



Review Article

Methodological quality and risk of bias of systematic reviews about loading time of multiple dental implants in totally or partially edentulous patients: An umbrella systematic review



Clovis Marinho Carvalho Heiderich^a, Tamara Kerber Tedesco^a, Syrio Simão Netto^a,
Rafael Celestino de Sousa^b, Sergio Allegrini Júnior^a, Fausto M. Mendes^c,
Thais Gimenez^{a,c,*}

^a Graduate Program in Dentistry, Ibirapuera University, Av. Interlagos, 1329, São Paulo, Brazil

^b Faculdade São Leopoldo Mandic, Instituto de Pesquisas São Leopoldo Mandic (SLM), Campinas, Brazil

^c Department of Pediatric Dentistry, School of Dentistry, Av. Prof. Lineu Prestes, 2227, University of São Paulo, São Paulo, SP, Brazil

ARTICLE INFO

Article history:

Received 22 April 2020

Received in revised form 11 August 2020

Accepted 19 September 2020

Keywords:

Dental implantation

Dental prosthesis

Implant-Supported

Systematic review

ABSTRACT

Background: There are several systematic reviews of multiple implant loading techniques, but results are conflicting.

Aim: To perform an umbrella review on methodological quality of systematic reviews about techniques for loading multiple dental implants.

Material and methods: MEDLINE (PubMed) and Scopus were searched up to December 31, 2019. Unpublished literature was searched through OpenGray and references of included articles were manually verified. Eligibility criteria were: articles had to (1) be about multiple dental implants; (2) mention the moment of loading; (3) be a systematic review. Two independent reviewers participated in the entire process. Qualitative description of included studies as well as methodological quality measurement and risk of bias through AMSTAR and ROBIS were performed.

Results: 21 reviews were included. Thirteen stated that there was a similarity between loading techniques, two did not affirm which one was more appropriate and six mentioned that conventional technique was better. Eight papers were classified as high risk of bias, twelve as low and one as uncertain risk.

Conclusion: When evaluating only studies with a low risk of bias, there are no significant differences in implant loading time.

© 2020 The Authors. Published by Elsevier Ltd on behalf of The Japanese Association for Dental Science. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Introduction

The use of dental implants to rehabilitate tooth loss has increased in the last 30 years [1]. At the beginning of the implantology, Branemark and colleagues recommended that a healing period of three months with the unloaded implant to the mandible and six months to the maxilla after implant placement was necessary to facilitate osseointegration [2]. Currently, there are several variations with the aim of improving osseointegration and treatment success, such as the number of implants, type, and time installation of the prosthesis. Due to the new morphological designs, surface

preparations and other implant-related features, studies have considered that the loading time can be reduced. Immediate loading of dental implants has gained widespread popularity because of its advantages in shortening treatment duration and improving esthetics and patient acceptance [3].

There are several systematic reviews on different loading times of multiple dental implants for partially or totally edentulous patients. Multiple systematic reviews with different approaches can provide a complete picture of a topic, but these overwhelming systematic reviews published each month worldwide are often not well-conducted. In this sense, clinicians commonly modify their clinical decision making relying on the prestige of this kind of studies, because they represent the upper part of the evidence pyramid. And it is difficult for clinicians to perform a critical analysis on the methodological quality and risk of bias of these systematic reviews, but this can greatly influence the results found and its reliability. For

* Corresponding author at: University Ibirapuera (UNIB), Av. Interlagos, 1329, Chácara Flora, São Paulo, SP, 04661-100, Brazil.

E-mail address: thais.gimenez@ibirapuera.edu.br (T. Gimenez).

```

(("dental implants"[MeSH Terms] OR ("dental"[All Fields] AND
"implants"[All Fields]) OR "dental implants"[All Fields] OR ("dental"[All
Fields] AND "implant"[All Fields]) OR "dental implant"[All Fields]) AND
(("review"[Publication Type] OR "review literature as topic"[MeSH Terms]
OR "systematic review"[All Fields]) OR ("Syst Rev"[Journal] OR
("systematic"[All Fields] AND "reviews"[All Fields]) OR "systematic
reviews"[All Fields]) OR overview[All Fields]) AND (("prosthesis
implantation"[MeSH Terms] OR ("prosthesis"[All Fields] AND
"implantation"[All Fields]) OR "prosthesis implantation"[All Fields] OR
"prosthesis"[All Fields] OR "protheses and implants"[MeSH Terms] OR
("protheses"[All Fields] AND "implants"[All Fields]) OR "protheses and
implants"[All Fields]) AND loading[All Fields]) OR loading[All Fields])

