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RESTORATIVE DENTISTRY

As described in the last issue, this section aims to summarize a few important topics of debate that are published on the main dentistry journals indexed, touching the hot topics of modern restorative dentistry. For this issue, we selected studies that evaluate a few finishing/polishing systems for composite resins. The finishing stage of a composite-based restoration has a demanding need of well executed polishing and refining touches. This stage is essential for keeping marginal integrity, maintenance of longevity, oral health, comfort to the patient, pigmentation reduction and material wears. Therefore, negligence and execution failures on the finishing touches may eventually lead to infiltrations, cavity reincidences, bigger susceptibility to superficial stains, gingival inflammation, and bigger chances of plaque accumulation, leading to discomforts to the patient.

The main objective of finishing/polishing techniques is to help to provide an adequate anatomy of a restored tooth, removing excesses and keeping a smooth and bright surface. These procedures may be made with abrasive rubber, diamond burs, sandpaper, discs and polishing pastes. The systems used for these procedures may range from single-step to four or more steps. In order to have an imperceptible restoration, the surface of the composite must be the same as the enamel, having the last amount of roughness as possible. These characteristics are directly, related with the quality and kind of the composite used, in tandem with the correct finishing technique for each kinf composite.

With these reasons exposed, we reunited a few published articles, which discuss the effectiveness of composite polishing techniques, mainly focusing on the resulting variables (surface roughbess and brightness).

The first article compared two-step versus four-step composite finishing/polishing disc system, evaluating roughness and brightness of composite resins. The article was published in Operative Dentistry, in 2011.

COMPARISON OF TWO-STEP VERSUS FOUR-STEP COMPOSITE FINISHING/POLISHING DISC SYSTEMS: EVALUATION OF A NEW TWO-STEP COMPOSITE POLISHING DISC SYSTEM

da Costa JB, Goncalves F, Ferracane JL

Oper Dent. 2011 Mar-Apr;36(2):205-12. Epub 2011 Jun 24.

doi: 10.2341/10-162-L

Objective: The purpose of this study was to evaluate surface finish and gloss of a two-step composite finishing/polishing (F/P) disc system compared with two multistep systems on five composites.

METHODS: Seventy-five disc-shaped composite specimens (D=10.0 mm, 2 mm thick, n=15 per composite) were made of microfill (Durafill-D), nanofill (Filtek Supreme-FS), nanohybrid (Premise-PR), and microhybrids (Filtek Z250-FZ, Esthet-EX). One side of each specimen was initially finished with a carbide bur. Five specimens of each resin composite were randomly assigned to receive full F/P by each of the disc systems: two-step (Enhance Flex NST-EF) and four-step (Sof-Lex-SL, Super-Snap-SS). Surface gloss was measured with a glossmeter and surface roughness was measured with a profilometer. Results were analyzed by two-way analysis of variance (ANOVA)/Tukey's (α<0.05).

RESULTS: No difference in gloss was noted among the three F/P systems when used with D and EX; no difference between SL and EF when used with any composite, except for FS; and no difference between SL and SS when used with any composite. SL and EF showed similar surface roughness when used on all composites, except for EX. EF and SS showed similar surface roughness on PR. SL and SS showed similar surface roughness values on every composite, except for FZ.

CONCLUSIONS: EF was capable of providing similar gloss and surface roughness to SL on four composites evaluated but was not able to produce as glossy or as smooth a surface as SS for three of the five composites.

COMMENTARY: The two-step composite disc finishing/polishing system, Enhance Flex NST, can provide a nearly equivalent surface finish as two four-step systems on a variety of composites, in approximately half the time. All systems produce clinically acceptable gloss and surface roughness.

The second article analyzed the surface roughness and gloss of composites as polished with different polishing systems. The article was published in Operative Dentistry, 2015.

SURFACE ROUGHNESS AND GLOSS OF ACTUAL COMPOSITES AS POLISHED WITH DIFFERENT POLISHING SYSTEMS

Rodrigues-Junior SA, Chemin P,
Piaia PP, Ferracane JL

Oper Dent. 2015 Jul-Aug;40(4):418-29. Epub 2014 Sep 30.
doi: 10.2341/14-014L

OBJECTIVE: This *in vitro* study evaluated the effect of polishing with different polishing systems on the surface roughness and gloss of commercial composites.

