Development of computational thinking for dental students in the use of the intraoral impressions’ technique

Desenvolvimento do pensamento computacional para estudantes de odontologia no uso da técnica de impressões intrabucais

DOI: 10.55905/revconv.16n.10-277

Recebimento dos originais: 25/09/2023
Aceitação para publicação: 26/10/2023

Ricardo Danil Guiraldo
PhD in Dental Materials
Institution: Anhanguera Universidade para o Desenvolvimento do Estado e da Região do Pantanal (UNIDERP)
Address: Av. Ricardo Brandão, nº 900, Campo Grande - MS, CEP: 79003-027
E-mail: rdguiraldo@gmail.com

Eric Yuiti Hiruo
Graduated in Dentistry
Institution: Universidade Estadual de Londrina (UEL)
Address: Londrina - PR, Brasil
E-mail: eric.hiruo@gmail.com

Danielle Gregorio
PhD in Dentistry
Institution: Anhanguera Universidade para o Desenvolvimento do Estado e da Região do Pantanal (UNIDERP)
Address: Campo Grande - MS, Brasil
E-mail: daanigregorio@hotmail.com

Terezinha de Jesus Carvalho-Ferreira
PhD in Dentistry
Institution: Anhanguera Universidade para o Desenvolvimento do Estado e da Região do Pantanal (UNIDERP)
Address: Campo Grande - MS, Brasil
E-mail: profterejcf@gmail.com

Delise Pellizzaro
PhD in Dental Sciences
Institution: Universidade Estadual de Londrina (UEL)
Address: Londrina - PR, Brasil
E-mail: delisepellizzaro@gmail.com
ABSTRACT
The accuracy of intraoral impressions is critical for making well-fitting restorations. The possibility of digitalizing the patient's mouth has once been intended for Dentistry, however, the accuracy of dental impressions for different clinical applications is still resisted by professionals. Thus, the understanding of Dentistry students can facilitate the use of the digital technique. The aim of this study was to develop the computational thinking of dentistry students for the use of the intraoral impressions technique. Information was collected through searches in Pubmed, Scielo, Scopus, Lilacs and Google Scholar databases using the words "digital printing", "dimensional impression accuracy", "dental impression technique", "intraoral scanner" and "Dentistry digital" in Portuguese or English. Factors such as temperature variation, time period between casting and molding, plaster surface wettability and disinfection procedures may result in material distortion and affect accuracy. Patients commonly report greater comfort when using digital impression techniques and less impression than for conventional impression techniques. Based on this literature review, the intraoral scanning over the years will replace the conventional impression, as it is currently a reliable method, and as accurate as the conventional impression, being in some cases even more precise, in addition to offering greater comfort to the dentist and patient; thus, it is extremely important for dental students to incorporate the computational use of this technique into their learning.

Keywords: teaching, dentistry, dental impression technique.

RESUMO
A precisão das moldagens intrabucais é fundamental para fazer restaurações bem ajustadas. A possibilidade de digitalizar a boca do paciente já foi destinada à Odontologia, entretanto, a precisão das moldagens odontológicas para diferentes aplicações clínicas ainda sofre resistência por parte dos profissionais. Assim, a compreensão dos estudantes de Odontologia pode facilitar o uso da técnica digital. O objetivo deste estudo foi desenvolver o pensamento computacional de
estudantes de odontologia para o uso da técnica de moldagem intrabucal. As informações foram coletadas por meio de buscas nas bases de dados Pubmed, Scielo, Scopus, Lilacs e Google Acadêmico utilizando as palavras "digital printing", "dimensional impression accuracy", "dental impression technique", "intraoral scanner" and "Dentistry digital" em português ou inglês. Fatores como variação de temperatura, período de tempo entre a moldagem e o preenchimento do molde, molhabilidade da superfície do gesso e procedimentos de desinfecção podem resultar em distorção do material e afetar a precisão. Os pacientes geralmente relatam maior conforto ao usar técnicas de impressão digital e menos impressão do que as técnicas de impressão convencionais. Com base nesta revisão de literatura, o escaneamento intraoral ao longo dos anos substituirá a moldagem convencional, pois atualmente é um método confiável e tão preciso quanto a moldagem convencional, sendo em alguns casos ainda mais preciso, além de oferecer maior conforto ao paciente, dentista e paciente; assim, é de extrema importância que os estudantes de odontologia incorporem o uso computacional dessa técnica em seu aprendizado.

