TOMAC: An Orthognathic Treatment Planning System

Part 2 VTO Construction in the Horizontal Dimension

TONY G. McCOLLUM, BDS, MDent

TOMAC is a unique surgical-orthodontic treatment planning system (see Part 1, JCO, June 2001). The TOMAC VTO is constructed in three stages: test, presurgical-orthodontic, and surgical. The essential underlying principle is that the soft-tissue profile is changed first, setting a goal toward which hard-tissue changes are adapted.

Test VTO

This is where the various orthodontic and surgical options are tested and the optimum combination is visualized. In the anteroposterior plane, the facial contour angle (FCA) is changed to the chosen ideal. The upper and lower jaws, or both, are traced in their new positions according to the soft-tissue reactions to surgical movements, and the teeth are then decompensated accordingly. The incisor movements are measured and reconciled with arch-length discrepancies and with the physiological positions of the teeth in the alveolar bone.

In the vertical plane, the key is the position of the maxillary incisor in relation to the relaxed upper lip. The maxillary incisors are moved vertically on the tracing, if necessary, into their ideal positions relative to the upper lip, and the mandible is autorotated so that the correct vertical relationship of the maxillary and mandibular incisors is obtained. The new FCA is measured and compared with the chosen ideal FCA. Appropriate anteroposterior jaw movements are then effected to obtain the ideal total profile. The teeth are decompensated into positions most favorable to the desired surgical changes, keeping in mind arch-length discrepancies and physiological positions in the alveolar bone. The incisor movements required to accomplish the skeletal changes are measured for use in the presurgical VTO.

Presurgical-Orthodontic VTO

This is constructed from the information in the test VTO. Any necessary incisor decompensations, molar adjustments, and soft-tissue changes become the orthodontic objectives prior to the surgical procedure.

Surgical VTO

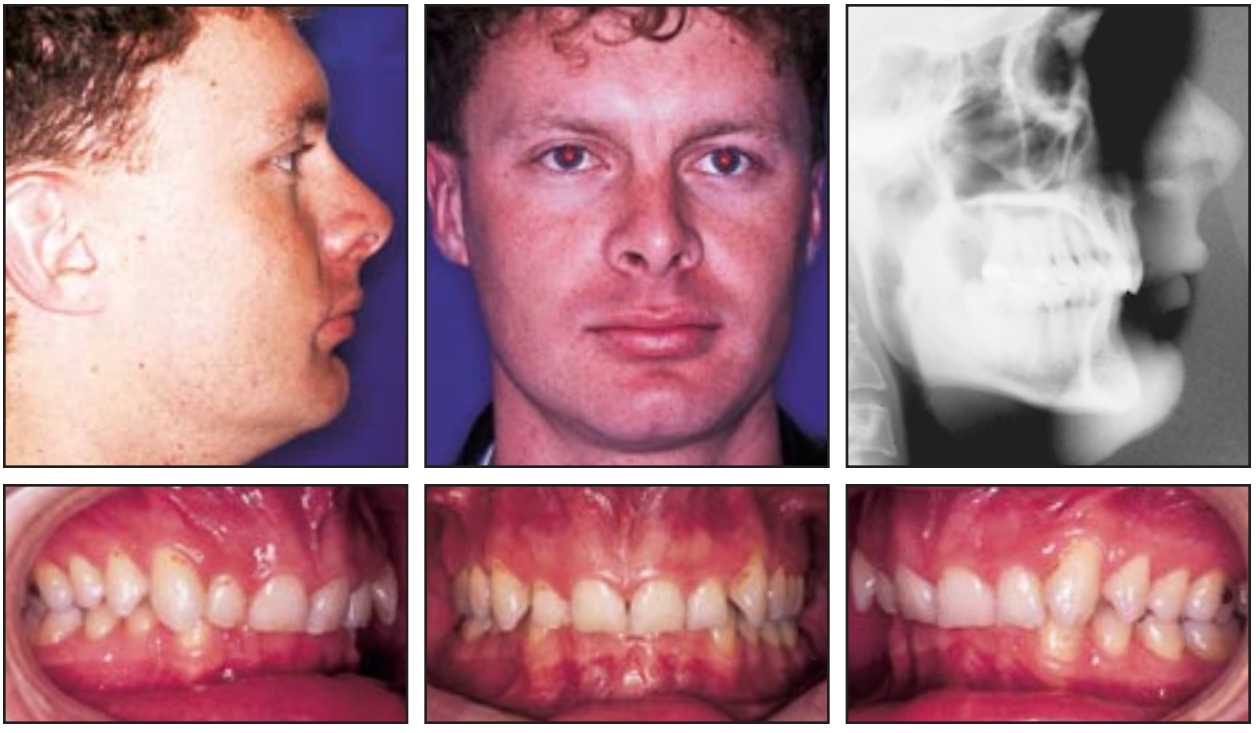
The surgical VTO is constructed over the presurgical VTO, with the surgical cuts diagramed on the tracings of the jaws. The simulated surgical movements are governed by the decompensated positions of the incisors. The soft-tissue profile is then drawn according to the expected soft-tissue/hard-tissue ratios of movement (see Part 1).

