Individualized orthodontic treatment: The Insignia system

Antonio Gracco, DDS1
Edoardo Stellini, MD, DDS2
Serena Incerti Parenti, DDS3
Giulio Alessandri Bonetti, MD, DDS4

This clinical report presents a case treated by a currently available customized orthodontic treatment system. The use of patient-specific brackets, indirect bonding transfer devices, and customized archwires decreases treatment and chairside time, making orthodontic cases more predictable, accurate, and efficient. The need for time-consuming adjustments is greatly reduced, and appliance customization further facilitates the achievement of the final desired occlusion from the first day of treatment.

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Technologic advances in photography, digital scanning, and cone beam computed tomography (CBCT) have greatly improved the diagnostic and treatment planning procedures in orthodontics. Similarly, the application of computer-aided design and manufacturing technologies has allowed manufacturers to produce orthodontic appliances tailored to the specific tooth shape of the individual patient (ie, customized orthodontic appliances). This provides the potential for decreased treatment and chairside time, making orthodontic cases more predictable, accurate, and efficient.1

Customized orthodontic treatment systems rely on digital models of the patient’s occlusion, which are generated from accurate impressions taken before treatment, scans of the dental arches, scans of the plaster casts, or CBCT acquisition.1–8 A virtual setup of the desired outcome is, then, derived. This setup serves as a three-dimensional (3D) interactive treatment planning tool and is used for the production of personalized appliances (archwires, brackets, and indirect bonding transfer devices).8–14

This clinical report outlines the main features and the clinical advantages of a currently available customized orthodontic treatment system.

MANUFACTURING PROCESS

The first step in the Insignia system (Ormco) for custom-designed orthodontics is to send precise polyvinyl siloxane impressions as well as photographic and radiographic information to the manufacturer. An accurate scanning of the plaster casts or CT scanning of the impressions is performed by the technicians, thus producing a digital model with a 3D representation of the dental arches, from which a virtual setup of the desired final tooth positions and an
archwire shape are derived. Before further processing, the clinician is asked to make adjustments to the proposed initial occlusal setup and archwire shape via the online interface. The following virtual tools can mainly be used:

1. 3D control of tooth placement (torque, tip, in/out, intrusion, and extrusion) (Fig 1)
2. Control of the arch form within the patient-specific biologic limits based on the buccal and lingual limits of the alveolar bone (Fig 2)
3. Alteration of the smile arc (Fig 3)
4. Alteration of the dental contacts in the final centric occlusion (Fig 4)
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After the final setup for the patient has been approved, the brackets chosen by the clinician are placed virtually on the setup in order to allow for insertion of a straight final full-size archwire according to the wire sequence selected by the clinician.¹ The patient-specific appliances (brackets, archwire, and precision positioning devices) are not fabricated until the doctor has reviewed and accepted the virtual treatment planning. Insignia metal twin brackets are individualized by a precise milling of the slot, based on each single bracket position on the tooth in the specific setup.¹ Insignia self-ligating (SL) brackets are a customized version of Damon Q SL brackets (Ormco), which are individualized by varying the thickness and angulations of the metallic bases (Fig 5). When esthetic brackets are selected, no milling can be performed; therefore, customization is carried out by prescription selection, adjustments to the positioning jigs, and customized archwire design. Adaptations can also be performed with first-order compensation bends, which the Insignia system permits in nickel titanium (Ni-Ti), copper Ni-Ti, stainless steel (SS), and titanium molybdenum archwires (TMA) (Fig 6). Positioning devices are precisely milled from a spongy material to fit the occlusal surface of teeth in order to transfer the virtual position of the bracket to the patient’s mouth in an accurate and reliable manner (Fig 7).

CASE REPORT

A 16-year-old male patient presented with an occlusal sagittal molar relationship of Angle Class I on the left and Angle Class II on the right, posterior cross-bite on the right side, and moderate mandibular and maxillary crowding with palatal displacement of the maxillary right lateral incisor and buccal displacement of the maxillary right canine (Figs 8 to 13).
For the Insignia processing, Damon 3MX brackets (Ormco) and molar tube slot milling were selected because fully customized Insignia SL brackets were not available at that time. The chosen archwire sequence was: 0.014-inch copper Ni-Ti, 0.014×0.025-inch copper Ni-Ti, 0.018×0.025-inch copper Ni-Ti, 0.019×0.025-inch SS, and 0.019×0.025-inch TMA.

