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Accuracy in the marginal adaptation and/or internal adaptation of full-coverage fixed prostheses made with digital impressions and conventional impressions: A systematic review

Trabajo de titulación previo a la obtención del título de Especialista en Rehabilitación Oral y Prótesis Implanto Asistida

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Resumen

Objetivo: Verificar el cumplimiento de los requisitos establecidos por la comunidad científica y demostrar la validez y confiabilidad de las revisiones sistemáticas sobre la precisión (adaptación marginal y/o adaptación interna) de las prótesis fijas de cobertura total realizadas con impresiones digitales versus impresiones convencionales.

Métodos: Se realizaron búsquedas en tres bases de datos electrónicas, PubMed, Scopus y Web of Science, así como en la literatura gris. En la estrategia de búsqueda se utilizaron palabras de encabezado de tema médico (MeSH) en PubMed y términos libres para los títulos y resúmenes de cada artículo. Cada palabra clave fue separada por el operador booleano OR para luego combinarse con el operador booleano AND. Se incluyeron seis revisiones sistemáticas para la síntesis cualitativa. Para evaluar la calidad metodológica de las revisiones sistemáticas incluidas se utilizó la herramienta AMSTAR 2

Resultados: La búsqueda arrojó 131 estudios, de los cuales 78 permanecieron después de eliminar los duplicados. Se evaluaron el título y el resumen de cada estudio elegido y se incluyeron 22 artículos para lectura de texto completo. Finalmente, se incluyeron seis estudios, de los cuales tres se consideraron de confianza baja, mientras que los otros tres se consideraron de confianza críticamente baja. Además, las seis RS evaluaron la adaptación o ajuste marginal, mientras que solo tres estudios midieron la adaptación interna.

Conclusiones: El uso de impresiones digitales en prótesis fijas unitarias mantiene un nivel marginal dentro del límite de aceptabilidad clínica, sin embargo, la calidad metodológica de las revisiones sistemáticas es deficiente, según la herramienta AMSTAR 2.

Palabras clave: ajuste marginal, ajuste interno, impresiones convencionales, impresiones digitales, prótesis fija

Abstract

Objective: To verify compliance with the requirements established by the scientific community and to demonstrate the validity and reliability of the systematic reviews on the accuracy (marginal adaptation and/or internal adaptation) of the full-coverage fixed prostheses made with digital impressions versus conventional impressions.

Methods: Searches were performed in three electronic databases, PubMed, Scopus, and Web of Science, as well as in the gray literature. In the search strategy, medical subject heading (MeSH) words were used in PubMed, and free terms were used for the titles and abstracts of each article. Each keyword was separated by the Boolean operator OR to later be combined with the Boolean operator AND. Six systematic reviews were included for qualitative synthesis. To assess the methodological quality of the included systematic reviews, the AMSTAR 2 tool was used

Results:The search yielded 131 studies, of which 78 remained after removing duplicates. The title and abstract of each chosen study were assessed, and 22 articles were included for full text reading. Finally,six studies were included, of which three studies were considered to have low confidence, while the other three were considered to have critically low confidence. In addition, the six SRs evaluated the adaptation or marginal fit, while only three studies measured internal adaptation.

Conclusions: The use of digital impressions in single fixed prostheses maintains a marginal level within the limit of clinical acceptability, however, the methodological quality of systematic reviews is poor, according to the AMSTAR 2 tool.

Keywords: marginal fit, internal fit, conventional impressions, digital impressions, fixed prostheses

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1. Introduction

“Computer-aided design and manufacturing” (CAD/CAM) has been used in the preparation of dental restorations, especially crowns and ceramic fixed prostheses, since the 1980s [1-4]. It is believed that fixed dental prostheses, fabricated from intraoral digital impressions, have several notable advantages over those obtained through conventional impressions [5-9]. To mention a few, digital impressions better prevent errors of accuracy in the restoration margins than conventional impressions [10]. In addition, the general operating cost of the procedure and the clinical work time is reduced compared to conventional impressions [11-16].

A growing number of fixed prostheses are made using intraoral digital impressions, so this technique has become a fundamental part of digitalization in prosthodontics [17-21]. A good-quality fixed prosthesis that ensures treatment longevity depends on the marginal accuracy and internal fit between the abutment and the restoration [9,22,23]. The most common indicators of poorly adjusted restorative margins[24-31] are cement dissolution, plaque retention, periodontal problems such as increased gingival inflammation and probing depth[32], dental hypersensitivity and caries [33,34].The use of intraoral scanners, has been introduced to minimize microadaptation errors and subsequent problems that conventional impression techniques can cause [35,36].

