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REVIEW ARTICLE

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Concept of Marginal Fit Accuracy of a Single Crown Prosthesis Using Conventional Impression Techniques and Intra-Oral Scanner

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Abstract

The goal of this work is to carry out a systematic review to assess the evidence about the potential advantages and accuracy of the marginal ridge of digital impression techniques in comparison to traditional impression techniques. A comprehensive search was conducted through the following databases to find publications that contrasted electronic impression techniques with traditional impression techniques: Cochrane Central Register of Controlled Trials, Web of Science, and PubMed. Free-text terms, a restricted vocabulary, and well-defined inclusion and exclusion criteria were all used in the search. The accuracy of the marginal ridge of fixed zirconia prosthesis in digital impressions is comparable to traditional impression techniques, the result shows It is therapeutically appropriate to use digital impression accuracy for the manufacture of Zr FDPs. Conventional impression techniques produced accurate impressions. For creating Z-crowns and short FDPs, digital impression techniques offer an acceptable substitute for traditional imprint techniques. Furthermore, the creation of Zr FDPs uses digital imprint technology to provide a clinically appropriate fit. It is possible to reduce the operation time by employing faster digital impression techniques. This study suggests that full-arch impressions should be taken using the conventional impression procedure.

Keywords: Marginal fit, Internal fit, Digital impression technique, Conventional impression technique, Zirconia crown

1. Introduction

Dental restorations, particularly crowns and ceramic fixed prostheses, have been made with computer-aided design and manufacture (CAD/CAM) since the 1980s [1, 2]. When compared to fixed dental prostheses made from traditional impressions, it is thought that those made from intraoral digital impressions offer some significant advantages [3]. For example, electronic impressions are more accurate in the restoration margins than traditional impressions. Additionally, compared to typical impressions, the procedure's overall operating costs and clinical work hours are lower [4–6]. Intraoral digital imprints are becoming increasingly important in the digitization of prosthodontics as zirconia prostheses are being manufactured with them [7–10]. The internal fit and marginal precision between the abutment and the restoration is critical for a high-quality zirconia prosthesis that guarantees treatment duration [11, 12]. Cement breakdown, plaque retention, and periodontal issues, including increased gingival inflammation and probing depth [13].

Dental hypersensitivity, and caries [14, 15] are the most prevalent signs of incorrectly adjusted restorative margins. Intraoral scanners have been utilized to lessen the likelihood that traditional imprint processes could result in micro-adaptation errors and related problems. Several investigations of the subject have found that both digital and traditional impression procedures are highly recommended and therapeutically acceptable. However, some fairly

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contentious findings emerge when comparing the accuracy of the two systems. To provide the best possible prosthetic work with the longest possible lifespan, practitioners must make a clinically sound choice supported by empirical data. Some authors claim that the traditional technique yields superior results, while others suggest that the digital technique has better marginal adaptability than the conventional technique based on an organized analysis of the literature in science [16, 17].

The purpose of this systematic review was to determine if earlier SRs on the correctness (marginal adaptation and/or internal adaptation) of zirconia fixed prosthesis made with digital vs conventional impressions met standards set by the scientific community. This evaluation's objectives were to determine each SR's validity and reliability and provide a more comprehensive picture of clinical application while making long-lasting permanent restorations. For the marginal fit of the crown, the imprinting procedure is crucial. Fixing restorations were completed with standard impression materials and methods. Nevertheless, there are disadvantages to the traditional impression techniques as well, including discomfort for the patient, the need to store trays and equipment, mix the imprint chemicals, and disinfection [17].

Voids and bubbles in the imprint, split impression material from trays, embedded retraction cables, and preparation debris all cause the casting to be inaccurate. Variations in humidity and temperature can cause 8 Casts to warp [18]. According to reports, impressions sent to labs can include more than 50% of the preparation finish line missing [19]. In the early 1980s, the idea of an intraoral digital impression was proposed. When fabricating dental restorations, digital impressions and procedures are options [20, 21]. Digital approaches were developed to improve restoration quality and automate the production process. Digital impression, digital design, and digital manufacture are all part of the digital workflow. A full digital process has been made possible by intraoral scanners (IOSs), and multiple studies have shown that the pictures they provide are therapeutically acceptable [22–24].

