Comparison of marginal fit of zirconia crown with digital and conventional impression

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ABSTRACT
Marginal fit is an important measure of the quality and clinical success of a fixed restoration. Different types of impression materials and techniques used can affect the marginal fit of the restoration. Conventional impression procedures have long been performed by dentist to duplicate patient's oral cavity, but this impression technique has several disadvantages. Currently, along with the development of the era of dental treatment, it is moving towards digital technology. Technological advances in dentistry today are able to eliminate the shortcomings of conventional impression. The purpose of this review was to evaluate the marginal fit of CAD/CAM fabricated zirconia restoration produced via conventional and digital impression techniques. It is concluded that intraoral scanner can be used instead of conventional impression procedures in denture fabrication. Many studies show that digital impression can replace conventional impression which is still widely used. The use of various types of intraoral examination tools and various systems used can give different results.
Keywords: marginal fit, zirconia crown, impression techniques

INTRODUCTION

The impression procedure is an important step in the process of making dental restorations. Accuracy in the impression procedure is an important requirement for getting accurate print so that success the right restoration manufacturer could achieve. In addition to conventional techniques that use various types of impression materials. Currently, digital impression techniques are also available for fabricating artificial teeth.[1-3]

There are two techniques for tooth impression that are conventional impression and digital impression using digital technology. Conventional impression techniques do not require expensive special machines and accurate results can be achieved if the work steps are carried out correctly. The impression material that is often used for this technique is polyvinyl siloxane (PVS), polyether or polysulphide. To obtain a perfect impression this material must exhibit properties such as accuracy, dimensional stability as well as rheological and thixotropic characteristics. Various factors such as uncontrolled salivary flow during the procedure, undercut, deep storage long time, moisture, deformation of the material and incompatibility with the material can affect the accuracy of the impression and subsequently lead to inaccuracies and mismatches of the restoration.[1] Besides that, the practitioner's level of knowledge and skills, potential distortion of impression materials, disinfection procedures, removal of impression materials from impression tray and transportation to the dental laboratory under different climatic conditions also become factors decisive important level accuracy in conventional impression procedure.[4]

New digital impression technology introduced in nature attempt to increase parameters such as accuracy, patient comfort and ease of use.[5] One of the most important steps in the fabrication of a fixed prosthesis is the final margin acceptable fit. Impression which is performed to transfer the required information from the patient's oral cavity to the laboratory, will produce a model and easy communication among dentists and technicians.[6]

Advances in the field of dentistry eliminate the disadvantages of impression conventional. In the early 1970s, Dr. Francois Duret, made a draft on how digital technology used in the industry could customized with the dentist. Digital impression system can scan teeth imagine that have been prepared later, visualize them on a computer monitor and could be fabricated. The dentist could see pictures with high resolution of oral cavity. Good visualization allow dentist for viewing and evaluating the preparation quality. Digital impression helps reduce some time-consuming steps and procedures in dental clinic, including tray selection, preparation and arrangement of materials and delivery to the laboratory, the process in the dental laboratory will be more saves time because there is no need to build or install models on articulators.[6-8]

Along with the development of technology, the use of intraoral digital scanners to create virtual impressions has enabled dentists to eliminate the use of impression materials, identify preparation margins, evaluate the interocclusal space and de-

sign a prosthesis. Three factors that must be considered for the success of a ceramic restoration are marginal fit, fracture resistance and aesthetics. Of these three factors, the marginal fit is directly related to impression accuracy.[7,9]

Marginal fit is an important measure of the quality and clinical success of fixed restorations. Accuracy of marginal fit and internal fit of dental restorations created in a fully digital workflow is an important factor determining long-term clinical success. Insufficient marginal fit can lead to plaque and material retention of luting agent, causing secondary caries, periodontal inflammation and pulp or loss of restoration retention.[5,10] The marginal fit theoretically means a linear contact line or gap-free transition between the preparation and the restoration margin. For clinical use, Christensen et al. concluded that visible margins wider than 39 ηm were clinically unacceptable. However, due to various factors, it seems almost impossible to achieve this ideal value in a clinical setting. According to the literature, the *final fit is* 50-100 ηm considered technically feasible. *Marginal fit* larger ones will provide a place for oral and salivary pathogens, which can cause problems such as periodontal inflammation, secondary caries and dissolution of cement.[1]