Several studies have analyzed conventional and digital impression techniques, concluding that both procedures are clinically acceptable and therefore widely recommended. However, when studying the comparative accuracy of both techniques, results that can still be considered controversial begin to appear. Some authors suggest the better results for the conventional technique over the digital technique, and others report better marginal adaptation for the digital technique than the conventional technique, thus confusing the professional who must make a scientifically supported clinical decision to provide high-quality prosthetic work with the greatest possible durability. A systematic review of the scientific literature could help evaluate the accuracy of these two techniques in a more comprehensive manner [37,38].

For these reasons, this “systematic review” has been written as nothing more than a technical and scientific review of the systematic reviews currently published. This systematic review assesses the compliance with the requirements established by the scientific community in performing systematic reviews (SRs) on the accuracy (marginal adaptation and/or internal adaptation) of full-coverage fixed prostheses made with digital impressions versus conventional impressions, with the goal of revealing the validity and reliability of each of these reviews and painting a clearer picture of clinical applicability when fabricating long-lasting fixed restorations.

2. Materials and methods

2.1. Protocol and registration

A general protocol was developed based on the “preferred reporting items for systematic reviews and metaanalytical protocols (PRISMA-P) checklist” [39] and was registered in the “International Platform of Registered Systematic Review and Meta-Analytical Protocols” (INPLASY). The registry is publicly available under the number INPLASY2021100024.

2.2. Eligibility criteria

To be considered eligible, studies had to meet the following criteria:

● Systematic reviews with or without meta-analysis that evaluated the accuracy (marginal adaptation and/or internal adaptation) of full-coverage fixed prostheses on natural teeth in clinical studies and on tooth replicas in in vitro studies.

● Systematic reviews with or without meta-analysis that compared digital impressions made with an intraoral scanner versus conventional impressions taken with any type of impression material.

● Systematic reviews and/or meta-analyses of randomized clinical trials (RCTs) and of comparative, prospective, nonrandomized, and in vitro clinical trials.

There were no time or language restrictions.

2.3. Exclusion criteria

● Literature reviews, case reports, and pilot studies

● Studies that evaluated seating in crowns on implants and partial restorations.

● Studies whose authors did not respond to our requests for information.

● Systematic reviews that did not meet the patient/population, intervention, comparison, outcomes (PICO) question

2.4. Sources of information and search strategy.

On July 17, 2020, an electronic search was conducted in three databases (Scopus, PubMed and Web of Science). The gray literature was also searched through Google Scholar and the New York Academy of Medicine Gray Literature Report. The bibliography of the included studies were manually examined. The studies obtained were exported to the Mendeley bibliographic reference manager (Mendeley Desktop v1.19.4.0), and duplicate studies were eliminated. The search strategy is found in Appendix A. A search update was performed on September 22, 2021.

2.5. Study selection

The selected studies were entered into Microsoft Excel, a software program for data analysis. Initially, two reviewers (M.A.C. and M.C.) independently selected the studies and read all their titles and abstracts to define if each article met the inclusion criteria. These two reviewers then read the full text of each remaining article. A third and fourth reviewer (J.A. and Y.A.) were consulted in case of disagreement. Finally, any studies that did not meet the inclusion criteria were excluded.

2.6. Data collection

The information of the articles was collected using a table previously prepared by two reviewers (M.A.C. and M.C.), independently and in duplicate. The data were compared, and discrepancies between authors were decided by a third and fourth reviewer (J.A. and Y.A.). The information extracted from the selected articles is shown in Table 1.

2.7. Assessment of methodological quality

The AMSTAR 2 tool “A MeaSurement Tool to Assess Systematic Reviews” was used by two reviewers (M.A.C. and M.C.) to assess the methodological quality of the SRs included, independently and in duplicate. AMSTAR 2 has 16 domains that can be answered with three possible answers: "yes", "no", or "partially yes"[40]. Seven of its domains are considered critical, since they can substantially affect the validity of a review and its conclusions. The general confidence (high, moderate, low, and critically low) of the studies was evaluated according to Shea et al. [40]: high: no or noncritical weaknesses; moderate: more than one noncritical weakness; low: a critical defect with or without noncritical or critical weaknesses; and critically low: more tan one critical defect with or without noncritical weaknesses. AMSTAR 2 does not generate an overall score, but the purpose of this tool is to identify high-quality systematic reviews.

2.8. Data synthesis

The main results of each SR were categorized into the following topics: type of prosthetic restoration, marginal gap, internal gap, marginal discrepancy, marginal adaptation, and type of impression. (Table 1). The data were visually presented as a traffic light plot where green represents the better marginal or internal adaptation, red represents poor marginal or internal adaptation, and yellow no differences between the groups compared. The numerical data, the mean difference, and the relative risk are found in the Table 2 and 3.

Table 1. Summary of the overall descriptive characteristics of the included systematic reviews (n = 6).