Clinicians may now design prostheses, assess interocclusal space, detect preparation margins, and do away with the need for impression materials thanks to the intraoral digital scanner, which creates a virtual impression. To develop a three-dimensional data file, the digital process entails taking an image of the prepared tooth as well as the neighboring and opposing teeth. The crown is then designed using this file. There is no need for gypsum cast manufacturing for articulation, land transportation, or disinfection during the transmission of digital impressions. Consequently, the possibility of dimensional errors may be removed [25, 26]. The impression technique and the manufacturing process that follows determine the final fit of the FDPs, which in turn represents a critical factor related to their survival and success. Inadequate fit leads to plaque accumulation, which is associated with microleakage, carious lesions, endodontic inflammation, or periodontal complications. When evaluating marginal fit, the criteria established by McLean and von Fraunhofer are adopted by most investigators in the literature Based on these, a maximum of 120 μm is acceptable for the marginal opening of an FDP. Besides, adequate internal fit is also an essential element, since it affects the seating of the crown, and consequently the marginal fit, while wide internal gaps may reduce the fracture resistance of dental restorations [27].

Both old and digital technology have benefits and drawbacks. Depending on the clinical scenario and the patient's preferences, dentists have a significant influence in the best approach. Inlays, onlays, crowns, and FPD imprint procedures are anticipated to be performed in the future using digital impression techniques. Studies comparing digital to traditional impression techniques in terms of overall patient choice, operator preference, overall length, internal fitness, marginal fitness, and repeatability have been published in the literature [28, 29]. In this study, the marginal fits of metal copings made with the electronic IMP technique and the traditional impression approach were compared in an in vitro model.

In light of the previous discussions, this systematic review seeks to synthesize existing evidence and critically assess studies that compare the marginal and internal fit of various types of fixed dental prostheses (FDPs) fabricated using digital, conventional, or hybrid impression techniques.

This investigation represents the first effort to systematically classify studies based on the Population, Interventions, focusing on the comparison between digital, conventional, and hybrid impression workflows, to discern the distinct contributions of each variable.

The primary objective of this review is to identify and isolate specific synergistic factors associated with different impression techniques, thereby facilitating robust conclusions regarding the effects of digital versus conventional impression methods on the accuracy of marginal and internal fit in FDPs.

Through a comprehensive review of the available literature, this study aims to elucidate the influence of impression technique (digital vs. conventional) on the clinical outcomes of FDPs, specifically in terms of their marginal and internal fit, by considering each factor within the context of the PICO framework.

This review endeavors to offer a critical synthesis of research comparing the marginal and internal fit of FDPs fabricated through varying impression methodologies, systematically categorizing studies based on the digital and conventional workflows, with the aim of drawing definitive conclusions regarding the impact of these techniques on restoration accuracy.

By focusing on both digital and conventional impression techniques, this review systematically analyzes the relevant literature to assess the impact of these methods on the marginal and internal fit of FDPs, isolating the contributory factors associated with each technique.

2. Materials and methods

Google Scholar, PubMed, Science Direct, and Z-library were used for an open period in the databases of Traditional impressions, stationary prostheses, digital imprints, internal fit, marginal fit, and careful inspection.

2.1. Inclusion criteria

A few systematic reviews have evaluated the accuracy of full-coverage zirconia prosthesis on natural teeth from clinical research and on the tooth replicas from in vitro experiments, either with or without a meta-analysis. These reviews focus on the internal and marginal modifications of zirconia restorations. Comparing and Evaluating Digital Impression Digital impressions obtained using intraoral scanners to traditional impressions generated with various impression materials, either with or without meta-analysis. The goal is to assess digital scanning technologies' accuracy and dependability in the dental impression collection process. Information from clinical trials and in vitro studies: Systematic reviews and meta-analyses are also used to examine the data from prospective nonrandomized trials, comparative studies, randomized clinical trials (RCTs), and in vitro clinical trials. Our understanding of impression techniques and zirconia prostheses in several clinical contexts is improved by these reviews. All things considered, these systematic studies have a lot to teach dental professionals and researchers interested in restorative dentistry Scholar as well. The mentioned papers' bibliographies underwent a manual screening process. Duplicate studies were removed from the collected studies and exported to Mendeley Desktop's bibliographic reference system.

