# THE CUTTING EDGE

*(Editor's Note: This quarterly column is compiled by JCO Technology Editor Ronald Redmond. To help keep our readers on The Cutting Edge, Dr. Redmond will spotlight a particular area of orthodontic technology every three months. Your suggestions for future subjects or authors are welcome.)*

I love systems. Every orthodontic practice consists of a series of systems that we put in place to accomplish important tasks. Some systems are better than others; many are essential to the health of our practices; some develop intentionally, while others simply grow out of necessity.

Indirect bonding has been around for years, and proponents have long praised its efficiencies and clinical results. Most orthodontists, however, have felt the indirect system is too cumbersome to implement into their busy practices.

Now, computer technology, which has had dramatic effects on so many of our practice systems, has made it possible to streamline the indirect-bonding process. In this month's Cutting Edge column, Dr. Michael Mayhew describes the pros and cons of computer-aided indirect bonding, and he presents a compelling argument that this new version of an old system should be integrated into every orthodontic practice. No longer should indirect bonding be considered overly time-consuming or complicated.

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## Computer-Aided Bracket Placement for Indirect Bonding

Bracket placement is critical in achieving the full potential of preadjusted appliances.[1] Poor bracket positioning can affect tooth alignment in all planes of space and can lead to increased chairtime for rebonding or archwire adjustments, extended treatment times, and inadequate results.

Studies comparing the accuracy of bracket placement between direct and indirect bonding methods have all found some inaccuracies in one or more alignment variables.[2-6] Hodge and colleagues, however, showed a greater range of angulation, vertical, and mesiodistal errors with direct bracket placement.[6]

Contemporary indirect-bonding techniques are derived from the Thomas method, in which the brackets are initially bonded to stone casts.[7] Pencil markings and various types of gauges have been used for positioning the brackets on the casts,[8-14] but may not be consistently accurate. The purpose of this article is to describe an indirect-bonding procedure using computer-aided bracket placement software.

### OrthoCAD System

The OrthoCAD* system develops digital models from accurate polysiloxane or alginate-substitute impressions of the patient's dentition. These are shipped with a wax bite and the orthodontist's treatment plan, in packaging provided by OrthoCAD, to the processing center. The digital models and virtual treatment plan are then

*Trademark of Cadent, Inc., 640 Gotham Parkway, Carlstadt, NJ 07072. Dr. Mayhew has a financial interest in the company.

electronically transferred back to the office.

OrthoCAD software not only provides diagnostic model measurements, but also has the capability of producing multiple diagnostic set-ups, allowing a quick review of different treatment approaches. Tooth-size discrepancies, occlusal harmony, and tooth alignment can all be readily evaluated.

OrthoCAD's bracket-placement software shows the optimal bracket position and eventual alignment for each tooth. Once the virtual appliances are placed, a virtual treatment can be viewed. Bracket positions can then be changed to assess the results of various tooth alignments. The clinician can also evaluate the effective torque anticipated with different sizes of finishing wires, which aids in planning for variable-torque brackets and anticipated finishing techniques.

Redmond has described how the OrthoCAD system is applied in direct bonding.[15] For indirect bonding, the digital bracket-positioning information is transferred to an actual stone cast of the patient's dentition. The stone is conditioned with a tin-foil substitute, and light-cured composite is placed on the bracket bases prior to positioning on the cast. A camera wand connected to the computer projects an image of each tooth on the monitor while the virtual bracket silhouette is depicted over the tooth. The optimum bracket placement is then indicated with a "target" (Fig. 1). When all the brackets have been placed, the cast is placed in a light-curing unit, or the brackets are cured individually with a light source.

## Indirect Tray Fabrication

Many indirect transfer systems have been described.[8-14] In Hickham's two-tray transfer method, for instance, a 1mm-thick mouthguard material is vacuum-formed over the brackets and stone cast to make the inner tray, and a 1mm-thick hard splint material is formed over the soft tray.[16] The trays are trimmed and removed from the casts, and the bracket bases are cured again. The custom base on each bracket is lightly microetched to clean and prepare it for final bonding. The bracket bases and trays are then thoroughly cleaned and dried, and they are stored in a labeled plastic bag until the bonding appointment.

Indirect-bonding laboratory services are now available from OrthoCAD. The impressions, treatment plan, and brackets are shipped to the company, and a virtual bracket placement is e-mailed to the orthodontist for approval. After e-mail confirmation from the doctor, OrthoCAD completes the laboratory procedures, and the indirect-bonding trays are delivered within six to 10 working days.

