Randomized controlled within-subject evaluation of digital and conventional workflows for the fabrication of lithium disilicate single crowns. Part III: marginal and internal fit

Zeltner, Marco; Sailer, Irena; Mühlemann, Sven; Özcan, Mutlu; Hämmerle, Christoph H F; Benic, Goran I

Abstract: STATEMENT OF PROBLEM Trials comparing the overall performance of digital with that of conventional workflows in restorative dentistry are needed. PURPOSE The purpose of the third part of a series of investigations was to test whether the marginal and internal fit of monolithic crowns fabricated with fully digital workflows differed from that of crowns fabricated with the conventional workflow. MATERIAL AND METHODS In each of 10 participants, 5 monolithic lithium disilicate crowns were fabricated for the same abutment tooth according to a randomly generated sequence. Digital workflows were applied for the fabrication of 4 crowns using the Lava, iTero, Cerec inLab, and Cerec infinident systems. The conventional workflow included a polyvinyl siloxane impression, manual waxing, and heat-press technique. The discrepancy between the crown and the tooth was registered using the replica technique with polyvinyl siloxane material. The dimensions of the marginal discrepancy (Discrepancymarginal) and the internal discrepancy in 4 different regions of interest (Discrepancyshoulder, Discrepancyaxial, Discrepancycusp, and Discrepancyocclusal) were assessed using light microscopy. Post hoc Student t test with Bonferroni correction was applied to detect differences (=.05). RESULTS Discrepancymarginal was 83.6 ±51.1 m for the Cerec infinident, 90.4 ±66.1 m for the conventional, 94.3 ±58.3 m for the Lava, 127.8 ±58.3 m for the iTero, and 141.5 ±106.2 m for the Cerec inLab workflow. The differences between the treatment modalities were not statistically significant (P>.05). Discrepancyshoulder was 82.2 ±42.4 m for the Cerec infinident, 97.2 ±63.8 m for the conventional, 103.4 ±52.0 m for the Lava, 133.5 ±73.0 m for the iTero, and 140.0 ±86.6 m for the Cerec inLab workflow. Only the differences between the Cerec infinident and the Cerec inLab were statistically significant (P=.036). The conventionally fabricated crowns revealed significantly lower values in Discrepancycusp and Discrepancyocclusal than all the crowns fabricated with digital workflows (P<.05). CONCLUSIONS In terms of marginal crown fit, no significant differences were found between the conventional and digital workflows for the fabrication of monolithic lithium disilicate crowns. In the occlusal regions, the conventionally manufactured crowns revealed better fit than the digitally fabricated crowns. Chairside milling resulted in less favorable crown fit than centralized milling production.

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Randomized controlled within-subject evaluation of digital and conventional workflows for the fabrication of lithium disilicate single crowns. Part IV: Marginal and internal fit

ABSTRACT

Statement of problem. Trials comparing the overall performance of digital and conventional workflows in restorative dentistry are needed.

Purpose. The purpose of the fourth part of a series of investigations was to test whether the marginal and internal fit of monolithic crowns fabricated with fully digital workflows differed from that of crowns fabricated with the conventional workflow.

Material and methods. In each of 10 participants, 5 monolithic lithium disilicate crowns were fabricated for the same abutment tooth according to a randomly generated sequence. Digital workflows were applied for the fabrication of 4 crowns with Lava, iTero, Cerec inLab, and Cerec infinident systems. The conventional workflow included a polyvinyl siloxane impression, manual waxing, and heat-press technique. The discrepancy between the crown and the tooth was registered using the replica technique with polyvinyl siloxane material. The dimensions of the marginal discrepancy ($Discrepancy_{marginal}$) and the internal discrepancy in 4 different regions of interest ($Discrepancy_{shoulder}$, $Discrepancy_{axial}$, $Discrepancy_{cusp}$, and $Discrepancy_{occlusal}$) were assessed with a light microscope. Post hoc *t* tests with Bonferroni correction were applied to detect differences (α=.05).

Results. $Discrepancy_{marginal}$ was 83.6 ±51.1 µm for the Cerec infinident, 90.4 ±66.1 µm for the conventional, to 94.3 ±58.3 µm for the Lava, 127.8 ±58.3 µm for the iTero, and 141.5 ±106.2 µm for the Cerec inLab workflow. The differences between the treatment modalities were not statistically significant (*P*>.05). $Discrepancy_{shoulder}$ was 82.2 ±42.4 µm for the Cerec infinident, 97.2 ±63.8 µm for the conventional, 103.4 ±52.0 µm for the Lava, 133.5 ±73.0 µm for the iTero, and 140.0 ±86.6 µm for the Cerec inLab workflow. Only the difference between the Cerec infinident and the Cerec inLab was statistically significant (*P*=.036). The conventionally fabricated crowns revealed significantly lower values in $Discrepancy_{cusp}$ and $Discrepancy_{occlusal}$ than all the crowns fabricated with digital workflows (P<.05).

Conclusions. In terms of marginal crown fit, no significant differences were found between the conventional and digital workflows for the fabrication of monolithic lithium disilicate crowns. In the occlusal regions, the conventionally manufactured crowns revealed better fit than the digitally fabricated crowns. Chairside milling resulted in less favorable crown fit than centralized milling production.

CLINICAL IMPLICATIONS

Lithium disilicate crowns fabricated with digital workflows have similar marginal fit to conventionally fabricated lithium disilicate crowns. In terms of internal fit, conventionally manufactured lithium disilicate crowns are better than restorations fabricated with a digital workflow.