The TOMAC system allows the orthodontist to perform precise treatment planning in liaison with the surgeon. Two cases have been selected to illustrate TOMAC principles in the horizontal dimension. Part 3 will cover the vertical dimension.

Case 1: Mandibular Advancement

A 28-year-old male presented with the chief complaint of attrition of the mandibular incisors. He was diagnosed as a skeletal Class II with minimal crowding in the mandibular arch, 3mm of crowding in the maxillary arch, severely retroclined maxillary incisors, moderately retroclined mandibular incisors, a deep overbite, a relative maxillary posterior crossbite, and attrition of the mandibular incisors (Fig. 4). The soft-tissue profile was convex, with a recessive mandible, short chin, deficient lower anterior facial height, deep labiomental fold, obtuse nasolabial angle, and recessive lower lip.

Dr. McCollum is a senior visiting lecturer in the Department of Orthodontics, University of the Witwatersrand, Johannesburg, and in the private practice of orthodontics in Sandton, South Africa. His address is P.O. Box 7104, Bryanston 2021, South Africa; e-mail: mccollut@hixnet.co.za.



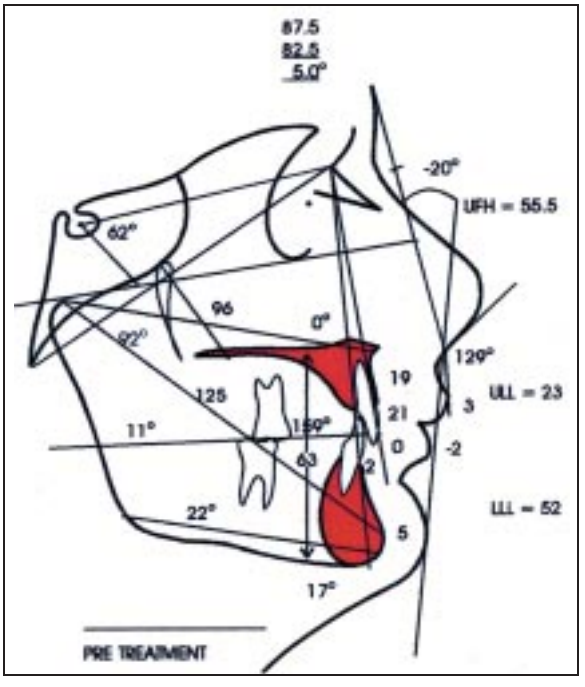


Fig. 4 Case 1. 28-year-old male skeletal Class II patient before treatment.

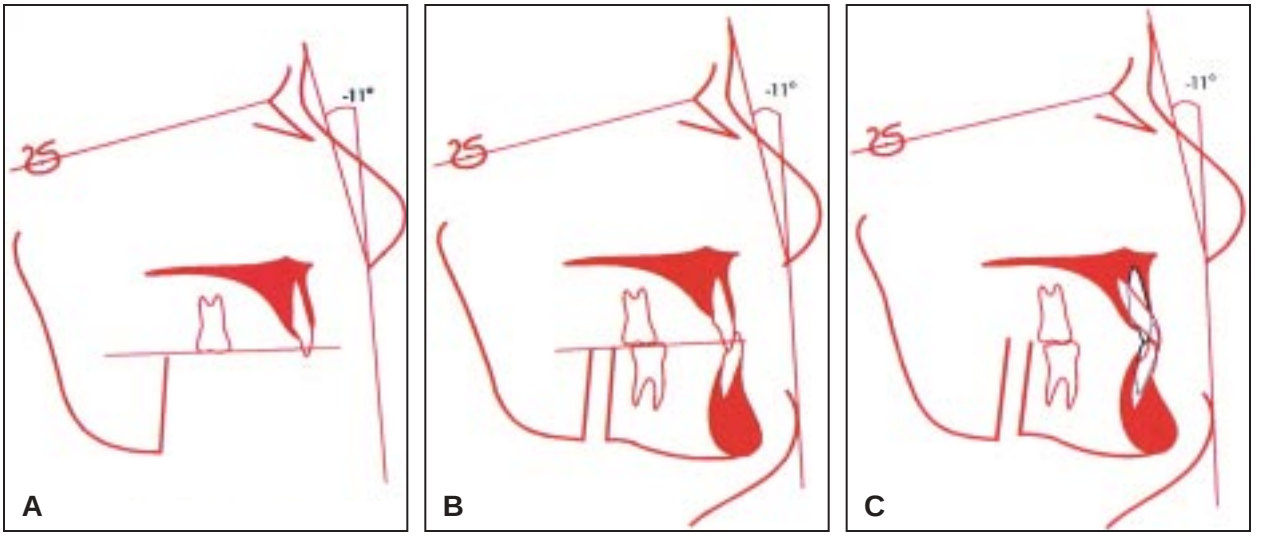


Fig. 5 Case 1. Test VTO. A. Hard and soft tissues that will not change with surgery. B. Mandibular structures after advancement. C. Incisor decompensation needed to achieve best profile.