```

Fig. 1. Search strategy.

that reason, summaries are necessary to appraise the evidence of systematic reviews through umbrella reviews, also called overview or revision of systematic reviews. The focus of an umbrella review is to provide a wide picture of the evidence related to a particular question and highlight where the evidence base for a question is consistent or if contradictory or discrepant findings exist and to explore and detail the reasons why [4]. Thus, we performed an umbrella review about techniques for loading multiple dental implants in order to discuss methodological quality and risk of bias of those studies.

2. Materials and methods

This umbrella review has followed the guidelines of the manual “Preferred Reporting Items for overview of systematic reviews (PRIO)” [5] for its writing. PRIO is a pilot tool designed to help authors of umbrella reviews.

2.1. Registration protocol

The present study has been registered in the PROSPERO platform (CRD42018093633).

2.2. Sources of information

We have searched up to December 31, 2019 for systematic reviews that investigated techniques for loading multiple dental implants in totally or partially edentulous patient. The databases used were MEDLINE (PubMed) and Scopus. The unpublished literature was searched through the OpenGrey database and the references of the included articles were manually verified.

2.3. Search strategy

The search has been developed in the MEDLINE (PubMed) database based on the PICO question: What are the methodological quality about regarding multiple implant loading techniques for edentulous patients? using keywords and Mesh Terms (Fig. 1) and boolean operators OR and AND. There was no restriction on the language or the date of the publications. This strategy was adapted to the other databases used.

2.4. Study selection and eligibility criteria

All the titles and abstracts of studies found were initially evaluated based on the inclusion criteria: (1) they had to be about dental implants; (2) they had to mention the moment of loading; and (3) they had to be a systematic review.

The full papers of the included studies for evaluation of the exclusion criteria were then read to ensure they were related to the direct comparison of different loading times of multiple dental implants and had followed the methodology of a systematic review. Immediate loading was considered when the prosthesis was installed immediately after the implant placement surgery.

With conventional loading, the time between implant placement and prosthesis installation varies from 4 months (for the mandible) to 6 months (for the maxilla).

The selection of studies was performed independently by two reviewers (CH and SN). The discordances were resolved by talking with a third researcher (TG). For studies with the same data set, such as updates of systematic reviews, only the work considered more complete was included.

2.5. Data collection

Two independent reviewers (CH and TKT) have collected data in structured tables in Excel spreadsheets (Office 2016 for Windows).

The information extracted was: authors, year, title of the review, protocol record (yes or no), number of articles included, databases used, date of search, search strategy, number of reviewers, inclusion and exclusion criteria, data collected, quality and risk analysis of bias (yes or no and which tool was used), type of analysis (qualitative or quantitative), the results found in terms of success or failure of the implants, and conclusion of the review. We have considered results related to success and failure, implant survival data, evaluation of osseointegration and post-implant complications, such as bone loss.

2.6. Evaluation of methodological quality, risk of bias and data synthesis

The methodological evaluation was performed by using the AMSTAR tool [6] and the risk of bias of the included systematic reviews through the ROBIS tool [7] by other two independent reviewers (FMM and RCS). The interpretation of the questions and requirements for classification regarding the responses to the quality and risk of bias assessment followed the requirements proposed by the tools themselves. A qualitative description of the included studies was also performed.

3. Results

Seven hundred and fifty-seven articles were found in both databases. After removing the duplicates, 609 unique articles were evaluated through the titles and abstracts to verify the inclusion criteria, of which 50 were selected. After applying the exclusion criteria, 21 articles were considered eligible (Fig. 2). No articles were found in the OpenGrey database or found manually. Kappa inter-reviewers were 0.8 in the screening process.