After customized brackets were bonded, and 0.014-inch copper Ni-Ti archwires were placed, two bite turbos were applied to the lingual surface of the maxillary canines to open the bite slightly and facilitate the correction of the posterior crossbite. Two months later, the maxillary right lateral incisor and canine were well aligned; therefore, 0.014×0.025-inch copper Ni-Ti archwires
were engaged. At 3 months from bracket placement, the transverse relationship between the maxillary and mandibular arches was normalized without the use of crossbite elastics. At that time the patient was asked to wear light elastics from the maxillary canine to the mandibular first molars on both the right and left side. Two months later, correction of the sagittal molar and canine relationship had been achieved. Treatment progressed with 0.018 × 0.025–inch copper Ni-Ti and 0.019 × 0.025–inch SS archwires. The finishing phase was performed by means of 0.019 × 0.025–inch TMA archwires, and the patient was instructed to wear triangular elastics from the maxillary canine to the mandibular first premolar and first molar in order to improve intercuspation (Figs 14 to 19).

The treatment required 12 visits over a total treatment time of 17 months. During that time no bracket bond failure occurred, and no repositioning was necessary.

**DISCUSSION**

As a result of technologic advances, manufacturers are shifting from mass-produced prefabricated orthodontic appliances based on an average tooth shape toward customized brackets and archwires that are tailored to the patient's specific tooth shape and generate the ideal force system to produce the desired tooth movement.\(^\text{15}\) Individualized appliances provide the advantages of increased quality and efficiency of the orthodontic treatment. The Insignia system enables clinicians to see and refine a virtual setup of the desired final 3D tooth positions prior to the beginning of treatment. Bracket placement and customization are, then, carried out on the final setup once approved by the clinician. The overcorrection software calculates the bracket prescription required in order to overcome the side effects of the archwire mechanics (ie, the play between the archwire and the slot of the bracket), thus permitting the
accurate achievement of the desired final tooth position. This reduces or eliminates the need for finishing at the end of treatment, a phase that adds time to treatment with conventional appliances and involves a burden of care on the patient and the family. The clinician also has control over arch form, the shape of which is chosen at the beginning and adhered to throughout treatment based on the shape and size of the cortical limits of the mandibular bone. All these factors also eliminate time-consuming adjustment, aiming to achieve the final desired occlusion from the first day of treatment. Moreover, transfer jigs fit the occlusal and incisal surface of teeth accurately, thus reducing the risk of errors in bracket placement or replacement.

By means of 3D interactive treatment planning, the orthodontist can perform accurate measurements, analyses, and simulations. This can facilitate collaboration and easy communication via online interface with other specialists in multidisciplinary treatment planning, eg, when space management is required for implant and/or prosthesis placement. The 3D digital representation of the dental arches also facilitates communication with patients during the diagnostic and treatment planning process, which is of utmost importance in order to better assess their expectations prior to the beginning of treatment.

A decreased inventory is needed with the use of patient-specific appliances. Moreover, the digital storage of virtual models, simulations, photographs, and radiographs provides an easily accessible patient archive. In Europe, it takes 4 to 5 weeks to receive the Insignia package, so it is better to schedule the bonding appointment 1.5 months after the impressions are taken.

One important limitation of this system is the lack of information available regarding the roots of the teeth, which explains why it is sometimes necessary to add small corrective bends in the archwires during the finishing phase. In the future, the combination of this type of technology with CBCT will further refine the potential benefits of this system by providing more precise information about the anatomy of the tooth roots.

Fig 18  Posttreatment maxillary occlusal view.
Fig 19  Posttreatment mandibular occlusal view.
CONCLUSION

The Insignia system provides interactive treatment planning in which the 3D representation of the dental arches and the virtual setup of the desired final tooth positions enhance communication with the patients and with other specialists. The use of patient-specific brackets, indirect bonding transfer devices, and customized archwires provides the potential for decreased treatment and chairside time, making orthodontic cases more predictable, accurate, and efficient. The need for time-consuming adjustments is greatly reduced, and appliance customization facilitates the achievement of the final desired occlusion from the first day of treatment.

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