2.2. Exclusion criteria

Case studies, literature reviews, pilot project research, and studies assessing crown seating for full and partial restorations were not included in the systematic review research, the authors of which did not reply to our inquiries for further details. reviews of systematic literature that fell outside of the PICO model (outcomes, comparison, patient/population, intervention, and intervention). Teeth with apical lesions, teeth having endodontic therapy, and teeth with periodontal involvement (bleeding during periodontal probing and deep pocket probing deeper than 4 mm) were also excluded after periapical radiography examination.

2.3. Information sources and search approach

The mentioned papers' bibliographies underwent a manual screening process. Duplicate studies were removed from the collected studies and exported to Mendeley Desktop's bibliographic reference system

2.4. Data synthesis

The categories of impression type, marginal discrepancy, internal gap, marginal gap, and prosthetic restoration type were used to group the main data from each SR.

Based on the above, the present systematic review aimed to collect evidence and critically review studies comparing the marginal and internal fit of different types of FDPs fabricated through digital, conventional, or combination impression techniques. This study attempts for the first time to categorize studies based on the Population Interventions, focusing on the comparison between digital, conventional, and hybrid impression workflows, to discern the distinct contributions of each variable.

and type of workflow (digital and conventional or their combination), to isolate each synergistic factor and, therefore, draw secure conclusions on the impact of the impression technique (digital vs. conventional) on the marginal/internal fit of each type of restoration.

An electronic search was conducted across three databases: Web of Science, PubMed, and Scopus. We used Google (Table 1). Describe an overview of the general descriptive features of the included systematic evaluations detailing the impact of traditional and digital impression techniques on the marginal fit of dental zirconia crowns.

3. Discussion

Studies conducted on permanent prostheses constructed from traditional or digital impressions during the last ten years have evaluated both internal and marginal adaptation; however, the methods used to

Table 1. An overview of the general descriptive features of the included systematic evaluations (in web of Science, PubMed, and scopus) detailing the impact of traditional and digital impression techniques on dental zirconia crowns.

Author/Ref	Title	Interventions and Comparators	Study type	Clinical and labrotary relevance
Yasser Haddadi1 et al. [30]	Accuracy of crowns based on digital intraoral scanning compared to conventional impression-a split-mouth randomised clinical study	Digital scanning as an intervention Control: traditional impression methods	Comparative studies, in vivo prospective: randomized controlled clinical studies:	Similar to crowns based on conventional impression, crowns based on a fully digital approach can provide clinically acceptable marginal adaptation.
Tabesh et al. [31]	Marginal adaptation of zirconia complete-coverage fixed dental restorations made from digital scans or conventional impressions: A systematic review and meta-analysis	Intervention: digital scans Control: conventional impression	Prospective clinical trials:	The chosen studies' heterogeneity, encompassing the various techniques for preparing teeth, fabricating restorations, and assessing marginal gaps.
Júnio [32]	Marginal and internal fit of four-unit zirconia fixed dental prostheses based on digital and conventional impression techniques	Intervention: digital scans Control: conventional impression techniques	vitro study	Both digital and traditional impressions produced frameworks with a clinically acceptable marginal fit, however the digital impression produced a superior internal fit than the conventional impression did.
Shinyoung [33]	Evaluating the marginal fit of zirconia copings with digital impressions with an intraoral digital scanner	Intervention: digital scans Control: conventional impression	vitro study	When comparing the groups utilizing the digital imprint method to the group using the conventional impression approach, there was a statistically significant difference in the marginal gap between the restoration and the definitive cast base metal die. But the marginal differences across all groups
Rinet Dauti, et al. [34]	Fit of tooth-supported zirconia single crowns—A systematic review of the literature	Intervention: Comparing the digital image obtained with the LavaTM Chairside Oral Scanner to the zirconia copings made from traditional impressions	vitro study	The marginal dimensions of the copings made following a digital impression using LavaTM C.O.S. and those made following a traditional impression using polyvinyl siloxane are similar. The digital and conventional groups' mean marginal gap values fall within the range that is considered clinically appropriate.
Goustaphassan Mha [35]	Evaluation of the fit of zirconia three-unit fixed partial dentures fabricated by different impression techniques	Intervention: digital scans Conventional different impression techniques	vitro study	The intraoral scanner group showed the greatest disparity at the incisal tip and the least at the margins. When compared to the traditional impression group, this group demonstrated superior adaption at the axial walls.

