META-ANALYSIS / *MÉTA-ANALYSE*

Prosthodontics / *Prothèse Fixée*

COMPARATIVE EVALUATION OF MARGINAL AND INTERNAL FIT OF ZIRCONIA CROWN DESIGNED USING ARTIFICAL INTELLIGENCE AND CAD-CAM SOFTWARE: A SYSTEMATIC REVIEW

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Introduction: The long-term performance of dental restorations depends on their internal and marginal fits. Improvements in the fit of restorations, especially zirconia crowns, have been investigated through the use of diverse materials, manufacturing processes, and impression techniques.

Objectives: The purpose of this review was to examine the internal and marginal fit of zirconia crowns made with CAD/CAM software with artificial intelligence (AI) software.

Methods: Using a combination of keywords and MeSH terms, the literature search was carried out across seven databases: PubMed, Scopus, Web of Science, Cochrane Library, Embase, ProQuest, and ScienceDirect from inception till 1st of September, 2024. To guarantee correctness and uniformity in the data that was retrieved, a standardised form was established. In vitro or in vivo studies were considered for inclusion, and two reviewers evaluated the selected literature.

Results: CAD/CAM-generated restorations showed better fit than conventionally manufactured restorations in all 5 of the studies included in the review, especially those made with digital workflows and imprint techniques. Compared to other approaches, digital technologies including completely digital (IOS) and digital intra-oral impressions produced a better fit. For single-visit zirconia treatment, high-speed sintering produced encouraging results with lower marginal gap values. When compared to milled zirconia (MZ) crowns, self-glazed zirconia (SGZ) crowns showed superior internal and overall fit.

Conclusions: The results showed that, when compared to restorations that were conventionally produced, CAD/CAM-fabricated restorations, particularly those that were planned with the use of digital workflows and imprint techniques, had greater marginal and internal fit. Zirconia crown fit has improved thanks to promising advances in digital technology, including high-speed sintering and entirely digital operations. To determine the long-term clinical performance of restorations created with CAD/CAM and AI, more research is required.

Keywords: digital workflows, CAD/CAM, artificial intelligence, zirconia crowns, marginal fit, internal fit, and digital dentistry

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ÉVALUATION COMPARATIVE DE L'ADAPTATION MARGINALE ET INTERNE DES COURONNES EN ZIRCONE CONÇUES À L'AIDE DE L'INTELLIGENCE ARTIFICIELLE ET D'UN LOGICIEL DE CAO-FAO: UNE REVUE SYSTÉMATIQUE

Introduction: La performance à long terme des restaurations dentaires dépend de leur adaptation interne et marginale. L'amélioration de l'adaptation des restaurations, notamment des couronnes en zircone, a été étudiée grâce à l'utilisation de divers matériaux, procédés de fabrication et techniques d'empreinte.

Objectifs: Cette revue avait pour objectif d'examiner l'adaptation interne et marginal des couronnes en zircone réalisées avec un logiciel de CFAO et d'intelligence artificielle (IA).

Méthodes: À l'aide d'une combinaison de mots-clés et de termes MeSH, une recherche bibliographique a été effectuée dans sept bases de données : PubMed, Scopus, Web of Science, Cochrane Library, Embase, ProQuest et ScienceDirect, depuis leur création jusqu'au 1er septembre 2024. Afin de garantir l'exactitude et l'uniformité des données récupérées, un formulaire standardisé a été établi. Des études in vitro ou in vivo ont été prises en compte pour l'inclusion, et deux évaluateurs ont évalué la littérature sélectionnée.

Résultats: Les restaurations générées par CFAO ont montré une meilleure adaptation que les restaurations conventionnelles dans les cinq études incluses dans la revue, en particulier celles réalisées avec des flux de travail numériques et des techniques d'empreinte. Comparées à d'autres approches, les technologies numériques, notamment les techniques intra-orales totalement numériques (IOS) et les empreintes intra-orales numériques, ont produit une meilleure adaptation. Pour le traitement de la zircone en une seule visite, le "sintering" à grande vitesse a produit des résultats encourageants avec des valeurs d'espace marginal plus faibles. Comparées aux couronnes en zircone usinée (MZ), les couronnes en zircone auto-émaillée (SGZ) ont montré une meilleure adaptation interne et globale.

