A New Non-Surgical Approach for Treatment of Extreme Dolichocephalic Malocclusions

Part 2 Case Selection and Management

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A variety of dental and skeletal conditions can exist within the dolichocephalic population. Figure 13A illustrates a patient with a severe open bite and an acceptable smile line in which the occlusal plane should be tipped postero-superiorly. Since a great deal of posterior intrusive force will be required to reduce AFH and MPA, there will be a strong tendency toward anterior extrusion (see Fig. 12, Part 1). To prevent this undesirable effect on the smile line, an anterior ligature wire should be attached from the buccal bar. Most of the intrusive force should be placed on the second molar so that

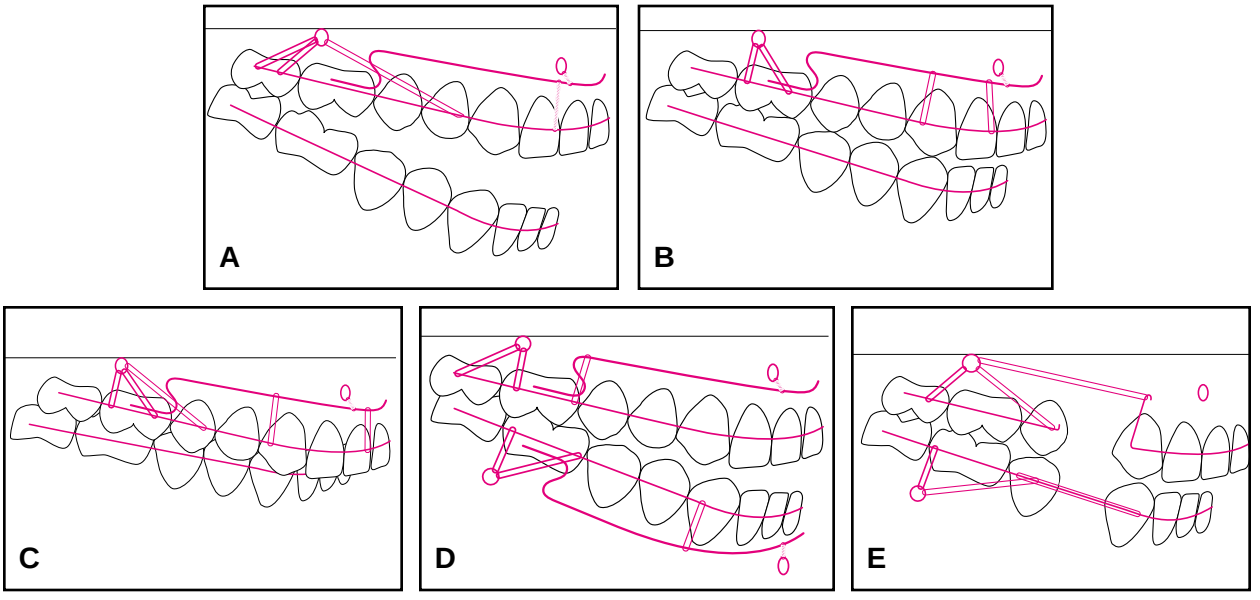

Fig. 13 VAC treatment variations applied to various dolichofacial skeletal patterns (maxillary occlusal plane constructed at 15° to true horizontal[44]). A. Severe open bite, partial Class II molar relationship, acceptable smile line: Anterior ligature wire to maintain vertical incisor position; .030" power cord to intrude second molars; .025" power cord placed more anteriorly to counteract Class III component of posterior power cord. B. Moderate anterior open bite, partial Class II molar relationship, smile line with excessive gingival display: .025" incisal and canine power cords, with incisal power cord changed every two months; .030" power cords to molars. C. Deep bite, pronounced Class II molar relationship, smile line with excessive gingival display: .025" incisal, canine, premolar power cords; .030" power cords to molars. D. Severe open bite, Class I molar relationship, insufficient tooth display in smiling: No incisal attachment to maxillary buccal bar; .030" power cord to molars, with Class II component in maxillary arch and Class III component in mandibular arch; .025" power cord to mandibular canine. E. Same type as in B, but requiring four premolar extractions: .025" Class I power cord to retract anterior teeth; .030" power cords to molars; .025" power cords to premolars, depending on anchorage vs. intrusion considerations.

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the rotation moves distally toward location 3 (see Fig. 10, Part 1). The horizontal component of these posterior vectors will tend to increase the Class II tendency, however, requiring an additional lighter and more anterior power cord. At subsequent appointments, variable retraction forces can be placed, depending on the need for Class II correction.