METHODS: One hundred disk-shaped specimens (10 mm in diameter × 2 mm thick) were made with Filtek P-90, Filtek Z350 XT, Opallis, and Grandio. The specimens were manually finished with #400 sandpaper and polished by a single operator using three multistep systems (Superfix, Diamond Pro, and Sof-lex), one two-step system (Polidores DFL), and one one-step system (Enhance), following the manufacturer's instructions. The average surface roughness (μm) was measured with a surface profilometer (TR 200 Surface Roughness Tester), and gloss was measured using a small-area glossmeter (Novo-Curve, Rhopoint Instrumentation, East Sussex, UK). Data were analyzed by two-way analysis of variance and Tukey's test (α=0.05).

RESULTS: Statistically significant differences in surface roughness were identified by varying the polishing systems ($p<0.0001$) and by the interaction between polishing system and composite ($p<0.0001$). Pairwise comparisons revealed higher surface roughness for Grandio when polished with Sof-Lex and Filtek Z250 and Opallis when polished with Enhance. Gloss was influenced by the composites ($p<0.0001$), the polishing systems ($p<0.0001$), and the interaction between them ($p<0.0001$). The one-step system, Enhance, produced the lowest gloss for all composites.

CONCLUSIONS: Surface roughness and gloss were affected by composites and polishing systems. The interaction between both also influenced these surface characteristics, meaning that a single polishing system will not behave similarly for all composites. The multistep systems produced higher gloss, while the one-step system produced the highest surface roughness and the lowest gloss of all.

COMMENTARY: The choice of polishing system should take into consideration the type of composite used. For actual commercial composites, multistep systems produce lower surface roughness and higher gloss than the one-step system.

The third article evaluated the effect of the application of surface sealants, comparing them with conventional polishing systems, evaluating the influence of the waiting time for polishing. The article was published in Operative Dentistry in the year 2018..

EFFECT OF SURFACE SEALANTS AND POLISHING TIME ON COMPOSITE SURFACE ROUGHNESS AND MICROHARDNESS

Ruschel VC, Bona VS, Baratieri LN, Maia HP

Oper Dent. 2018 Jul/Aug;43(4):408-415. Epub 2018 Apr 9.
doi: 10.2341/17-048-L

OBJECTIVE: The objective of this study was to evaluate the effect of surface sealants and polishing delay time on a nanohybrid resin composite roughness and microhardness.

METHODS: Eighty disc specimens were made with a nanohybrid resin (Esthet-X HD, Dentsply). The specimens were divided into two groups (n=40) according to polishing time: immediate, after 10 minutes; delayed, after 48 hours. Each group was subdivided into four groups (n=10),

according to the surface treatment: CG, control-rubber points (Jiffy Polishers, Ultradent); PP, rubber points + surface sealant (PermaSeal, Ultradent); PF, rubber points + surface sealant (Fortify, Bisco); PB, rubber points + surface sealant (BisCover, Bisco). Surface roughness (Ra) and microhardness (50 g/15 seconds) were measured. Surface morphology was analyzed by scanning electron microscopy and atomic force microscopy. The data were analyzed statistically using one-way analysis of variance and the Games-Howell post hoc test (α=0.05).

RESULTS: PermaSeal roughness (G2) in the delayed polishing group was significantly higher (p=0.00) than that of the other groups. No difference was observed among the groups between immediate and delayed polishing (p=1.00), except for PermaSeal (p=0.00). Moreover, PermaSeal showed the lowest microhardness values (p=0.00) for immediate polishing. Microhardness was higher at delayed polishing for all the surface treatments (p=0.00) except Fortify (p=0.73).

CONCLUSION: Surface smoothness similar to polishing with rubber points was achieved when surface sealants were used, except for PermaSeal surface sealant, which resulted in a less smooth resin composite surface. However, surface sealant application did not significantly improve composite resin microhardness.

COMMENTARY: Application of surface sealants do not improve the surface smoothness and microhardness of the composite resin.