Internal fit and *marginal fit* can be measured as the degree of closeness between the abutment and the restoration (inner and marginal surfaces). So, in general, the better the impression accuracy so the closer the degree of proximity between the restoration and the abutment and the better the internal and *marginal fit* of the restoration.[4] Holmes et al. explain various types of measurement between casting surface and teeth so that *marginal fit* can be determined and described in the appropriate standard.[6,11]

Zirconia is widely used in fixed partial denture restorations for its high esthetic results and fracture resistance. Uses of zirconia in treatment started from 1970 's and started in the 1990s for root canal treatment. Zirconia has been introduced to dental practice as alternative restoration tooth metal ceramics. Compared with restoration metal-fused porcelain, zirconia restoration has more aesthetic, because naturally has excellent optics and especially there is no the presence of a black line on the cervical line from restoration. The overall properties of zirconia make it a first choice. Recently, zirconia also started being used as an ingredient in making dental implant. Several studies have been conducted to see marginal fit accuracy of zirconia restorations with the use of conventional and digital impression. Several studies previously been

conducted with various methods and give varying results, where there is research that shows significant results or no significant. The purpose of this research is to find out accuracy comparison *marginal fit* from acquired zirconia restoration through digital and conventional impression techniques.

LITERATURE STUDIES

This paper was aimed as a *scoping review* based on the definition presented by Arksey & O'Mailey. The objective of this *scoping review* is to summarize and present the results of research that has been there being about one part certain from something topics or field science. Writing *scoping review* arranged from several stages, that determines question study, determining type relevant research, conducting selection study, do data collection on a chart, and composing, making summary and reporting study results. This *scoping review* writing follows framework stages by Arksey and guide *preferred reporting items for systematic review extension for scoping review* (PRISMA- ScR).[12]

Research question used in composing *scoping* this review is "Is technique digital impression produces marginal fit compatibility and accuracy better than a conventional impression in making zirconia restoration?". Specimens used are natural tooth nor *typodonts* that have been conducted preparation and then conducted impression conventional and digital. The concept used are conventional and digital impression in making restoration fixed zirconia. Whereas the context used is the marginal fit of zirconia restorations.

Literature searching was conducted using the digital database of two sources, namely PubMed and EbscoHost. Keywords used in searches in Pubmed and EbscoHost. Database is "(((((marginal fit) OR (marginal gap)) AND (zirconia crown)) AND (impression)) AND (techniques)". The limitations of literature those are published 2014-2021, clinical studies and published in language English. Inclusions and exclusions criteria used for selecting literature that has been obtained could see in the table 1.

Literature searching produced 97 (33 literature from PubMed, EBSCO totaling 64 relevant kind literatures with the topic. Then from all literature obtained from the results was conducted to eliminate duplication from three electronic databases (n = 87).

Next literature the selected based on title and abstract. Several literatures were excluded because not relevant to the topics selected (n=30), were not used English language, and is not related to dentistry. The remaining literature was studied tho-

Table 1 Criteria inclusions and exclusions used

Criteria	Inclusion	Exclusion
Period	Published start January 2016 – September 2021	Published before January 2016
Language	English	Non english
Subject	Patient's natural teeth, *typodont*	Besides patient's natural tooth and *typodont*
Draft	Comparing the marginal fit of restorations zirconia using conventional impression technique and digital scanning technique	Does not compare the marginal fit of restorations zirconia using conventional impression technique and digital scanning technique
Context	*Marginal fit, Marginal gap, vertical marginal discrepancy*	Not discuss *marginal fit, marginal gap, vertical marginal discrepancy*
Design	Laboratory, Clinical trial, *case control*	Report case, *systematic review, literature review*

roughly from the version *full text,* so obtained literature from journals scientific as much 11 journals (n = 8).
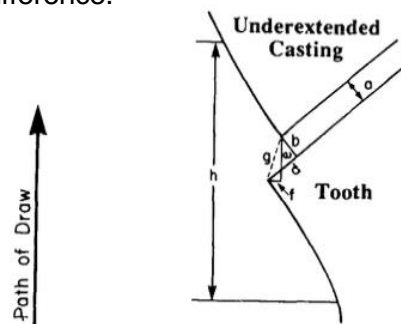
The aim of this *scoping* review is to review and compare the marginal fit of restorations zirconia is made using conventional impression and digital scanning techniques. After literature was selected based on title and abstract for review return topics reviewed in each literature, obtained a total of 9 related literatures with the topic. Appropriate literature with criteria inclusion in writing is studied in clinical and laboratory.