Author (year)	Population	Interventions and comparators	Primary studies	Mention of the following items: 1. PRISMA 2. PROSPERO 3. GRADE 4. Meta-analysis	Reported review limitations
Bandiaky *et al*. (2022) [41]	Fixed - supported prostheses	Intervention: digital scans Control: conventional impressiontechniques	Comparative studies, prospective: 2; randomized controlled clinical studies: 14	1. Yes 2. Yes 3. No 4. Yes	Few studies per parameter and few participants included in each study. Evidence level was low for the studies thatwere otherwise heterogeneous. [41]
Chochlidakis *etal*. (2016) [36]	Fit of fixed dental restorations	Intervention: digital impression techniques Control: conventional impressiontechniques	Clinical studies: 2; in vitro studies: 9	1. Yes 2. No 3. No 4. Yes	Additional cost of purchasing an intraoral scanner and the learning curvefor adjusting to the new technology [36]
Hasanzade *et al*. (2021) [42]	Fixed prostheses	Intervention: digital scanning and conventional fabrication and digitalscanning and fabrication. Control: conventional impression and fabrication and conventional impression and digital fabrication	Clinical trials: 8; in vitro studies: 21	1. Yes 2. Yes 3. No 4. Yes	No mention
Hasanzade *et al*. (2019) [43]	Full-coverage restorations	Intervention: digital impression Control: conventional impression	Prospective clinical trials: 8; in vitro studies: 26	1. Yes 2. Yes 3. Yes 4. Yes	"Uncontrolled factors may have had a directinfluence on marginal and internal adaptation, including scanner type, finish line design, amount of spacer, fabrication technique, measurement of cemented or uncemented restorations, technical error during the laboratory stages, and adjustmentof restorations. Subanalysis could not be performed due to the limited number of included studies. Only studies in English were included in the meta-analyses". [43]

Tabesh *et al.* (2021) [44]	Single-unit zirconia crowns	Intervention: digital scans Control: conventional impression	Prospective clinical trials: 8; in vitro studies: 11	1. Yes 2. Yes 3. No 4. Yes	"Heterogeneity of the selected studies, including the different methods of tooth preparation, fabrication of restorations, and evaluation of marginal gaps." [44]
Tsirogiannis *et al.* (2016) [45]	Ceramic restorations	Intervention: digital impression Control: conventional impression	In vitro: 8; in vivo: 4	1. No 2. No 3. No 4. Yes	No mention

Table 2. Marginal gap/discrepancy marginal/marginal fit in the general results, graphically represented by colors, where green represents the better marginal adaptation, red represents poor marginal adaptation, and yellow that there are no differences between the compared groups.

Systematic review	**DI**	**CI**	**Reported results**	**Studies for comparison**
Bandiaky *et al*. (2022), France, *Journal of ProstheticDentistry* [41]	🟡	🟡	Marginal fit: MD: -11.1 (C.I. = -32.5, 10.4), P > .05	Comparative studies, prospective(2), and randomized controlled clinical studies (14)
Chochlidakis *et al*. (2016), *Journal of Prosthetic Dentistry* [36]	🟡	🟡	Marginal discrepancy: MD: 0.24 (-0.32, 0.79), I2= 82.64%, P < .001	Clinical studies (2) and in vitrostudies (9)
Hasanzade *et al*. (2021), Iran,*Journal of Prosthetic Dentistry* [42]	🟢	🔴	Marginal gap: MD: 0.25 (0.09, 0.59), I2 = 66.5%, P = .006	Clinical trials (8) and in vitrostudies (21)
Hasanzade *et al*. (2019), Iran,*Journal of Evidence Based Dental Practice* [43]	🟢	🔴	Marginal gap: MD: -0.59 (C.I. = -0.93, -0.24), I2 = 86%, P < 0.00001	Prospective clinical trials (8) andin vitro studies (26)
Tabesh *et al*. (2021), Iran, *Journal of Prosthetic Dentistry* [44]	🟢	🔴	Marginal gap: MD: –0.89 (–1.24, –0.54), I2 = 78.2%, P < .001	Prospective clinical trials (8) andin vitro studies (11)
Tsirogiannis *et al*. (2016),Germany, *Journal of Prosthetic Dentistry* [45]	🟡	🟡	Discrepancy marginal in vivo: adjustedMD: 27.2 (C.I. = -5.3, 59.7), P = .084	4 in vivo studies
	🟡	🟡	Discrepancy marginal in vitro: adjustedMD: -4.2 (C.I. = -33.0, 24.5), P = .763	8 in vitro studies

DI, digital printing; CI, conventional printing; MD, mean difference; CI, confidence interval

Table 3. Internal gap/internal adaptation in the general results graphically represented by colors, where green represents the better internal adaptation, red represents poor internal adaptation, and yellow indicates that there are no differences between compared groups.