INTRODUCTION

Multiple factors, including clinician preferences, patient comfort, and treatment costs, play a role in the planning of reconstructive treatment. The longevity of the restoration, however, remains key when it comes to long-term patient satisfaction. In this context, not only the participants' compliance regarding oral hygiene but also the marginal adaptation and the mechanical stability of the restoration are essential criteria. Poorly fitting restoration margins are associated with a risk of biologic complications through increased plaque accumulation and high rates of microleakage.[1,2] However, the internal fit influences the mechanical stability of the restoration. An increase in the size of the internal discrepancy between the abutment tooth and restoration reduces mechanical retention and increases the rate of ceramic fractures.[3,4]

The evolution of computer-aided design and computer-aided manufacturing (CAD/CAM) technology and the adaptation of tooth preparation techniques to the needs of CAM fabrication have significantly improved the fit of CAD/CAM restorations.[5-7] This fact together with the increase in production efficiency and the possibility of processing new restorative materials has led to the increasing acceptance of digital technology by dental technicians and clinicians.

The marginal accuracy of single crowns has been investigated in several in vitro studies and clinical trials.[8-15] A recent systematic review assessed the results of the marginal fit for crowns fabricated with 17 different fabrication processes.[16] The analysis revealed a wide range in the results. However, direct comparison between the systems was impossible because of the heterogeneity of the experimental protocols of the included studies, for example, the measurement method.

Currently, evidence is insufficient from clinical studies comparing the fit of digitally and conventionally fabricated restorations. In a clinical investigation, the marginal fit of zirconia crowns fabricated from digital impressions was compared with that of crowns obtained from conventional impressions.[8] In each of the 20 participants, 1 test and 1 control crown were fabricated for the same abutment tooth. The crowns fabricated by means of digital impressions resulted in better marginal adaptation than the crowns produced from the polyvinyl siloxane impressions. This study investigated the influence of the impression method on the crown fit. However, all the components of the digital technical workflow, the scanning, the CAD and the CAM processes influence the quality of the resulting restoration.[17,18]

The present randomized controlled clinical trial was designed to compare the overall performance of 4 digital and 1 conventional workflow for the fabrication of tooth-supported lithium disilicate crowns, from the impression to the delivery of the restoration. A design with intrasubject comparison and blinded assessment was used to reduce the influence of the confounding factors on the study outcome. Part I of the investigation assessed the digital and conventional impressions with respect to time effectiveness and the perception of both the participants and operators. Part II analyzed the time effectiveness and the efforts in the dental technical workflows. Part III investigated the clinical quality of the resulting crowns and the time needed for the prosthetic adjustments.

The purpose of part IV of this study was to test whether monolithic crowns fabricated with fully digital workflows differ from crowns fabricated with the conventional workflow with respect to marginal and internal fit.

MATERIAL AND METHODS

This study was designed as a blinded randomized controlled clinical trial with within-subject comparison of 4 digital and 1 conventional workflow for the fabrication of tooth-supported crowns. The study was performed at the Clinic of Fixed and Removable Prosthodontics and Dental Material Science, Center of Dental Medicine, University of Zurich, Zurich, Switzerland. The trial was approved by the local ethical committee (Kantonale Ethik-Kommission, Zurich, Switzerland) (Ref. KEK-ZH-Nr. 2011-0102/5).

10 participants in need of a single crown in the posterior jaw regions (8 molars and 2 premolars) were included in the study. The study inclusion criteria are reported in part I of this investigation. Written informed consent was obtained from all those participating in this study.

If 2 or more teeth per patient were available, fulfilling the inclusion criteria, 1 was selected by throwing a die. For each tooth, 4 crowns were digitally fabricated and 1 crown was conventionally fabricated. The sequence of the crown assessment was randomly allocated according to a computer-generated list. To eliminate operator bias, the investigators generated and evaluated the replicas without being able to distinguish among the crowns under investigation.

Three calibrated clinicians (GB, SM, IS) performed the clinical procedures. The clinicians were experienced with the tested digital impression systems and ceramic CAD/CAM restorations .The abutment teeth were prepared according to the guidelines for the fabrication of all-ceramic CAD/CAM crowns.[19] At the subsequent clinical appointment, 3 digital impressions and 1 conventional impression were made in each participant. The description of the impression procedure is reported in part I of this investigation.

Five monolithic lithium disilicate glass-ceramic crowns were fabricated for each abutment tooth. For the Lava workflow, optical impressions were made with the system-specific intraoral scanner (LAVA C.O.S.; 3M ESPE), and restorations were designed with the manufacturer's software (Lava C.O.S. Lab Software v3.0.2; 3M ESPE). Spacers were set at 70 μm and started 0.8 mm from the preparation margin. Data were subsequently exported to the Cares software (Cares Visual 6.2; Institut Straumann AG) and sent to a centralized milling center (Institut Straumann AG). The restorations were milled from lithium disilicate glass ceramic blocks (IPS e.max CAD; Ivoclar Vivadent AG).

For the iTero workflow, the optical impressions were made with the iTero scanner (Align Technologies Inc), and the restorations were subsequently designed with the Cares software (Cares Visual 6.2; Institut Straumann AG). The spacer was set at 70 μm and started 0.8 mm from the preparation margin. The lithium disilicate restorations (IPS e.max CAD; Ivoclar Vivadent AG) were milled in the same centralized milling center (Institut Straumann AG).

For the Cerec inLab workflow, optical impressions were made with the Cerec Bluecam (Sirona Dental Systems GmbH). and the restorations were designed with the Cerec Connect (SW 4.0.3; Sirona Dental Systems GmbH) and the Cerec inLab 3D Software (SW 4.0.3; Sirona Dental Systems GmbH). The spacer was set at 60 μm and started 0.8 mm from the preparation margin. The restorations were milled from lithium disilicate glass ceramic blocks (IPS e.max CAD; Ivoclar Vivadent AG) using a chairside milling device (Cerec inLab MC XL unit, Sirona Dental Systems GmbH).