Figure 13B shows a patient similar to the one in Figure 11 (Part 1) and Case 1. Such a patient presents with excessive gingival display in smiling, a mild-to-moderate anterior open bite, and a partial Class II molar relationship. Because the treatment goal is to translate the maxillary occlusal plane superiorly, power cords are positioned as indicated. The force magnitudes and locations can later be adjusted as the clinician deems necessary to prevent a cant of the occlusal plane (see Figs. 7 and 9, Part 1). If the anterior teeth are allowed to intrude more than the molars, however, there may be no reduction in MPA or AFH (see Fig. 11). In fact, a combination of 6mm of anterior intrusion and 2mm of first molar intrusion, as measured at the mesiobuccal cusp, can actually result in a 2° increase in MPA and a 3mm increase in AFH (Fig. 14).

The patient illustrated in Figure 13C presents with a generalized deep bite, a severe Class II occlusion, and an excessive smile line. The forces and vectors shown would be reasonable at first, but as treatment progresses, changes will have to be made in magnitude, locations, and vectors to account for unknown variables. A word of caution about this type of patient: Moderate overintrusion in the anterior region can result in significant clockwise mandibular rotation. It would be advisable to strive for a slight posterior open bite to assure that the desired counterclockwise rotation occurs. I always feel comfortable with a slight posterior open bite in the second molar region during the active phase of VAC treatment.

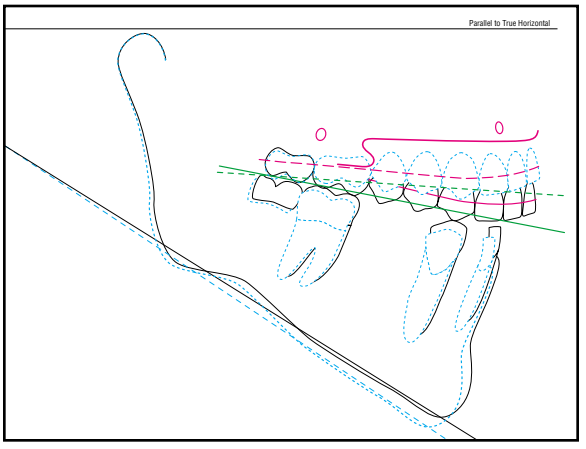
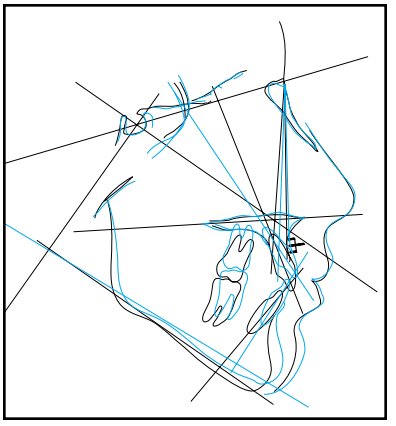


Fig. 14 Same theoretical patient as in Figure 13B after 6mm of anterior intrusion and 2mm of first molar intrusion, measured at mesiobuccal cusp. Note 3mm increase in AFH and 2° increase in MPA despite both molar and incisor intrusion.

A dolichocephalic patient with maxillary anterior vertical deficiency, insufficient smile line, and the commonly accompanying Class III tendency is represented in Figure 13D. Because the maxillary anterior teeth need to be extruded, no force or ligation to the buccal bar should be placed in that region. Class III horizontal components to the maxillary posterior vertical vectors should be added, probably throughout treatment. Because these patients frequently have mandibular vertical excess, a mandibular VAC is almost always prescribed. In my experience, this has been the most difficult type of VAC treatment to administer. Not only does the autorotation produced by the VAC tend to result in a more Class III occlusion, but growth also contributes to a Class III pattern that may originally have appeared as a rather simple Class I. High-angle Class III patients often present as in Figure 13D at 13-14 years of age, then turn into difficult Class III cases because of the VAC treatment and growth.

Premolar extractions may be more commonly prescribed in dolichocephalic than in brachycephalic patients. In Figure 13E, maxillary and mandibular VACs without the buccal bars are placed in an extraction patient similar to the one depicted in Figure 13B. Effective anterior retraction can be performed with either a power arm or a continuous

Fig. 15 Case 1. Beginning of VAC treatment.