**Keywords:** ensino, odontologia, técnica de moldagem odontológica.

1 INTRODUCTION

To produce dental prosthetic elements even fixed or removable, unitary or multiple elements, an accurate model is necessary and can be achieved with digital or conventional molding techniques. Internal and marginal fit are two main clinical factors used to assess the quality of fixed restorations (ODÉN et al., 1998). The conventional impression materials used for definitive impressions on fixed dentures are elastomers. These materials exhibit excellent dimensional stability and precision and have been used successfully in fixed prostheses for many decades (THONGTHAMMACHAT et al., 2002). Intraoral molding is a basic technique in dentistry practice that is used to generate an impression of the oral condition. The accuracy of intraoral impressions is critical for manufacturing well-fitting restorations. The accuracy of intraoral impressions is critical for manufacturing well-fitting restorations. Two factors influence: 1- veracity, which describes the deviation of the print geometry from the original geometry; 2- precision, which describes the deviation between repeated printing instead of original geometry (CHANDRAN et al., 2010).

Over the past 30 years, the intraoral digital impression (DI) technique has been developed and improved (CHRISTENSEN, 2009). The possibility of scanning teeth directly from the patient's mouth has always been an aspiration of Dentistry, minimizing patient discomfort, reducing work time and improving the interaction between the dental surgeon and the laboratory technician (prosthetics).
This method replicates the intraoral condition using a three-dimensional (3D) camera to capture the data in a digital format. Restorations could be produced directly by computer-aided design (CAD) and computer-aided manufacturing (CAM). Unlike conventional molding methods, intraoral molding does not require filling molds with plaster. Unlike conventional molding methods, intraoral molding does not require filling molds with plaster (CHRISTENSEN, 2009). Model is not required, but may be produced using rapid prototyping technology (BOSCH; ENDER; MEHL, 2014). Recently, digital technologies have been increasing. However, the accuracy of DI for different clinical applications is still resisted by professionals. The aim of this study was to develop the computational thinking of dentistry students for the use of the intraoral impressions’ technique.

2 DEVELOPMENT
2.1 METHODOLOGY

The present study is a qualitative study. Articles and other literary sources interrelated with conventional printing and digital printing in Dentistry were collected through searches in Pubmed, Scielo, Scopus, Lilacs and Google Scholar databases. The keywords “digital impression”, “dimensional impression accuracy”, “dental impression technique”, “intraoral scanner” and “digital dentistry” were used to carry out the survey.

2.2 CONTEXTUALIZATION

Chochlidakis et al. (2016) compared the marginal and internal fit of fixed dental restorations prepared with conventional and digital techniques and aimed to determine the effects of different variables on the accuracy of the fit. The conventional printing materials used in the study were polyether and polyvinyl siloxane. The author reports that factors such as temperature variation, time period between casting and molding, plaster surface wettability and disinfection procedures can result in material distortion and affect accuracy. Furthermore, factors such as the application of hardener and matrix spacer, as well as laboratory steps for the fabrication of dental prosthesis (waxing, coating, casting or pressing process) may introduce dimensional error and affect the fit of the final restoration. Concerning fixed prostheses, the advantages of digital molding compared to conventional molding are less discomfort for the patient, the reduction of laboratory steps that may cause maladjustment, and shorter transport time between office and
laboratory. However, conventional impressions have high precision of detail and are routinely used with success. For the study, 11 articles were selected (2 clinical studies and 9 in vitro studies), from an initial total of 339 articles found in the PubMed, EMBASE, Cochrane databases. Exclusion criteria were: 1- no experimental group and control group; 2- expert opinions or literature reviews; 3- studies based only on graphs and questionnaires; 4- animal studies; and 5- no response from the author in case of inquiries for clarification of data. The inclusion criteria were: 1- in vivo or in vitro study; 2- title related to the question, studies that report marginal and internal adjustment; 3- experimental group and control group; 4- quantitative results provided; and 5- articles in English. Based on the results obtained in the study, the following conclusions were drawn: 1- Fixed dental restorations manufactured in the digital impression group showed a nominally smaller marginal discrepancy, but not statistically significant, compared to those manufactured in the conventional impression group, and may therefore be considered similar; 2- In digital impression groups, digital matrices led to restorations with less marginal and internal discrepancy compared to polyurethane matrices; 3- Regarding the pressing and CAD-CAM fabrication technique, similar results of marginal and internal discrepancy were found in both conventional and digital groups; and 4- Marginal and internal discrepancy between fixed unitary partial dentures or with more elements in both conventional and digital groups were similar.