Conclusions: Les résultats ont montré que, comparativement aux restaurations conventionnelles, les restaurations fabriquées par CFAO, en particulier celles planifiées à l'aide de flux de travail numériques et de techniques d'empreinte, présentaient une meilleure adaptation marginale et interne. L'adaptation des couronnes en zircone s'est améliorée grâce aux avancées prometteuses de la technologie numérique, notamment le "sintering" à grande vitesse et les opérations entièrement numériques. Des recherches supplémentaires sont nécessaires pour déterminer les performances cliniques à long terme des restaurations créées par CFAO et IA.

Mots clés: flux de travail numériques, CFAO, intelligence artificielle, couronnes en zircone, ajustement marginal, ajustement interne et dentisterie numérique

Introduction

The advancement of computer-aided design and computer-aided manufacturing (CAD-CAM) technologies has revolutionised dentistry by enabling the production of more precise and accurate dental restorations [1]. Among the several materials used in CAD-CAM dentistry, zirconia has emerged as a popular option for aesthetically pleasing crowns due to its exceptional mechanical properties and biocompatibility [2].

Using digital scanning technology, exact data from the patient's mouth cavity is obtained and delivered directly to the computer system in CAD-CAM dentistry. This technology is a major enhancement to modern dentistry operations since it can speed up the fabrication process and remove the requirement for manual labour [3]. Because the CAD-CAM process eliminates the manual handling associated with traditional systems that require physical models or materials comparable to plaster, it lowers the potential of production errors [4]. Patients are also more inclined to accept recommended treatments including partial metal ceramic structures rather than full ceramic reconstructions since it offers them the best potential functionality and cosmetic appeal. Additionally, zirconia crowns may enhance a patient's overall dental health and wellbeing [5].

On the other hand, the proper functioning of a zirconia crown depends on precise fitting. Achieving a precise fit is essential to maintain the integrity of the tooth-restoration interface and prevent further problems such as periodontal disease, dental cavities, and marginal leakage [6]. A zirconia crown's internal and marginal fittings can be used to assess the crown's fitness. The marginal fit indicates how precisely the restoration's margins are cut, while the internal fit indicates how closely the restoration's inner surfaces match those of the oral cavity. A precise marginal fit allows a smooth transition between the tooth and the restoration and stops leaks at the margins, while a fine internal fit helps to preserve structural integrity by preventing fractures or dislodgement from adjoining teeth [7-8].

The development of artificial intelligence (AI) has led to the development of CAD-CAM software with AI assistance, which is expected to enhance the accuracy and efficiency of zirconia crown design [9]. The ability of artificial intelligence (AI) systems to identify trends and analyse complex, large-scale data sets makes it easier to create highly accurate digital models and the best restoration plans [10-11].

However, nothing is known about how applying AI-assisted CAD-CAM software in zirconia crown manufacturing will actually affect the industry. Furthermore, no information is available on the differences between zirconia crowns manufactured with AI-assisted CAD-CAM software and those made with traditional CAD-CAM software in terms of internal and marginal fits. This review aims to give readers a fundamental grasp of the differences between zirconia crowns made with AI-assisted software and those made with traditional CAD-CAM software, with a particular emphasis on marginal and internal fit.

Materials and Methods

Research question

This review aimed to determine whether AI-assisted crowns made from CAD-CAM software are better designed with respect to marginal and internal adaptation compared to those made using CAD-CAM software.

Eligibility criteria

The PECO protocol was established according to the PRISMA reporting guidelines. The registration number assigned to this review after the PROSPERO registration was CRD42024578657. The target population was the patients who needed zirconia crowns in their mouths. This population was not considered specific by age, gender or dental condition. The exposures had been zirconia crowns that were CAD-CAM designed using either AI-assisted or traditional CAD-CAM software. A comparative evaluation was established for the evaluation of the marginal and internal fit of zirconia crowns designed on AI-assisted CAD-CAM software compared to those designed by traditional CAD-CAM software. The primary outcomes from this literature review were the marginal and internal fit of the zirconia crowns. The selection criteria devised for the review are detailed in table 1. In vitro or in vivo