DISCUSSION

Several factors considered for success restoration of ceramic are marginal fit, fracture resistance and esthetics. In this case, the marginal suitability is related directly with accuracy impression. The marginal fit that doesn't adequate for restoration could cause accumulation plaque, causing caries and periodontal disease which ultimately results in failure restoration. Significant periodontal inflammation was happened to the crown with the marginal discrepancy is about 250-430 μm. Values from 100-120 μm proposed by Holmes et al, Fransson et al, McLean and von Fraunhofer have been used as a reference in a lot of research.[7]

Marginal fit in *casting* can be defined as discrepancies measured at various points between the casting surface and the teeth. Measurement between casting and teeth can be made from points along the internal surface, at the margin, or on the outer surface casting. The perpendicular measurement from the internal surface of the casting to the axial wall preparation is called *internal fit* and the same measurement at the margin is called *marginal fit.* Incompatibility marginal vertical measured parallel to the direction casting is called vertical marginal discrepancy. Horizontal marginal discrepancy measured perpendicular to the direction casting is called horizontal marginal final discrepancy. The overextended margin is the perpendicular distance from the marginal gap to the casting margin. The underextended margin (Fig.1) is the perpen-

dicular distance from the marginal cleft to the cavosurface angle of the tooth. The combination of the angle of the marginal gap and the extension error (overextension (Fig.2) or underextension) is called the absolute marginal discrepancy. Specifically, it is the hypotenuse of a right triangle with sides defined as either too long or too short margins and marginal gaps. The angle combination of the vertical marginal difference and the horizontal marginal difference also defines the same absolute marginal difference.[13]

Figure 1 The underextended casting

a. INTERNAL GAP
b. MARGINAL GAP
c. OVEREXTENDED MARGIN
d. UNDEREXTENDED MARGIN
e. VERTICAL MARGINAL DISCREPANCY
f. HORIZONTAL MARGINAL DISCREPANCY
g. ABSOLUTE MARGINAL DISCREPANCY
h. SEATING DISCREPANCY
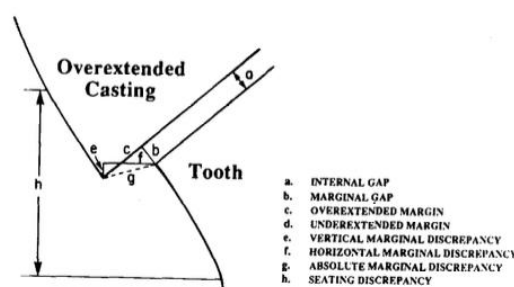
Figure 2 The overextended casting

Eight literatures discussed in *scoping review* this consist from study clinical as many as three studies and five in vitro studies. Of these eight included literatures in this *scoping review*. Three literatures use printing from natural tooth prepared, five literature use *typodont*. Various number type of system digital scanner is used in research among them is TRIOS 3 shape digital scanner, iTero digital scanner, Carestream 3600 digital scanner, CEREC and later COS Lava compared with printing conventional with using PVS.