## Bonding Procedure

The tray can be seated by quadrant or as a full arch. It is critical to ensure proper isolation with cheek retractors and to prevent saliva contamination by using an evacuator and absorbent pads or cotton rolls. An antisialogue may be prescribed to control saliva flow. Prior to tooth preparation, the custom bracket bases are lightly

**Fig. 1 Computer targeting method used for optimal bracket placement (images courtesy of Cadent).**

coated with Ortho Solo,** and any excess is removed with a light air spray. The bonding medium, Reliance FlowTain,*** is spread evenly over each custom base, and the prepared tray is placed under a light-proof cover to avoid premature curing.

The tooth surfaces are pumiced, rinsed, dried, and etched with 37% phosphoric acid. After the etchant is rinsed off and the teeth are dried, the Ortho Solo is applied to the teeth.

The indirect bonding tray is then seated, and each bracket is light-cured. The tray is removed by peeling off first the hard outer shell, and then the soft inner tray. A scaler can be used to remove any loose bonding material, followed by a fine fluted bur in a high-speed handpiece to remove excess composite from around the brackets. With experience, the amount of flash will be minimal.

Initial alignment wires can be placed immediately. A panoramic radiograph should be taken before proceeding to stainless steel or nickel tita-

**Trademark of Ormco/"A" Company, 1717 W. Collins Ave., Orange, CA 92867.

***Trademark of Reliance Orthodontic Products, P.O. Box 678, Itasca, IL 60143.

**Fig. 2 Case 1. 13-year-old male patient with deep bite, mandibular crowding, and short lower face before treatment.**

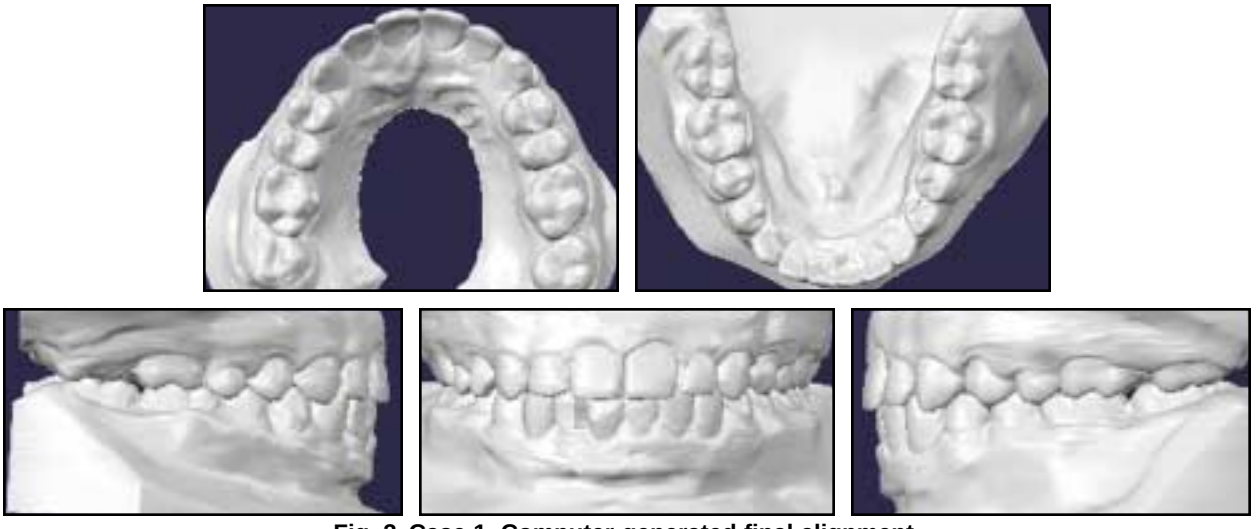