Systematic review	**DI**	**CI**	**Reported results**	**Studies for comparison**
Bandiaky *et al*. (2022), France, *Journal of Prosthetic Dentistry* [41]			Internal gap: MD: 0.03 (-0.91, 0.96), I2 = 92.22%, P < .0001	Comparative studies, prospective (2), and randomized controlled clinical studies (14)
Hasanzade *et al*. (2021), Iran, *Journal of Prosthetic Dentistry* [42]			Internal adaptation: MD: 0.32 (C.I. = 0.08, 0.56), I2 = 0.0%, P = .457	Clinical trials (8) and in vitro studies (21)
Hasanzade *et al*. (2019), Iran, *Journal of Evidence Based Dental Practice* [43]			Internal gap: MD: -0.17 (C.I. = -0.53, -0.20), I2 = 86%, P < 0.00001	Prospective clinical trials (8) and in vitro studies (26)

DI, digital printing; CI, conventional printing;MD, mean difference; CI, confidence interval

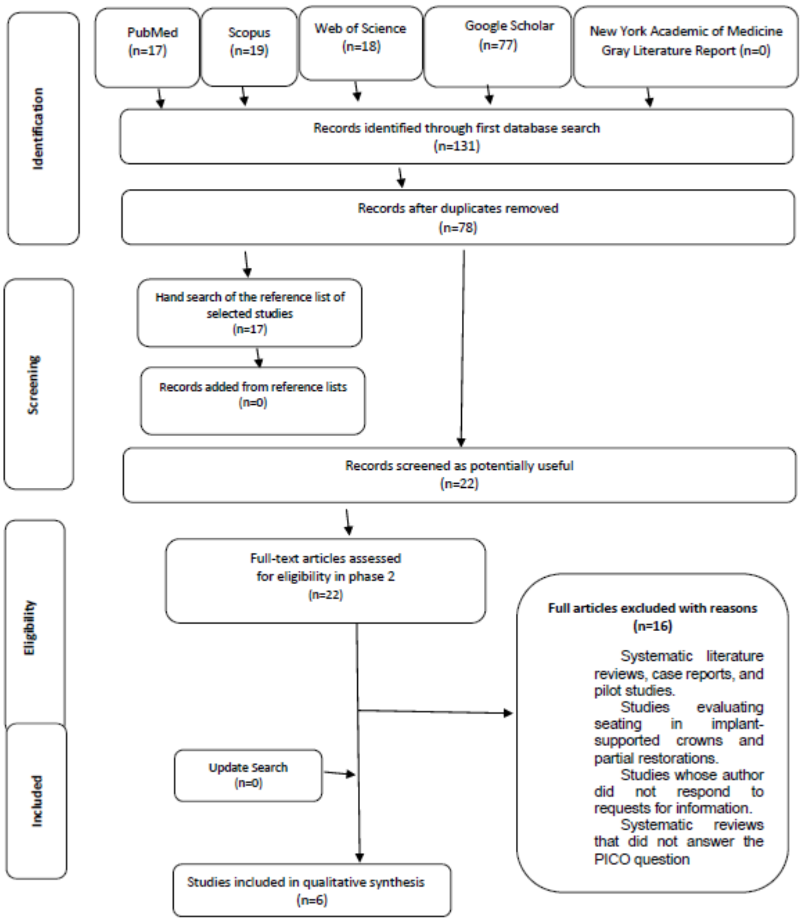
3. Results

3.1. Review of primary study

From the searches of the electronic databases and the gray literature, 131 references were obtained, of which 78 remained after eliminating duplicates. No articles from reference lists were added. Initially, the title and abstract of each chosen study were assessed, and 22 articles were included for reading the full text.

The search was refreshed, in order to obtain recent information that can be included in the study but no new articles were found. Finally, six SRs were included for qualitative synthesis. The reasons for excluding SRs are found in Appendix B. The complete process of the identification and selection of studies is presented in Fig. 1.