For the Cerec infinident workflow, the optical impressions were made with Cerec Bluecam (Sirona Dental Systems GmbH), and the restorations were also designed with the Cerec Connect (SW 4.0.3; Sirona Dental Systems GmbH) and the Cerec inLab 3D Software (SW 4.0.3; Sirona Dental Systems GmbH). The spacer was set at 60 µm and started 0.8 mm from the preparation margin. In contrast to the Cerec inLab workflow, restorations were milled in a centralized milling center (infiniDent; Sirona Dental Systems GmbH).

For the Conventional workflow, impressions were made with a polyvinyl siloxane material (President; Coltène/Whaledent), and dental stone casts were subsequently fabricated (Type IV, Quadro-rock plus; Picodent). After a single application of die spacer (Chromo Spacer No. 1; Benzer Dental AG), a manual wax pattern of the restorations was made (Inlay Wax Soft; GC Austria GmbH). The restorations were fabricated using the lost-wax heat-pressing technique with lithium disilicate glass ceramic pellets (IPS e.max Press; Ivoclar Vivadent AG).

In each participant, the fabrication of Cerec inLab and Cerec infinident crowns was performed by using the same digital data set obtained with Cerec Bluecam. For the design of the CAD/CAM crowns, the spacer dimensions were set as recommended by the manufacturer. To ensure blinded evaluation, the lithium disilicate CAD/CAM crowns underwent crystallization firing to obtain a tooth shade.

A detailed description of the technical and clinical workflows used for the fabrication of lithium disilicate crowns is reported in part II and the part III of this investigation.

At the clinical evaluation appointment, 4 CAD/CAM crowns and 1 conventional crown were clinically assessed. If interproximal contact areas hindered the seating of the crown, the corresponding surfaces of the crown were reduced with diamond rotary instruments. The description of the clinical assessment of the restoration quality is reported in part III of this investigation.

Subsequently, the marginal and internal fit of the crowns was registered by means of the replica technique.[20-22] The crowns were filled with a light-body polyvinyl siloxane (Coltène Affinis light-body; Coltène/Whaledent) and placed on the abutment tooth by applying finger pressure in the apical direction. After the impression material had set, the crown was carefully removed together with the polyvinyl siloxane film adhering to the internal surface. The thin polyvinyl siloxane film was stabilized by injecting a heavy-body polyvinyl siloxane (Memosil; Heraeus Kulzer) into the crown. After setting, the polyvinyl siloxane materials were removed from the crown. Each replica was sectioned mesiodistally and buccolingually into 4 parts (Fig. 1). The cutting procedure was standardized by means of a study specific device to ensure the replicas of the same abutment tooth were sectioned in the same position (Fig. 2).

The thickness of the light-body polyvinyl siloxane representing the discrepancy between the crown and the abutment tooth was measured with a light microscope at ×200 magnification (Keyence VHX-2000 digital microscope; Keyence Deutschland GmbH). All the specimens were measured by 1 blinded investigator (MZ).

The discrepancy was assessed in 5 different regions of interest (Fig. 3). $Discrepancy_{marginal}$ was defined as the distance between the points representing the preparation finish line and the restoration margin. $Discrepancy_{shoulder}$ was defined as the mean value of 4 measurements in the region representing the shoulder (1 measurement each 100 µm), $Discrepancy_{axial}$ was defined as the mean value of 4 measurements in the region representing the axial wall (1 measurement each 250 µm), and $Discrepancy_{cusp}$ was defined as the mean value of 4 measurements in the region representing the cusp (1 measurement each 100 µm). The cusp was thereby characterized as the transition zone between the axial and occlusal surfaces. $Discrepancy_{occlusal}$ was defined as the mean value of 4 measurements in the region representing the occlusal surface (1 measurement each 250 μm). The specimens representing the mesial, buccal, distal, and lingual aspects of the crowns were consecutively analyzed.

Custom-written scripts in R (R Foundation for Statistical Computing) and SPSS Statistics v22.0 (IBM Corp) were used for statistical analysis. The data distributions were represented with boxplots, and the data were reported with means, standard deviations, ranges, and 95% confidence intervals. A linear mixed effects analysis was performed, and the data were log-transformed to approximate normal distribution. The restorations, the regions of interest, and the measurement locations (mesial, buccal, distal, lingual) were considered as fixed effects, and the intercepts for participants as random effects. If fixed factors or their interactions were statistically significant, the post hoc paired *t* test with Bonferroni correction was performed (α=.05).

RESULTS

The factor location (mesial, buccal, distal, lingual) and the interactions with this factor were not significant (P>.1), whereas the factors treatment modality, region of interest, and their interaction were statistically significant (P<.001). The pairwise comparison of different restorations was performed for each region of interest separately.

$\text{Discrepancy}_{\text{marginal}}$ was 83.6 ±51.1 μm for the Cerec infinident, 90.4 ±66.1 μm for the conventional, 94.3 ±58.3 μm for the Lava, 127.8 ±58.3 μm for the iTero, and 141.5 ±106.2 μm for the Cerec inLab workflow (Table 1, Fig. 4). The differences between the workflows were not statistically significant (P>.05).

$\text{Discrepancy}_{\text{shoulder}}$ was 82.2 ±42.4 μm for the Cerec infinident, 97.2 ±63.8 μm for the conventional, 103.4 ±52.0 μm for the Lava, 133.5 ±73.0 μm for the iTero, and 140.0 ±86.6 μm for the Cerec inLab workflow (Table 1, Fig. 5). The difference between the Cerec infinident and the Cerec inLab was statistically significant (P=.036).