The fourth article evaluated the roughness and surface morphology of nanoparticulate resins polished with different systems. The article was published in the Journal of Esthetic and Restorative Dentistry in the year 2016.

EFFECTS OF NOVEL FINISHING AND POLISHING SYSTEMS ON SURFACE ROUGHNESS AND MORPHOLOGY OF NANOCOMPOSITES

Aytac F, Karaarslan ES, Agaccioglu M, Tastan E, Buldur M, Kuyucu E

J Esthet Restor Dent. 2016 Jul;28(4):247-61. Epub 2016 Apr 28.

doi: 10.1111/jerd.12215

OBJECTIVE: The purpose of this *in vitro* study was to evaluate the effects of different finishing/polishing techniques on the surface roughness of nanocomposites after thermocycling aging.

MATERIALS AND METHODS: Five contemporary resin-based composites (Clearfil Majesty ES-2, Filtek Z550, EsteliteΣQuick, Zenit, Filtek Z250) were tested. For each resin-based composite, 50 disc-shaped specimens were prepared and groups were divided into five subgroups according to the finishing/polishing methods (n = 10): control, finishing/polishing brush, finishing/polishing disc, and two different finishing/polishing wheels. Before and after aging, the surface roughness of specimens was measured. For each treatment method two samples were analyzed using a scanning electron microscope. Two-way analysis of variance and paired samples t-tests were used to evaluate the data and the means were compared by Bonferroni tests ($p \leq 0.05$).

RESULTS: Before aging, the Filtek Z250 resin with the Mylar strip group showed the lowest surface roughness (Ra) value (0.13 ± 0.03 µm, $p < 0.05$) and the Clearfil Majesty ES 2 resin with Occlubrush finishing/polishing system showed the highest (0.7 ± 0.13 µm, $p < 0.05$). After aging, the Clearfil Majesty ES 2 resin with the Mylar strip group showed the highest surface roughness (Ra) value (0.96 ± 0.4 µm) and the Clearfil Majesty ES 2 resin with the Sof-Lex aluminum oxide disc finishing/polishing system showed the lowest surface roughness (Ra) value (0.25 ± 0.06 µm, $p < 0.05$).

CONCLUSIONS: Composite type and finishing/polishing method significantly affected the surface roughness of composites before and after thermocycling aging.

COMMENTARY: There were significant interactions between finishing/polishing methods and composite types for surface roughness. The results give clinicians some flexibility in choosing appropriate finishing/polishing techniques for each resin composite material.

The fifth article was a randomized study using 3D profilometer and Scanning Electron Microscope to analyze the surface of different types of composite resins, polished with different polishing systems. The article was published in the Journal of Dentistry in the year 2018.

A RANDOMISED CONTROLLED STUDY ON THE USE OF FINISHING AND POLISHING SYSTEMS ON DIFFERENT RESIN COMPOSITES USING 3D CONTACT OPTICAL PROFILOMETRY AND SCANNING ELECTRON MICROSCOPY

Daud A, Gray G, Lynch CD, Wilson NHF, Blum IR

J Dent. 2018 Apr;71:25-30. Epub 2018 Jan 31.

doi: 10.1016/j.jdent.2018.01.008

OBJECTIVE: The aim of this study was to evaluate theeffects of different finishing and polishing techniques on the surface roughness of microhybrid and nanofilled resin composites.

METHODS: The resin composites included were Filtek Z250 (a universal microhybrid resin composite) and Filtek Supreme XTE (a universal nanofill resin composite). Ninety cylindrical-shaped specimens were prepared for each composite resin material. The

polishing methods used included tungsten carbide bur (TC); diamond bur (Db); Sof-Lex discs (S); Enhance PoGo discs (PG); TC + S; Db + S; TC + PG; Db + PG. Polymerisation against a Mylar strip without finishing and polishing acted as the control group. Surface roughness was measured using a 3D contact optical profilometer and surface morphology was examined by scanning electron microscope examination.

