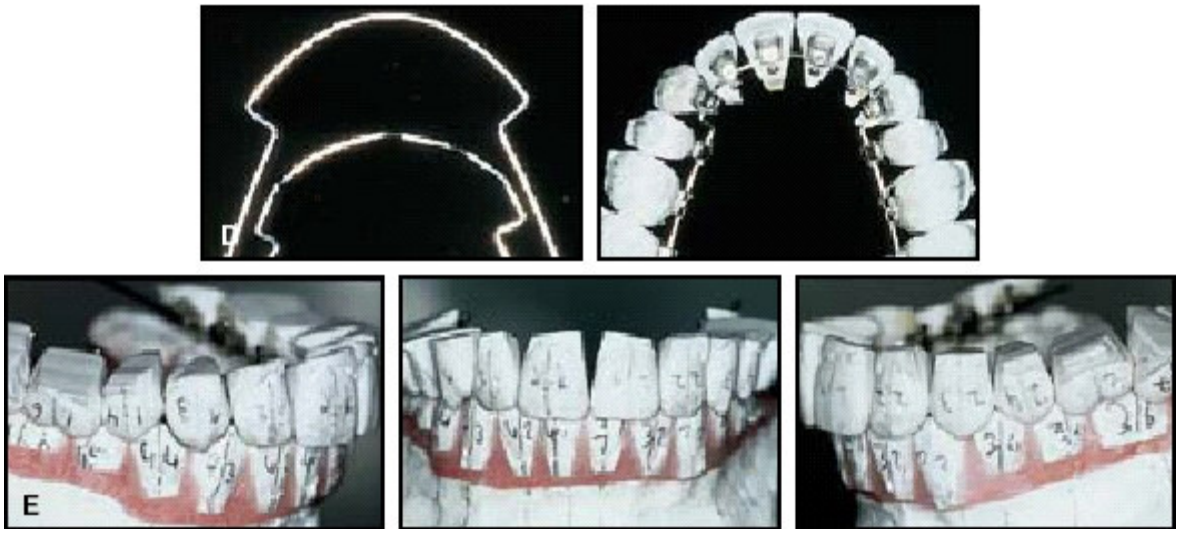

Fig. 13DE Type II finishing with Orthomate: Laboratory procedure. D. Initial mushroom archwire compared to ideal PTA. E. Simulation of final intercuspation.

Fig. 14AB Case 5: Type II finishing. A. Improperly aligned canines on superelastic nickel titanium lingual archwire. B. Simulation by RTS.