**Fig. 3 Case 1. Computer-generated final alignment.**

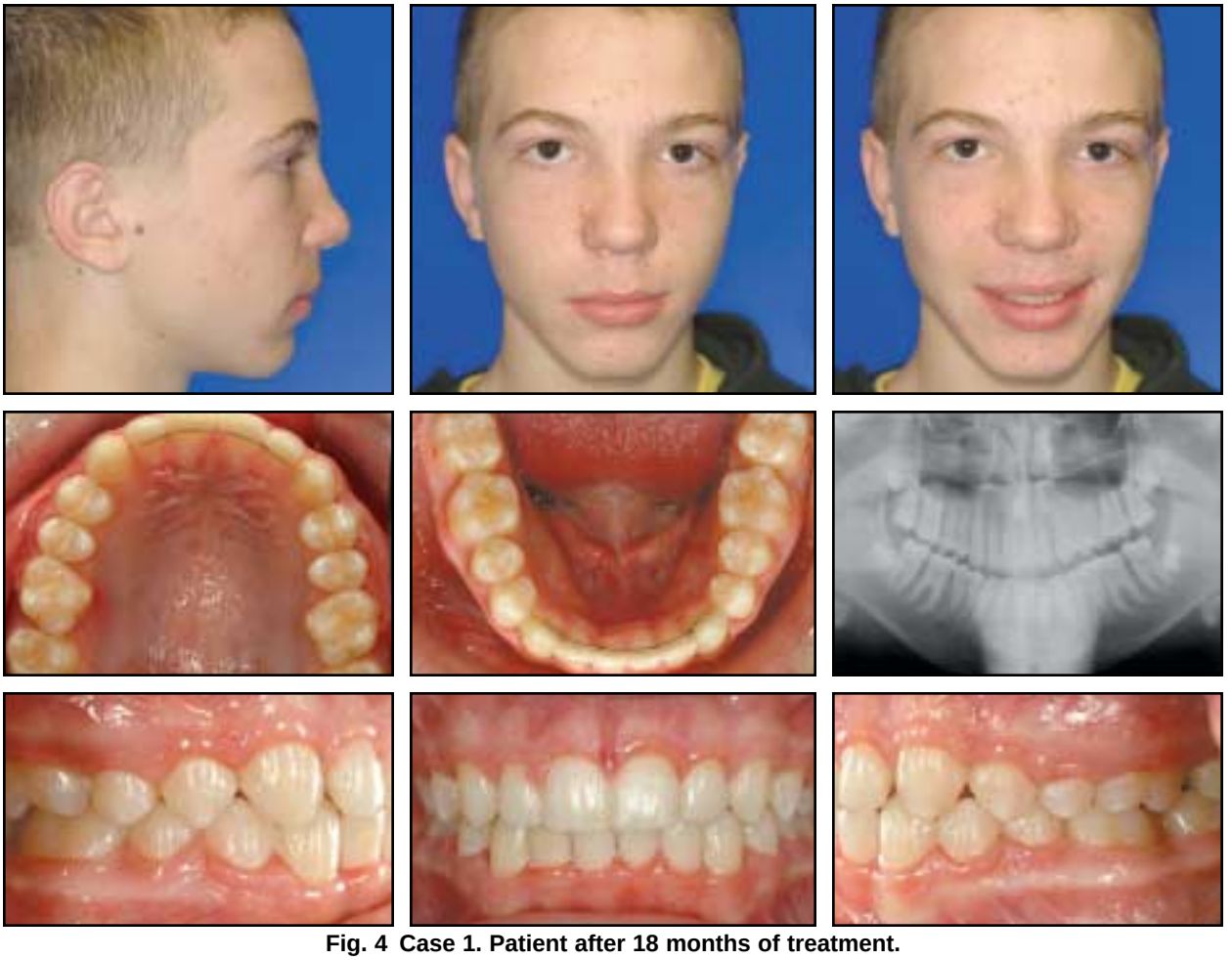

**Fig. 4 Case 1. Patient after 18 months of treatment.**

nium finishing wires. If a bracket needs to be repositioned, however, it should be done while the patient is still in a superelastic wire. My experience has shown that the computerized bracket placement does not always match what I would consider the appropriate position. In these instances, it is important to allow the initial archwires to work and to progress to a rectangular superelastic wire before evaluating bracket positions and root paralleling. In fact, minor discrepancies may not be evident until the final, full-dimension wire has been placed. The decision must then be made whether to bend the wire for detailing or to reposition the bracket.

## Case 1

A 13-year-old male was referred by his pediatric dentist because of a deep bite and dental malalignment (Fig. 2). He had a mild mandibular arch-length deficiency and a short lower facial height, with spacing in the upper arch and crowding in the lower.

A virtual alignment was generated, and indirect bonding was carried out as described above (Fig. 3). The mandibular right lateral incisor could not be bonded initially due to crowding, but was bonded directly several months into treatment.

Three detailing bends were needed in the mandibular arch for the incisors and the right first premolar, which had a poor marginal ridge anatomy on the distal. One detailing bend was placed in the maxillary archwire. Nine appointments were required, including the bonding and debonding visits. Treatment was completed in 18 months—six months earlier than predicted (Fig. 4).