RESULTS: The results showed that the Mylar-formed surfaces were smoothest for both composites. Finishing with the 20 m diamond finishing bur caused significantly greater surface irregularity ($P < 0.0001$) and damage than finishing with the tungsten carbide finishing bur. The Enhance PoGo polishing system produced smoother surfaces than the Sof-Lex disc polishing system; this difference was statistically highly significant ($P < 0.0001$).

CONCLUSION: For both composites, the Mylar-formed surfaces were smoothest. Where indicated clinically, finishing is better conducted using a tungsten carbide bur- rather than a diamond finishing bur. The Enhance PoGo system was found to produce a smoother surface finish than the Sof-Lex system.

COMMENTARY: If finishing and polishing is required the use a tungsten carbide finishing bur followed by Enhance PoGo polishing may be found to result in the smoothest surface finish.

The sixth article evaluated the influence of polishing systems on the color stability of composite resins. The article was published in the Journal of Dentistry in the year 2012.

THE EFFECTS OF FINISHING AND POLISHING TECHNIQUES ON SURFACE ROUGHNESS AND COLOR STABILITY OF NANOCOMPOSITES

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J Dent. 2012 Dec;40 Suppl 2:e64-70. Epub 2012 Jul 20.
doi: 10.1016/j.jdent.2012.07.005.

OBJECTIVE: The aim of this *in vitro* study was to evaluate the effects of different finishing and polishing techniques on the surface roughness and color stability of nanocomposites.

METHODS: Two nanohybrid (Grandio, Aelite Aesthetic Enamel), two nanofill (Filtek Supreme XT Dentin and Translucent), and a microhybrid (Filtek Z250) composites were used. Two hundred and eighty disc-shaped specimens were cured under a mylar strip. Seven specimens of each resin composite were randomly assigned to one of the seven polishing

systems. A profilometer was used for assessing surface roughness. ΔE was calculated with a colorimeter at baseline and 48 h after storage in a coffee solution. The results were analysed by two-way ANOVA and Tukey's HSD test (α=0.05). Regression analysis was used to examine the correlation between surface roughness and color stability (α=0.01).

RESULTS: There was no significant difference in R(a) values between mylar strips and Sof-Lex polishing discs ($p>0.05$). The highest ΔE and R(a) values were obtained from Grandio ($p<0.05$), and Aelite Aesthetic Enamel had the lowest ΔE values ($p<0.05$). The Enhance system showed the lowest color differences among all the finishing systems. The highest ΔE values were found in the composite resin groups under mylar strips and finished with diamond burs ($p<0.05$).

CONCLUSIONS: While the Sof-Lex discs provided the lowest surface roughness, the Enhance Polishing system provided the most stain-resistant groups. Grandio presented the highest surface roughness and staining susceptibility after storage in coffee solution. Aelite Aesthetic Enamel, which did not include TEGDMA in its composition, showed the least discoloration.

COMMENTARY: The composites with smaller filler size did not necessarily show low surface roughness and discoloration. Staining of composite resins was dependent on monomer structure, as well as surface irregularities.

The seventh article evaluated the color stability of nanoparticulate resins, influenced by the polishing system used. The article was published in the Journal of Prosthetic Dentistry in the year 2012.

EFFECT OF POLISHING SYSTEMS ON STAIN SUSCEPTIBILITY AND SURFACE ROUGHNESS OF NANOCOMPOSITE RESIN MATERIAL

Barakah HM, Taher NM

J Prosthet Dent. 2014 Sep;112(3):625-31. Epub 2014 Apr 12.

doi: 10.1016/j.prosdent.2013.12.007

OBJECTIVE: Different polishing systems vary in their effect on reducing surface roughness and stain susceptibility of dental composite resin materials.

PURPOSE: The purpose of this study was to compare the effect of 3 polishing systems on the stain susceptibility and surface roughness of 2 nanocomposite resins and a microhybrid composite resin.

MATERIAL AND METHODS: Forty-five disks (2×10 mm) each were fabricated of 2 nanocomposite resins (Filtek Supreme XT and Tetric EvoCeram) and 1 microhybrid composite resin (Z250). Both sides of the disks were wet finished, and 1 side was polished with PoGo, Astropol, or Hi-Shine (n=5). Unpolished surfaces served as controls. The average roughness (Ra, μm) was measured with a profilometer, and the baseline color was recorded with a spectrophotometer. All specimens were incubated while soaking in a staining solution of coffee, green tea, and berry juice for 3 weeks. The color was recorded again, and the data were analyzed with 2-way ANOVA at α=.05 and Tukey multiple comparison tests.