Table 1. Inclusion and exclusion criteria devised for the review

Criteria	Inclusion	Exclusion
Study design	In vitro or in vivo studies	Review articles, case reports, and opinion articles
Population	Patients requiring zirconia crowns	Studies on other types of dental restorations
Exposure	Zirconia crowns designed using AI-assisted CAD-CAM software or traditional CAD-CAM software	Studies on other materials or CAD-CAM systems
Outcome	Marginal and internal fit of zirconia crowns	Studies on other outcomes, such as aesthetics or mechanical properties
Language	English language studies	Non-English language studies
Date	From inception till 1st of September, 2024	

studies eligible were patients who needed zirconia crowns, especially when designed using AI-assisted or traditional CAD-CAM software. Only English studies which were assessing the marginal and internal fit of zirconia crowns, from their inception until September 1, 2024, were considered. Review articles, case reports, opinion articles, other studies on different types of dental restorations, CAD-CAM systems or on outcomes like aesthetics, mechanical properties, etc., were excluded.

Database search protocol

Boolean operators and MeSH keywords were used in our database search, which was conducted across seven distinct databases. PubMed, Scopus, Web of Science, Cochrane Library, Embase, ProQuest, and ScienceDirect were the databases that were searched. Keywords and MeSH phrases were combined, the specifics of which are provided in table 2, to create search strings.

Extracted variables

In order to assure consistency and correctness in the obtained data, a standardised form was developed and matched this protocol with the research question and review objectives. Next, a methodical plan was developed for data extraction to collect relevant information from the chosen studies. After finishing a pilot research to validate the standardised extraction form, two trained reviewers separately extracted data from each trial. They then worked together to resolve any differences in their evaluations before entering the data into a spreadsheet for analysis.

Procedure for bias assessment

The QUIN method was employed for bias assessment [13], which has been modified to evaluate the potential for bias in in vitro dental trials. Two reviewers carried out the evaluation methodology, independently determining each study's likelihood of bias.

Table 2. Search strings utilised across the assessed databases

Database	Search string
PubMed	((“zirconia crown” OR “zirconia restoration”) AND (“CAD-CAM” OR “computer-aided design” OR “computer-aided manufacturing”) AND (“artificial intelligence” OR “AI-assisted” OR “machine learning”)) AND (“marginal fit” OR “internal fit” OR “precision fit”)
Scopus	(TITLE-ABS-KEY(“zirconia crown” OR “zirconia restoration”) AND TITLE-ABS-KEY(“CAD-CAM” OR “computer-aided design” OR “computer-aided manufacturing”) AND TITLE-ABS-KEY(“artificial intelligence” OR “AI-assisted” OR “machine learning”)) AND TITLE-ABS-KEY(“marginal fit” OR “internal fit” OR “precision fit”)
Web of Science	(TS=(“zirconia crown” OR “zirconia restoration”) AND TS=(“CAD-CAM” OR “computer-aided design” OR “computer-aided manufacturing”) AND TS=(“artificial intelligence” OR “AI-assisted” OR “machine learning”)) AND TS=(“marginal fit” OR “internal fit” OR “precision fit”)
Cochrane Library	(“zirconia crown” OR “zirconia restoration”) AND (“CAD-CAM” OR “computer-aided design” OR “computer-aided manufacturing”) AND (“artificial intelligence” OR “AI-assisted” OR “machine learning”) AND (“marginal fit” OR “internal fit” OR “precision fit”)
Embase	(‘zirconia crown’ OR ‘zirconia restoration’ OR ‘zirconia crown fabrication’) AND (‘CAD-CAM’ OR ‘computer aided design’ OR ‘computer aided manufacturing’) AND (‘artificial intelligence’ OR ‘AI-assisted’ OR ‘machine learning’) AND (‘marginal fit’ OR ‘internal fit’ OR ‘precision fit’)
ProQuest	((“zirconia crown” OR “zirconia restoration”) AND (“CAD-CAM” OR “computer-aided design” OR “computer-aided manufacturing”) AND (“artificial intelligence” OR “AI-assisted” OR “machine learning”)) AND (“marginal fit” OR “internal fit” OR “precision fit”)
ScienceDirect	(TITLE-ABS-KEY(“zirconia crown” OR “zirconia restoration”) AND TITLE-ABS-KEY(“CAD-CAM” OR “computer-aided design” OR “computer-aided manufacturing”) AND TITLE-ABS-KEY(“artificial intelligence” OR “AI-assisted” OR “machine learning”)) AND TITLE-ABS-KEY(“marginal fit” OR “internal fit” OR “precision fit”)