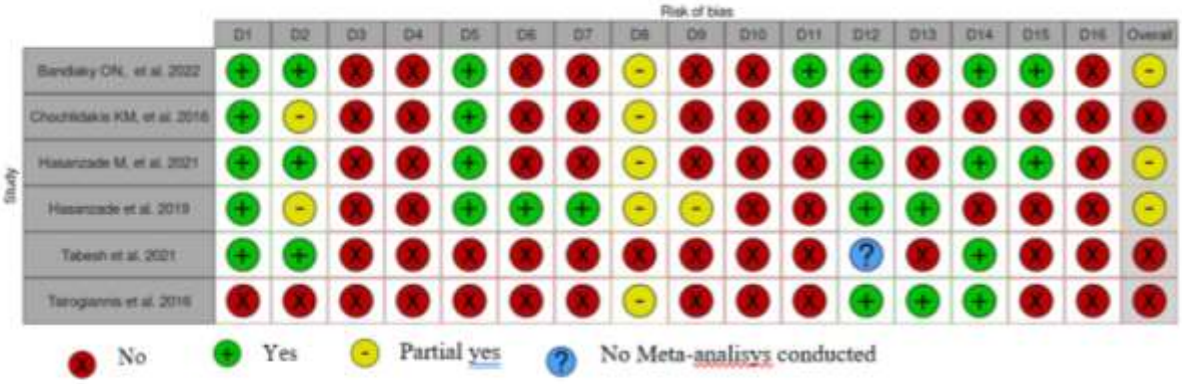
Fig. 1 Flow diagram of the literature search and selection criteria.



3.2. Assessment of methodological quality

Three systematic reviews [41-43] were considered to have low confidence, while the other three [36,44,45] were considered to have critically low confidence. The explanation of the design selection of the included studies, an exhaustive literature search strategy, and the mention of the sources of funding of the studies included in the SRs, corresponding to domains 3, 4, 10 and 16 respectively, were considered critical. None of the SRs met these criteria. One SR partially complied with domain 9, regarding the assessment of the risk of bias of the included studies. [43]. More information on the evaluation of the methodological quality is provided in Fig. 2 and in Appendix C.

Fig. 2 Summary of the authors' judgments on each included SR, assessed by the critical appraisal tool forsystematic reviews AMSTAR 2 and graphically represented as a traffic light plot, generated using robvis (a visualization tool). Green means "yes," yellow "partially yes," and red "no." Blank cells represent the lack of meta-analysis on that question.



D1	Did the research questions and inclusion criteria for the review include the components of PICO?
D2	Did the report of the review contain an explicit statement that the review methods were established prior to the conduct of the review and did the report justify any significant deviations from the protocol?
D3	Did the review authors explain their selection of the study designs for inclusion in the review?
D4	Did the review authors use a comprehensive literature search strategy?
D5	Did the review authors perform study selection in duplicate?
D6	Did the review authors perform data extraction in duplicate?
D7	Did the review authors provide a list of excluded studies and justify the exclusions?
D8	Did the review authors describe the included studies in adequate detail?
D9	Did the review authors use a satisfactory technique for assessing the risk of bias (RoB) in individual studies that were included in the review?
D10	Did the review authors report on the sources of funding for the studies included in the review?
D11	If meta-analysis was performed did the review authors use appropriate methods for statistical combination of results?
D12	If meta-analysis was performed, did the review authors assess the potential impact of RoB in individual studies on the results of the meta-analysis or other evidence synthesis?
D13	Did the review authors account for RoB in individual studies when interpreting/ discussing the results of the review?
D14	Did the review authors provide a satisfactory explanation for, and discussion of, any heterogeneity observed in the results of the review?
D15	If they performed quantitative synthesis did the review authors carry out an adequate investigation of publicationbias (small study bias) and discuss its likely impact on the results of the review?
D16	Did the review authors report any potential sources of conflict of interest, including any funding they received for conducting the review?

3.3. Synthesis of results

The results can be seen in Tables 2 and 3.

3.4. Marginal fit/marginal gap/marginal adaptation/marginal discrepancy

The marginal discrepancy was defined by Holmes et al. as the vertical marginal discrepancy measured between the crown and the margins of the preparation under a 3D optical microscope [46].

The six SRs evaluated the adaptation or marginal fit [36,41-45], and three SRs [36,41,45] showed that there was no significant difference in the marginal adaptation of single-unit fixed prostheses between digital and conventional impressions. Three SRs [42-44] showed a better marginal adaptation with digital impressions (Table 2). The mean difference in marginal adaptation between digital and conventional impressions ranged from -0.59 (CI - 0.93, -0.24) to -4.2 (CI: -33.0, 24.5) micrometer. One SR [45] reported a mean marginal adaptation of 27.2 micrometer (with a range of -5.3 to 59.7 micrometer) in in vivo studies and -4.2 micrometer (with a range of -33.0 to 24.5 micrometer) in in vitro studies. Chochlidakis et al. [36] performed a quantitative and qualitative analysis of in vitro studies and reported a mean marginal discrepancy of 0.24 (-0.32, 0.79) micrometer, but they only performed a qualitative analysis of in vivo studies due to the small number of included studies.