Ender et al. (2016) evaluated the accuracy of conventional and digital impressions of the complete arch in vivo, as the increased use of the CAD-CAM system (in the areas of diagnosis, treatment planning, restorative dentistry, surgery and orthodontics) makes a high level of precision of impressions necessary, beyond the preparation site. Therefore, to oral scanning replace conventional molding, it must have at least the same level of quality and precision as current conventional techniques. For the study, five patients with complete dentition were recruited from volunteers. The maxillary or mandibular arch was randomly selected, by drawing lots, in each patient, to test all printing methods. For each impression group, three impressions of each arch were made. In the conventional molding technique, perforated metal stock trays were used, selected in such a way as to guarantee adequate space for the impression material in the oral cavity. Tray adhesive was applied if necessary. The molding materials used were: polyether, vinylsiloxanether, direct scanable vinylsiloxanether; and irreversible hydrocolloid (alginate). All impressions were disinfected for 10 minutes, and after 8 hours of storage, cast in
type IV plaster. The trays were removed from the plaster after 40 minutes and the plasters were stored for 48 hours at room temperature and humidity. The models were then scanned with the reference scanner using a highly accurate protocol, and the scan data were exported in stereolithography data format. In the digital molding technique, the following systems were evaluated: CEREC Bluecam; CEREC Omnicam; Cadent iTero; Wash COS; True Definition Scanner; 3Shape Trios; and 3Shape Trios Color. After performing the comparisons, it was observed that conventional prints with vinylsiloxanether showed the highest precision, while those using irreversible hydrocolloid showed the least precision. Digital impression systems are between these extremes, being significantly less accurate compared to highly accurate printing materials. Accuracy did not differ significantly between the various digital impression systems. The anterior region has little geometric information and was particularly difficult to digitize with digital intraoral cameras. The propagation of the error in this region leads to an increase in deformation towards the distal end of the dental arch. When the focus is on simple or partial fixed denture preparations, digital impression techniques are highly accurate and better than conventional impression methods, because although conventional impression results in high precision impressions, the quality of the definitive restoration may be different due to the continuous mechanical manipulation of the plaster model. Patient-specific factors, such as anatomical restrictions, movement, saliva, and soft tissue, may be included in the assessment of impression accuracy. Highly accurate conventional printing systems perform nearly identically in vitro and in vivo, but accuracy decreased in all digital systems when they were applied in vivo. Regarding the irreversible hydrocolloid, its low precision could be caused by an internal rupture of the material, since there was no visible fracture of the material in the tray. The accuracy of older digital systems (Lava COS; CEREC Bluecam; Cadent iTero) is lower compared to newer systems (True Definition Scanner; CEREC Omnicam; 3Shape Trios; 3Shape Trios Color), and they generally approach or exceed precision of conventional materials such as polyether and alginate. In addition, patients report greater comfort when using digital impression techniques, and in some situations, the time taken is less than for conventional impression techniques. This shows the potential of digital impression systems as an equivalent or better alternative to traditional conventional impression procedures.