Results

Study selection process

314 documents were found in the first phase of database searches (Figure 1). Nothing additional was found in the registers. 46 records were removed out of the 274 records that were evaluated after 40 duplicate entries were found. 39 reports were not located out of the 228 records that were still being sought after. When the 189 retrieved publications were assessed for eligibility, 182 papers were disqualified for a number of reasons: they were editorials (n = 18), they were off-topic (n = 29), they were literature reviews (n = 31), they were scoping reviews (n = 25), they were grey literature (n = 35), and they did not react to PECO (n = 44). Seven studies [14–18] in total were covered by the review.

Evaluated degrees of bias

Bias concerns were raised in several studies [14, 16, 17], with issues in the randomization process, missing outcome data, and outcome measurement being the main culprits (Figure 2). Only one study [15] was found to have a substantial risk of bias due to problems with missing outcome data.

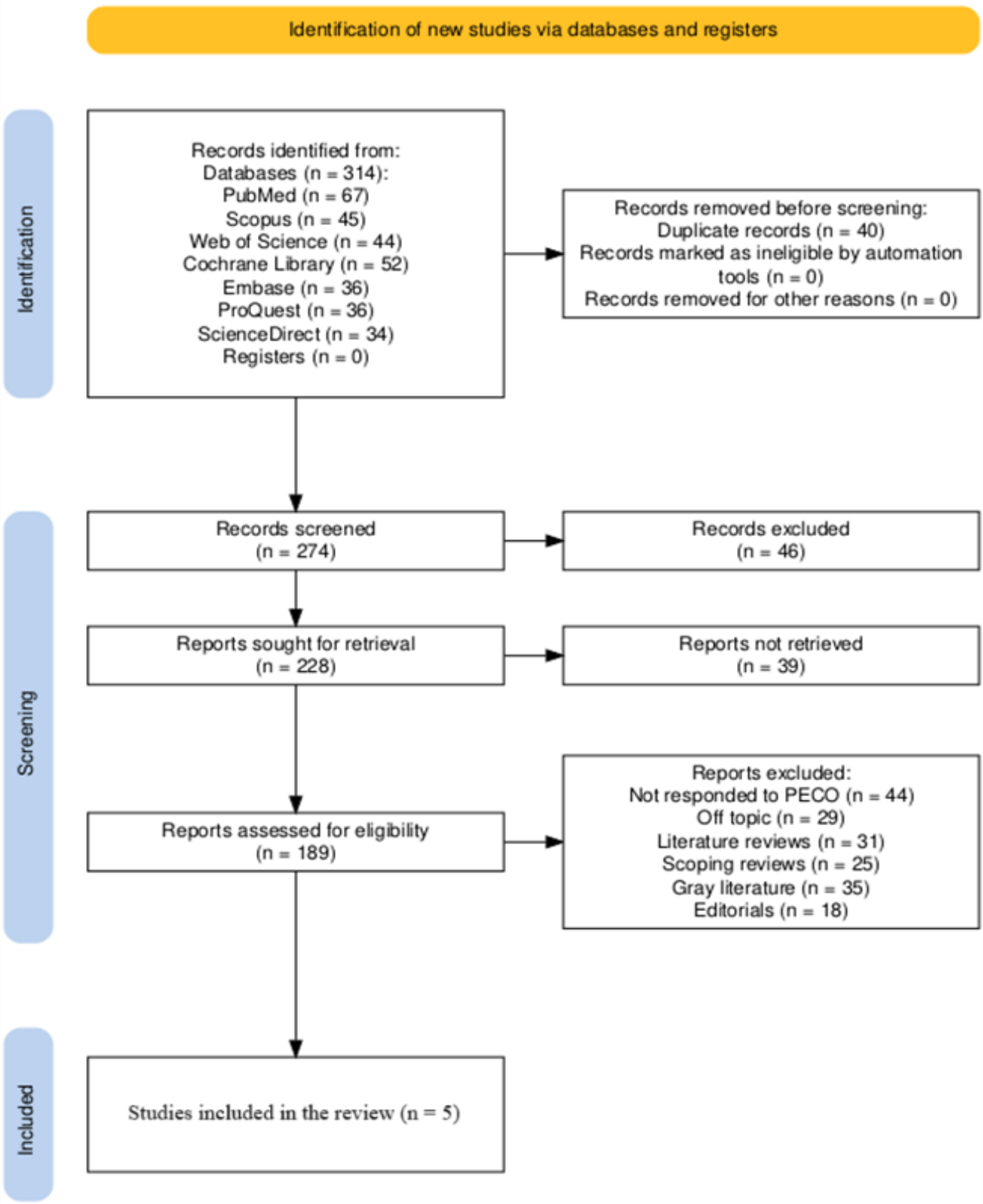

Figure 1. Article selection schematics for the review using the PRISMA guidelines