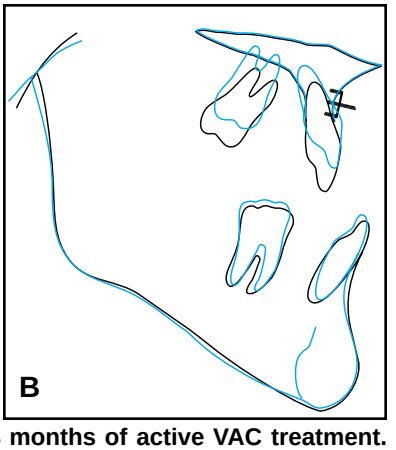


Fig. 16 Case 1. A. Patient after 14 months of active VAC treatment. B. Superimposition of cephalometric tracings before and after 14 months of active VAC treatment.

archwire (see Fig. 8, Part 1), or a closing-loop archwire can be used. The buccal bar is often not placed until the extraction sites are nearly closed (Case 5). In fact, the mandibular anterior anchor and accompanying buccal bar are sometimes not needed, depending on the required degree of autorotation and smile-line correction (Fig. 8).

Selected patients are presented to demonstrate the results of a variety of VAC treatments. All cephalograms were evaluated according to a method described previously,[33] except that an original palatal plane was constructed and transferred to all subsequent tracings to determine the extent of maxillary intrusion.

Case 1

This patient was initially offered two treatment plans: four premolar extractions with Le Fort surgery, or a single skeletal anchor at A point. She chose the latter option. After five months of leveling and alignment with some extraction space closure, the anchor was activated with an auxiliary .016" × .022" overlay wire for intrusion of the maxillary anterior teeth.[45] Three months later, the anchor

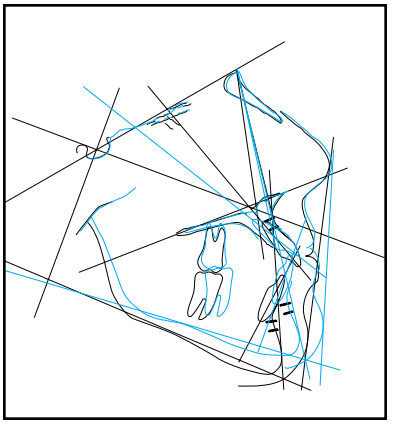
TABLE 1
SUMMARY OF CASE 1

Maxillary VAC	Yes
Mandibular VAC	No
Four first premolars extracted and all spaces closed before VAC placement	
Duration of VAC phase	14 months
Age at completion of VAC	17 years, 6 months

	Start of VAC	End of VAC
SNA	75.0°	75.0°
SNB	70.0°	72.5°
SN-GoGn	52.0°	48.0°
AFH	67.0mm	60.0mm
PFH	67.0mm	67.0mm
U6-PP	26.0mm	21.0mm
L6-GoGn	36.0mm	37.0mm
U1-PP	31.5mm	25.5mm
U1-SN	95.0°	107.0°
L1-GoGn	95.0°	91.0°
L1-APo	+1.0mm	0.0mm

*Eureka Orthodontics, 1312 Garden St., San Luis Obispo, CA 93401.

Fig. 17 Case 2. Beginning of VAC treatment.



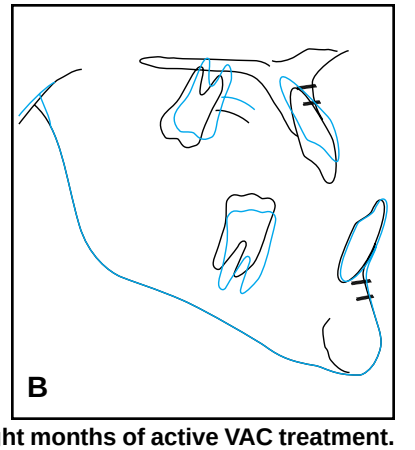


Fig. 18 Case 2. A. Patient after eight months of active VAC treatment. B. Superimposition of cephalometric tracings before and after eight months of active VAC treatment.

failed, and the surgical option was again presented and refused.

After 22 months of conventional treatment with the upper intrusion overlay wire and with Eureka Springs* and headgear as the only sagittal devices, the patient was well into the finishing phase. By this time, the VAC system had become routine in my practice, and it was offered to the patient as an option that would require an additional 14-18 months of treatment.

Because a considerable amount of maxillary intrusion would be required to yield a pleasant smile line and the patient had sufficient alveolar height, as evidenced by the distance from the molar roots to the palatal plane (Table 1), only a maxillary VAC was needed (Fig. 15). Fourteen months later, the VAC phase was completed (Fig. 16).

