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.)

In recent Cutting Edge columns, I've discussed the current technology race to replace polyvinyl siloxane impressions with a digital process—either cone-beam computed tomography (CBCT) or intraoral scanning. As CBCT images have become more refined and digitally produced models have tested successfully for dimensional reliability, CBCT has seemed to be the horse to back in this race.

Intraoral scanning of individual teeth has been possible for some time, but has required the use of scanning powder because of the translucency of enamel and dentin—a rather messy and uncomfortable process for patients. Now, however, scanners can produce full digital arches by "stitching" the images together, with no powder required.

In this month's Cutting Edge column, Drs. Francesco Garino and Battista Garino demonstrate the practical application of the OrthoCAD intraoral scanner in a busy orthodontic practice. In the race between CBCT and scanning technologies, it appears to me that the intraoral scanner has taken the lead and is sprinting toward the finish line.

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The OrthoCAD iOC Intraoral Scanner: A Six-Month User Report

Although our office had been using computerized three-dimensional models processed from conventional impressions since 2002, along with digital radiographs, charts, and images, our ultimate goal had always been to acquire 3D models directly, thereby eliminating the need for impressions. When we installed the OrthoCAD iOC* intraoral scanner in the summer of 2010, our 20-year project of fully digitizing our operations was finally complete.

Until recently, we were required to ship polyvinyl siloxane impressions and bite registrations to the OrthoCAD center in the United States to obtain digital models, virtual setups, and indirect bonding trays. Once received at the OrthoCAD center, the impressions were poured, trimmed, scanned, and processed to generate the 3D digital model—the starting point for all OrthoCAD ser-

*Trademark of Cadent, Inc., 640 Gotham Parkway, Carlstadt, NJ 07072; www.cadent.biz.

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vices (Fig. 1). The digital file was then automatically downloaded to our office network. This process remains available for customers who prefer to use conventional impressions.

In our new system, however, the iOC intraoral scanner generates a 3D model of the dentition in real time and then uploads the information to the OrthoCAD network. The flow of information is reversed from that of the impression-based process.

This article describes our experience with the iOC over its first six months of use and the resulting changes in our daily routine.

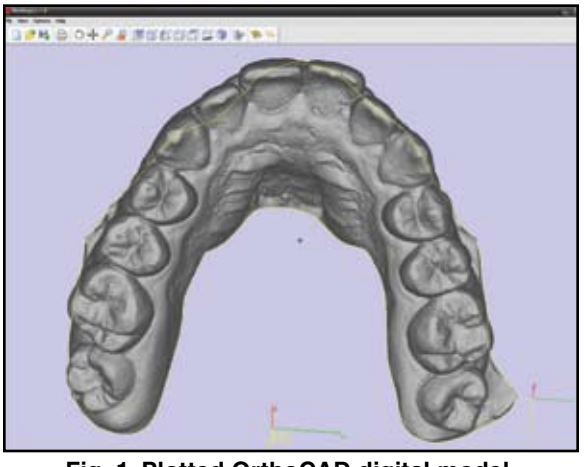

Fig. 1 Plotted OrthoCAD digital model.

In-Office Procedure

The new iOC scanner is based on powder-free iTero* intraoral scanning technology, which has been utilized for more than 250,000 dental restorations since 2007. The iOC employs a patented, optical-focus-detection-based technique to capture the 3D geometry of the dentition and gingivae. The scanning wand emits multiple light waves of discrete wavelengths and captures returned light from the hard and soft tissues in a complementary metal oxide semiconductor (CMOS) imager. A mobile cart houses the computational platforms, electronic drivers, and power supplies; an air pump to defog the wand lenses; a flat-screen monitor; a wireless communication module; and a foot pedal.

The iOC can be stationed in the records room or moved around the clinic. Once the patient has been seated, case details are entered and the operator is prompted to select the type of scanning process. Current applications include digital study models, virtual setups, computer-optimized indirect bonding, printed physical models, and appliance fabrication. Further uses are being developed.

Because this is a relatively new technology, we have found it helpful to give each patient a brief instructional session. Shortly before the scan begins, the protective shield on the wand is replaced

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Fig. 2 OrthoCAD iOC scanner in use on patient.

with a disposable sleeve, ensuring sterility. The wireless pedal is placed on the floor, ready to be used for scanning control and navigation. The patient is advised to swallow saliva between scans and, in some instances, to bite down gently on the wand for better positioning.