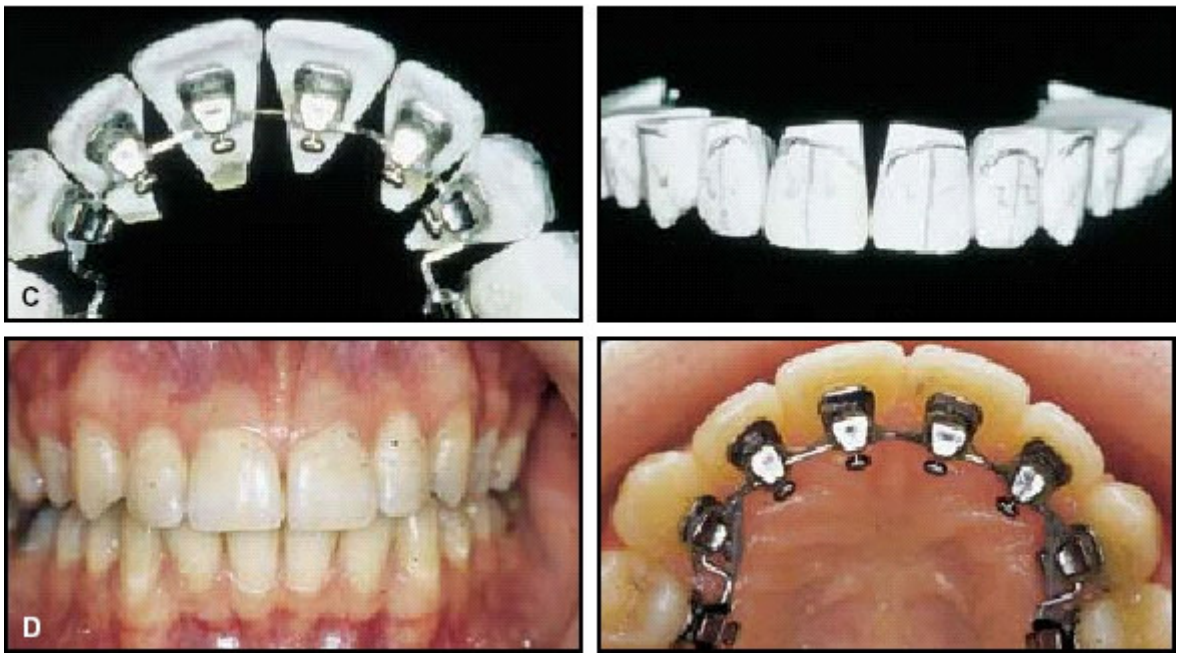

Fig. 14CD Case 5: Type II finishing. C. Corrections placed in PTA. D. After treatment.

