Accuracy of Dies Captured by an Intraoral Digital Impression System Using Parallel Confocal Imaging

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The purpose of this investigation was to measure the accuracy of digital impressions (DIs) compared to conventional impressions (CIs). Using the iTero system, a master cast was scanned to produce stereolithography dies. As a control group, silicone impressions were taken and poured using stone. The resulting stereolithography and stone dies were scanned and overlayed on the scanned reference image of the master cast. The mean (± standard deviation) dimensional difference to the master cast was 23.9 (± 17.6) μm for DIs and 17.6 (± 45.6) μm for CIs. The results indicate that DIs also provides enough accuracy for clinical application. *Int J Prosthodont 2013;26:161–163. doi: 10.11607/ijp.3014*

Digital impressions (DIs) offers speed and efficiency, as well as the ability to indefinitely store the information captured and to quickly and easily transfer digital images between the dental office and laboratory. Also, patients consider this method to be more comfortable than that of conventional impressions (CIs).[1] However, the expansion of DIs for general use depends on the accuracy of the impression.

The iTero DI system (Cadent), which was launched in 2006, uses parallel confocal imaging, digitally captures 100,000 points of laser light, provides remarkable tooth images of more than 300-mm focal length, and, unlike the digital systems by CEREC and 3M ESPE, does not require scanning powder. However, besides the manufacturer's statement, an in vitro measurement on the accuracy of the iTero DI system has never been reported. Therefore, the purpose of this investigation was to measure the accuracy of iTero DIs and compare the results to CIs of working dies.

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Materials and Methods

A typodont cast with prepared maxillary central incisor, second premolar, and second molar metal teeth was used as the master cast. A 360-degree shoulder preparation was made on the incisor and buccal shoulder, with a chamfer preparation on the second premolar and a 360-degree chamfer preparation on the second molar.

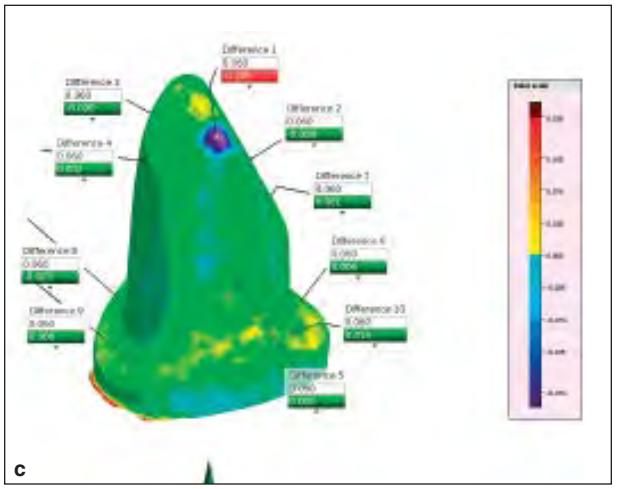
A total of 15 DIs of the master cast were taken with the iTero system. The data were transmitted electronically to the manufacturing center (Dio Health Care) where the stereolithography (STL) working casts were milled from a polyurethane block using a computer-aided design/computer-assisted manufacturing (CAD/CAM) system.

As a control group, 15 CIs (Exafine Putty, GC and Imprint 2 Light Body, 3M ESPE) were taken of each prepared tooth and poured into a Class IV resin-reinforced die stone (ResinRock, Whip Mix).

After cast fabrication, the STL dies from the iTero system and the stone dies from the CIs were digitized by a mechanical scanning instrument (Q700 scan system, 3Shape). The digital images were then overlayed on the digitalized reference image of the master cast.

Superimposition was conducted by a face-to-face method. The most congruous states of two scanned images were selected in three dimensions and rolled into one stereoscopic image. The dimensional differences (DDs) to the master cast of the DI working dies and conventional working dies were measured in micrometers on 10 common points of each prepared tooth, which were evenly distributed on all surfaces and specified randomly by a practitioner (Fig 1). In addition, for the DI group, the DDs in the master cast were compared according to tooth position and marginal form.

Figs 1a to 1d Polyurethane casts fabricated by the iTero DI and CAD/CAM milling system. **(a)** iTero working die; **(b)** stone casts fabricated by silicone impressions (control group). Superimposition of the working model to the master model for the incisor: **(c)** iTero model; **(d)** stone model.



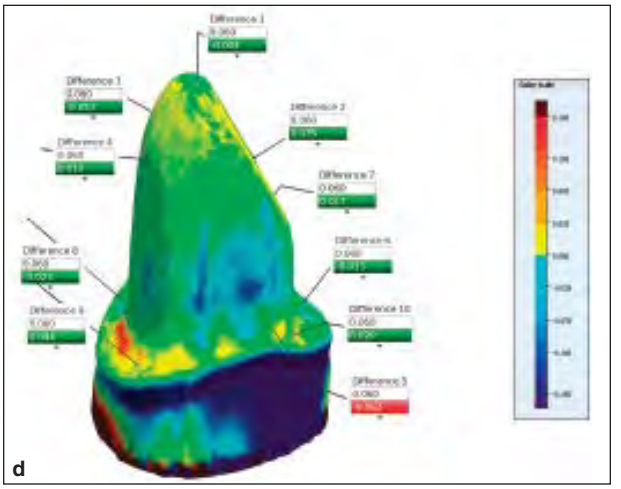


Table 1 Mean Dimensional Differences to the Master Cast for Digital and Conventional Impressions

Impression technique	Mean differences ± SD (μm)	*P**
Digital	23.9 ± 17.6	.005
Conventional	17.6 ± 45.6	

SD = standard deviation.
*Significance was analyzed statistically by a *t* test ($P < .05$).