RESULTS: All polishing systems improved the staining resistance of Filtek Supreme XT and Z250 but did not affect that of Tetric EvoCeram. The surface color of Filtek Supreme XT was changed significantly and was the smoothest after polishing with PoGo, whereas Hi-Shine produced significantly rougher surfaces but with the lowest color change. Hi-Shine produced the highest color change in Z250. The surface roughness did not differ significantly between the other polishing systems. Tetric EvoCeram showed no significant differences in color change or surface roughness.

CONCLUSIONS: Staining susceptibility and surface roughness depend mainly on material composition and on the polishing procedures. Polishing improves the staining resistance of composite resins. Nanocomposite resins did not exhibit better staining resistance or surface roughness than microhybrid composite resin.

COMMENTARY

Polishing is recommended to improve the staining resistance of Filtek Supreme XT and Z250. Of the materials tested, Tetric EvoCeram had the greatest stain resistance with or without polishing.

The choice of polishing system should take into consideration the type of composite used. Multistep systems produce lower surface roughness and higher gloss than the one-step system. Application of surface sealants do not improve the surface smoothness and microhardness of the composite resin. The articles give clinicians some flexibility in choosing appropriate finishing/polishing techniques for each resin composite material. If finishing and polishing is required the use a tungsten carbide finishing bur followed by polishing may be found to result in the smoothest surface finish. The fine tungsten carbide burs provided less roughness compared to a fine diamond bur. The composites with smaller filler size did not necessarily show low surface roughness and discoloration. Staining of composite resins was dependent on monomer structure, as well as surface irregularities.

PROSTHESIS

Currently the development of the scanners has offered several possibilities, either for acquisition of images directly in the patient's mouth (direct scanning technique) or for the digitization of a previous model and construction of virtual models through a desk scanner (indirect scanning). For various purposes, the images can be used for diagnosis and planning, CAD / CAM technique, among others. Several trademarks are available on the market, each one with its own peculiarities and different methods of image acquisition, such as Confocal laser scanning microscopy, Optical triangulation, Accordion edge interferometry, Active wavefront sampling and Optical coherence tomography, among others.

CONFORMITY, RELIABILITY AND VALIDITY OF DIGITAL DENTAL MODELS CREATED BY CLINICAL INTRAORAL SCANNING AND EXTRAORAL PLASTER MODEL DIGITIZATION WORKFLOWS

Kirschneck C, Kamuf B, Putsch C, Chhatwani S, Bizhang M, Danesh G

Comput Biol Med. 2018 Sep 1;100:114-22. Epub 2018 Jun 30.

doi: 10.1016/j.compbiomed.2018.06.035.

BACKGROUND: *In dentistry, digitization of dental arches with intraoral scanners could one day replace impressions and plaster model digitization processes, if accuracy is clinically sufficient. This study aimed to assess the reliability, validity and conformity of an intraoral scanning procedure (Lythos©, Ormco) and of two extraoral digitization workflows via alginate impression and plaster model scanning with the D810© (3shape) or the Atos II Triple Scan© (GOM) under clinical conditions.*

METHODS: *In 20 subjects three consecutive intraoral scans, three alginate and one reference polyether impression were taken of both the upper and lower dental arch, respectively. The digital models created from the corresponding plaster models and the intraoral scans were superimposed with the polyether reference standard by both a global and a local best-fit algorithm. Reliability, validity and conformity of the three digital workflows were assessed via intraclass (ICC) and Lin's concordance correlation coefficients (CCC) as well as analyses according to Bland-Altman.* **RESULTS:** *The digital models created from the intraoral scanning procedure were less in agreement with the polyether reference (validity) than those from the extraoral procedures with reduced conformity and reliability. Local numerical deviations from the reference standard were approximately twice as high compared to the extraoral procedures, which showed high conformity and were equivalent and clinically acceptable in terms of reliability and validity.* **CONCLUSIONS:** *Although the intraoral scanning method with Lythos© seems to have drawbacks in terms of reliability, validity and conformity to the indirect alginate methods, all procedures proved to be clinically equivalent for diagnostic purposes.*