carry out these assessments have not yielded results that are satisfactory. Consequently, physicians are relying on questionable studies to guide their therapeutic decisions. Using digital impressions vs conventional impressions, the goal of this systematic review was to assess the methodological quality of the currently available SRs regarding the accuracy (marginal adaptation and/or internal adaptation) of zirconia fixed prosthesis. One potential benefit of the current systematic review is the implementation of strict selection criteria for research that include both experimental and control groups for comparative analysis. It was not possible to compare the new data with the results of earlier systematic reviews.

Significant heterogeneity is defined as studies with heterogeneity scores higher than 75%. This explanation is supported by their use of a variety of restoration techniques [37] lab manufacturing processes, different types of scanners, spacer needs, preparation designs [38] and techniques for evaluating marginal adaptability (optical microscope [39] stereomicroscope, microscope, or explorer). Furthermore, most authors [40]. The silicone replica approach was used to assess the crown's marginal fit prior to cementation. This non-invasive method can be somewhat precise, but it can also lead to errors [41].

According to Yasser Haddadi et al., using the replica technique, crowns based on IOS demonstrated

a significantly better marginal fit prior to cementation than crowns based on CI. Nevertheless, no variations were discovered when marginal integrity after cementation was assessed using the CDA quality assessment system. When comparing the two treatments clinically after cementation, there could not be much of a difference because the resin composite luting cement covers the marginal gap and is therefore clinically undetectable with a probe. The observed lack of association between the CDA scores and the measurements of the greatest gaps at the crown margins may be explained by this. Poor marginal fit, on the other hand, has been demonstrated to exacerbate plaque deposition, irritate the gingiva, cause the luting cement to disintegrate, and ultimately result in secondary caries or periodontal disease.

The difference in the marginal space between the crowns based on the two impression processes, as noticed before cementation, may therefore have an impact on the crowns' long-term survival if the excess luting cement that was hiding the gap eventually vanishes. The study's conclusions should be interpreted cautiously since the teeth were easy to treat—the preparation's border was applied equally or subgingivally, going no farther than 1 mm. and incredibly impressionable. The quality of the IOS scan and CI may suffer in more challenging clinical scenarios [42]. In 2021, Tables and associates Because of their many benefits, digital impressions are becoming more and more frequent in therapeutic settings. By facilitating electronic transfer, digital file storage, and in-office milling of final restorations, this method does away with the necessity to choose trays and impression materials [43]. The increased expense of purchasing an intraoral scanner, the requirement to attend workshops and training sessions, and the requirement to keep up with quickly evolving technological developments are some drawbacks of digital impressions Hasanzade et al. [44]. While in vitro research showing that digital impressions result in greater marginal adaptation, no appreciable differences were observed between the digital and traditional groups *in vivo* tests. Mai et al. [45]. noted in their SR that the marginal adaptability values determined in in vitro testing using digital versus conventional methods were somewhat greater, even though there was no statistically significant difference. Study conducted by by Morsy et al. showed that digital scanning produces a marginal fit that is noticeably better than a traditional imprint when creating fixed partial dentures with up to four pieces, in any area of the arch, and in either monolithic or structured form [46].

There is less information available in the literature regarding the fit of restorations made using a digital technique than there was for Júnio's study on the fit of zirconia restorations made using traditional impressions. In an in vivo investigation, Syrek et al. [47]. employed the replica technique to assess single zirconia crowns created using silicone impression or LavaTM C.O.S digital impression in a clinical context. Their findings demonstrated that the marginal fit of single crowns produced with an intraoral scan was superior to that of crowns constructed with silicone impressions. Despite the fact that our investigation employed a polyether imprint medium, comparable marginal fit values for conventional impressions were found.