Evaluation of *marginal fit* could conduct with

Tabel 2 Analysis of the articles

No	Author (Year)	Study	Destination Study	Aspects	Subject Study	Research results	Conclusion
1	Carrilho Baltazar Vaz & Pimmentel Coelho Lino Carracho (2020)	Laboratory test	Comparing the marginal fit of coping zirconia made using conventional impression and 2 digital scanning techniques	Marginal value discrepancy	Each 10 second premolar typodonts left jaw lower for three group technique printing	The SD of vertical marginal discrepancy were 106±87 mm for PVS group, 53±56 mm for TRIOS 3 group, and 93 ±69 mm for the CS 3600 group.	Digital scan with TRIOS 3 shows the value of lower marginal discrepancy than digital scanning with the CS 3600 and conventional prints with elastomers
2	Sakornwimon & Leevailoj (2016)	Clinical trial	Evaluating the marginal fit of the crown monolithic zirconia and patient preferences for digital printing compared printing pol y vinyl siloxane (PVS)	patient preferences and marginal differences fit	16 participants with indications for a single crown. After crown preparation, digital impressions with an intraoral scanner and PVS impressions were made.	Visual analog scale score for printing digital is statistically significantly higher than printing with polyvinyl siloxane.	No difference was found in the clinical marginal fit of zirconia crowns made from digital impressions compared to PVS impressions. Furthermor, patient satisfaction with digital printing is significantly higher than with conventional printing.
3	An et al (2014)	Laboratory test	Comparing marginal fit coping zirconia designed using an iTero digital scanner with those designed with conventional printing techniques.	Marginal value discrepancy	30 identical impressions of 1 maxillary central incisor prepared for crown restoration ceramic	Statistically significant differences were found between the printing groups conventional and group i Tero	Marginal gap between restoration and die was greater in the group using the digital printing method compared to the group using the conventional printing method.
4	Dauti et al. (2016)	Laboratory test	Seeing the marginal fit of coping zirconia already cement produced after digital printing with LavaTM COS compared to conventional impression with polyvinyl siloxane	Marginal gap and absolute marginal discrepancy were measured on mesial & distal	Prepared t y podont teeth , replicated The die was randomly divided into two groups according to the mold taking technique.	No significant difference of marginal parameters between digital and conventional groups was found	Coping produced with digital printing shows marginal parameters that are comparable to copings made with conventional printing with poly vinyl siloxane.
5	Rödiger et al (2016)	Clinical trial	Evaluate marginal and internal fit of four unit CAD / CAM manufactured zirconia fixed prostheses made with digital and conventional prints	internal and marginal gaps	20 molar teeth prepared, Conventional impression taking (CI) with PVS and intraoral (IS) scans of each preparation done.	Single crown of zirconia produced by scanning technique intraoral shows statistically better precision than internal fit only in certain areas.	CAM fabricated single zirconia crowns manufactured by CI and IS techniques provide adequate marginal and internal precision.
6	Mustapha et al (2018)	Laboratory test	To evaluate the marginal and internal fit of the zirconia fixed partial denture used different impression technique	marginal, incisal and axial discrepancy	Nissan models Typodont, including maxillary central incisors and canines with missing lateral incisors.	The T group had the smallest difference compared to the C and S groups at the marginal level.	Better adaptation was achieved with the intraoral scanning group, except at the incisal tip.
7	Cetik et al (2017)	Laboratory test experimental	Precision of digital prints (Trios, 3Shape) compared to conventional impressions with three different magnins (shoulder, chamfer and knife edge) on Frasaco teeth	Marginal	The sample consists of 60 crowns part zirconia , is divided into six groups according to the type of mold and margins.	No statistically significant differences were found between printing conventional and digital scanning , except for two of the eight points.	Zirconia crowns made from digital prints and those made from conventional molds provide similar adaptations and offer identical results.
8	Boeddinghaus (2019)	Clinical trial	Comparing the marginal fit of zirconia crowns based on three different intraoral digital printing methods and one conventional impression method.		49 teeth out of a total of 24 patients were prepared and treated with restorations with crowns full restoration.	Printing with CEREC Omnicam produce the largest value of the marginal gap compared with printing conventional and other intraoral scanners.	Based on intraoral scans and laboratory scans of conventional models of zirconia coping restorations, it was obtained results that are comparable to their marginal fit.

measure the gap at the margin. Two common techniques that are often used is technique silicone replica then conducted direct visualisation with a mechanical device for measuring relative distortion at margins. Measurement could be conducted with to do measurement upright straight from restoration internal surface until closest preparation with the finish line. The replication technique silicone could be used for in vivo and in vitro studies. In this technique, silicon replica light body from marginal discrepancy made and cut then thickness be measured with a stereomicroscope.[1,13,14] Besides using this technique silicon replica, measurement marginal discrepancy can also be conducted using the technique of cementation using zinc phosphate.[5,6]