COMMENT: *This study compared three digital streams to obtain diagnostic models for orthodontic purposes. From these, two indirect flows were evaluated, one with alginate molding, obtaining the gypsum model and subsequent digitization; and the other molding with polyether and subsequent digitization of the plaster model (control group). In the direct flow, the intraoral scan of the arch was performed. Based on the results of this study, it was found that intraoral scanning obtained the greatest variation, and lower reliability and compliance in relation to the alginate group, when compared to the control group. Despite the differences, the authors concluded that direct and indirect methods are equivalent for diagnostic purposes. Perhaps this conclusion was different if one were evaluating the adaptation and one fixed partial prosthesis.*

EVALUATION OF THE FIT OF ZIRCONIA COPINGS FABRICATED BY DIRECT AND INDIRECT DIGITAL SCANNING PROCEDURES

Lee B, Oh KC, Haam D, Lee JH, Moon HS

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doi: 10.1016/j.prosdent.2017.08.003

STATEMENT OF PROBLEM: *Intraoral scanners are effective for direct digital scans when dental restorations are fabricated using computer-aided design and computer-aided manufacturing (CAD-CAM); however, if the abutment tooth cannot be dried completely or the prepared margin is placed subgingivally, accurate digital images cannot always be guaranteed.* **PURPOSE:** *The purpose of this in vitro study was to compare the internal and marginal discrepancies of zirconia copings fabricated directly using an intraoral scanner with those fabricated indirectly with impression scanning.* **MATERIAL AND METHODS:** *Forty-five resin dies fabricated with a 3-dimensional (3D) printer were divided into 3 groups: direct scanning (DS), impression scanning (IMP), and lost-wax casting (LW). For the DS group, a resin die was scanned with an intraoral scanner (Trios; 3Shape), whereas for the IMP group, impressions made with polyether were scanned with a cast scanner (D700; 3Shape). The zirconia copings were fabricated in the same way in the DS and IMP groups. For the LW group, impressions were made in the same way as in the IMP group, and Ni-Cr alloy copings were fabricated using LW. The marginal and internal discrepancies of the copings were measured by cementing them onto resin dies, embedding them in acrylic resin, and sectioning them in a buccolingual direction. The cement layer was measured, and the Kruskal-Wallis test was used to detect significant differences (α=.05). A nonparametric Friedman test was also performed to compare the measurements of each group by location (α=.05).* **RESULTS:** *The mean marginal discrepancies in the DS, IMP, and LW groups were 18.1 ±9.8, 23.2 ±17.2, and 32.3 ±18.6 μm (mean ±standard deviation), respectively. The mean internal discrepancies of the DS, IMP, and LW groups in the axial area were 38.0 ±9.1, 47.0 ±16.3, and 36.5 ±15.8 μm, and those in the occlusal area were 36.7 ±16.9, 33.4 ±21.6, and 44.5 ±31.9 μm, respectively. No statistically significant differences were found in marginal or internal discrepancies among groups (P>.05).* **CONCLUSIONS:** *Within the limitations of this study, the zirconia copings fabricated with CAD-CAM using different digitization methods and Ni-Cr copings fabricated using the lost-wax technique and casting produced clinically acceptable marginal and internal discrepancies. No significant differences were found among the DS, IMP, and LW groups.*

COMMENT: *The present study evaluated the internal discrepancy and marginal adaptation of zirconia copings in two different possibilities: DS- through direct scanning; IMP – through the indirect scanning of printed models obtained from a polyether mold; additionally, the same parameters were also evaluated for NiCr copings made in the same way as the IMP group. The results of the study showed variances in the marginal adaptation and discrepancies in the thickness of the cementation line between the 3 groups, however, without statistical differences between them. In our opinion, this study brings important information in the comparison of the DS group and IMP. However, the comparison between the three groups is not possible, since they use different materials to make copings (DS and IMP zirconia and LW-NiCr). Perhaps the use of a metal alloy capable of being machined by the CAD / CAM technique and also by the lost wax technique would be the most correct for the purpose of multiple comparisons.*

EVALUATION OF OPERATING TIME AND PATIENT PERCEPTION USING CONVENTIONAL IMPRESSION TAKING AND INTRAORAL SCANNING FOR CROWN MANUFACTURE: A SPLIT-MOUTH, RANDOMIZED CLINICAL STUDY

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doi: 10.11607/ijp.5405.