Table 2 Mean Dimensional Differences to the Master Cast of the DI Incisor, Premolar, and Molar Models

Tooth position	Mean differences ± SD (μm)	*P**
Incisor	25.4 ± 17.1	.282
Premolar	24.3 ± 18.8	
Molar	22.2 ± 16.8	

DI = digital impression; SD = standard deviation.
*Mean values were not significantly different by one-way ANOVA ($P > .05$).

Table 3 Mean Dimensional Differences to the Master Cast of the DI Shoulder and Chamfer Margins

Margin	Mean differences ± SD (μm)	*P**
Shoulder margin	16.01 ± 2.854	.638
Chamfer margin	14.32 ± 2.163	

DI = digital impression; SD = standard deviation.
*Significance was statistically analyzed by a *t* test ($P > .05$).

Data were imported into a statistical program (SPSS version 12, IBM). A two-sample *t* test and one-way analysis of variance (ANOVA) were carried out at a level of 5% significance.

Results

The mean (± standard deviation [SD]) absolute DD to the master cast was 23.9 (± 17.6) μm for the DIs and 17.6 (± 45.6) μm for the CIs. Working dies obtained through CIs were significantly more accurate than those obtained through DIs. However, each cast for both groups was considered to be clinically acceptable for placement (Table 1). No significant difference in accuracy according to tooth position or marginal form was found in the DI group (Tables 2 and 3).

Discussion

The DI working dies were accurate enough in light of other factors such as tooth mobility,[2] mandibular deflection,[3] thickness of die spacer, and acceptable marginal gaps of crowns (120 μm).[4,5] The DIs performed better in the aspect of repeatedly obtaining uniform values. While errors in DIs could be compensated for by overlapping several scanned images, CI errors could not be corrected and appeared to contribute to a larger SD.

The iTero digital scanner equally recognized all teeth in the different positions in the arch. It could be suggested that the accuracy of the DI was not restricted by the form of the margin or tooth position.

The present study included the following limitations. The impressions were created from a typodont cast with prepared metal teeth that differed from natural teeth. The cast conditions differed from natural teeth in an oral environment since soft tissue, saliva, sulcular fluid, and patient movement that would disturb the digital scanning process were not present. As a control group, individual CIs were taken for the incisor, premolar, and molar teeth in this study, which differed from impressions with full-arch trays in clinical situations. However, this study is important for being the first to compare the DDs of working dies from two major impression methods.

Conclusions

The results of this study indicate that DIs provide enough accuracy for clinical application. Further studies should be carried out to examine the prostheses produced from DIs and to compare them with prostheses produced from CIs.

Acknowledgments

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Literature Abstract

The association of tooth scaling and decreased cardiovascular disease: A nationwide population-based study

The objective of this study was to investigate the correlation between tooth scaling and the risk of cardiovascular disease by using a nationwide, population-based study and a prospective cohort design. The analyses were conducted by using information from a random sample of 1 million people registered in the nationally representative Taiwan National Health Insurance Research Database. Cases consisted of all subjects who were aged ≥ 50 years and who received at least one tooth scaling in 2000. The control group consisted of persons who did not undergo tooth scaling and were matched to cases using propensity score matching by the time of registration, age, sex, history of coronary artery disease, diabetes, hypertension, and hyperlipidemia. During an average of 7-years follow-up, 10,887 subjects who had ever received tooth scaling (cases) and 10,989 age-, sex-, and comorbidity-matched subjects who had not received tooth scaling (controls) were registered. The cases had a significantly lower incidence of acute myocardial infarction (1.6% vs 2.2%, $P < .05$), stroke (8.9% vs 10%, $P < .05$), and total cardiovascular events (10% vs 11.6%, $P < .05$) compared with controls. After multivariate analysis, tooth scaling was an independent factor correlated with reduced risk of developing future myocardial infarction (hazard ratio [HR], 0.69; 95% confidence interval [CI], 0.57–0.85), stroke (HR, 0.85; 95% CI, 0.78–0.93), and total cardiovascular events (HR, 0.84; 95% CI, 0.77–0.91). Moreover, when compared with the control group, increasing frequency of tooth scaling was correlated with a greater risk reduction of acute myocardial infarction, stroke, and total cardiovascular events ($P < .001$). The authors concluded that tooth scaling with daily tooth brushing was correlated with a reduced risk for cardiovascular events in the future.

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