The included systematic reviews were published between 2004 and 2019 and selected from six to one hundred and twenty primary articles. Most of the revisions searched more than one database. In addition, seven did not make clear how many reviewers participated in the study selection and data collection [8–14]. Only eight reviews did not make any restrictions on the language [3,9,10,12,15–18], and the rest included practically only articles in English. Virtually all systematic reviews included randomized or non-randomized clinical trials, but some prospective studies were also included [10,18–22]. Five reviews did not specify whether the implants were in the maxilla or mandible [16,17,22–24], eight of them evaluated the implants in both arches [3,10,12,14,18,21,25,26], five studies only in the mandible [11,13,15,19,27] and three only in the maxilla [8,9,20]. Most of the reviews included articles with at least six months of follow-up, but seven did not report any criteria for follow-up [3,11,12,18–20,24]. Fourteen reviews stated that there was a similarity between loading techniques (conventional and immediate) [11–13,15,17,23,24,26,27], two stated it was not possible to confirm which one was more appropriate [14,25] and five

Table 1
Characteristics of the studies classified as high risk of bias by the Robis tool.

Authors	No. of included articles	Databases searched	Language	Type of Studies	Outcomes	Maxillary or mandible?	Anterior or posterior region?	Fixed or removable denture?	Follow-up criteria	Risk of bias assessment	Meta-analysis?	Main results	Favors to
Gallucci et al. [10]	61	MEDLINE, PubMed, the Cochrane Controlled Trials Register, and the Cochrane Health Group Specialized Register	No language restriction	RCT, prospective studies and retrospectives	Compatibility of different loading protocols with the achievement of osseointegration	Both	No	Fixed denture	>1 year	No	No	The highest level of scientific and clinical validation was found for conventional loading with mandibular overdentures and maxillary fixed dental prostheses. Insufficient scientific or clinical documentation/validation was found for immediate loading of maxillary overdentures, as well as for immediate loading of immediately placed implants combined with fixed or removable dental prostheses in either jaw.	Conventional
Sennerby & Gottlow [12]	6	PubMed database	No language restriction	not informed	Clinical outcomes	Both	No	Fixed denture	Not informed	No	No	No differences between implants with a moderately rough or smooth surface topography were observed.	Similar
Chiapasco [14]	46	MEDLINE-EMBASE	English	No	Survival rate	Both	No	Fixed denture	Minimum follow-up of 1 year	No	No	Poor methodologic quality with regard to allocation concealment, completeness of follow-up, sample size, randomization, exclusion and inclusion criteria, type of opposing arch dentition, type of occlusion, and success criteria.	Uncertain
Cordaro et al. [19]	19	MEDLINE (PubMed) and Specialist Register of the Cochrane OHG	English	RCT and prospective studies	Survival rate, success rate, and marginal bone loss.	Mandible	Posterior	Fixed denture	Not informed	No	No	Immediate loading of microroughened dental implants in the partially edentulous posterior mandible proved to be a viable treatment alternative.	Similar

Table 1 (Continued)

Authors	No. of included articles	Databases searched	Language	Type of Studies	Outcomes	Maxillary or mandible?	Anterior or posterior region?	Fixed or removable denture?	Follow-up criteria	Risk of bias assessment	Meta-analysis?	Main results	Favors to
Kawai & Taylor [13]	9	MEDLINE	English	RCT	Adverse effects	Mandible	No	Removable denture	12 and/or 24 months	No	No	There was no evidence that immediate or early loading of implant-retained overdentures have adverse effects for up to 24 months when compared to conventional timing of loading	Similar
Al-Sawai & Labib [8]	120	Google Scholar, Centre for Evidence-Based Dentistry, Cochrane Oral Health Group's Trials Register, Central, Medline, Web of Knowledge, Cinahl and EMBASE	Published in English	RCT	Compare the clinical performance	Maxillary	No	Fixed denture	Long follow-up periods (~1 year After loading)	No	No	Trends suggest that immediately loaded implants have lower survival rates than conventionally loaded implants, but are less common than those loaded early. A high degree of primary implant Stability (high insertion torque) seems to be a prerequisite for a successful procedure	Conventional
Grütter & Belser [9]	29	MEDLINE, The COCHRANE library and PubMed	No language restriction	Not informed	Implant survival, implant success, and esthetic appearance	Maxillary	Anterior	Fixed denture	At least 1 year	No	No	Success criteria such as bone levels, soft tissue recession, and probing depth cannot be evaluated based on the available literature, when the implant is placed immediately after the extraction, with an immediate restoration and occlusal load, the survival rate drops by approximately 10% (4 studies).	Conventional
Rocuzzo et al. [20]	17	MEDLINE (PubMed).	English	RCT and prospective studies	Survival rate, success rate, and marginal bone loss.	Maxillary	Posterior	Fixed denture	Not informed	No	No	No studies prove significant superior results with one technique over another.	Similar

Table 2
Characteristics of studies classified as unclear and low risk of bias by the Robis tool.