Case 2

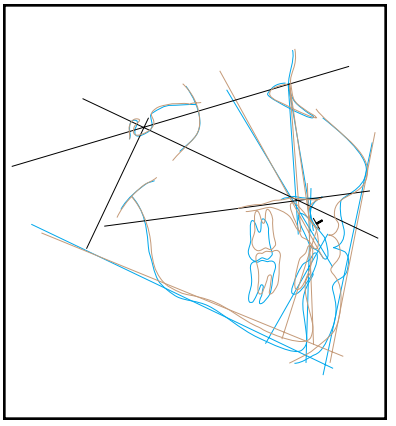
At the initial consultation, this patient was presented with options including conventional nonextraction treatment with headgear, single-jaw Le Fort surgery, double-jaw mandibular advancement with genioplasty, and bimaxillary VAC

TABLE 2
SUMMARY OF CASE 2

Maxillary VAC	Yes
Mandibular VAC	Yes
Nonextraction	
Duration of VAC phase	8 months
Age at completion of VAC	14 years, 3 months

	Start of VAC	End of VAC
SNA	74.0°	73.5°
SNB	68.5°	72.0°
SN-GoGn	53.0°	46.5°
AFH	65.0mm	55.5mm
PFH	61.0mm	62.5mm
U6-PP	22.5mm	20.0mm
L6-GoGn	31.5mm	29.0mm
U1-PP	33.5mm	28.0mm
U1-SN	100.0°	111.5°
L1-GoGn	95.0°	93.5°
L1-APo	+3.0mm	+4.5mm

Fig. 19 Case 3. Beginning of VAC treatment.



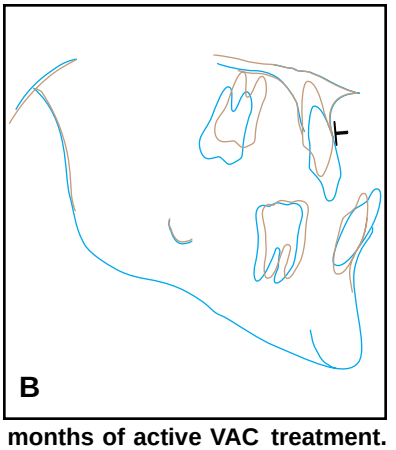


Fig. 20 Case 3. A. Patient after 12 months of active VAC treatment. B. Superimposition of cephalometric tracings before and after 12 months of active VAC treatment.

treatment, all involving rapid palatal expansion. The VAC approach was chosen. Six anchors were inserted after the initial palatal expansion, and intrusion began two weeks later (Fig. 17).

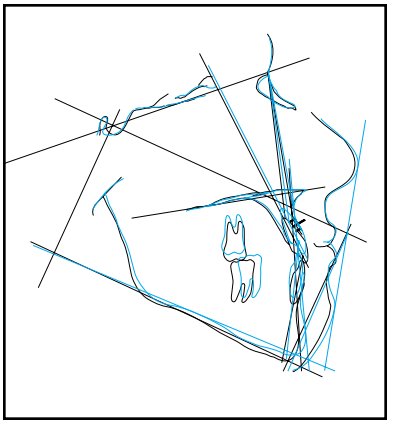
The rapid palatal expansion increased SN-GoGn from 51.5° to 53°, so that this patient's SN-GoGn and AFH measurements were similar to those in Case 1 (Table 2). Less of her vertical excess was in the maxillary arch, however, as shown by the reduced distance from the roots to the palatal plane and diminished gingival display in smiling. For these reasons, VAC treatment was prescribed in both arches. The active phase of VAC treatment took less than nine months (Fig. 18).

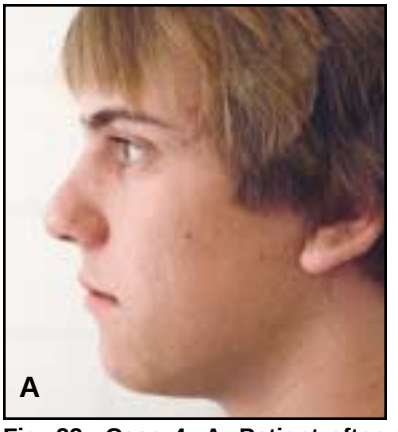
Important observations regarding this patient include the ease with which mandibular molar intrusion can be obtained, the rapid and dramatic results possible with bimaxillary VAC treatment, and the significance of the root locations in relation to the underlying basal bone. The mandibular anterior anchor was needed for stabilization of the buccal bar so that intrusion of the canines and premolars could occur. No mandibular anterior intrusive force was used. Although 15° of labial root torque was placed in the maxillary .016" × .022" archwire after four months of treatment, the upper incisor to SN angle of 100° indicates that it should have been placed initially. As is frequently observed after VAC treatment, the lip commissure migrated superiorly, and the labialis superioris became more prominent.