The iOC uses consecutive, individual scans to display a real-time, aggregated model rendering (Fig. 2). The process typically starts in the left mandibular quadrant, with the operator moving the wand from posterior to anterior. After scanning the lower arch, the operator proceeds to the upper arch, the bite, and the palate. The scan can be stopped and restarted at any point, going forward or backward to recapture areas of missing data. (A videotaped example is available via a link from the online version of this article at www.jco-online.com.)

The system takes less than a minute to process and compile the individual segments into a complete 3D digital model. At this point, the raw model data are viewable only on the iOC unit. To obtain a compressed digital file that can be accessed from the practice's network or through a secure Internet connection (and for backup purposes), the office must submit the information electronically to OrthoCAD. The orthodontist can also submit an online treatment plan (Fig. 3) and receive a virtual setup (Fig. 4) a few days later. Using the OrthoCAD software, the orthodontist can then view, diagnose, and present the case at the office or elsewhere.

Our initial training consisted of a comprehensive clinical course conducted in the office immediately after installation of the scanner. On the first day, clinicians and staff were trained to scan a model; over the next two days, they scanned fellow staff members and then real patients. Seeing our scanning times improve over just two days helped us gain confidence in the system and overcome apprehensions. Four weeks after the initial training, a one-day follow-up session was provided, with the goals of fine-tuning the process and increasing proficiency.

Over the first six months of iOC use in our office, we scanned 120 patients. The average time required for a full scan (upper and lower arches, palate, and bite registration) was 16.7 minutes for

2. Appliances

Wire: SPEED Wire(TM) Medium-Jaw 10
Brackets: Garino 1
Tubes: Garino 1

Bond	Tooth	Vendor	Set Name	Catalog #	Torque	Angulation	Rotation	Hook	Invert
☐	UR8								
☑	UR7	SPEED System(TM)	Hanson .022	22UR7-10M-	-10	+9	0		
☑	UR6	SPEED System(TM)	Hanson .022	22UR6-10DT	-10	+5	0	☑	
☑	UR5	SPEED System(TM)	Rhomboid .022	22UR5-7WRM-	-7	0	0	☑	
☑	UR4	SPEED System(TM)	Rhomboid .022	22UR4-7WRM-	-7	0	0	☑	
☑	UR3	SPEED System(TM)	Rhomboid .022	22UR3-2HRM-	-2	+9	0	☑	
☑	UR2	SPEED System(TM)	Rhomboid .022	22UR2+14HRM-	+14	0	0		
☑	UR1	SPEED System(TM)	Rhomboid .022	22UR1+12HR	+12	0	0		
☑	UL1	SPEED System(TM)	Rhomboid .022	22UL1+12HR	+12	0	0		
☑	UL2	SPEED System(TM)	Rhomboid .022	22UL2+14HRM+	+14	0	0		
☑	UL3	SPEED System(TM)	Rhomboid .022	22UL3-2HRM+	-2	+9	0		
☑	UL4	SPEED System(TM)	Rhomboid .022	22UL4-7WRM+	-7	0	0	☑	
☑	UL5	SPEED System(TM)	Rhomboid .022	22UL5-7WRM+	-7	0	0		
☑	UL6	SPEED System(TM)	Hanson .022	22UL6-10DT	-10	+5	0	☑	
☑	UL7	SPEED System(TM)	Hanson .022	22UL7-10M+	-10	+9	0	☑	
☐	UL8								
☐	LL8								
☑	LL7	SPEED System(TM)	Hanson .022	22LL7-28STPE	-28	+2	0	☑	
☑	LL6	SPEED System(TM)	Hanson .022	22LL6-10STLH	-10	+5	0	☑	
☑	LL5	SPEED System(TM)	Rhomboid .022	22LL5-17WRM-	-17	0	0		
☑	LL4	SPEED System(TM)	Rhomboid .022	22LL4-11WRM-	-11	0	0	☑	
☑	LL3	SPEED System(TM)	Rhomboid .022	22LL3-7WRM-	-7	0	0	☑	
☑	LL2	SPEED System(TM)	Rhomboid .022	22LL2-1MPR-	-1	+2	0		
☑	LL1	SPEED System(TM)	Rhomboid .022	22LL1-1MPR-	-1	+2	0		
☑	LR1	SPEED System(TM)	Rhomboid .022	22LR1-1MPR+	-1	+2	0	☑	
☑	LR2	SPEED System(TM)	Rhomboid .022	22LR2-1MPR+	-1	+2	0	☑	
☑	LR3	SPEED System(TM)	Rhomboid .022	22LR3-7WRM+	-7	0	0	☑	
☑	LR4	SPEED System(TM)	Rhomboid .022	22LR4-11WRM+	-11	0	0	☑	
☑	LR5	SPEED System(TM)	Rhomboid .022	22LR5-17WRM+	-17	0	0	☑	
☑	LR6	SPEED System(TM)	Hanson .022	22LR6-10STLH	-10	+5	0	☑	
☑	LR7	SPEED System(TM)	Hanson .022	22LR7-28STPE	-28	+2	0	☑	

Fig. 3 Section of online treatment plan prepared by orthodontist after submission of scanning data.