Authors	N of included articles	Databases searched	Language	Type of studies	Outcomes	Maxillary or mandible?	Anterior or posterior region?	Fixed or removable denture?	Follow-up criteria	Risk of bias assessment	Meta-analysis?	Main results	Favors to
Zygiopoulos et al. [25]	14	MEDLINE, EMBASE, The Cochrane Central Register of Controlled Trials, and The Cochrane Database of Systematic Reviews	English language only.	RCT	Success and survival rates of the implants	Both	No	Removable denture	Minimum follow-up of 12 months were selected	No	No	A recommendation on a certain number, diameter of implants, and attachment system selected with immediate loading protocol was not possible.	Uncertain
Papaspyridakos et al. [21]	62	Medline-PubMed, Embase, and the Cochrane Central Register of Controlled Trials (CENTRAL)	English and German	RCT, case-control studies, and cohort studies	Implant and prosthesis survival, failure, and complications.	Both	No	Fixed denture	1–15 years	Yes.	Yes	The estimated 1-year implant survival was above 99 % with all three loading protocols.	Similar
Schrott et al. [26]	24	Medline, Embase, and Central	English	RCT and NRCT	Implant survival	Both	Both	Fixed denture	A minimum follow-up time of 12 months	Yes.	Yes	IL presents similar implant survival rates as EL or CL for partially edentulous patients with extended edentulous sites in the posterior zone.	Similar
Schimmel et al. [27]	58	Medline, Embase, CENTRAL	English, German, French	RCT	Dental implant survival	mandible	No	Removable denture	1 year	Yes.	Yes	Although all three loading protocols provide high survival rates, early and conventional loading protocols are still better documented than immediate loading and seem to result in fewer implant failures during the first year. Only a few prospective case series are available to document immediate loading of implants supporting an overdenture in the edentulous maxilla.	Similar

Table 2 (Continued)

Authors	N of included articles	Databases searched	Language	Type of studies	Outcomes	Maxillary or mandible?	Anterior or posterior region?	Fixed or removable denture?	Follow-up criteria	Risk of bias assessment	Meta-analysis?	Main results	Favors to
Alsabeeha et al. [15]	10	PubMed, EMBASE, the Cochrane Database of Systematic Reviews, and the Cochrane Controlled Trial Register	No language restriction	RCT and NRCT	Survival rates	Mandible	No	Removable denture	Minimum follow-up of 2 years	Yes	Yes	Short-term outcomes of early or immediate loading protocols for mandibular implant overdentures achieved comparable success to conventional loading ones.	Similar
Sanz-Sanchez et al. [16]	37	(1) The National Library of Medicine (MEDLINE via Pubmed); (2) Embase; and (3) Cochrane Central Register of Controlled Trials.	No language restrictions	RCT	Risk for implant failure crestal bone resorption, impact on peri-implant soft tissues and patient's preference.	No	No	Fixed denture	A minimum follow-up time of 6 months and a maximum of 84 months	Yes.	Yes	Immediate loading may impose a greater risk for implant failure when compared to conventional loading, although the survival rates were high for both groups.	Conventional
Engelhardt et al. [23]	10	PubMed Cochrane Central Register of Controlled Trials (Central	English	RCT	Implant survival or marginal bone-level stability.	No	No	Fixed denture	Follow-up time: ≥ 1 year	Yes.	Yes	(1) The number of studies regarding RCTs reporting at least 1-year outcome data on loading within 24 h after implant placement as compared to Conventional Loading is limited and that (2) no clinically relevant difference regarding radiographic bone-level changes between conventionally and immediately loaded implants can be found, for up to 5 years of follow-up.	Similar

Table 2 (Continued)