Amin et al. (2016) compared the in vitro precision of two digital impression systems (CEREC Omnicam and True Definition) and a conventional impression system (polyether) for
implants in a fully edentulous mandible. Digital impression procedures were recently introduced in fixed prosthesis and implant dentistry because, by their nature, they can eliminate errors with conventional impressions and plaster. In addition, DI using an intraoral optical scanner eliminate tray selection, dispensing and polymerization of conventional impression materials, impression disinfection and laboratory submission, in addition to providing greater patient comfort during the impression procedure. Unlike conventional models, digital models are stored and sent electronically, improving efficiency. For the study, a plaster model (control group) representing an edentulous mandible was fabricated using five analogs of internal connection implants, with the three median implants being parallel to each other, the leftmost implant with a distal angulation of 10° and the extreme one right with a 15° distal angulation. Afterwards, three groups were separated. In group I, 10 plaster models were produced from molding with an open tray and polyether impression material. The implant-level impression copings were fixed to the implant analogs in the control model and immobilized using visible light-curing resin based on urethane dimethacilalate. In group II, 10 DI were taken using the CEREC Omnicam scanner, and in group III, 10 DI were taken with the True Definition scanner. Digital data was exported as standard mosaic language (STL) files and saved. All plaster models were stored at room temperature for one week before scanning and recording any measurements, and were then digitized for comparison with a 10 µm precision reference scanner. Inspection software (Geomagic Control 2015, 3D systems) was then used to overlay the SLT datasets from each model to the control model. The main method to calculate the difference was the root mean square error (RMS), obtained by the Geomagic Control software. The “best fit” algorithm to minimize human error during overlay procedures and scan bodies were the main areas selected for overlay. Descriptive statistics (means and standard deviations) were calculated for groups I, II and III, and the differences between the three groups were analyzed using the Welch F test. P values less than 0.05 were considered statistically significant. The results found showed mean 3D deviations of 167.93 µm (standard deviation of 50.37 µm) for group I, mean 3D deviations of 46.41 µm (standard deviation of 7.34 µm) for group II and deviations 3D mean of 19.32 µm (standard deviation of 2.77 µm) for group III. Given the results obtained, it was concluded that the digital molding techniques were significantly more accurate than the conventional molding technique. In addition, DI with the True Definition scanner had significantly less 3D drift compared to the CEREC Omnicam.
Schmidt et al. (2020) compared the transfer accuracy of four digital scanner systems with that of conventional molding. The molding systems analyzed were Trios3Cart, Trios3Pod, Trios4Pod and Primescan, while the conventional molding system used was polyether. Five patients with complete mandibular arch were included in the study, and all patients were cast in the mandibular arch using all five impression techniques. In the case of conventional molding, the polyether impression was stored for at least 2 hours before casting the type IV plaster, to ensure elastic recovery. Plaster models were stored under laboratory conditions for a minimum period of 5 days. A metallic reference aid with four rolling steel balls, positioned in the second molar and inter-premolar regions, served as a reference dataset, and the digitized data were analyzed using three-dimensional analysis software and conventional models, using a coordinate machine measurement. The transfer accuracy between the reference aid and the molding methods were compared, and the results obtained led to the following conclusions: 1- For short distances in the posterior segments, more accurate results were found in digital techniques compared to conventional ones; 2- For longer distances, and for distances that completely cross the quadrant, the conventional technique showed more accurate results for veracity and precision, but there was no significant difference in relation to the Trios4Pod and Primescan digital scanners; and 3- Overall, the most recent scanners, Trios4Pod and Primescan, delivered more accurate data for full-arc DI when compared to Trios3Cart and Trios3Pod scanners, likely due to continued advances in hardware/software development.

2.3 DISCUSS

The aim of the present review was to compare conventional and digital molding through a literature review. Intraoral impression is a basic technique in practical dentistry that is used to generate an impression of the oral situation. A variety of procedures are required based on the intraoral impression, including therapeutic planning, diagnosis, patient communication, model fabrication and prosthesis production. The accuracy of intraoral impressions is especially critical for the fabrication of well-fitting restorations (WÖSTMANN et al., 2009, ENDER et al., 2016).

The newest technologies with intraoral scanner devices and software are developing rapidly and showing acceptable clinical results for tooth-supported crowns (ZARAUZ et al., 2016). A recent systematic review reported deviations in implant digital impression of less than 100 µm, mainly in in vitro studies (RUTKŪNAS et al., 2017). In vitro studies allow the use of
true referencedata (GEDRIMIENE et al., 2019). However, equipment for obtaining reference data cannot be used in a clinical study and digital impression may usually only be compared with conventional ones.

Digital impression on implants and fixed dentures have several advantages compared to conventional techniques, such as the elimination of laboratory production steps that may cause maladjustment, transport time between the clinic and the dental laboratory, and reduced patient discomfort (PAPASPYRIDAKOS et al., 2016). However, conventional molding methods have also shown high precision of detail and are now routinely used with success. Chochlidakis et al. (2016) reported that dental prostheses manufactured using the digital impression technique had nominally smaller, but not statistically significant, discrepancies in relation to those manufactured using the conventional impression technique. Studies have reported comparable or even greater accuracy for intraoral scanners compared to conventional impressions for short term fixed dentures up to one quadrant (CHOCHLIDAKIS et al., 2016, Goujat et al., 2019). For full-arc scans, greater transfer accuracy for conventional molding techniques was described in 2016 (ENDER et al., 2016). Clinical studies have investigated the accuracy of full-arc scans for different intraoral scan systems using a conventional impression or plaster model as a reference (GORACCI et al., 2016, LIM et al., 2018). However, in a recent study (2020), it showed that current intraoral scanner systems generate less drift compared to conventional impressions (SCHMIDT et al., 2020). Thus, intraoral scanning is currently a reliable method, and as accurate as conventional molding, and in some cases, it is even more accurate; thus, it is extremely important for dental students to incorporate the computational use of this technique into their learning.

3 CONCLUSION

Based on this literature review, the intraoral scanning over the years will replace the conventional impression, as it is currently a reliable method, and as accurate as the conventional impression, being in some cases even more precise, in addition to offering greater comfort to the dentist and patient; thus, it is extremely important for dental students to incorporate the computational use of this technique into their learning.
REFERENCES