## Case 2

A 20-year-old female presented with the chief complaint of "crooked front teeth" (Fig. 5). Clinical examination revealed Class I skeletal and dental relationships. Brackets were bonded indirectly using OrthoCAD trays.

Torque adjustments were required for the maxillary and mandibular right canines because the treatment plan was more demanding than the pretorqued canine brackets would accommodate. No variable-torque brackets were used. Treatment was finished in 16 months with eight appointments, including bonding and debonding (Fig. 6).

## Case 3

A 14-year-old female reported with the chief complaint of "crooked front teeth" (Fig. 7). She had mild crowding, some angulation and torque problems, and a minimal overbite. Indirect bonding was performed using the OrthoCAD system.

One detailing bend was required at the maxillary right first premolar, and a fractured maxillary left lateral incisor ceramic bracket had to be replaced (Fig. 8). There were four bond failures, but these caused no delay in treatment. Appliances were removed after 16 months of treatment and eight appointments, including bonding and debonding (Fig. 9).

## Discussion

These cases are representative of the 37 patients I have completed to date using OrthoCAD computer-aided bracket placement and indirect bonding. The estimated treatment times averaged 19 months, with a range of 12-24 months. Actual treatment times averaged 16 months, with a range of 12-23 months. It took an average of nine appointments to complete treatment, including bonding and debonding, with a range of six to 14. An average of .5 brackets per patient had to be repositioned, with a range of zero to three. Detailing bends in final archwires averaged 2.6 per patient, with a range of zero to six. There were an average of 1.25 emergency appointments per patient, with a range of zero to four.

A combination of the OrthoCAD digital bracket placement system with time-tested indirect-bonding techniques provides multiple benefits. Computer-guided targeting of the bracket positions can be delegated to staff members after