Authors	N of included articles	Databases searched	Language	Type of studies	Outcomes	Maxillary or mandible?	Anterior or posterior region?	Fixed or removable denture?	Follow-up criteria	Risk of bias assessment	Meta-analysis?	Main results	Favors to
Chambrone et al. [17]	7	MEDLINE (via PubMed), (MEDLINE, EMBASE and the Cochrane Oral Health Group's Trials Register (PRISMA; Moher et al. 2009), the Cochrane Collaboration (Higgins & Green 2011) and CheckReview (Chambrone et al. 2010c), (OpenGREY)	No language restriction	RCT	Survival rates, clinical attachment level (CAL), probing depth (PD) and radiographic changes in the peri-implant bone level.	No	No	Fixed denture	At least 6-month	Yes	Yes	The survival percentages, clinical and radiographic outcomes of dental implants submitted to immediate or early occlusal loading seem to be similar (comparable) to those reported in the literature by implants submitted to conventional loading protocols (3–6 months).	Similar
Xu et al. [24]	6	The Cochrane Central Register of Controlled Trials, MEDLINE, EMBASE, CNKI database, VIP database, WANFANG Database, and World Health Organization International Clinical Trials Registry Platform Search Portal	English	RCT	Effectiveness and safety of the immediate versus early loading of dental implants with flapless placement.	No	No	Fixed denture	Not informed	Yes.	Yes	Immediate and early loading of dental implants after flapless placement both demonstrated an acceptable short-to medium-term survival rate. Immediate loading seems more acceptable because of the time benefit.	Similar
Jokstad & Carr [22]	22	PubMed	English	RCT, prospective and retrospective	assess the effects of time to loading of implants on treatment outcomes.	No	No	Fixed and removable dentures	At least 1 year	No	Yes	Although the average outcome was in favor of delayed loading, there are no indications that immediate or early loading cannot be a safe procedure.	Similar

Table 2 (Continued)

Authors	N of included articles	Databases searched	Language	Type of studies	Outcomes	Maxillary or mandible?	Anterior or posterior region?	Fixed or removable denture?	Follow-up criteria	Risk of bias assessment	Meta-analysis?	Main results	Favors to
Rutkunas et al. [11]	8	MEDLINE/Pubmed, EMBASE and CCTR (The Cochrane Controlled Trials Register)	English	RCT, NRCT and cost-effectiveness analyses (CEAs)	Implant survival and success rates, periimplant parameters, prosthetic maintenance and patient satisfaction	Mandible	No	Removable denture	Not informed	Yes.	No	Considering implant success rates and peri-implant parameters early loading protocol produces equal outcomes as with conventional loading.	Similar
Chen et al. [3]	50	CENTRAL (The Cochrane Central Register of Controlled Trials), EMBASE, and MEDLINE via PubMed (The National Library of Medicine)	No language restriction	RCT	implant survival rate, marginal bone level changes, periimplant gingival level, plaque index, probing depth, implant stability, the rate of peri-implantitis or peri-implant mucositis, and subjective feeling of patients	Both	Both	Fixed denture	No restriction on the follow-up period	Yes	Yes	Compared with early loading, immediate loading could achieve comparable implant survival rates and marginal bone level changes. Compared with conventional loading, immediate loading was associated with a higher incidence of implant failure.	Conventional
Gallardo et al. [18]	16	PubMed (2008 to January 2018), Scopus (2006 to January 2018), and Cochrane Oral Health Group Trials Register (2005 to January 2018)	No language restriction	RCTs and observational studies	implant failure rate, success rate, survival rate, biological, technical and mechanical complications, marginal bone loss, patient related outcomes	Both	Both	Fixed denture	No restriction on the follow-up period	Yes	No	There is evidence of high survival-success implant rate (95–100%) for either loading protocols (immediate restoration/loading, early loading, and conventional loading).	Similar