However, Syrek et al. [47] discovered a 49 μm marginal match, while our data showed a 63.9 μm mean digital impression [48] who evaluated the marginal fit of single zirconia crowns created from digital impressions in a similar way using LavaTM C.O.S. The propensity towards bigger marginal errors in longer span restorations can account for the discrepancy between the marginal fit mean values from the previously stated research and ours, since four-unit frameworks undergo more distortion during manufacturing than single crowns [49].

According to Shinyoung, all of the marginal gap values are thought to fall within a range that is clinically appropriate. Specifically, the digital impression copings showed a faithfulness of less than 120 mm, which corresponds to the marginal gap of the traditional casting. Additional studies that consider several components, such as internal fit measurement and fixed dental prostheses, as well as more assessments of prostheses in intraoral settings are required in order to get more trustworthy research data on the marginal gap of copings manufactured with the iTero technology.

Digital impression crowns did not perform as well as crowns equipped with LavaTM C.O.S., according to an in vivo study by Rinet Dauti et al. The median marginal gap was 49 μm. The digital group's median marginal gap was found to be 79.57 μm using an optical microscope and 88.02 μm using a scanning electron microscope. This study differs from the previous one. The experiment's higher values were initially believed to be the consequence of sealing the copings with zinc phosphate cement. The silicone replica approach was used to make the measurements in the aforementioned experiment, which may have led to an increase in the marginal values.

This method cannot accurately duplicate the thickness of ZnO phosphate cement, and the viscosity of the silicone substance selected will determine how well the fit turns out [51]. Using the three distinct imprint techniques resulted in statistically significant changes in the internal and marginal fits of the three-unit FPD. The finish line might be defined more precisely thanks to the intraoral scanner. This is in line with a study by Nedelcu et al. that used a 3D analysis

to evaluate the accuracy of IOS and one traditional impression. They came to the conclusion that trios offered the best resolution and distinctiveness at the finish line [51].

Because of their many benefits, digital impressions are becoming more and more frequent in therapeutic settings. Because this technology allows for digital file storage, in-office milling of final restorations, and electronic transfer, it does away with the necessity to choose trays and impression materials. putting electronics away [52]. The increased expense of purchasing an intraoral scanner, the requirement to attend workshops and courses, and the requirement to keep up with evolving technology advancements are some drawbacks of digital impressions.

Despite the fact that there were multiple SRs, the systematic review methodology demonstrated how urgently a standardized process employing assessment tools such as AMSTAR 2 was required to improve the quality of their reporting. To support the methodological consistency of the early studies, more study is suggested to tighten the inclusion and exclusion criteria. Similarly, new primary trials (RCTs) need to be carried out with the highest level of methodological rigor in order to yield more reliable results and better SRs.

Future research should adhere to a standard protocol that details the type of restoration, preparation design, conventional impression material, laboratory fabrication technique, amount of spacer required, type of scanner, and methods used to measure the marginal adaptation in order to consistently compare marginal and internal fit.

4. Conclusion

Of the systematic reviews, half showed better marginal adaptation with digital impressions, and the other half suggested significant differences between conventional and digital impressions.

When compared to dental restorations made with the traditional impression approach, the digital imprint strategy yielded restorations with statistically equal marginal deviations. For the manufacture of zirconia FPD, digital scanning offers a marginal and intaglio fit that is significantly superior than traditional impression fabrication.

Ethical issue

Not applicable.

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Conflicts of interest

The authors declare no conflict of interest.

Abbreviations used in this review

Nomenclature & symbols

Zr FDPs	Zirconia Fixed Dental Prostheses.
Zr	zirconia
SRs	Systematic review
FPD	Fixed partial denture
CAD/CAM	Computer aided design Computer aided manufacture
IOSs	intraoral scanners
vs	versus
IMP	Impression
RCTs	randomized clinical trials
ZnO	Zinc oxide
CI	Conventional impression
CDA	California Dental Association
Z crown	Zirconia crown
SR	Systematic Reviews

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