PURPOSE: *To compare operating time and patient perception of conventional impression (CI) taking and intraoral scanning (IOS) for manufacture of a tooth-supported crown.* **MATERIALS AND METHODS:** *A total of 19 patients needing indirect full-coverage restorations fitting the requirements for a split-mouth design were recruited. Each patient received two lithium disilicate crowns, one manufactured from CI taking and one from IOS. Both teeth were prepared following the manufacturers' recommendations. For both impression techniques, two retraction cords soaked in 15% ferric sulphate were used for tissue management. CIs were taken in a full-arch metallic tray using one-step, two-viscosity technique with polyvinyl siloxane silicone. The operating time for each step of the two impression methods was registered. Patient perception associated with each method was scored using a 100-mm visual analog scale (VAS), with 100 indicating maximum discomfort.* **RESULTS:** *Median total operating time for CI taking was 15:47 minutes (interquartile range [IQR] 15:18 to 17:30), and for IOS was 5:05 minutes (IQR 4:35 to 5:23). The median VAS score for patient perception was 73*

(IQR 16 to 89) for CI taking and 6 (IQR 2 to 9) for IOS. The differences between the two groups were statistically significant (P < .05) for both parameters. **CONCLUSION:** *IOS was less time consuming than CI taking, and patient perception was in favor of IOS.*

COMMENTS: *This study evaluated through a split-mouth study (study design that evaluates 2 treatments in a single individual) the time consumed and the patients' perception regarding the procedures of intraoral scanning and conventional molding. In order to calculate the time spent in each technique, the following steps were taken into account: selection of the tray, molding of the tooth in question, molding of the antagonist arch, interocclusal registration and color selection. According to the authors, intraoral scanning was performed faster than conventional casting. Among the steps described above, the major difference occurred in the shaping of the tooth of interest (IOS 2:07 ", and CI 10:58"). The intraoral scanning also showed with a better perception by the patients than conventional molding. An important aspect when taking into consideration the results of the study was the performance of procedures in relatively easy to perform procedures, such as teeth with supragingival or little subgingival margins, which may facilitate intraoral scanning.*

DIGITAL VERSUS CONVENTIONAL IMPLANT IMPRESSIONS FOR EDENTULOUS PATIENTS: ACCURACY OUTCOMES

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Clin Oral Implants Res. 2016 Apr;27(4):465-72.

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PURPOSE: To compare the accuracy of digital and conventional impression techniques for completely edentulous patients and to determine the effect of different variables on the accuracy outcomes. **MATERIALS AND METHODS:** A stone cast of an edentulous mandible with five implants was fabricated to serve as master cast (control) for both implant- and abutment-level impressions. Digital impressions (n = 10) were taken with an intraoral optical scanner (TRIOS, 3shape, Denmark) after connecting polymer scan bodies. For the conventional polyether impressions of the master cast, a splinted and a non-splinted technique were used for implant-level and abutment-level impressions (4 cast groups, n = 10 each). Master casts and conventional impression casts were digitized with an extraoral