Case 3

This patient was selected to demonstrate VAC treatment in a moderate dolichocephalic facial pattern following second premolar extractions, rapid palatal expansion, and partial extraction space closure (Fig. 19). Maxillary molar protraction was used to help release some anchorage, with a force vector as illustrated in Figure 13D. After initial mandibular anterior alignment, additional mesial molar movement was obtained with Class II Eureka Springs.[46] These springs are often coupled with Class I intra-arch forces in single-arch VAC treatment because they can help produce sagittal corrections while delivering intrusive force. The desired relationships of the

Fig. 21 Case 4. Beginning of VAC treatment.





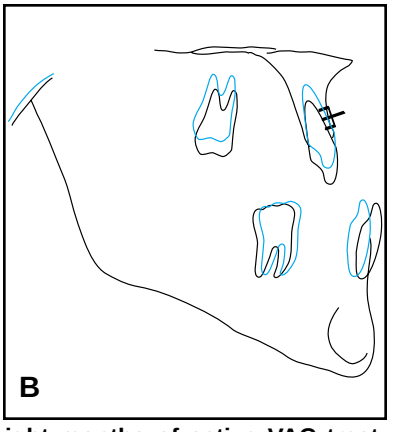


Fig. 22 Case 4. A. Patient after eight months of active VAC treatment. B. Superimposition of cephalometric tracings before and after eight months of active VAC treatment.

TABLE 3
SUMMARY OF CASE 3

Maxillary VAC	Yes
Mandibular VAC	No
Four second premolars extracted at start of VAC treatment	
Duration of VAC phase	12 months
Age at completion of VAC	15 years, 0 months

	Start of VAC	End of VAC
SNA	82.5°	82.0°
SNB	77.0°	78.5°
SN-GoGn	42.5°	39.0°
AFH	67.0mm	60.5mm
PFH	66.5mm	66.5mm
U6-PP	26.0mm	27.0mm
L6-GoGn	34.5mm	20.5mm
U1-PP	29.5mm	24.0mm
U1-SN	104.0°	102.5°
L1-GoGn	94.5°	86.0°
L1-APo	+4.0mm	+1.0mm

lower incisor to the mandibular plane and APo line can be maintained in extraction cases by varying the force magnitudes of the Class II Eureka Springs and the Class I intra-arch mechanics.

After 12 months of VAC treatment, mesial migration of the molars was evident in both arches (Fig. 20). The angulation of the maxillary incisor was controlled better than in Case 2 because 15° of labial root torque was applied initially, and because extraction of premolars generally results in more upright incisors (Table 3).

Case 4

A male patient was initially offered the options of Le Fort surgery or conventional nonextraction treatment with high-pull headgear. After four and a half years of extended treatment with poor headgear compliance, many missed appointments, and several consultations, progress records were taken. VAC therapy, in conjunction with four first premolar extractions, was finally accepted (Fig. 21).

Clear improvement could be seen after only

TABLE 4
SUMMARY OF CASE 4

Maxillary VAC	Yes
Mandibular VAC	No
Four first premolars extracted and all spaces closed before VAC treatment	
Duration of VAC phase	9 months
Age at completion of VAC	18 years, 9 months

	Start of VAC	End of VAC
SNA	81.0°	81.0°
SNB	77.5°	79.0°
SN-GoGn	44.0°	41.5°
AFH	71.5mm	66.0mm
PFH	71.0mm	71.5mm
U6-PP	30.5mm	27.0mm
L6-GoGn	39.0mm	40.0mm
U1-PP	36.5mm	31.5mm
U1-SN	97.5°	98.0°
L1-GoGn	77.0°	74.0°
L1-APo	+3.5mm	0.0mm

TABLE 5
SUMMARY OF CASE 5

Maxillary VAC	Yes
Mandibular VAC	Yes
Four first premolars extracted after VAC phase	
Duration of VAC phase	5 months
Age at completion of VAC	17 years, 10 months

	Start of VAC	End of VAC	2 Yrs. Later
SNA	78.5°	79.0°	78.0°
SNB	74.0°	77.0°	78.0°
SN-GoGn	41.5°	37.0°	37.5°
AFH	76.5mm	69.0mm	70.5mm
PFH	75.5mm	76.0mm	76.5mm
U6-PP	28.0mm	25.0mm	25.0mm
L6-GoGn	33.0mm	30.5mm	33.0mm
U1-PP	35.0mm	30.0mm	30.0mm
U1-SN	97.5°	106.0°	96.5°
L1-GoGn	92.5°	86.0°	80.0°
L1-APo	+3.5mm	+2.5mm	–1.0mm

eight months of treatment (Fig. 22), but the reduction in AFH and MPA was less than expected (Table 4). The third molars had erupted into occlusion during this time, preventing further autorotation even as the rest of the maxillary posterior dentition continued to intrude. In this case, the third molars should have been removed prior to the miniplate placement. Likewise, in nonextraction cases where distal molar movement is required, the third molars should be removed before VAC treatment to avoid extending treatment longer than the patient and parents may be willing to accept.