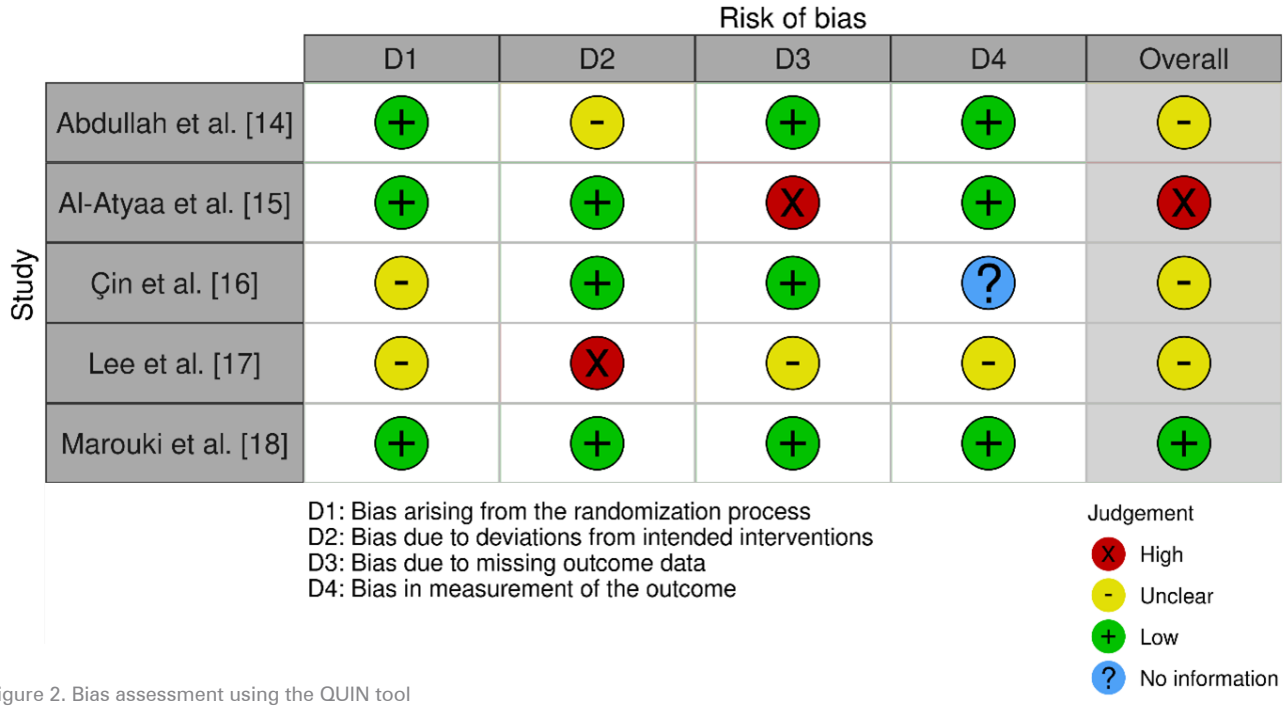

Figure 2. Bias assessment using the QUIN tool

Table 3. Studies included and their observed inferences

Study	Assessment Parameters	Comparison Groups	Sample Size	Marginal Gap (μm)	Internal Gap (μm)	Key Findings
Abdullah et al. [14]	Fit, strength, and fracture mode	CAD-Temp, PEEK, Telio, Protemp	10 per group	VITA: 60.61, PEEK: 46.75, Telio: 56.10, Protemp: 193.07	VITA: 124.94, PEEK: 113.14, Telio: 110.95, Protemp: 143.48	CAD/CAM provisional crowns outperform direct crowns in terms of fit and strength.
Al-Atyaa et al. [15]	Marginal and internal gaps	Conventional (2-step, 1-step) and digital impression	8 per group	Group I: 60.299, Group II: 68.803, ..., Group V: 53.533	Group I: 133.749, Group II: 139.772, ..., Group V: 128.439	Digital intra-oral impression showed the smallest gaps, with significant differences between groups and areas.
Çin et al. [16]	Marginal and internal fit	Fully digital (IOS) vs. semi-digital (EOS) workflows	10 per group	IOS: 28-42, EOS: 43-77	IOS: 28-42, EOS: 43-77	Fully digital workflow provided better fit compared to semi-digital workflow, with acceptable gap values.
Lee et al. [17]	Marginal and internal fit	Conventional vs. high-speed sintering of zirconia crowns	30 per group	Conventional: 419.384, High-speed: 400.482	Conventional: 200.426, High-speed: 194.170	High-speed sintering method showed promising results with smaller marginal gaps and internal fit values.
Marouki et al. [18]	Marginal and internal fit, internal accuracy	Self-glazed zirconia (SGZ) vs. milled zirconia (MZ) crowns	10 per group	Direct-view: SGZ > MZ (P = 0.044)	Occlusal, internal, total mean distances: SGZ > MZ (P < 0.001)	SGZ crowns demonstrated better internal and total fit, with advantages in marginal fit using direct-view technique.

Baseline parameters evaluated

The included studies and their findings are displayed in Table 3. The marginal gap, internal fit, and strength of four distinct crown materials were assessed in one study [14]. Another study [15] compared the peripheral and internal gaps of five distinct imprint procedures. Simultaneously, one investigation [16] focused on the internal and marginal fits of two digital workflows. The peripheral and internal fit of zirconium crowns produced with two distinct sintering techniques was examined in another study [17]. The internal accuracy, marginal fit, and internal fit of two different types of zirconium crowns were assessed in another analysis [18].