With respect to $\text{Discrepancy}_{axial}$, no significant differences were found among the digitally fabricated crowns (P>.05) (Table 1, Fig. 6). $\text{Discrepancy}_{axial}$ was significantly lower for the crowns fabricated with the conventional workflow (80.0 ±40.4 μm) than for the crowns fabricated with the Cerec infinident workflow (107.1 ±48.0 μm) (P=.018).

The conventionally fabricated crowns revealed significantly lower values for $\text{Discrepancy}_{cusp}$ and $\text{Discrepancy}_{occlusal}$ than for all the digitally fabricated crowns (P<.05) (Table 1, Figs. 7, 8). $\text{Discrepancy}_{cusp}$ was significantly lower for the Lava (150.1 ±74.1 μm) than for the Cerec inLab workflow (198.1 ±95.2 μm) (P=.024). In the majority of the groups, the highest mean value of the internal discrepancy was found in the occlusal region followed by the cusps, the shoulder, and the axial walls (Fig. 9).

DISCUSSION

The present study revealed no significant differences in the marginal fit between the single crowns made of monolithic lithium disilicate fabricated with conventional and digital workflows. In the occlusal regions, the conventionally fabricated crowns revealed significantly better internal fit in comparison with the CAD/CAM crowns. Chairside milling resulted in less favorable crown fit than centralized milling.

The present findings regarding marginal fit assessed by the replica technique are in accordance with the results of the clinical examination, which were analyzed in part III of this investigation. Clinically, the monolithic digitally fabricated crowns did not differ from the conventionally fabricated crowns with respect to the marginal adaptation. However, the poorer internal fit of the CAD/CAM crowns found by the replica technique had no impact on the clinically assessed mechanical retention. At the clinical evaluation, no differences in the resistance to lateral and rotational forces were identified between the conventional and the CAD/CAM crowns.

Many in vitro studies have investigated the marginal fit of ceramic single crowns. A recent systematic review summarized the findings regarding the marginal fit of ceramic crowns obtained from 17 different fabrication procedures.[16] The analysis revealed a large range in the marginal discrepancy, with over 90% of the measured values < 120 μm. However, owing to the heterogeneity of the experimental protocols in the included trials (for example different measurement method), a direct comparison between the systems was impossible. The data from this systematic review were in agreement with the results of the present clinical trial. In the present study, digitally and conventionally fabricated crowns were compared at the same abutment tooth, thus reducing the effect of confounding factors on the study outcome. In addition, blinded investigators performed the examinations to eliminate operator bias.

Previous investigations assessed the influence of digital and conventional impressions on restoration fit. In a recent in vitro trial, the conventional impressions were compared with the digital impressions for the fabrication of single crowns made of different materials.[10] In this study, the digital impression systems (Cerec, Lava C.O.S, and iTero) rendered similar marginal crown fit in comparison with the conventional impressions with polyvinyl siloxane. In a clinical study, the marginal fit of zirconia crowns fabricated from digital Lava C.O.S. impressions was compared with that of crowns obtained from conventional impressions.[8] Crowns fabricated from digital Lava C.O.S. impressions revealed significantly better marginal fit than crowns fabricated from conventional polyvinyl siloxane impressions.

Other studies evaluated the influence of digital and conventional workflows on the fit of the resulting restorations. Two in vitro trials compared the conventional workflow with the polyvinyl siloxane impression and heat-press technique with the digital workflow with optical scans and CAD/CAM for the fabrication of lithium disilicate crowns.[9,12] In 1 study, the conventional impressions were combined with the heat-press technique or with the CAD/CAM fabrication (E4D system).[9] Additionally, the digital Lava C.O.S. impression was combined with the press technique or with the CAD/CAM fabrication. The combination of polyvinyl siloxane impression and heat-press fabrication produced the most accurate marginal fit of lithium disilicate crowns. In the second study, the CAD/CAM fabrication with the E4D system using different spacer settings was compared with the conventional press technique.[12] Similar to the findings of the previously described trial, the conventional technical workflow produced better marginal fit in comparison with the CAD/CAM fabrication. Moreover, in terms of internal fit, the conventionally fabricated crowns were superior to the digitally produced ones. The discrepancy between the results from different investigations may be explained by differences in the study design and the digital systems used for crown fabrication. A recent in vitro trial compared the marginal fit of lithium disilicate crowns fabricated with CAD/CAM technology by using the conventional and 2 digital impression techniques (LAVA C.O.S. and iTero).[11] The impression technique was found to have no significant effect on the marginal fit. Hence, digital and conventional impressions resulted in CAD/CAM crowns with similar marginal fit.

A previous clinical study compared the fit of veneered zirconia crowns fabricated by centralized milling (Lava) and chairside production (Cerec inLab) digital workflows. Regarding the marginal accuracy, significant differences were detected in favor of the crowns fabricated by centralized milling.[14] In the present trial, in general, the fit of the CAD/CAM crowns produced in a centralized milling center was better than that of the chairside-milled crowns. The lowest marginal fit was observed for the centralized and the highest values for the chairside fabrication with the Cerec system. Since the same optical scan and CAD software were used for the 2 CAM fabrication systems, it can be concluded that the differences in the restoration fit were a result of the differences in the milling production. This finding is in accordance with the results of a recent in vitro study which investigated the influence of different milling processes on the fit of ceramic restorations.[13] In this study, partial crowns were milled by using a 4-axial and a 5-axial milling unit. The accuracy of the restorations was assessed by means of 3D scanning and by superimposing the digital data sets. Restorations produced with a 5-axial milling unit revealed higher fit in comparison with those milled with a 4-axial milling unit.

