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 this Cutting Edge article, Drs. Sivabalan Vasudavan, Stephen Sullivan, and Andrew Sonis set the stage for the impending showdown between intraoral scanning and cone-beam imaging. As many have predicted, conventional orthodontic impressions (whether alginate or polyvinyl siloxane) will soon be history. The question remains: Which digital format will prevail for taking occlusal records?

Unfortunately, the new equipment, whether it's an intraoral scanner, a cone-beam scanner, or a stereolithographic machine, is significantly more expensive than traditional impression materials and storage. Considering the advantages of such systems as listed by this month's authors, however, many orthodontists will accept the additional costs required to provide their patients with these advanced techniques. As acceptance grows, the expense will gradually decrease.

It's yet another step in the digital evolution of the orthodontic profession.

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Comparison of Intraoral 3D Scanning and Conventional Impressions for Fabrication of Orthodontic Retainers

Digitally scanned occlusal records have several advantages over traditional study casts, in that they:

- Are accurate and simple to produce.
- Cause minimal patient discomfort.
- Eliminate the need to maintain the materials required for conventional impressions.
- Minimize disinfection and cross-contamination issues.
- Avoid the storage problems of plaster casts.

The OraScanner is used in diagnosis and appliance design for orthodontic patients treated with the proprietary SureSmile* system.[1,2] Other digital scanning devices currently used in den-

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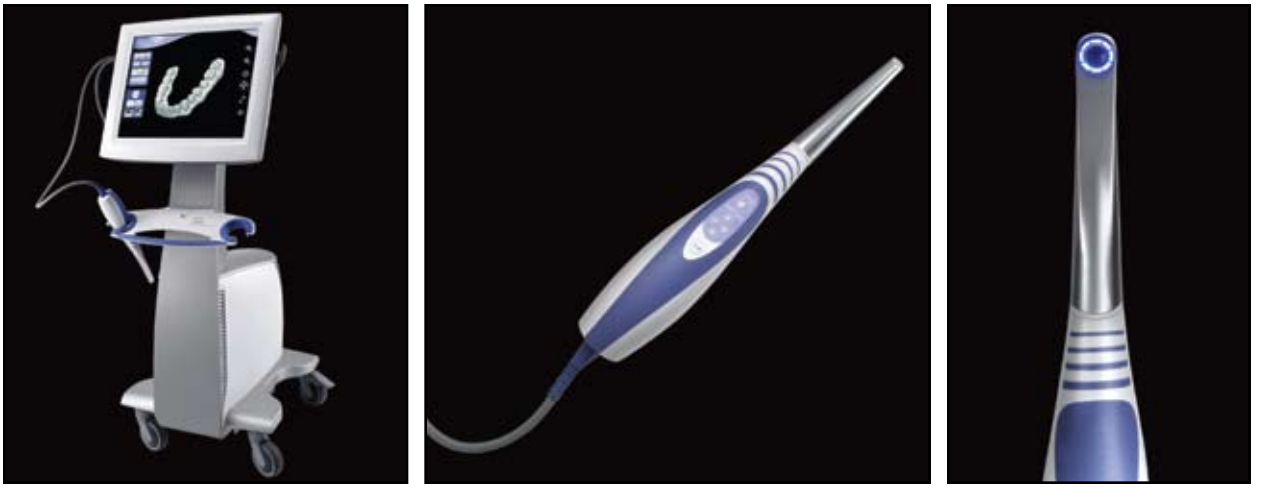

Fig. 1 Lava Chairside Oral Scanner (images provided by 3M ESPE Dental Products).

tistry include the iTero**[3] and the Lava Chairside Oral Scanner*** (C.O.S.), both of which are designed for the production of crowns and fixed prostheses.

In this study, we applied the digital scanning technology of the Lava C.O.S. (Fig. 1) to fabricate orthodontic retainers for comparison with retainers produced by conventional impression techniques.

Methodology

The New England Institutional Review Board granted approval for this prospective, multicenter, crossover-design trial; informed consent and assent were obtained from the legal guardians and patients, respectively.

Two orthodontists in separate practices recruited a convenience sample of patients, all of whom had been undergoing full edgewise orthodontic appliance treatment and were scheduled for debonding. Three weeks before removal of the fixed appliances, each subject had a digital scan recorded using the Lava C.O.S. and a conventional impression taken of both dental arches in quick-set alginate.

The Lava C.O.S. captures the digital impression by scanning both arches and their interocclusal relationship. After the teeth are isolated and parotid shields and lip retractors are placed, a thin layer of titanium oxide powder is sprayed onto the tooth surfaces to prepare them for scanning. The Lava C.O.S. wand contains a single primary lens that captures images at video rate on three sensors. It delivers 20 three-dimensional data sets per second using patented wavefront-sampling technology. The wand cable is connected to a cart that houses the central processing unit, which models the input in real time and displays the data on a touch-screen monitor.[4]

For this study, all scanning was performed by orthodontic assistants who had each taken a two-hour training session. The sequence of digital scanning and impression-taking was randomized among the patients. The digital scans were used to produce stereolithographic models, and the alginate impressions to produce stone casts. Two sets of maxillary and mandibular Hawley retainers—one "digital" set and one "conventional" set—were fabricated to the same prescription and by the same technician for each patient. Orthodontists and patients were blinded as to the method of retainer fabrication. After both sets of retainers were fitted, the orthodontist's perceptions of accuracy and retainer preference and the patient's assessment of comfort and retainer preference were recorded.