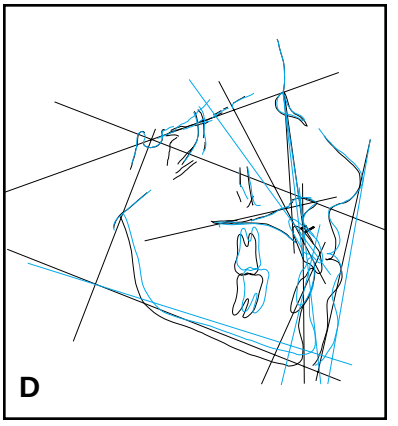
Case 5

This patient demonstrates the results of a short bimaxillary VAC phase, utilizing sagittal and intrusive anchorage from the miniplates in both arches, followed by the extraction of four first premolars (Fig. 23). Pronounced retraction of the anterior segments was accomplished with the miniplate anchorage (Fig. 24). Two years after active VAC treatment, at the completion of orthodontic treatment, however, some of the mandibular molar intrusion had relapsed, with a slight increase in AFH and MPA, although the maxillary molar and incisor intrusion and the rest of the dentition had remained stable (Table 5).

This patient's treatment would have been much simpler if the extractions had been performed before the VACs were placed. The final profile photograph suggests that excessive anterior retraction occurred, probably due to sagittal forces from the miniplates. The absence of the buccal bar may have contributed to the increase in AFH and MPA during the finishing phase.

Precautions and Concerns

Excellent hygiene, including the use of a Water Pik irrigator,** is even more crucial in VAC treatment than in conventional orthodontics because of the implants and the trans-arch stabilizing



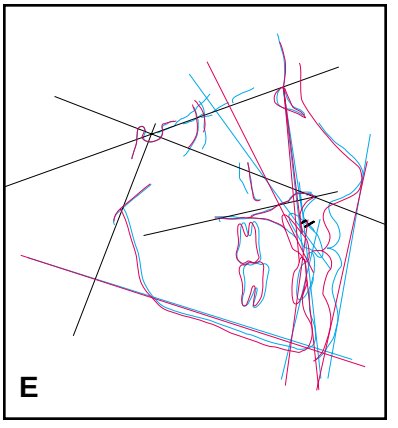


Fig. 23 Case 5. Beginning of VAC treatment.

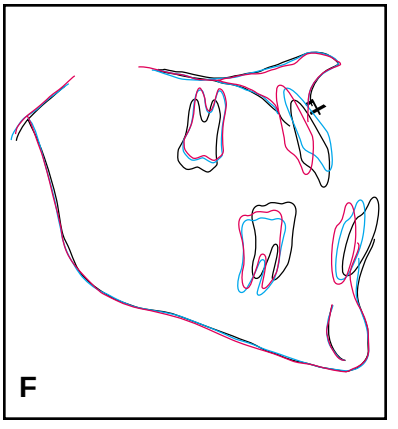


Fig. 24 Case 5. A. Patient after 26 months of orthodontic treatment, including five months of active VAC treatment. B. Occlusion day of debonding. C. Occlusion two months later. D. Superimposition of cephalometric tracings before and after five months of active VAC treatment. E. Superimposition of cephalometric tracings after active VAC treatment and after two more years of conventional orthodontic treatment. F. Superimposition of cephalometric tracings before treatment (black), after five months of active VAC treatment (blue), and after two more years of conventional orthodontic treatment (red).

appliance. Cope has emphasized the importance of maintaining gingival health and controlling inflammation in achieving success with skeletal anchorage.[47] Furthermore, if banding results in more loss of gingival attachment than bonding in routine orthodontic treatment,[48] it seems reasonable to assume that VAC treatment would cause somewhat more loss of attachment than banding. Of the more than 50 VAC patients I have treated since 2000, acute 5mm pockets developed in two patients because of lingual food impaction in the triangular embrasures between the first and second molars. In one of these patients, office irrigation, home saline rinses, and improved oral hygiene were adequate. In the other, the appliance was immediately removed, the area was irrigated and curetted, and

**Waterpik Technologies, Newport Beach, CA.

antibiotics and saline-Listerine*** rinses were prescribed; after eight days, the tissues had responded, and the appliance was recemented. Four other patients experienced acute buccal gingival swelling as a result of food impaction in the embrasures between the first and second molars. Three of these areas were curetted and irrigated, and they subsequently improved without appliance removal.