The following steps are performed to construct the VTO for mandibular advancement. For a mandibular setback, the directions would be reversed.

Test VTO

1. Overlay a new acetate sheet on the original tracing. Trace in the hard tissues that will not change with surgery—anterior cranial base, the maxilla, the maxillary molars and incisors, and the proximal segment of the mandible—and the soft-tissue outline from glabella to subnasale (Fig. 5A). Draw in the upper facial contour plane, and construct the lower facial contour plane at the ideal angulation (–8° to –11°). Add the occlusal plane.
2. Superimpose the tracing on the occlusal plane, and slide the tracing to the left to simulate mandibular advancement (or to the right for a mandibular setback) so that the soft-tissue chin is tangent to the new, ideal lower facial contour plane. The basic landmarks of the profile—upper face (glabella), midface (subnasale), and lower face (pogonion)—will now approximate normal positions. Draw in the symphysis, the distal segment of the mandible, and the mandibular molars and incisors (Fig. 5B). (Remember: this is before any orthodontic movement.)

The maximum surgical movement that can be achieved is 6-8mm with a mandibular advancement, and 6mm with a mandibular reduction. There are exceptions, but these extreme cases should be discussed with the surgeon.
3. Reconcile the incisor movements or decompensation required to create the ideal profile with arch length and the bony anatomy (Fig. 5C). Make any extraction decisions as necessary, and evaluate the anchorage requirements. If a normal interincisal relationship with the teeth in good physiological position in the alveolar bone cannot be achieved, compromise profiles will have to be sought. Thus, the optimum combination of orthodontic and surgical movements required for the best possible profile is determined. The information derived from the test VTO is applied in the orthodontic and surgical VTOs that follow.

Presurgical-Orthodontic VTO (Fig. 6)

Construct a new VTO to reflect the orthodontic movements that will be needed to allow surgery to create the ideal (or nearest to ideal) profile. Bite opening or closing is measured by the change in angulation of the line from condylion to gnathion. It is important to draw in the soft-tissue changes that will occur as a result of any orthodontic decompensation.

Surgical VTO (Fig. 7)

1. Place a new acetate sheet over the presurgi-

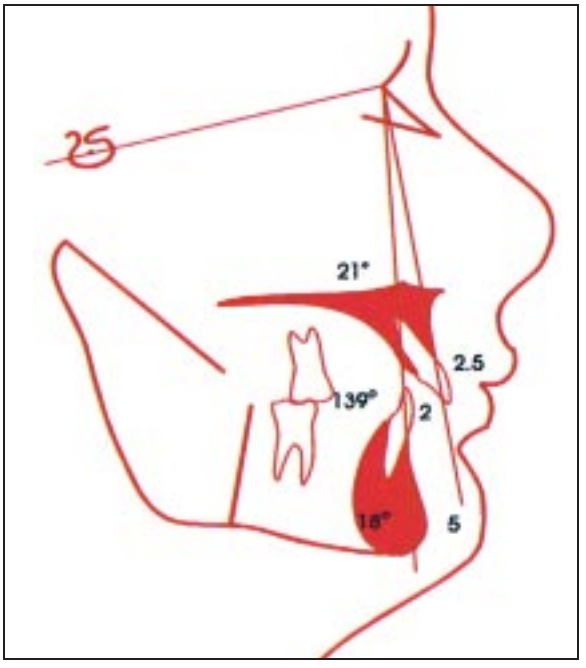


Fig. 6 Case 1. Presurgical-orthodontic VTO.

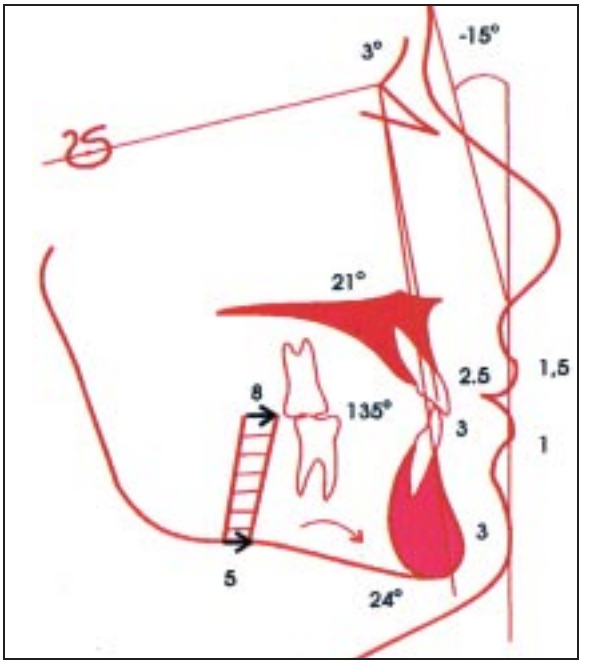


Fig. 7 Case 1. Surgical VTO.

cal-orthodontic VTO. Trace in the hard tissues that will not change with surgery and the soft tissues from glabella to subnasale, including the nose. The proximal and distal segments of the mandible should be separated by an osteotomy cut, represented by a nearly vertical line in the second molar region. Trace in the proximal segment.