In the present study, the conventional crowns revealed significantly better internal fit in the occlusal region than the CAD/CAM crowns. This finding is in accordance with the data of other studies that compared the CAD/CAM restorations and the conventionally fabricated ones.[12,15]

One of the main aims of fixed prosthodontics is to achieve restorations with excellent marginal adaptation and high mechanical stability. The fact that the CAD/CAM crowns did not differ from the conventionally fabricated crowns with respect to marginal fit is clinically relevant. The restorations fabricated by using fully digital workflows can perform similarly regarding resistance to marginal microleakage and caries to conventional restorations. However, the poor occlusal fit of the CAD/CAM restorations may imply an increase in the risk of fractures because of the reduced support and stabilization of the ceramic through adhesion to the tooth substance. The clinical implications of the findings from the present study with respect to the marginal seal, retention, and stability of restorations fabricated with fully digital workflows have not been sufficiently investigated. Future comparative studies should assess the long-term clinical performance of CAD/CAM restorations.

CONCLUSION

Within the limitations of the present clinical study, the following was concluded for single tooth-supported monolithic lithium disilicate crowns:

1. In terms of marginal fit, no significant differences exist between the conventional and digital workflows for crown fabrication.
2. In the occlusal regions,conventionally fabricated crowns have better fit than digitally fabricated crowns.

3. Chairside milling resulted in less favorable crown fit than centralized milling production.

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TABLES

Table 1: Discrepancy size in different regions of interest

	Lava			**iTero**			**Cerec inLab**			**Cerec infinident**			**Conventional**		
	Mean ± SD (Median)	**95% CI (Range)**	***P****	**Mean ± SD (Median)**	**95% CI (Range)**	**p-value***	**Mean ± SD (Median)**	**95% CI (Range)**	***P****	**Mean ± SD (Median)**	**95% CI (Range)**	***P****	**Mean ± SD (Median)**	**95% CI (Range)**	***P****
Marginal	94.3 ± 58.3 (81.5)	75.6 - 112.9 (22.0 - 242.0)	iTero >.1 Cerec inLab >.1 Cerec infinident >.1 Conv. >.1	127.8 ± 58.3 (111.5)	103.1 - 152.5 (34.0 - 312.0)	Lava >.1 Cerec inLab >.1 Cerec infinident >.1 Conv. >.05	141.5 ± 106.2 (126.5)	107.6 - 175.4 (12.0 - 418.0)	Lava >.1 iTero >.1 Cerec infindent >.1 Conv. >.1	83.6 ± 51.1 (75.0)	67.0 - 100.2 (12.0 - 253.0)	Lava >.1 iTero >.1 Cerec inLab >.1 Conv. >.1	90.4 ± 66.1 (76.0)	69.0 - 111.9 (10.0 - 335.0)	Lava >.1 Tero >.05C erec inLab >.1 Cerec infinident >.1
Shoulder	103.4 ± 52.0 (92.3)	86.7 - 120.0 (26.3 - 213.3)	iTero >.1 Cerec inLab >.1 Cerec infinident >.1 Conv. >.1	133.5 ± 73.0 (116.1)	110.1 - 156.8 (35.5 - 355.3)	Lava >.1 Cerec inLab >.1 Cerec infinident >.1 Conv. > 0.05	140.0 ± 86.6 (123.5)	112.3 - 167.7 (15.3 - 369.0)	Lava >.1 iTero >.1 Cerec infindent=.036† Conv. >.1	82.2 ± 42.2 (71.8)	68.7 - 95.8 (3.8 - 187.8)	Lava >.1 iTero >.1 Cerec inLab = .036† Conv. >.1	97.2 ± 63.8 (76.5)	76.5 - 117.9 (24.8 - 343.3)	Lava >.1 iTero >.05 Cerec inLab >.1 Cerec infinident >.1
Axial	91.2 ± 36.9 (83.75)	79.4 - 103.0 (38.0 - 205.0)	iTero >.1 Cerec inLab >.1 Cerec infinident >.1 Conv. >.1	111.4 ± 61.4 (98.4)	91.8 - 131.1 (42.3 - 408.0)	Lava >.1 Cerec inLab >.1 Cerec infinident >.1 Conv. >.1	96.9 ± 34.4 (95.9)	85.9 - 107.9 (42.5 - 195.5)	Lava >.1 iTero >.1 Cerec infindent >.05 Conv. >.1	107.1 ± 48.0 (89.8)	91.7 - 122.4 (47.3 - 224.5)	Lava >.1 iTero >.1 Cerec inLab >.1 Conv. = .018†	80.0 ± 40.4 (72.3)	66.9 - 93.1 (33.0 - 229.0)	Lava >.1 iTero >.05 Cerec inLab >.05 Cerec infinident=.018†
Cusp	150.1 ±74.1 (134.0)	126.4 - 173.8 (59.3 - 376.3)	iTero >.1 Cerec inLab = .024† Cerec infinident 0.1 Conv. <.005†	172.8 ± 78.1 (154.6)	147.8 - 197.8 (47.8 - 485.8)	Lava >.1 Cerec inLab >.1 Cerec infinident >.1 Conv. <.001†	198.1 ± 95.2 (169.6)	167.6 - 228.5 (73.3 - 515.0)	Lava = .024† iTero >.1 Cerec infindent >.1 Conv. <.001†	176.2 ± 55.1 (159.2)	158.6 - 193.8 (89.8 - 294.0)	Lava >.1 iTero >.1 Cerec inLab >.1 Conv.<.001†	98.9 ± 59.1 (87.0)	80.0 - 117.8 (30.0 - 329.0)	Lava <.005† iTero <.0001† Cerec inLab <.001† Cerec infinident <.001†
Occlusal	189.3 ± 72.1 (170.9)	166.3 - 212.4 (87.0 - 404.0)	iTero >.1 Cerec inLab >.05 Cerec infinident >.05 Conv. <.001†	205.5 ± 82.2 (169.5)	179.2 - 231.7 (106.8 - 451.3)	Lava >.1 Cerec inLab >.1 Cerec infinident >.1 Conv. <.001†	285.2 ± 153.7 (235.9)	236.1 - 334.4 (78.8 - 753.0)	Lava >.05 iTero >.1 Cerec infindent >.1 Conv. <.001†	230.6 ± 75.1 (216.3)	206.6 - 254.6 (125.8 - 426.3)	Lava >.05 iTero >.1 Cerec inLab >.1 Conv.<.001†	113.3 ± 73.1 (73.8)	89.9 - 136.7 (22.0 - 412.2)	Lava <.001† iTero <.001† Cerec inLab <.001† Cerec infinident <.001†