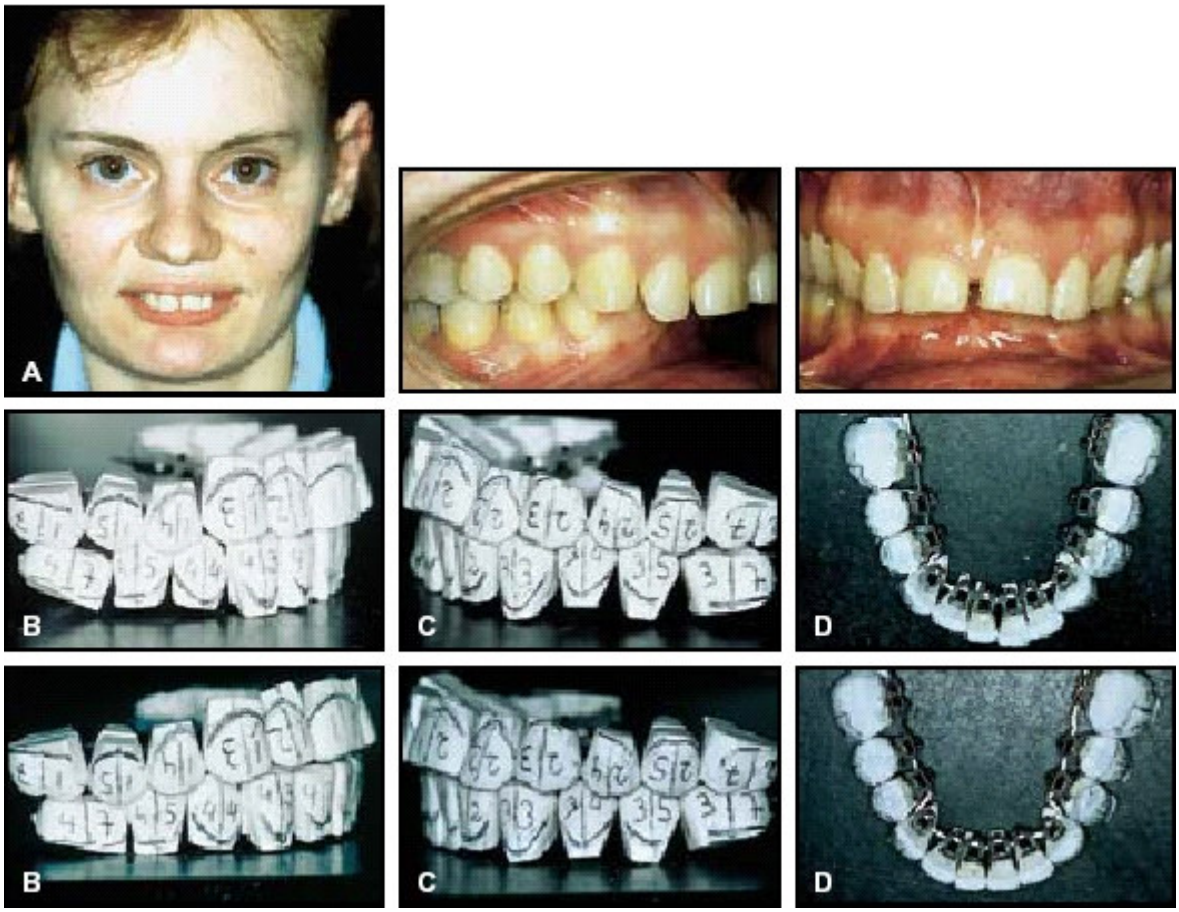

Fig. 15AD Case 6: Type II finishing. A. Before treatment. B. RTS correction of angulation of mandibular right molar. C. Correction of torque of mandibular left molar. D. Correction of rotation of mandibular left canine.

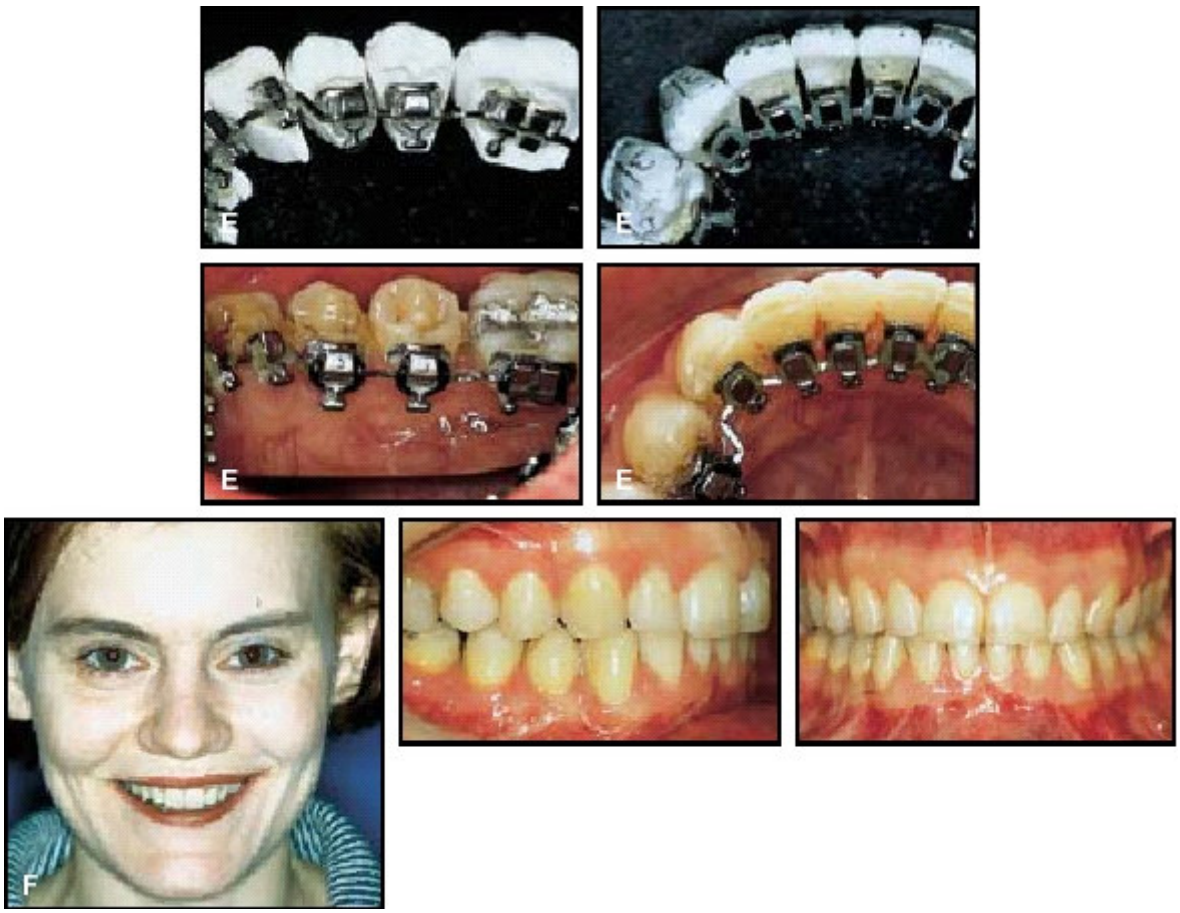

Fig. 15EF Case 6: Type II finishing. E. RTS simulation compared to clinical photographs with PTA in place. F. After treatment.