Research laboratory test

In a study conducted by Baltazar et *al* on typodont about the marginal fit of restoration zirconia coping, the difference marginal fit among group TRIOS 3 and CS 3600 scanners may occur because the difference in technology used in each intraoral scanner. On research about evaluation fixed restoration zirconia 3 units made by Moustapha et al, who also performed on the TRIOS 3 intraoral scanner typodont also gave results *marginal* and *internal fit* more restoration accurate compared with conventional printing.[5,8]

Measurement conducted use optical microscope. In study, this measurement of the marginal gap and absolute marginal difference with microscope optics show there is no significant difference among group technique digital and conventional impression. Next the average marginal gap value of coping for the second group is more small of 100 μm, indicating the margin that can be received clinically.[1] On research clinical previously done also with using COS Lava scanner got results that digital scanner generates more small marginal gap value compared with printing conventional. This causes the existence of difference techniques in measurement namely in the research previously mentioned use of silicon replica technique.[15]

It is different with other researches, in a laboratory tests conducted by An et al, using a prepared typodont for then conventional impression using PVS and an intraoral scanner, then fabrication zirconia coping was carried out and evaluated for marginal fit using silicone replica technique and measured at four points that is in buccal, lingual, mesial and distal, from measurement the obtained results that conventional impression give more marginal gap yield small compared to the resulting restoration through an intraoral scanner. However, the value of the resulting *gap* among second group is still within the range of score clinically possible accepted. An et al, say limitations in the research in the form of the possible use of metal dies could reflect light at the moment scan and iTero does not use powder for reducing thing the so that give different results from previous studies.[6]

Clinical trial research

A research conducted by Sakornwimon et al about comparison *marginal fit* zirconia crown with the use of conventional impression with PVS and digital printing with 3 shape D900 scanner in 16 patients obtained that *marginal fit* of clinical zirconia crown made from digital and PVS impression do not different, both are at in range that can be received through from the survey conducted use questionnaire obtained participant's results study more like digital printing. Various studies clinical has conducted to evaluate zirconia crown marginal discrepancy. Studies show that the marginal gap of 100 μm or 120 μm is still could be received clinically. This conclusion is stated by Matthias et al, in research conducted on 20 patients using TRIOS 3 shape intraoral scanner obtained results that in some point measurement digital printing provides results more *marginal* gap small if compared with conventional impression, similar with laboratory test studies on typodonts that also use TRIOS 3 shape intraoral scanner. In this study, prior to intraoral scanning and conventional print retrieval, retraction threads were placed using a double retraction technique. First, an intraoral scan was performed with the second retraction thread remaining in the sulcus. Then, the threads are removed and the conventional impression is taken. Thus, randomization was not necessary as the impression of the second technique was realized in one operation.[1,7,10,16]

Discussion about whether is resulting restoration through intraoral scan gives comparable precision or even more superior than restoration based on conventional impression still continuous. This thing supported by findings a several in vivo studies. On the other hand, there are also in vitro studies showing no there is significant difference in marginal accuracy when group digital and conventional restoration compared. There are one study clinical comparison three devices with different intraoral scans show significant differences in marginal and internal accuracy in three system tested scanner, so disclose influence significant from system scanner used. Besides that, in clinical trials other factors such as influence preparation margin

difficulty subgingival, contamination blood and saliva or reaction patient to digital or conventional impression need to be considered.

It is concluded that data obtained in the scope of this review show existing proof scientific that procedure intra-oral scan can be used as a replacement for procedure conventional impression in fabrication tooth restoration. Many studies show that digital impression can replace conventional impression that is still many used. This is supported by a good level of accuracy that is clinically acceptable. The use of different types of intraoral scanners and the different types of systems used may result in varying accuracy. However, several studies comparing the marginal fit of zirconia restorations on digital and conventional impressions have averaged clinically acceptable results between the two procedures.

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