Results evaluated

One study [14] reported that PEEK exhibited the smallest internal gap (113.14 ± 23.55 μm) and marginal gap (46.75 ± 8.26 μm) compared to other materials. After examining five different impression processes, another study [15] found that Group V, which used polyether digital intraoral imprint, had the lowest marginal gap (53.533 ± 6.44 μm) and internal gap (128.439 ± 6.425 μm). Another investigation [16] reported that the fully digital (IOS) technique resulted in smaller internal and marginal gaps compared to the semi-digital (EOS) approach. There was no significant difference in the marginal and internal fit between high-speed and traditionally sintered zirconia crowns in one study [17]. Significant variations were observed in the marginal and internal fit between SGZ and MZ crowns, with the MZ crown demonstrating a relatively better match in another study [18].

Discussion

CAD-CAM systems speed up the creation of design and fabrication by designing the individualized restorative solution based on patient individual requirements for better fit and longer durability and higher level of comfort [19-23]. Of all the materials produced in CAD-CAM dentistry, one of the most widely accepted materials is zirconia, mainly in the form of crowns, which owes this to excellent mechanical properties, such as high strength and high fracture resistance [24]. Besides, good wear compatibility is displayed with opposing natural teeth. Zirconia displays excellent biocompatibility through an absence of allergic reaction and adverse tissue reaction; therefore, there is no issue from a point of view of long-term use within the oral environment [25]. Unlike the conventional materials, zirconia also exhibits some degree of translucency which closely resembles the natural dentition structure; thus, it may achieve aesthetic results difficult to accomplish with metal-based restorations [26-29]. Zirconia crowns are therefore very long-lasting and aesthetically effective, meeting all criteria as far as both functionalities and cosmetics are concerned in current restorative dentistry [30].