2. Advance (or set back) the mandible along the occlusal plane by moving the tracing paper to the left (or right) so that the incisors form a normal Class I relationship. In most cases, the molars should then be Class I as well. In patients where a deep overbite correction is required in surgery, rotate the tracing paper clockwise (an opening rotation of the distal segment) to achieve a Class I incisor relationship. This is a surgically stable maneuver.

3. Trace in the distal segment of the mandible, the osteotomy cut, the molars, the incisors, and the soft-tissue chin outline. In anteroposterior mandibular surgical repositioning, the soft-tissue chin generally follows the bony chin in a 1:1 ratio, although a mild flattening of the soft tissue is seen in some cases. Measure the distances between the old and new osteotomy cut lines superiorly and inferiorly to establish the amount of mandibular movement.

4. Draw in the lips. Refer back to the soft-tissue changes associated with mandibular advancement and setback (Part 1) for detailed guidelines on lip response to surgery. Practically speaking, the lower lip advances 75% of the distance of a mandibular incisor advancement, and retracts similarly with mandibular setback.

5. It is now vital to test the chin position for profile harmony. Draw in the new FCA, and compare it to the norm. Measure and evaluate the positions of the lips relative to the lower facial contour plane. If necessary, repeat the VTOs using different orthodontic goals until a satisfactory esthetic result is achieved.

Results

The treatment objectives were achieved (Fig. 8). Because a downward and forward movement of the distal segment of the mandible was required to correct the large overjet and deep overbite, the chin was not advanced as much as the target FCA would have indicated. Still, the chin and lips were in favorable balance after treatment.