Cleanliness around the emerging posterior miniplates is a perennial problem, although no miniplates have been lost due to this localized inflammation and occasional formation of granulation tissue. The gingival tissue is usually quite tolerant of the miniplates, provided they emerge reasonably close to the mucogingival junction. An early patient developed a chronic low-grade infection around two of the six miniplates placed; even after surgical curettage, systemic and local antibiotic treatment, and improved hygiene, the granulation tissue persisted (Fig. 25). Still, these implants remained usable throughout VAC treatment.

Uneven intrusion occurs frequently in the posterior regions (see Fig. 7). In four patients, temporary TMJ symptoms developed because of the lack of bilateral posterior stops. To avoid this problem, the clinician should constantly check the posterior occlusion in centric relation, making certain that some posterior contact exists bilaterally. When an open bite develops, the power cord activation should be continued on the closed-bite side while the power cord on the open-bite side is either inactivated or replaced with ligature wire (Fig. 26). I have found that contact in the premolar region provides sufficient posterior support to prevent TMJ symptoms.

In two patients, all the miniplates were loose at the initial activation and came out within a month after placement. The failures in both patients were in the mandibular molar regions; visual examination after surgical removal showed mild crater-like depressions in the areas of the bone screws. In my other patients, six maxillary and two mandibular molar miniplates came loose after four to 10 months of use. Every maxillary anterior miniplate placed at A point failed within three months, but placement in all other regions has been successful.

Fig. 25 Developing posterior open bite and chronic granulation tissue around initial implant (which was not placed distal to first molar) and subsequent implant placed 11 months later. No further autorotation can occur unless premolars are intruded.

I have observed more root resorption in my VAC patients than in other patients. Maxillary anterior root resorption of 3-5mm has been seen in three of the approximately 25 patients who have completed active VAC treatment, and in each case there was excessive palatal root torque. Extreme caution should be taken to ensure that the upper incisor to SN angle is less than 110° and that anterior intrusion occurs slowly. The maxillary anterior roots must be examined on each progress cephalogram, and labial root torque should be placed as needed to keep the incisal roots within alveolar bone. Replacing the power cord to the anterior portion of the buccal bar every other month may be advisable to help prevent anterior root resorption.

Not all patients respond equally to VAC treatment. In about 15% of my cases in which any failed miniplates were replaced, there was less than a 4mm decrease in AFH and a 2° reduction in MPA. The greatest reductions at the end of active VAC treatment were 12mm in AFH and 7° in MPA. In one patient, the maxillary molar intrusion was less than 1mm, MPA closure less than 1°, and AFH reduction less than 2mm, even though the maxillary incisors intruded easily. This patient's