FIGURES

Figure 1: Thin layer of light-body polyvinyl siloxane (replica) stabilized with hea

polyvinyl siloxane (occlusal view). Sectioned in mesiodistal and buccolingual di

mesial, d: distal, b: buccal, l: lingual).

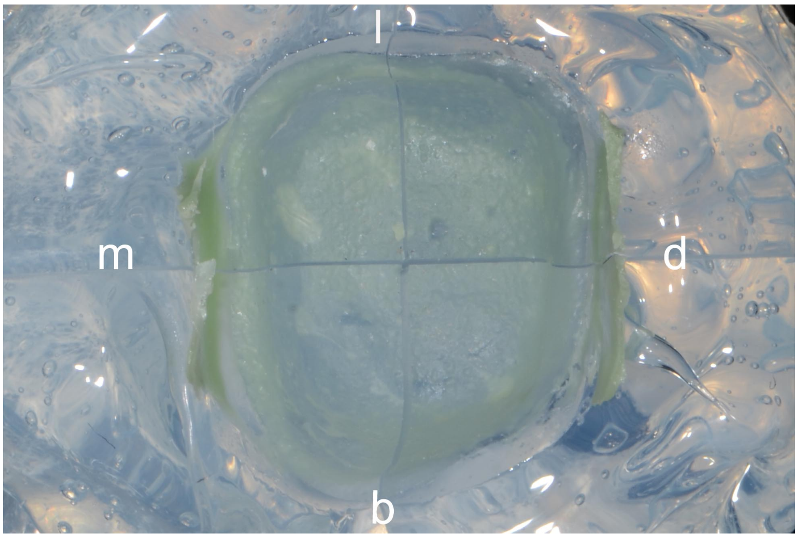

Figure 2: Study-specific device for standardized sectioning of polyvinyl siloxane replicas.