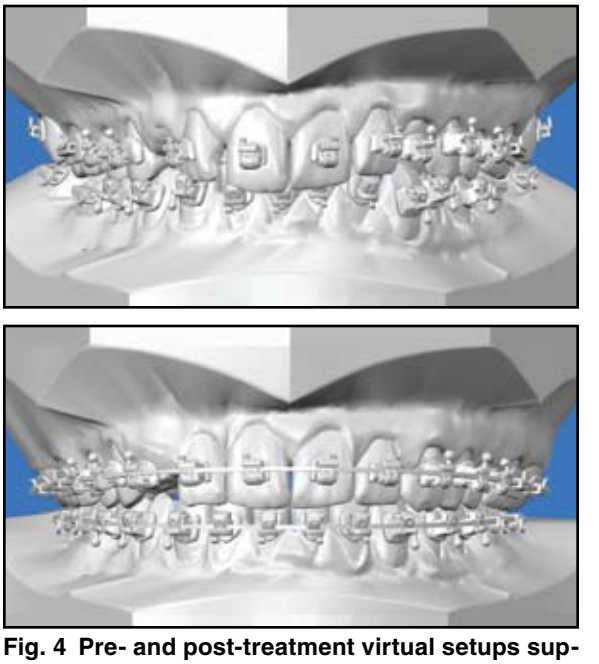

Fig. 4 Pre- and post-treatment virtual setups supplied by OrthoCAD.

Fig. 5 Stereolithographic (STL) models produced from universal STL files.

Fig. 6 Retainer fabricated on STL model.

the first 40 cases, but only 9.5 minutes for the last 20 patients. All 120 patients preferred intraoral scanning over conventional impressions; 95% said the scan was a positive experience, and 95% said they would recommend the "iOC experience" to their friends. We expect to improve our scanning times even more as we handle more patients.

Discussion

The iOC intraoral scanner has benefited our practice in several important ways:

1. The tasks associated with conventional impressions—tray selection, material mixing, storing of impression materials, cleaning, plaster pouring, and model storage—are all becoming history,[1] along with impression failures and model retakes. This is one aspect of orthodontics we were especially eager to get away from.
2. Patient reaction has been decidedly positive. The system can be used in young, mixed-dentition patients and in those with excessive gag reflexes or special needs. Patients appear to be fascinated by this new technology, in contrast to the negative experience of conventional impressions. No powdering or coating of the teeth is required with the iOC scanner, making the procedure even more comfortable.[2]
3. We can diagnose abnormalities and present the 3D virtual models to the patient, in addition to photographic and radiographic records, at the first appointment. This has significantly improved our acceptance rate.[3]
4. The iOC is, by definition, an open system. This means that the native scan files are not only available in OrthoCAD's 3DM format, but also as universal stereolithographic (STL) files, which can be used to print STL models (Fig. 5). These models, in turn, can be used to fabricate retainers and other fixed or removable appliances (Fig. 6). The same files will soon be consolidated with cone-beam computed-tomographic images,[4] providing much-needed high-resolution data on the dentition. Our laboratory has already produced retainers from printed polymer models, and the fit has been exceptional.
5. The seamless integration between the iOC and OrthoCAD software allows us to easily order virtual setups and computer-optimized indirect-bonding trays based on scan data.[5]

Considering that all technology can be enhanced by frequent upgrades in both software and hardware, a tool such as the iOC must be considered a medium-term investment. Spreading the cost over three to five years might be reasonable for a medium-to-large practice, but perhaps too expensive for a small practice or a consultant orthodontist. We would consider it a good investment for any office that handles digital models, virtual setups, and indirect bonding for colleagues, or for any practice with satellite offices.

The iOC system has fulfilled its promise thus far in our office, and our migration from conventional impressions to digital intraoral scanning has been easier than anticipated. We look forward to seeing how new applications will further enhance our daily operations.

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