**Fig. 5 Case 2. 20-year-old female patient with Class I malocclusion before treatment.**

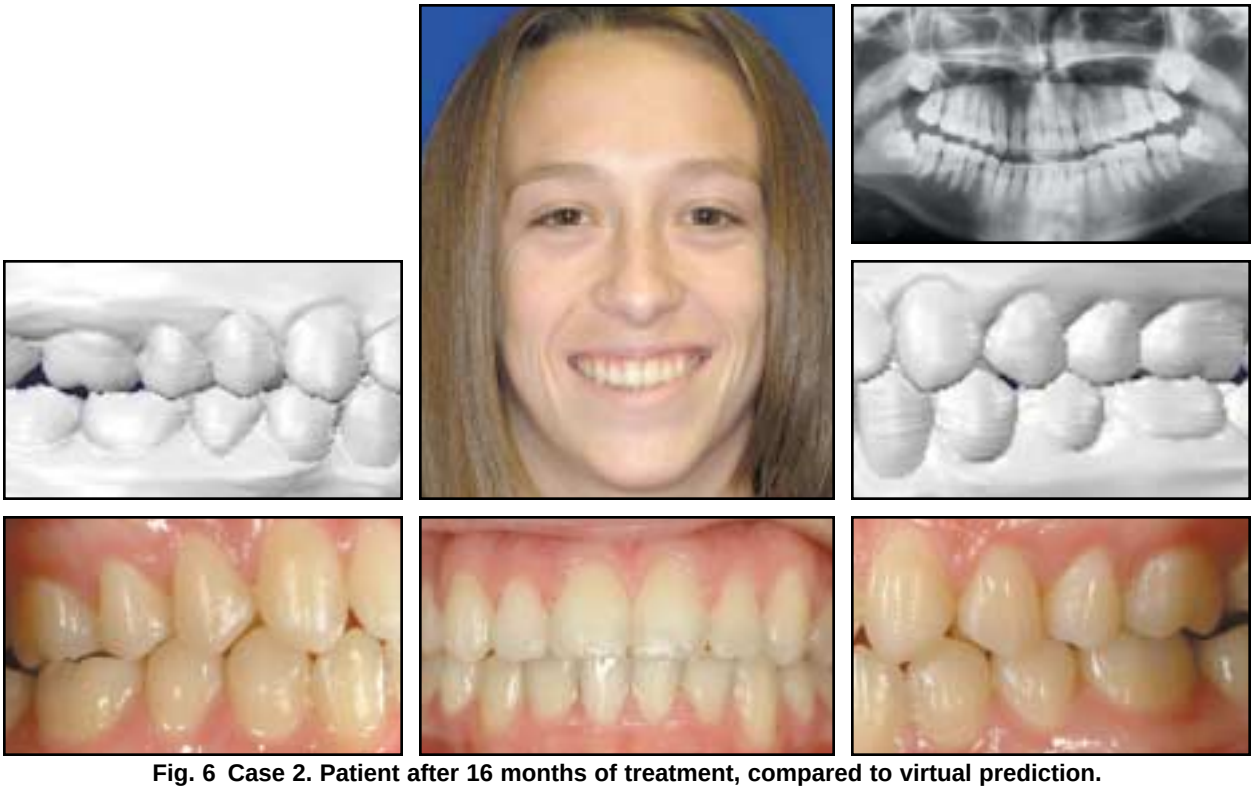

**Fig. 6 Case 2. Patient after 16 months of treatment, compared to virtual prediction.**

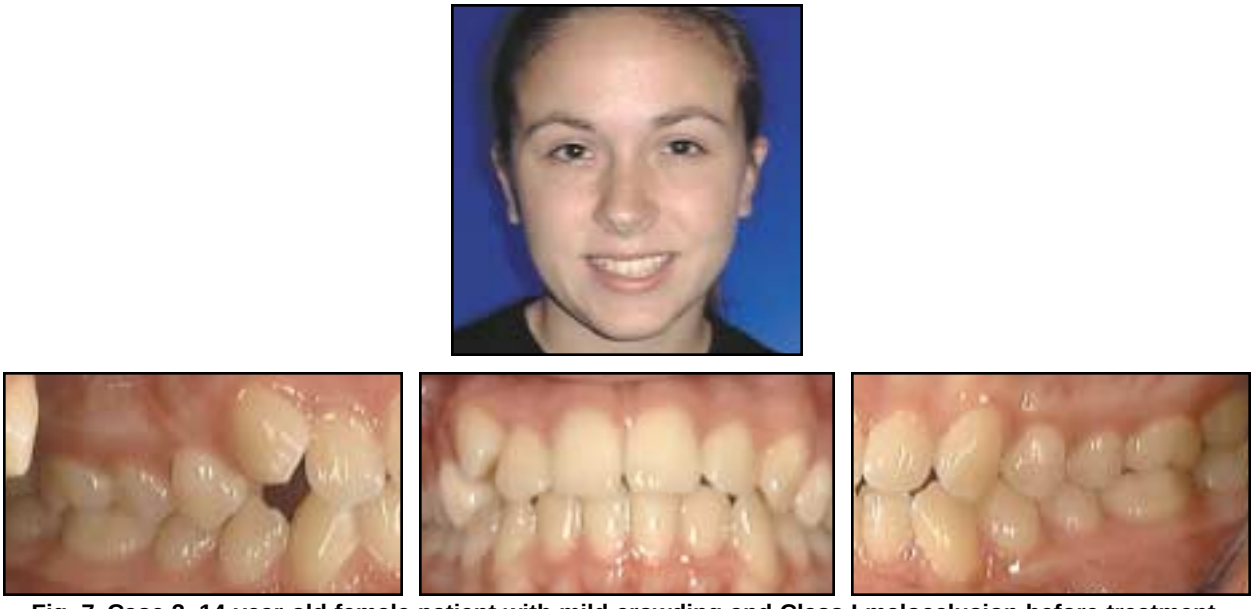

Fig. 7 Case 3. 14-year-old female patient with mild crowding and Class I malocclusion before treatment.

Fig. 8 Case 3. After 11 months of treatment, note detailing bend at maxillary right first premolar and new bracket on maxillary left lateral incisor.