3.5. Internal adaptation/internal gap

The internal discrepancy was defined by Holmes et al. as the perpendicular distance between the inner surface of the crown and the outer surface of the preparation under a 3D optical microscope [46]. Three studies measured internaln adaptation [36,42,43]. Two studies [36,43] reported that there were no significant differences in internal adaptation in single-unit fixed prostheses fabricated with digital and conventional impressions, with means of 0.03 (-0.91, 0.96) micrometer and -0.17 (-0.53, - 0.20 micrometer) (Table 3). One study [42] reported an average of 0.32 micrometer (with a range of 0.08 to 0.56 micrometer), showing a better internal adaptation with digital impression.

4. Discussion

During the last decade, research has evaluated of marginal and internal adaptation in single-unit fixed prostheses fabricated from a digital impression or a conventional impression, but the results have been contradictory, and the methods used to carry out these reviews have been unsatisfactory. Therefore, health professionals are basing their clinical decisions on unreliable studies. For this reason, the objective of this systematic review was to evaluate the methodological quality of the SRs currently published about the accuracy (marginal adaptation and/or internal adaptation) of full-coverage fixed prostheses made with digital impressions versus conventional impressions. “AMSTAR 2 tool” was applied to demonstrate the validity and reliability of each of these reviews.

When assessing the methodological quality of the SRs included in this study using the "AMSTAR 2 tool", low reliability and low quality were found, especially in domains 3, 4, 10 and 16 of "AMSTAR 2", since none of the SRs explained the selection of the study design, performed an exhaustive literature search, reported the sources of funding of the included studies, or reported the existence of possible sources of conflict of interest, including any funding received to conduct the review, considering these items in future SRs.

The studies included in the SRs showed high heterogeneity; some studies reported heterogeneity values above 75%, which is considered high. This can be explained by their use of different types of restorations [47] or laboratory fabrication techniques, types of scanner, amounts of spacer needed, preparation designs [48], and methods of measuring marginal adaptation (optical microscope [46,49,50], stereomicroscope, macroscope, or explorer). In addition, the majority of authors [51,52-56] used the silicone replica technique to measure the marginal fit of the crown before cementation, which is also a noninvasive practice with acceptable accuracy, however, this technique can lead to inaccuracies [43,57].

Hasanzade et al. [43] performed an SR in 2019 that concluded that the single-unit fixed prostheses fabricated from a digital impression showed a better marginal adaptation than those fabricated from a conventional impression, while the internal adaptation did not show statistically significant differences between the two techniques. However, in 2020, Hasanzade et al. [42] performed another SR that found that marginal adaptation and internal adaptation were better with the digital approach than conventional impression. This difference between the two studies can be because the first study did not specify the method used to make the crowns, while in the second study, fabrication was digital, and the use of scanners, design software, and the dental milling machines were optimally combined and compensated for the error tolerance of each step [42,43]

Tsirogiannis et al. [45] found no significant difference in the marginal discrepancy of single-unit ceramic restorations fabricated after digital and conventional impressions, either in vivo or in vitro studies. However, in the SR performed by Hasanzade et al. [43], they determined that there were no significant differences between the digital and conventional groups in vivo studies, but in vitro studies, digital impression resulted in better marginal adaptation. Mai et al. [58], in their SR, found that the marginal adaptation values measured by digital methods were nominally higher but not significantly different from those measured by conventional methods in vitro studies. Morsy et al. [59] found that digital scanning provided a significantly better marginal fit than conventional impression for fabricating fixed partial dentures of up to four units, either in monolithic form or structures and in any region of the arch.

Nagarkar et al. [51] indicated that, in marginal and internal adaptation, there were no significant differences between the impression techniques.

The clinical use of digital impressions is constantly increasing due to their various advantages. This technology eliminates the selection of trays and impression materials and facilitates electronic transfer, the storage of digital files, and in-office milling of final restorations [16]. The limitations of digital impressions include their additional costs related to the purchase of an intraoral scanner, the need to participate in courses and workshops, and the need to constantly update with advancing technology.

When performing this systematic review, it was observed that despite the many SRs, there is an urgent need to establish a standardized protocol to improve the quality of their reporting, using assessment tools such as AMSTAR 2. In addition, it is suggested improving the inclusion and exclusion criteria of future research, with the aim of increasing the methodological homogeneity of primary studies. Likewise, new primary studies (RCTs) should be done with high methodological rigor to yield more reliable results and high-quality SRs.

Future studies should have a standardized protocol regarding the type of restoration, preparation design, conventional impression material, laboratory fabrication technique, amount of spacer needed, type of scanner, and methods used to measure the marginal adaptation so that they can all compare marginal and internal fit in a similar way.

5. Conclusions

From the limitations of the SRs included in the present study, the following conclusions can be drawn.

• The methodological quality of published SRs is poor according to the AMSTAR 2 tool, making for low and critically low confidence. In addition, some reviews used the original MINORS scale to evaluate the methodological quality of their included studies, which has not been validated in terms of content or scoring.