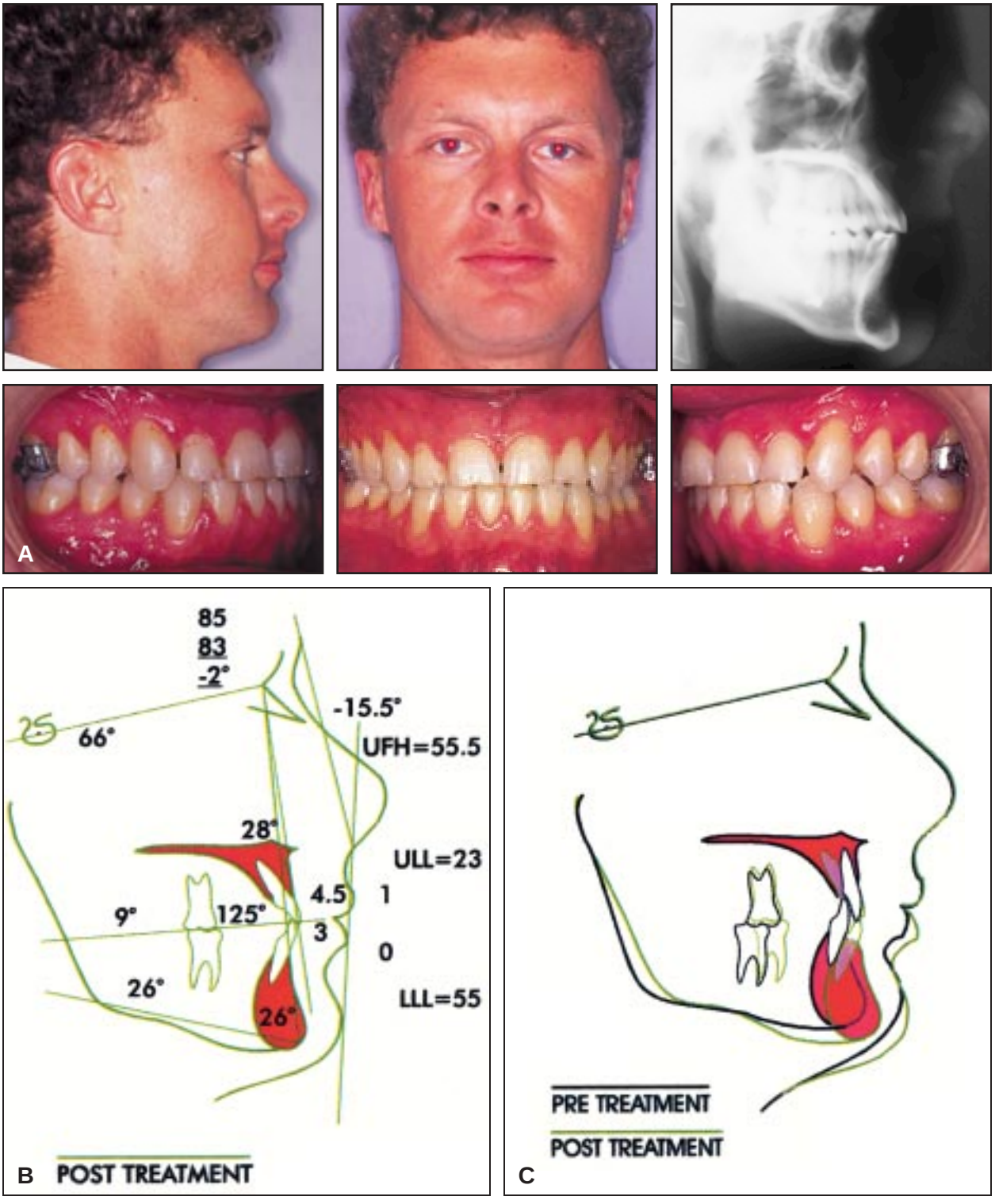
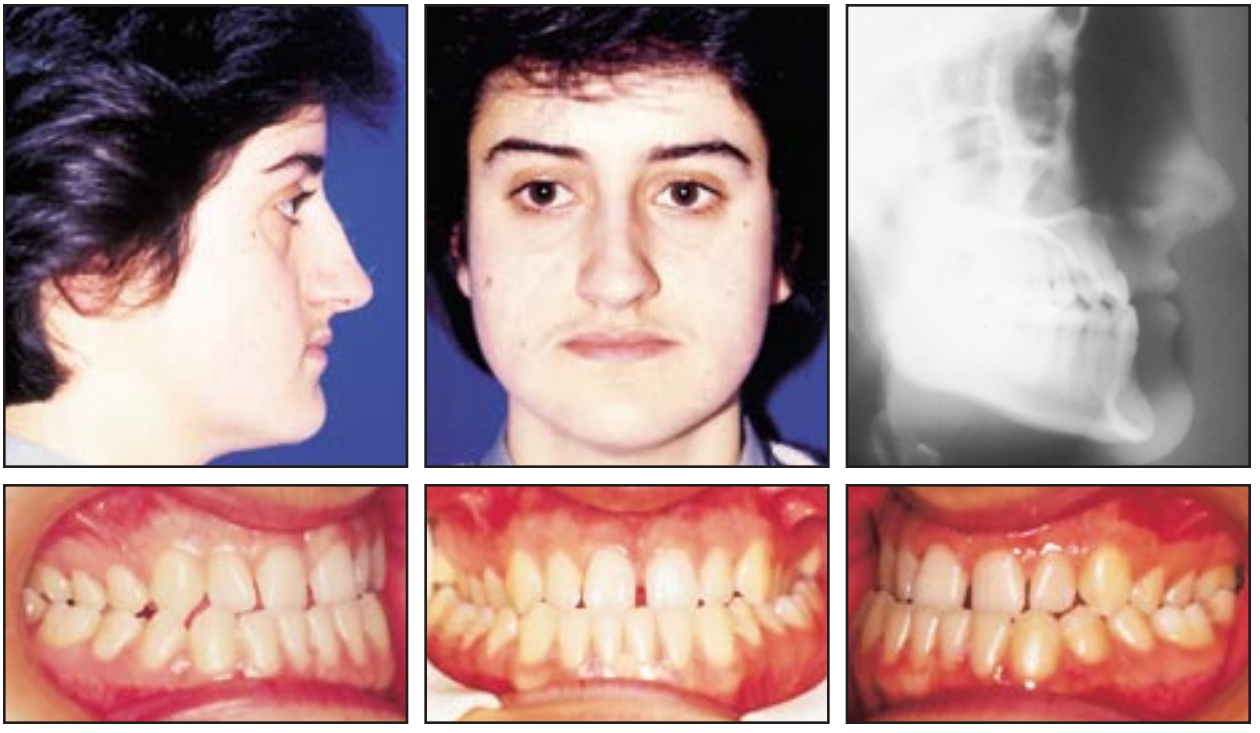


Fig. 8 Case 1. A. Patient after surgery. B. Cephalometric tracing after surgery. C. Superimposition of pre- and post-treatment tracings.



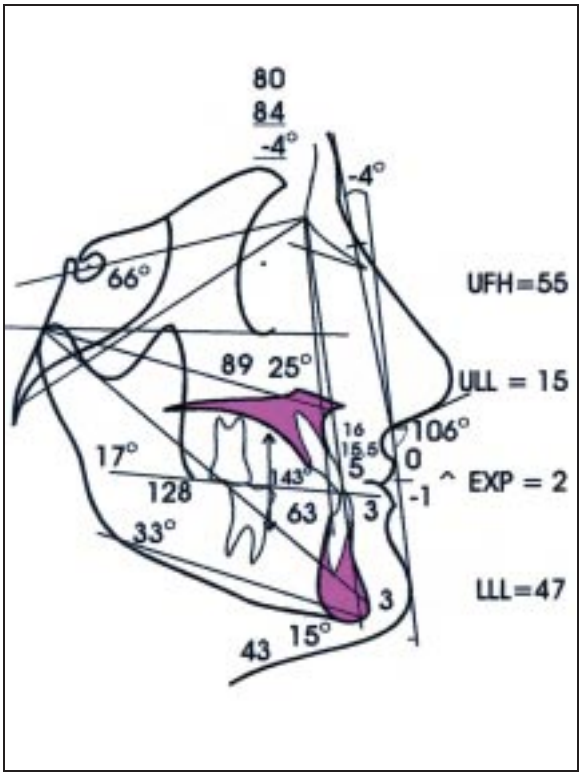


Fig. 9 Case 2. 16-year-old female skeletal Class III patient before treatment.