In line with our findings, Al Wadei et al. [31] carried out a thorough examination and found that 3D-printed temporary crowns and set prostheses showed superior internal adjustment and edge fitting compared to CAD/CAM-milled and conventional provisional resins. Our evaluation's results are consistent with this one, demonstrating the advantages of digital manufacturing techniques for improving restoration fit.

In order to determine how well AI can forecast the prognosis of dental implants, Wu et al. [32] carried out a scoping review. Even while their research focused on AI's ability to predict implant prognosis from radiographic images or patient medical information, it avoided directly addressing the impact of digital manufacturing techniques on restorative fit. However, their findings suggest that AI could assist physicians in making deliberate decisions before implant implantation. This might result in better therapeutic outcomes.

The application of AI-driven technologies in CAD/CAM restorative dentistry treatments and materials was compiled by Yeslam et al. [33]. They found that while creating dental restorations, AI might automate and incorporate occlusal designs, aesthetic components, and the CAD choices made by prior practitioners. Furthermore, it has the ability to forecast the likelihood of debonding in CAD/CAM restorations and the impact of material type composition variations on mechanical qualities. Although the study focused on potential benefits of AI in CAD/CAM workflow and material qualities, it did not explicitly assess how well AI-assisted restorations fit with conventional procedures.

Tabatabaian et al. [34] evaluated the applications, functions, and accuracy of artificial intelligence in many restorative dentistry domains in their narrative review. The scientists found that using AI models to detect cavities, determine margins for tooth preparation, design tooth restorations, cast metal structures, and identify dental restorations/implants produced encouraging outcomes. Furthermore, AI showed promise in both tooth shade identification and the design of removable partial dentures. Their study demonstrated how artificial intelligence (AI) could improve various aspects of restorative dentistry, even though they did not compare the fit of AI-assisted restorations to traditional approaches.

In their discussion of the development of CAD/CAM technologies and their impact on contemporary prosthodontics, Spitznagel et al. [35] emphasised the growing use of monolithic zirconia restorations as well as the clinical long-term success of bonded CAD/CAM glass-ceramic restorations. The benefits of CAD/CAM technologies in guaranteeing a consistent production process were emphasised in their study. This results in processes for simple or complex teeth-supported restorations that are dependable, predictable, and economical. Although they

did not directly compare the fit of CAD/CAM restorations to more conventional techniques, their research supports the idea that digital manufacturing is advantageous for contemporary prosthodontics.

Similar conclusions were reached by Abdullah et al. [14], Çin et al. [16], and Al-Atyaa et al. [15] about the ways in which digital manufacturing workflows and technologies might improve the accuracy of dental restorations. However, the papers by Lee et al., Marouki et al. [17], Marouki et al. [18], and Tsitrou et al. [20] focused on certain facets of the production of zirconia crowns or the operation of a specific CAD/CAM system with resin composite crowns. These studies also had more clear goals and conclusions. Studies conducted by Abdullah et al. [14] and Paul et al. [19] discovered that restorations created with CAD/CAM had greater fit accuracy than restorations created with traditional techniques. This makes a similar case for the advantages of digital production techniques.

The impact of digital processes and impression techniques on the marginal and internal fit of restorations was investigated by Çin et al. [16] and Al-Atyaa et al. [15]. Furthermore, Al-Atyaa et al. [15] assessed several impression techniques, such as digital intra-oral impression (Group V), whereas Çin et al. [16] contrasted fully digital (IOS) and semi-digital (EOS) workflows. It was found that digital methods (IOS and Group V) yielded a more accurate match than other techniques in both experiments. This demonstrates a similar conclusion about how digital technologies might enhance restoration fitting.