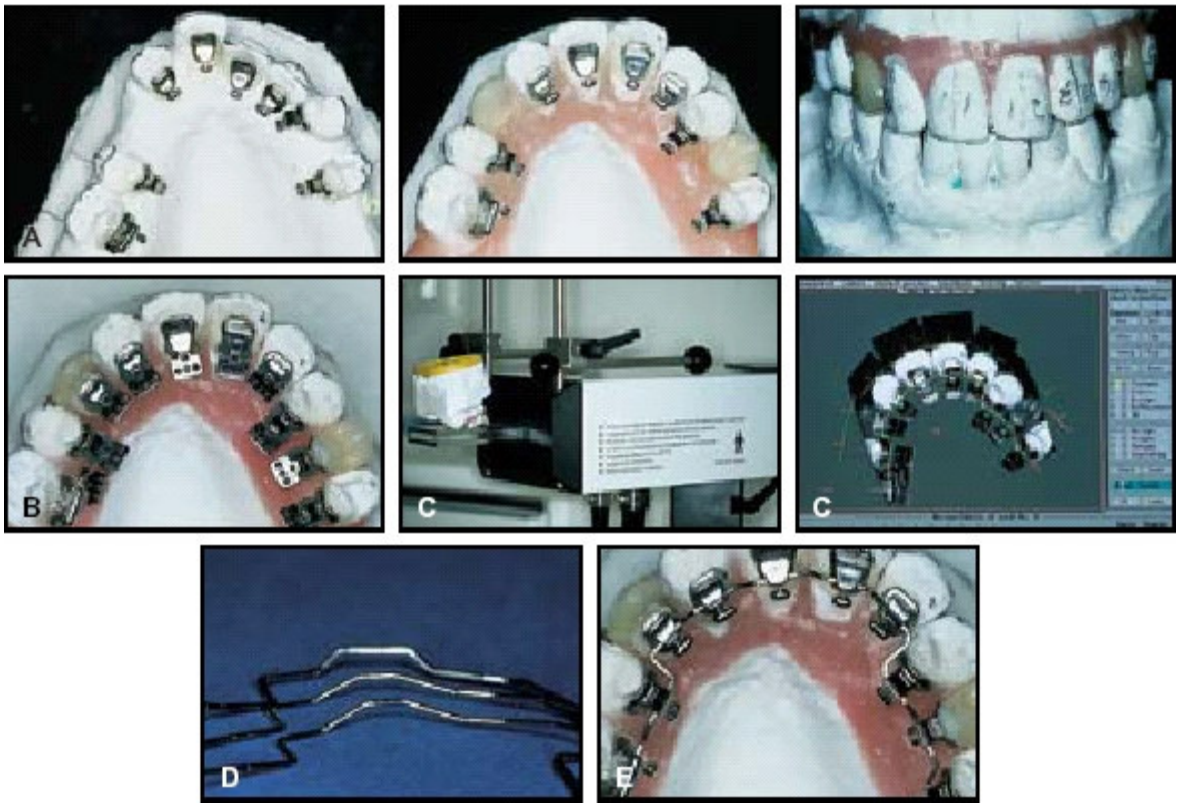

Fig. 16 Type III finishing with Orthomate: Laboratory procedure. A. Brackets transferred to duplicate of original model to produce target setup. B. Identification markers on brackets. C. Three-dimensional scanning with Orthomate camera. D. Passive PTAs. E. PTA passively inserted in target setup.

Fig. 17A Case 7: Type III finishing. A. Before treatment.

Fig. 17B Case 7: Type III finishing. B. Comparison of target setup with clinical photographs.

Fig. 17C Case 7: Type III finishing. C. After prosthetic rehabilitation.

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FOOTNOTES

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