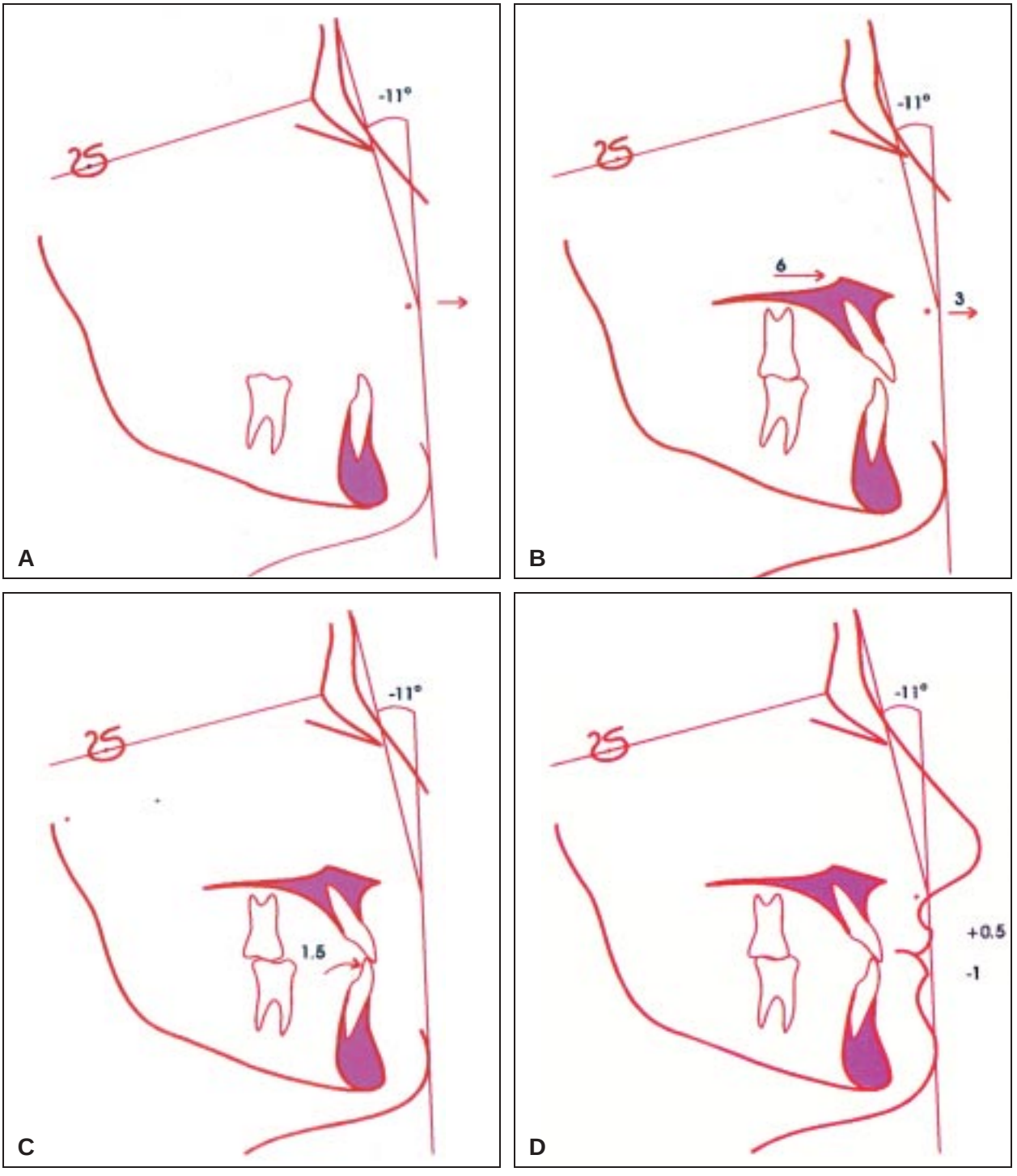


Fig. 10 Case 2. Test VTO. A. Hard and soft tissues that will not change with surgery. B. Maxillary structures after advancement. C. Incisor decompensation. D. Target profile.