• The studies included in the SRs showed high heterogeneity, the number of clinical studies in the SRs was small, which made it difficult for some SRs to perform a quantitative analysis of them and some SRs included only studies in English.

• Half of the systematic reviews showed a better marginal adaptation with digital impressions, while the other half showed no significant differences between conventional and digital impressions.

• Internal adaptation was better with digital impressions in one SR, while two SRs did not show statistically significant differences between conventional and digital impressions.

List of abbreviations

• Computer-aided design and manufacturing (CAD/CAM)

• Systematic reviews (SRs)

• Preferred reporting items for systematic reviews and meta-analytical protocols (PRISMA-P)

• International Platform of Registered Systematic Review and Meta-Analytical Protocols (INPLASY).

• Randomized clinical trials (RCTs)

• Patient/population, intervention, comparison, outcomes (PICO)

• Grading of Recommendations Assessment, Development and Evaluation (GRADE)

• A MeaSurement Tool to Assess Systematic Reviews (AMSTAR 2)

• Digital printing (DI)

• Conventional printing (CI)

• Mean difference (MD)

• Confidence Interval (CI)

Consent for publication

Not applicable

Availability of data and materials

The data analysed during the current study are available from the corresponding author upon request

Standards of reporting

PRISMA guideline has been followed.

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Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

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Ethics approval

Ethics approval was not required for this systematic review.

Informed consent: Formal consent is not required for this type of study

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Annexes

Apendixx A: Search Strateggy

SEARCH STRATEGY		
P		
PUBMED	("posterior fixed" OR "dental porcelain"[Mesh] OR "single-unit" OR "crowns"[Mesh] OR "full-coverage restorations"OR "fixed prosthodontics" OR "fixed dental prostheses")	36.995
WOS	TITLE: (("posterior fixed" OR "dental porcelain"OR "single-unit" OR "crowns"OR "full-coverage restorations"OR "fixed prosthodontics" OR "fixed dental prostheses"))	6.440
SCOPUS	TITLE-ABS-KEY (("posterior fixed" OR "dental porcelain" OR "single-unit" OR "crowns" OR "full-coverage restorations" OR "fixed prosthodontics" OR "fixed dental prostheses"))	164,635
GOOGLE SCHOLAR	("posterior fixed" OR "dental porcelain" OR "single-unit" OR "crowns" OR "full-coverage restorations"OR "fixed prosthodontics" OR "fixed dental prostheses")	939.000
NEW YORK ACADEMIC OF MEDICIN GRAY LITERATURE REPORT.	("posterior fixed" OR "dental porcelain"OR "single-unit" OR "crowns"OR "full-coverage restorations"OR "fixed prosthodontics" OR "fixed dental prostheses")	0
I		
PUBMED	("digital" OR "digital scans" OR "digital impressions")	148
WOS	TITLE: (("digital" OR "digital scans" OR "digital impressions"))	204.377
SCOPUS	TITLE-ABS-KEY (("digital" OR "digital scans" OR "digital impressions"))	1,186,95 9
GOOGLE SCHOLAR	("digital" OR "digital scans" OR "digital impressions")	7.160.00 0
C		
PUBMED	("conventional impressions" OR "manual impressions" OR "conventional")	501
WOS	TITLE: (("conventional impressions" OR "manual impressions" OR "conventional"))	75.259
SCOPUS	TITLE-ABS-KEY (("conventional impressions" OR "manualimpressions" OR "conventional"))	1,706,64 5
GOOGLE SCHOLAR	("conventional impressions" OR "manual impressions" OR "conventional")	5.790.00 0
O		
PUBMED	("accuracy" OR "adaptations" OR "dimensional accuracy" OR "marginal fit" OR "internal fit" OR "adjustment")	650.326
WOS	TITLE: (("accuracy" OR "adaptations" OR "dimensional accuracy" OR "marginal fit" OR "internal fit" OR "adjustment"))	158.262

SCOPUS	TITLE-ABS-KEY (("accuracy" OR "adaptations" OR "dimensionalaccuracy" OR "marginal fit" OR "internal fit" OR "adjustment"))	3,108,658
GOOGLE SCHOLAR	("accuracy" OR "adaptations" OR "dimensional accuracy" OR "marginal fit" OR "internal fit" OR "adjustment")	5.970.000