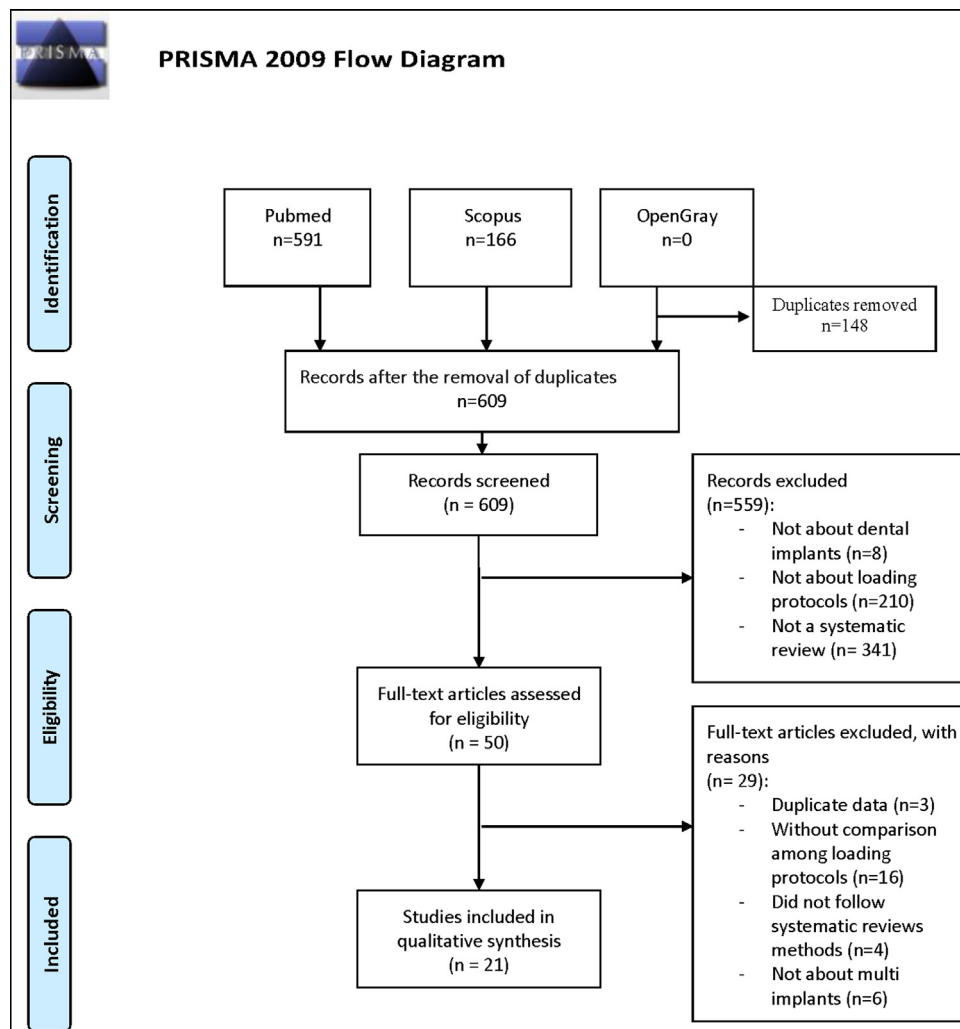


Fig. 2. Flowchart of studies selection.

said that the conventional technique was better [3,8–10,16] (Tables 1 and 2).

Regarding methodological quality, most of the studies presented a positive response (good quality) to the questions related to the protocol provided a priori, selection of studies by two reviewers, comprehensive search strategy, search for gray literature and provide characteristics of included studies. Almost half did not assess the quality of included studies nor did use this evaluation to consider the conclusion [8–10,12–14,19,20,22,25]. Twelve did not conduct a meta-analysis or checked publication bias [8,13,14,17–20,25]. Only one article provided the list of excluded articles [18] and only three included a conflict of interest statement [15,16,18] (Fig. 3).

As for the risk of bias, eight systematic reviews presented high risk of bias [8–10,12–14,19,20], while the other twelve were classified as low risk [3,15–18,21–27] and one as an uncertain risk [11]. The domains that presented a high risk of bias for most of the studies were the identification and selection of studies as well as the synthesis of data, since some searches were not made in more than one database, there was a restriction regarding the date and language as well as if they had not performed any statistical method for grouping the data. Articles classified as high risk, in addition to the previous characteristics, did not perform a correct data collection and evaluation (Table 3).

For studies classified as high risk of bias through the ROBIS tool, three obtained favorable results for the conventional load-

ing method [8–10], four with similar results between conventional and immediate protocol [12,13,19,20], and one did not confirm which would be better [14] (Table 1). As for articles classified as low risk, ten showed similarity between the protocols [11,15,17,18,21–24,26,27], two were in favor of the conventional [3,16] method and one did not state which would be better [25]. The only article classified as an uncertain risk showed similarity between loading moments (Table 2).

4. Discussion

This is the first overview that proposes to evaluate the methodological quality and risk of bias of the systematic reviews published and unpublished about different moments of loading of dental implants. It was observed that most of the reviews sought to analyze the success in the implantation of implants, either in terms of their failure, survival or bone integration; although, through the randomized studies, there is a similarity in the results among the techniques discussed.