Twenty-four female and six male patients participated in the study over a period of six months; 60 retainers of each type (30 upper and 30 lower) were produced. We assessed two primary efficacy endpoints:

1. Clinical acceptability of the initial retainer fit. This was a subjective evaluation made by the orthodontist, based on adaptation of the acrylic to the soft tissues, adaptation of the labial bow to the tooth surfaces, and the extent of clasp adjustment needed to provide adequate retention. Retainers that did not seat or had inadequate mechanical retention after adjustment were deemed unacceptable.
2. Orthodontist's retainer preference. If both digital and conventional versions of a retainer were judged clinically acceptable, the orthodontist decided which was better in terms of fit and finish.

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TABLE 1
CLINICAL ACCEPTABILITY OF INITIAL FIT AND ORTHODONTIST RETAINER PREFERENCE BY FABRICATION METHOD

	Digital Scanning (N = 60)	Alginate Impressions (N = 60)	Difference (95% CI*)	"p"
Clinically acceptable	86.7% ± 34.0%	88.3% ± 32.4%	–1.67% (–14%-10%)	0.785
Preferred by orthodontist	66.3% ± 48.6%	31.7% ± 46.9%	31.7% (14%-49%)	<0.001

*Confidence interval.

Secondary efficacy endpoints included the investigator's ability to procure digital scans, the relative ease of using the Lava scanning device, and the patient's degree of comfort while undergoing digital scanning. The latter was determined by asking the patients which recording technique they preferred.

Acceptability and preference data were summarized for the two fabrication types as mean percentages with standard deviations. Differences between groups were expressed as point estimates with 95% confidence intervals. A paired t-test was used to establish statistical significance.

Results

Clinical acceptability of retainers did not differ significantly by fabrication method (Table 1): 52 retainers fabricated from digital scans were considered acceptable, compared to 53 retainers made from alginate impressions. Of the retainers that were deemed clinically acceptable, however, the retainers made from digital scans were preferred significantly more often by the orthodontist than those made from alginate impressions.

Digital scanning times ranged from 16 to 46 minutes (mean duration = 26 minutes). Scanning times tended to decrease as operator experience increased.

Overall, orthodontists preferred the retainer fabricated with the digital scanning process in about two-thirds of the cases. A higher percentage of patients (77%) preferred the digital scanning procedure over conventional alginate impressions. No safety concerns were noted, but the impact of the "novelty effect" on patient evaluations cannot be discounted. Many thought the technology was "cool" because they could observe their scans being captured on the screen in real time, which could have skewed their perceptions.

Discussion

Although dental scanning has been used for years in restorative dentistry, the introduction of this technology to orthodontics is a relatively recent development. Assuming the practice performs adequate computer backups, the digital records are readily and indefinitely accessible to the doctor. Distortion-free images of the dental arches can be sent electronically to the laboratory, possibly improving the quality of impressions and, therefore, the quality of retainers,[5] as the present study indicates.

The Lava scanning technique is not without shortcomings. Patient preparation is more time-consuming than for conventional impressions, requiring strict isolation and coating of the teeth with titanium oxide. In our study, patients who preferred the conventional alginate impressions typically found the preparation for scanning more uncomfortable than the conventional impression procedure. Costs for scanning hardware and software are also substantial; a prolonged period of use would be required for practitioners to realize any savings relative to maintaining an inventory of conventional impression materials and storing plaster casts. Therefore, it is unclear whether digital scanning technology is cost-effective at this time. With the continued evolution of this technology, however, we will likely see the elimination of traditional impression-taking in the near future.

REFERENCES

1. Hajeer, M.Y.; Millett, D.T.; Ayoub, A.F.; and Siebert, J.P.: Applications of 3D imaging in orthodontics: Part II, J. Orthod. 31:154-162, 2004.
2. Sachdeva, R.; Frugé, J.F.; Frugé, A.M.; Ingraham, R.; Petty, W.D.; Bielik, K.L.; Chadha, J.; Nguyen, P.; Hutta, J.L.; and White, L.: SureSmile: A report of clinical findings, J. Clin. Orthod. 39:297-314, 2005.
3. Christensen, G.J.: The challenge to conventional impressions, J. Am. Dent. Assoc. 139:347-349, 2008.
4. Farah, J.W.; Reed, C.; and Wojtowicz, D.: Clinical Case Report: 3M ESPE Lava Chairside Oral Scanner C.O.S., Dent. Advisor, April 2009, pp. 1-3.
5. Christensen, G.J.: Will digital impressions eliminate the current problems with conventional impressions? J. Am. Dent. Assoc. 139:761-763, 2008.