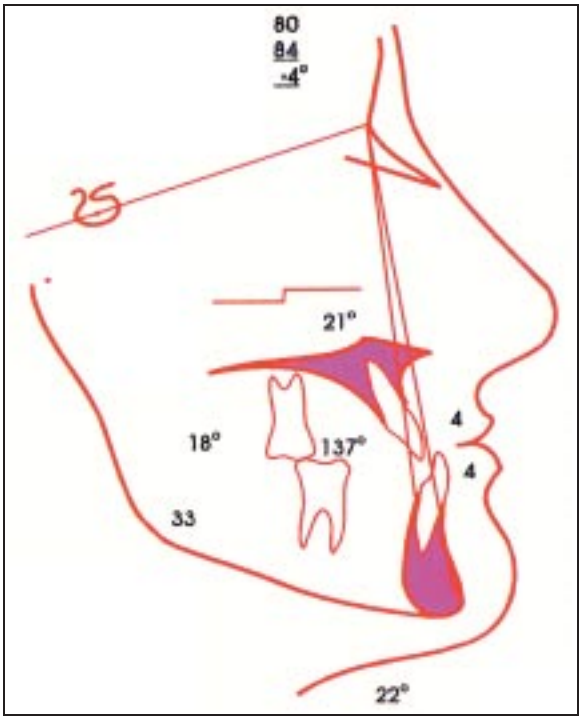


Fig. 11 Case 2. Presurgical-orthodontic VTO.

Case 2: Maxillary Advancement

The patient was a 16-year-old female whose chief complaints were an uncomfortable bite and a facial appearance that was "not normal". Diagnosis was made of a skeletal Class III jaw relationship and deficient lower anterior facial height (Fig. 9). The patient exhibited an anterior crossbite, relative bilateral posterior crossbite, a maxillary midline diastema, a .5mm upward and forward functional slide of the mandible, retroclined mandibular incisors, and 3mm of crowding in the mandibular arch. Her soft-tissue profile was concave, with a recessive lip position, deficient nasolabial angle, short upper lip, paranasal flattening, and deficient lower anterior facial height.

Test VTO

1. Draw in all the structures that will not change with surgery—the cranial base, the mandible and its teeth, the soft-tissue chin, the lower lip, the forehead, and the upper half of the nasal outline (Fig. 10A). Draw the ideal FCA.
2. Glabella and soft-tissue pogonion will remain static while subnasale is advanced. A 1mm advancement of subnasale means a 2mm advancement of the anterior maxilla. Therefore, using the palatal plane as a guide, advance the maxilla, including the teeth, twice the distance that subnasale has been advanced (Fig. 10B).
3. Assess the relationship of the maxillary and mandibular incisors. Is there now an overjet, or are they still in crossbite? Decide whether the maxillary or mandibular incisors, or both, can be tipped (decompensated) to achieve a Class I incisor relationship (Fig. 10C). The incisors must be in good physiological positions in the alveolar bone. Reconcile the required incisor movement with the arch-length discrepancy, and make the appropriate extraction decisions. If the FCA is ideal, but an unfavorable incisor relationship results, a compromise FCA must be determined.
4. Draw in the lips, which will advance at labrale superius by 75% of the movement of the teeth (Fig. 10D). Draw in the lower half of the nasal outline. The tip of the nose will advance about 15% of the maxillary movement. Assess the lip positions relative to the lower facial contour plane, and the total profile relative to FCA. If facial harmony has not been achieved, compromises must be sought.

Presurgical-Orthodontic VTO (Fig. 11)

Construct the orthodontic VTO from the information in the test VTO, taking into account bite opening or closing, arch-length discrepancy, molar adjustment, and the planned incisor positions. The lip profile should be adjusted if movement of the incisors is significant.

Surgical VTO (Fig. 12)

1. Place a new sheet of acetate paper over the presurgical-orthodontic VTO. Trace in all structures that will not change with surgery. Add the

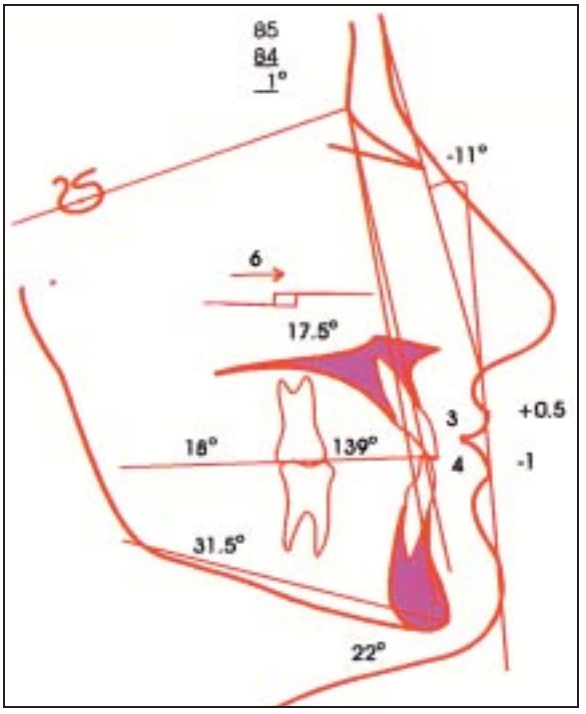


Fig. 12 Case 2. Surgical VTO.

occlusal plane. Draw the Le Fort I osteotomy cuts above the roots of the maxillary teeth.
2. Advance the maxilla into a Class I incisor relationship with the mandible.
3. Draw in the soft tissues using the ratios from the section on soft-tissue reaction to maxillary advancement (Part 1).
4. Assess the soft tissues. Draw in the FCA, and evaluate the harmony of the lips relative to the lower facial contour plane.