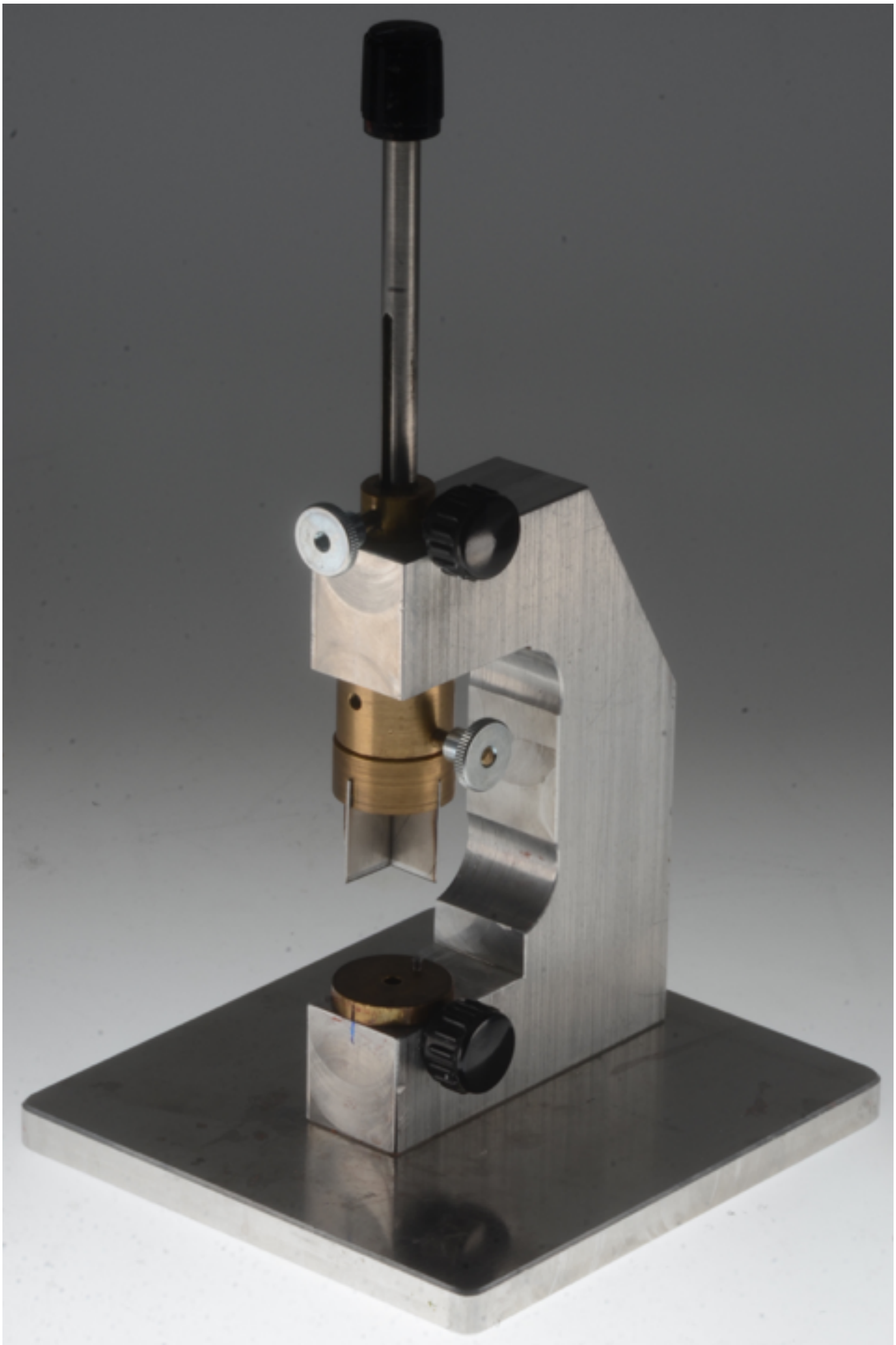

Figure 3 A, Section of replica specimen. B, Region of interest (ROI) shoulder. C, ROI axial wall. D, ROI cusp. E, ROI occlusal surface.

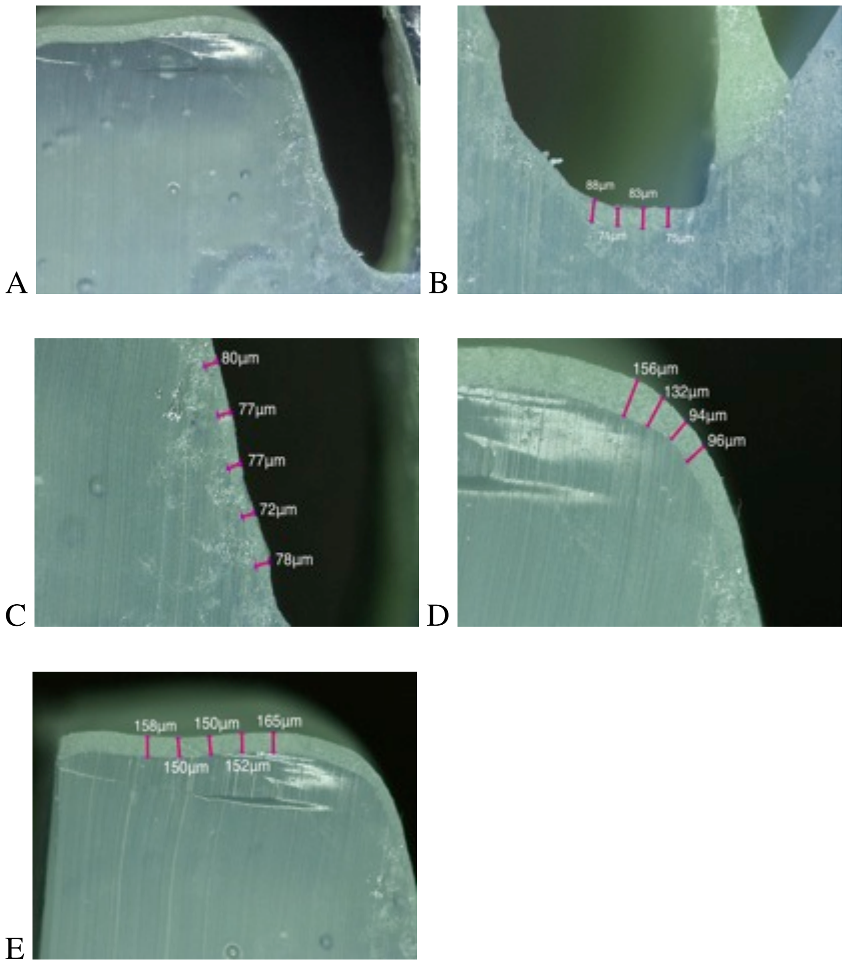

Figure 4: Size of marginal discrepancy (µm). Box plots represent mean, 25th and 75th percentiles, minimum, and maximum values.

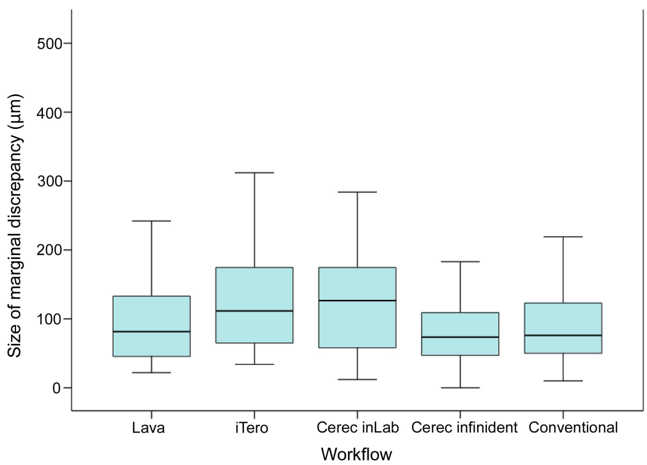

Figure 5: Discrepancy size in shoulder region (μm). Box plots represent mean, 25th and 75th percentiles, minimum, and maximum values.