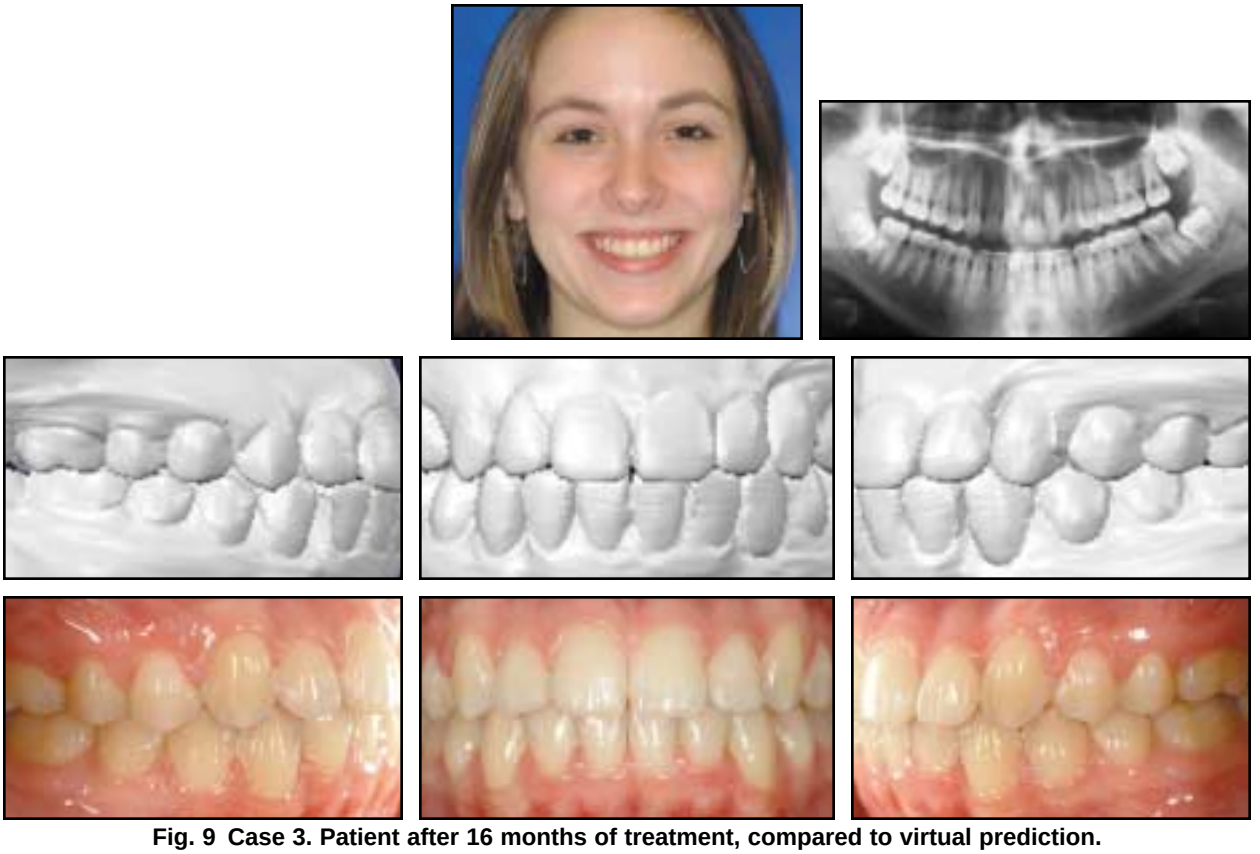

Fig. 9 Case 3. Patient after 16 months of treatment, compared to virtual prediction.

simple training. Bracket placement for both arches typically takes a staff member 10 to 15 minutes, and minimal doctor time is required to review the bracket positions. The state-of-the-art software allows a complete review of the virtual treatment and e-mail confirmation by the orthodontist. Final tray preparation takes only about five minutes. Thus, in-office laboratory procedures are virtually eliminated, and equipment requirements are limited to an Internet-connected computer.

Disadvantages of this system include the inability to achieve optimal initial bracket placement on severely rotated or incompletely erupted teeth. In addition, there is no method available at present to correlate soft-tissue relationships to the computer-generated virtual dental alignment. The learning curve involved with indirect bonding may also be a concern for some clinicians.

Kalange reviewed the advantages of indirect bonding in terms of clinical, technical, and ergonomic efficiencies.[17] Clinical advantages are gained in initial alignment, archwire progressions, and anticipated occlusal schemes due to optimal bracket positioning. Mechanotherapy is improved through optimal utilization of the tooth movements built into the brackets and shape-memory archwires. Ergonomic efficiencies are achieved with fewer bracket repositionings and detailing bends, simpler wire-changing appointments, and better overall clinical management. These benefits are appreciated by doctors and staff, as well as by patients and parents as treatment goals are achieved.

The ability to show the patient an anticipated end result has long been seen as an advantage in computer-assisted planning of orthognathic surgery. The OrthoCAD system likewise allows the clinician to "morph" the dental alignment, manipulate the digital models, and demonstrate the potential final alignment to patients and parents. This technological advancement has proven to be a valuable tool in patient education, case acceptance, and practice marketing.

The current trend of extending the time between office visits works well with a system of computer-aided bracket placement. Self-ligating brackets add a new dimension through improved control of the archwire within the bracket "tubes". Allowing the archwires to work out within tubes that are placed in computer-determined optimal positions may indeed be the perfect combination of clinical and technological advantages.

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