Zirconia crowns were explored by Lee et al. [17] and Marouki et al. [18], although they looked at different aspects of their manufacturing. In a comparison between high-speed and conventional sintering, Lee et al. [17] found that, for single-visit zirconia treatment, high-speed sintering produces better results with reduced marginal gap values. In their study, Marouki et al. [18] examined the fit of self-glazed zirconia (SGZ) crowns and contrasted it with a different study that looked at the fit of milled zirconia (MZ) crowns. When it came to internal and total fitting, the first study's findings were comparable to those of the second. Even though zirconia crowns were the subject of both investigations, their objectives and conclusions differed.

Tsitrou et al. [20] distinguished themselves from earlier studies examining different finishing lines and cementation techniques by evaluating the marginal gap of resin composite crowns made with a specific CAD/CAM system (CEREC 3). Because the study focused on a specific material and CAD/CAM technique, its conclusions differed slightly from those of the other studies.

Numerous studies that aim to establish appropriate limitations for clinical use have been conducted and have covered a great deal of ground regarding the minute and internal variations of dental restorations [21-26]. The stated figures differ greatly depending on a number of variables, including the restoration's design, material composition, impression-making techniques, manufacturing procedures, and cementing chemicals used. Despite the heterogeneity across studies, previous research indicates that acceptable ranges for internal fit are between 100-200 μm, whereas those associated to marginal fit are between 100-250 μm [24-26].

Fit evaluation of zirconia crowns has been studied in great detail, with many studies showing promising results [16-21]. In recent years, CAD/CAM has grown in popularity [22-24]. The precision additive 3D gel deposition process is one way to create self-glazed zirconia crowns. A premixed solution containing monomers, a cross-linking agent, and deionised water must first be prepared in order to produce zirconia slurry. The printer's computer-controlled screw extruder forces the slurry, catalyst, and initiator out of the nozzle to form three-dimensional forms [25]. This method produces a tailored hierarchical structure with smooth and rough surfaces divided by pore sizes that are orientated in a certain direction [26-28]. Beneath the outermost layer of the material, which has a smaller grain size, are particles with bigger diameters [28]. While building is in progress, we grind the intaglio surface of the crown. The next step is surface gelation, or the formation of a gel-like layer on top. It happens when organic monomers change into polymers in order to form materials that are macropolymeric [29]. The restorations are then made using the sintering procedure [30]. Because of their surface properties, which lessen the chance of interface fractures between the veneering material and the core, these crowns are usually manufactured in a single piece without the need for veneering or glazing [31].

Clinical recommendations

It is advised that uniform procedures be established in order to gauge the internal and marginal fit of dental restorations. This will facilitate direct comparisons between various studies. The second recommendation is that more clinical trials should be conducted to assess the long-term performance of zirconia crowns built with AI and CAD/CAM technology. This is because in vitro studies may not adequately depict the complexity of the oral environment. We also recommend more research on the effects of several factors, including as material characteristics, manufacturing parameters, and worker proficiency in zirconia crown fitting. This may improve the calibre of the restoration. Furthermore, employing digital techniques in their work with patients, including as CAD/CAM systems and digital impression abilities, may improve the fit and general quality of zirconia crowns. But because these technologies tend to have a learning curve, it's critical that those using them are well-trained.

Limitations

We acknowledge the limitations of our systematic review. It was challenging to compare the studies side by side because each examined a different combination of imprint procedures, materials, and production techniques. Furthermore, not all studies used the same sample sizes, methodologies, or measurement strategies. This might have had an impact on the outcomes. Our ability to draw conclusions is restricted by the lack of a standard technique for assessing internal and marginal fit. Furthermore, the majority of the studies in our analysis were conducted in vitro. These might not offer a clear picture of how effectively the fixes work in real-world circumstances (in vivo). Generalisations were also restricted by the small number of research that met all inclusion criteria.

Conclusion

Our findings indicate that restorations produced with CAD/CAM technology, especially those utilising digital and impression methods, exhibited enhanced internal and external fitting compared to traditionally fabricated restorations. We examined research illustrating how digital technologies, including fully digital methods, digitally recorded dental impressions, and quick sintering, can improve the fit of zirconia crowns. We acknowledge that further research is required to comprehensively assess the long-term performance of AI- or CAD/CAM-designed zirconia crowns in patients, given the discrepancies among the included studies and the constraints of in vitro investigations.

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