Results

After treatment, the bony, dental, and interdental relationships were evaluated, comparing the final tracing with the test VTO. In this case, the soft-tissue, dental, and skeletal objectives were achieved (Fig. 13). The upper lip was advanced into a position in good harmony with the lower lip. Subnasale advanced by 50% of the maxillary movement.

(TO BE CONTINUED)

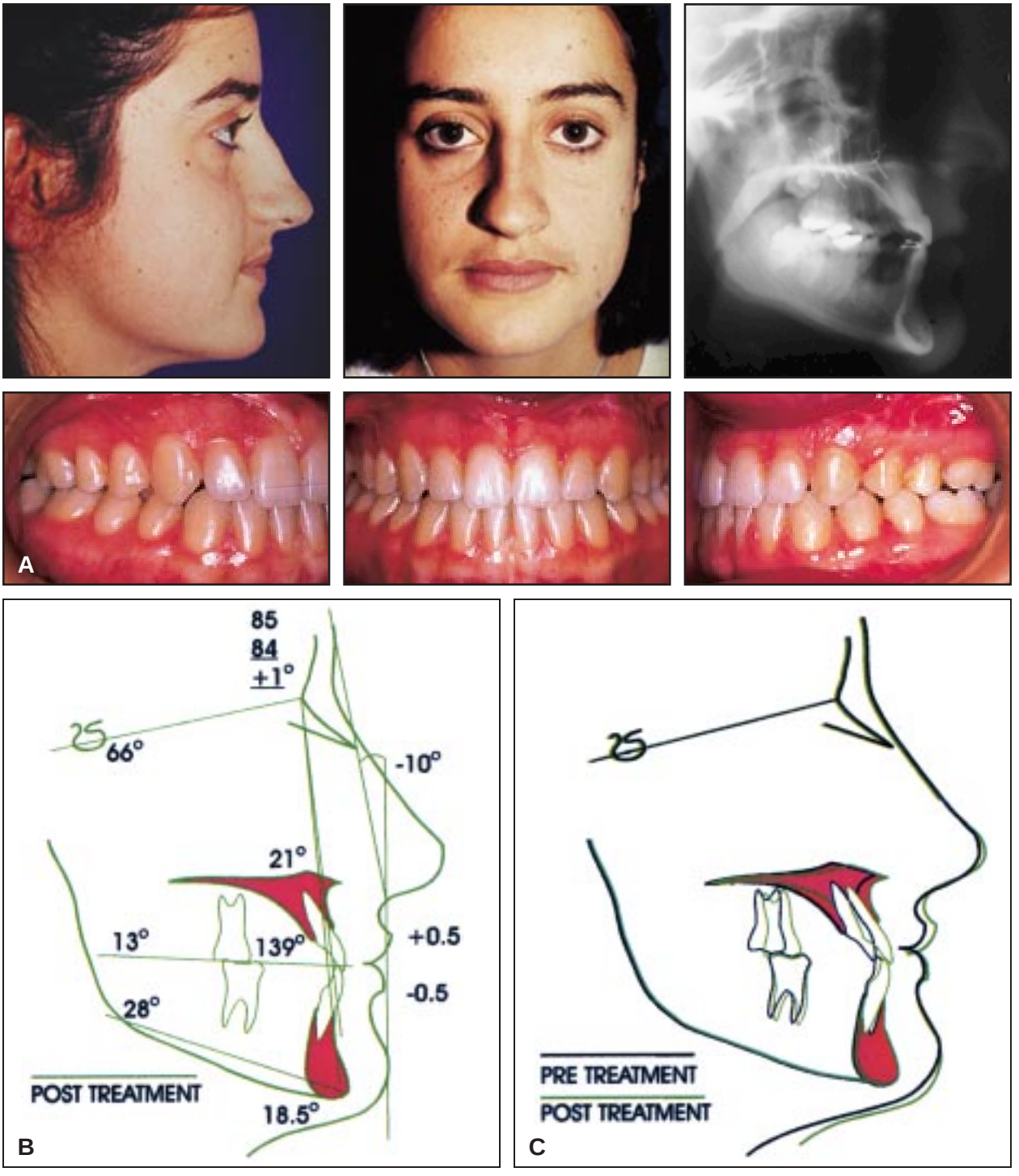


Fig. 13 Case 1. A. Patient after surgery. B. Cephalometric tracing after surgery. C. Superimposition of pre- and post-treatment tracings.