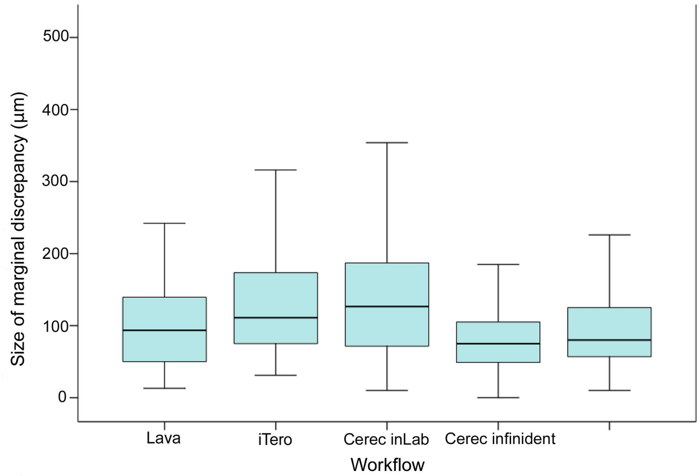

Figure 6: Discrepancy size of axial wall region (μm). Box plots represent mean, 25th and 75th percentiles, minimum, and maximum values.

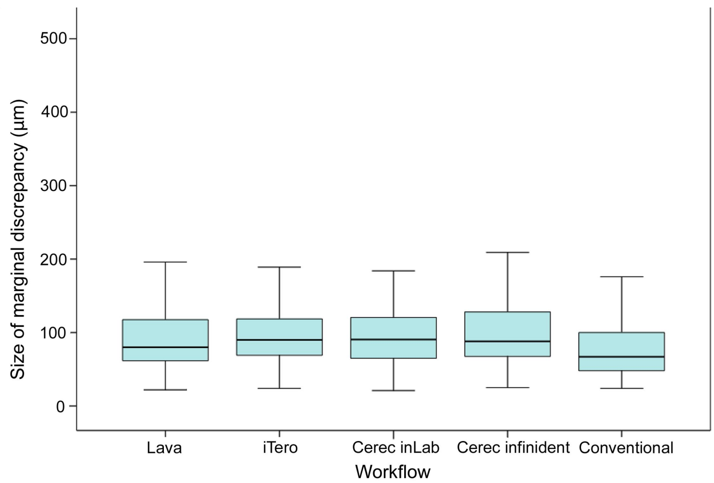

Figure 7: Discrepancy size in cusp region (µm). Box plots represent mean, 25th and 75th percentiles, minimum and maximum values.

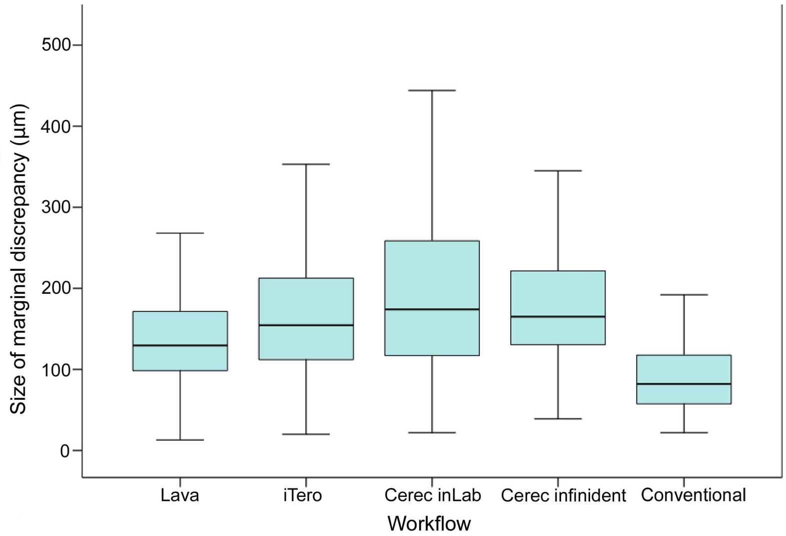

Figure 8: Discrepancy size in occlusal surface region (µm). Box plots represent mean, 25th and 75th percentiles, minimum, and maximum values.

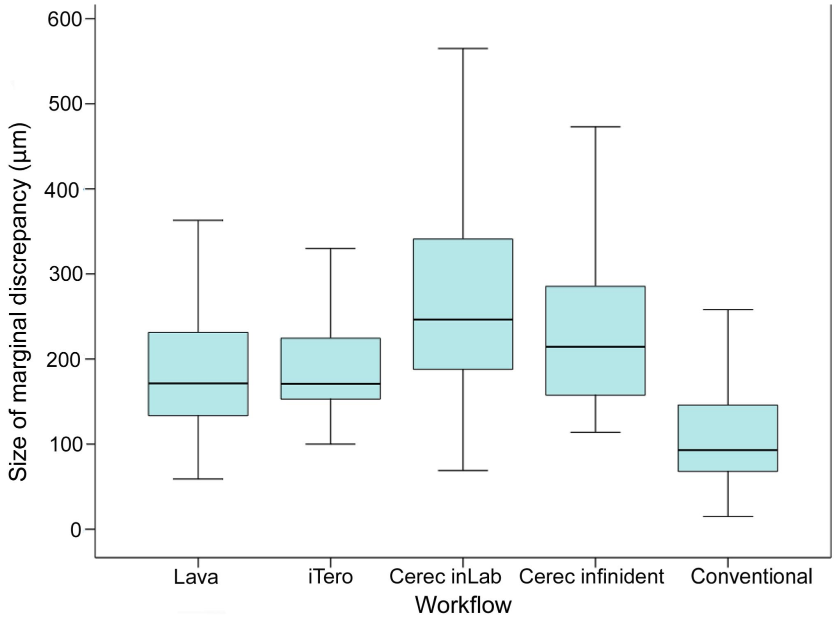

Figure 9: Discrepancy size in five regions of interest (µm). Box plots represent mean, 25th and 75th percentiles, minimum, and maximum values.