S		
PUBMED	("systematic review and meta-analysis" OR "systematic review" OR "meta-analysis")	306.094
WOS	TITLE: (("systematic review and meta-analysis" OR "systematic review" OR "meta- analysis"))	232.001
SCOPUS	TITLE-ABS-KEY (("systematic review and meta-analysis" OR "systematic review" OR "meta- analysis"))	457,226
GOOGLE SCHOLAR	("systematic review and meta-analysis" OR "systematic review" OR "meta-analysis")	17.800
PUBMED	("posterior fixed" OR "dental porcelain"[Mesh] OR "single-unit" OR "crowns"[Mesh] OR "full-coverage restorations"OR "fixed prosthodontics" OR "fixed dental prostheses") AND ("digital" OR "digital scans" OR "digital impressions") AND ("conventional impressions" OR "manual impressions" OR "conventional") AND ("accuracy" OR "adaptations" OR "dimensional accuracy" OR "marginal fit" OR "internal fit" OR "adjustment") AND ("systematic review and meta-analysis" OR "systematic review" OR "meta- analysis")	**17**
WOS	TITLE (("posterior fixed" OR "dental porcelain"OR "single-unit" OR "crowns"OR "full-coverage restorations"OR "fixed prosthodontics" OR "fixed dental prostheses")) *AND* TITLE: (("digital" OR "digital scans" OR "digital impressions")) *AND* TITLE: (("conventional impressions" OR "manual impressions" OR "conventional")) *AND* TITLE: (("accuracy" OR "adaptations" OR "dimensional accuracy" OR "marginal fit" OR "internal fit" OR "adjustment")) *AND* TITLE: (("systematic review and meta-analysis" OR "systematic review" OR "meta- analysis"))	**19**
SCOPUS	(TITLE-ABS-KEY (("posterior fixed" OR "dental porcelain" OR "single-unit"OR "crowns" OR "full-coverage restorations" OR "fixed prosthodontics" OR "fixed dental prostheses")) AND TITLE-ABS-KEY (("digital" OR "digital scans" OR "digital impressions")) AND TITLE-ABS-KEY (("conventional impressions" OR "manual impressions" OR "conventional")) AND TITLE- ABS-KEY (("accuracy" OR "adaptations" OR "dimensional accuracy" OR "marginal fit" OR "internal fit" OR "adjustment")) AND TITLE-ABS-KEY (("systematic review and meta-analysis" OR "systematic review" OR "meta-analysis")))	**18**
GOOGLE SCHOLAR	in title: ("crowns") AND ("digital impressions") AND ("conventional impressions") AND ("accuracy") AND ("systematic review and meta- analysis")	**77**

NEW YORK ACADEMIC OF MEDICIN GRAY LITERATUR E REPORT.	("crowns") AND ("digital impressions") AND ("conventional impressions") AND ("accuracy") AND ("systematic review and meta- analysis")	0

Appendix B. Articles excluded from the study

Study	Reason for exclusion
[Ahlholm P et al. 2018]	2
[Ahmed WM, et al. 2020]	1
[Al-Haj Husain N, et al. 2020]	2
[Arcuri L, et al. 2019]	3
[Carvalho T, et al. 2018]	1
[Chandran S, et al. 2019]	2
[Cicciù M, et al. 2020]	4
[Gallardo Y, et al. 2018]	4
[Giachetti L, et al. 2020]	2
[Kumar H, et al. 2020]	4
[Kyoung-Rok Kim, et al. 2018]	4
[Mai H, et al. 2020]	4
[Nagarkar S, et al. 2018]	4
[Papadiochou S, et al. 2017]	2
[Pecciarini M, et al. 2019]	2
[Svanborg P, et al. 2020]	2
1	Systematic reviews of the literature, case reports, pilot studies
2	Studies evaluating seating in implant crowns and partial restorations
3	Studies without response from the author to the information query requested
4	Systematic reviews that do not meet the PICO question

Appendix C. AMSTAR 2 assessment criteria and domains																	
Study	**Q 1**	**Q 2**	**Q 3**	**Q 4**	**Q 5**	**Q 6**	**Q 7**	**Q 8**	**Q 9**	**Q 10**	**Q 11**	**Q12**	**Q 13**	**Q 14**	**Q 15**	**Q 16**	**Overall confiance**
Bandiaky ON, et al. 2020	Y	Y	N	N	Y	N	N	PY	N	N	Y	Y	N	Y	Y	N	Low
Chochlidakis KM, et al. 2016	Y	PY	N	N	Y	N	N	PY	N	N	N	Y	N	N	N	N	Critically low
Hasanzade M, et al. 2020	Y	Y	N	N	Y	N	N	PY	N	N	N	Y	N	Y	Y	N	Low
Hasanzade et al. 2019	Y	PY	N	N	Y	Y	Y	PY	PY	N	N	Y	Y	N	N	N	Low
Tabesh et al. 2020	Y	Y	N	N	N	N	N	N	N	N	N	NMA	N	Y	N	N	Critically low
Tsirogiannis et al. 2016	N	N	N	N	N	N	N	PY	N	N	N	Y	Y	Y	N	N	Critically low

Y	YES
N	NO
PY	PARTIAL YES
NMA	NO META-ANALISIS