high-resolution scanner (IScan D103i, Imetric, Courgenay, Switzerland) to obtain digital volumes. Standard tessellation language (STL) datasets from the five groups of digital and conventional impressions were superimposed with the STL dataset from the master cast to assess the 3D (global) deviations. To compare the master cast with digital and conventional impressions at the implant level, analysis of variance (ANOVA) and Scheffe's post hoc test was used, while Wilcoxon's rank-sum test was used for testing the difference between abutment-level conventional impressions. **RESULTS:** Significant 3D deviations ($P < 0.001$) were found between Group II (non-splinted, implant level) and control. No significant differences were found between Groups I (splinted, implant level), III (digital, implant level), IV (splinted, abutment level), and V (non-splinted, abutment level) compared with the control. Implant angulation up to 15° did not affect the 3D accuracy of implant impressions ($P > 0.001$). **CONCLUSION:** Digital implant impressions are as accurate as conventional implant impressions. The splinted, implant-level impression technique is more accurate than the non-splinted one for completely edentulous patients, whereas there was no difference in the accuracy at the abutment level. The implant angulation up to 15° did not affect the accuracy of implant impressions. **COMMENTS:** This study evaluated through a split-mouth study (study design that evaluates 2 treatments in a single individual) the time consumed and the patients' perception regarding the procedures of intraoral scanning and conventional molding. In order to calculate the time spent in each technique, the following steps were taken into account: selection of the tray, molding of the tooth in question, molding of the antagonist arch, interocclusal registration and color selection. According to the authors, intraoral scanning was performed faster than conventional casting. Among the steps described above, the major difference occurred in the shaping of the tooth of interest (IOS 2:07 ", and CI 10:58"). The intraoral scanning also showed with a better perception by the patients than conventional molding. An important aspect when taking into consideration the results of the study was the performance of procedures in relatively easy to perform procedures, such as teeth with supragingival or little subgingival margins, which may facilitate intraoral scanning.

ACCURACY OF FOUR DIGITAL SCANNERS ACCORDING TO SCANNING STRATEGY IN COMPLETE-ARCH IMPRESSIONS

Medina-Sotomayor P, Pascual MA, Camps AI

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doi: 10.1371/journal.pone.0202916.

STATEMENT OF PROBLEM: Although there are specific and general digital scanning guidelines depending on the system used, it is important to have the necessary flexibility in the acquisition of three-dimensional (3D) images to adapt to any clinical situation without affecting accuracy. **PURPOSE:** The purpose of this *in vitro* study was to identify and compare the scanning strategy with the greatest accuracy, in terms of trueness and precision, of four intraoral scanners in the impression of a complete dental arch. **MATERIAL AND METHODS:** Four digital scanners were evaluated with a 3D measuring software, using a highly accurate reference model obtained from an industrial scanner as a comparator. Four scanning strategies were applied 10 times on a complete maxillary arch cast inside a black methacrylate box. The data were statistically analyzed using one-way analysis of variance (ANOVA) and post hoc comparisons with Tamhane T2 test. **RESULTS:** The trueness of the Trios and iTero system showed better results with strategy "D," Omnicam with strategy "B," and True Definition with strategy "C". In terms of precision, both iTero and True Definition showed better results with strategy "D", while Trios showed best results with strategy "A" and Omnicam with strategy "B". There were significant differences between the scanning strategies ($p<0.05$) with the iTero scanner, but not with the other scanners ($p>0.05$). **CONCLUSIONS:** The digital impression systems used in the experiment provided sufficient flexibility for the acquisition of 3D images without this affecting the accuracy of the scanner.

COMMENTS: The study evaluated the precision of the transfer of implants positioned in the mandible using direct scanning technique and conventional molding with splinted and non-splinted implants, transferred at implant level or in abutment. According to the results, direct scantling resulted in precision compared to the conventional casting technique with the splinted implants. In conventional casting with non-splinted implants, there was less accuracy. However, this comparison was only verified at the implant level. The transfers

in the abutment were only checked for the conventional casting technique. Thus, in implantology, multiple implant scanning obtained similar acuracy to the conventional technique with splinted implants.

FINAL COMMENTS ON THE INTRABUCAL SCANNERS

Certainly, the future of impression procedures will be by means of the intraoral scanners. This technology has some of the advantages as facility to use, possibility of sharing images with other dentists and laboratory quickly, greater comfort to the patient, quickly clinical procedure. However, there are situations where intraoral scanners (direct technique) still do not replace the conventional impressions, or ara still in development, as in dental preparation placed subgingival, and for complete edentulous patients without implants (manufacture of complete dentures). In addition, the investment for acquisition of the scanners is still high.

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