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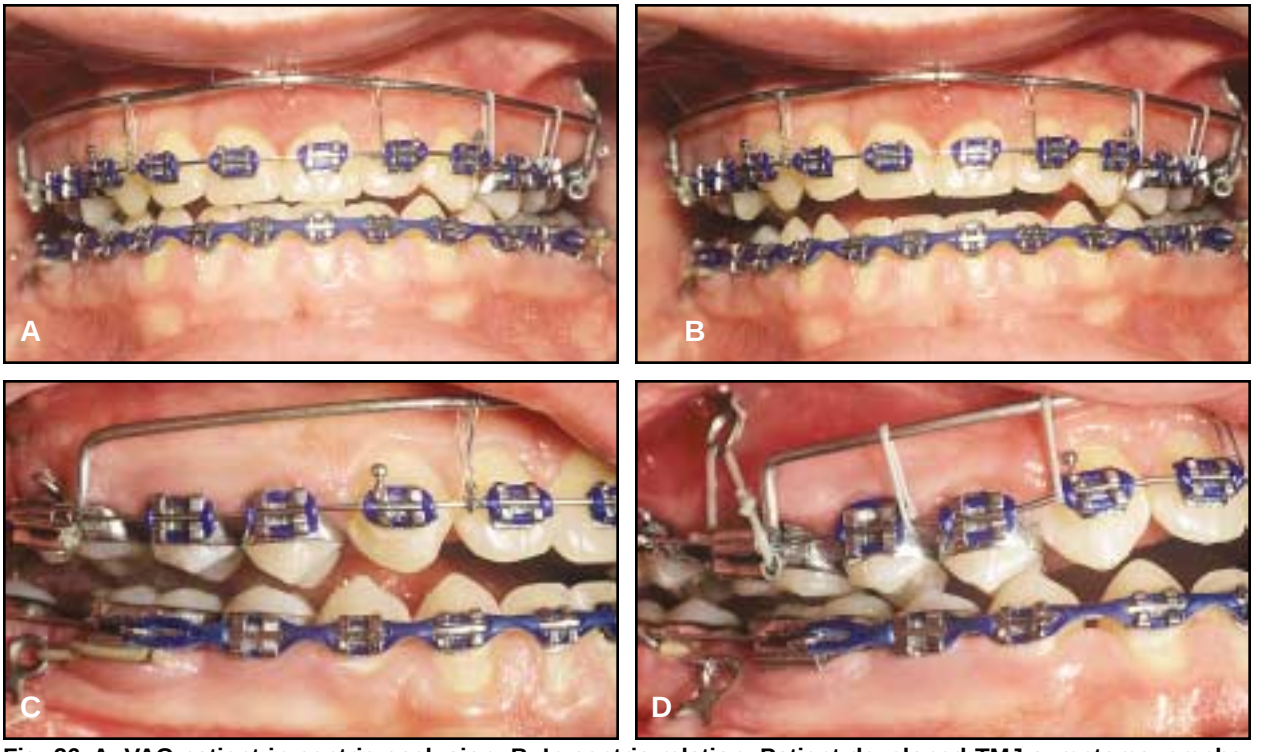

Fig. 26 A. VAC patient in centric occlusion. B. In centric relation. Patient developed TMJ symptoms, emphasizing importance of checking occlusion in centric relation and maintaining bilateral posterior stops. C. Patient in centric relation after replacement of power cords with ligature wires from miniplate to molar and buccal bar to archwire; mandibular vertical power cord has been removed, but horizontal power cord remains to aid in retraction of mandibular dentition. D. New power cords placed between miniplate and molar and between premolars, with old power cord left in place between canine and premolar.

initial cephalogram showed large maxillary sinuses and a diminished distance from the palatal plane to the molar roots, but other such patients have responded favorably to VAC treatment.

The posterior miniplates frequently emerge as much as 4mm away from the desired locations within the buccal corridors (Fig. 25). Because this makes it difficult to develop the desired force vectors, it is the most frustrating aspect of the VAC system. Next most frustrating is that the distal aspects of the second molars cannot be intruded as rapidly as the mesial aspects of the first molars, and may actually extrude due to a shift in the center of rotation of the manipulated occlusal plane (see Fig. 11). In two patients, the molars were intruded as easily as the incisors, but one or both canine-premolar regions did not intrude as readily.

There is a limit to the amount of mandibular molar intrusion that can be achieved in each case. In some adults, the distal aspects of the mandibular second molars are submerged up to the distal marginal ridge (Fig. 27), while in others, the lower border of the mandible restricts molar intrusion (Fig. 28). Likewise, maxillary molar intrusion may be limited by the palatine bone, and intrusion is certainly slowed when the mesiobuccal roots of the first molars are palpable before treatment. Root prominence in the canine regions can also dramatically reduce the rate of intrusion.

Although intrusion of teeth is more stable than extrusion,[49] the long-term stability of major VAC-induced facial alterations has not been studied. It

Fig. 27 Submerged mandibular second molar in 23-year-old patient after 13 months of VAC treatment.

is possible that mandibular molar intrusion may not be as stable as maxillary molar intrusion (Fig. 24E). As the roots of the mandibular molars approach the neurovascular bundle, the stability of intrusion may diminish. Encroachment on the mandibular nerve may prove to be the most important limiting factor. Since maxillary anterior intrusion has generally proved stable,[45] no anterior relapse would be anticipated from VAC treatment unless it was preceded by molar extrusion.

Conclusion

Until now, only two treatment approaches have been available for patients with extreme dolichocephalic facial patterns: Le Fort surgery and conventional orthodontic masking procedures. The VAC offers these patients a third option—a non-surgical maxillofacial treatment that can produce results similar to those obtained by surgery.

Acceptance of VAC treatment has been almost universal among my patients for whom a Le Fort procedure was also offered, while the acceptance rate has been about 66% for patients with less severe conditions. I have referred only one patient for Le Fort surgery since 2000.

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Fig. 28 Cephalograms taken before and after 15 months of VAC treatment, showing proximity of mandibular molar roots to border of mandible.

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