Among the analyzed articles, a high risk of bias is observed. From the 21 articles, eight presented high risk, twelve presented low risk and one was not clear. Considering that practically 40% of the works presented a high risk of bias, the professional is placed in a situation of conflict over the success, since some of the results found in the systematic reviews do not seem to be reliable. However, when we evaluate the results found only by the works with low

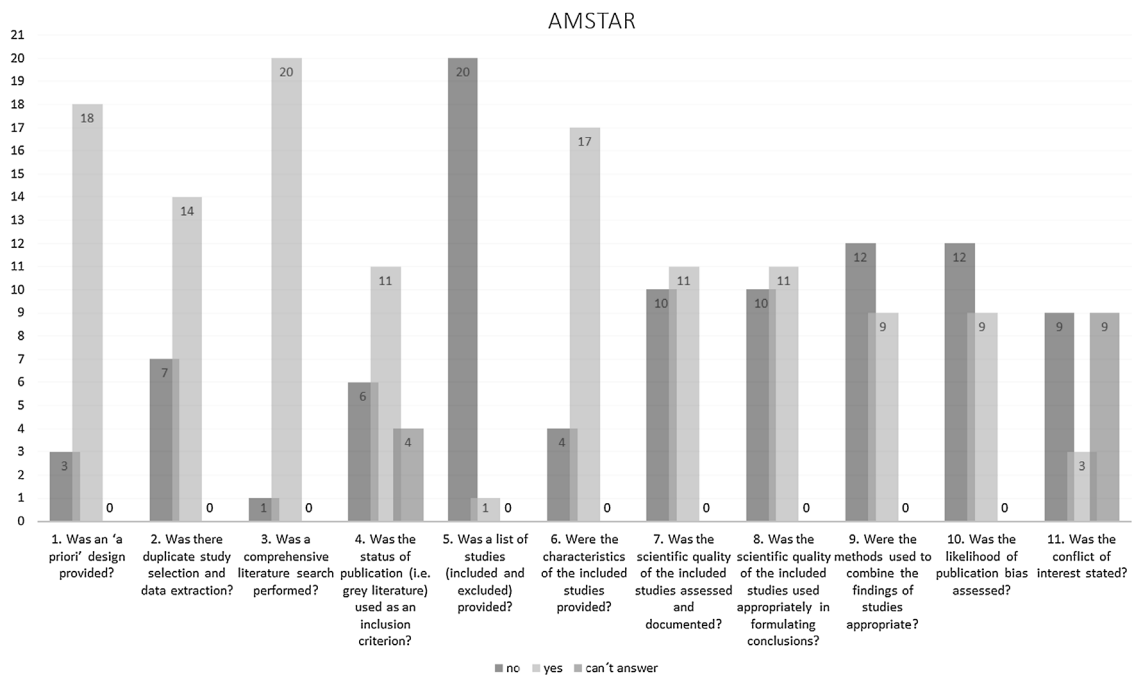


Fig. 3. Evaluation of methodological quality through the Amstar tool.

Table 3
Evaluation of the risk of bias through the Robis tool.

Review	Phase 2				Phase 3 Risk of bias in the review
	1. Study eligibility criteria	2. Identification and selection of studies	3. Data collection and study appraisal	4. Synthesis and findings	
Al-Sawai & Labib [8]	⊗	⊗	⊗	⊗	⊗
Zygiannis et al. [25]	⊙	⊙	⊙	⊗	⊙
Sanz-Sanchez et al. [16]	⊙	⊙	⊙	⊙	⊙
Engelhardt et al. [23]	?	?	⊙	⊙	⊙
Chambrone et al. [17]	⊙	⊙	⊙	⊙	⊙
Xu et al. [24]	⊗	⊙	⊙	⊙	⊙
Schimmel et al. [27]	⊙	⊙	⊙	⊙	⊙
Papaspyridakos et al. [21]	⊙	⊙	⊙	⊙	⊙
Schrott et al. [26]	?	⊙	⊙	⊙	⊙
Grütter & Belsler [9]	?	?	⊗	⊗	⊗
Alsabeeha et al. [15]	⊙	⊙	⊙	⊙	⊙
Cordaro et al. [19]	⊗	⊙	?	⊗	⊗
Rocuzzo et al. [20]	⊗	⊙	?	⊗	⊗
Gallucci et al. [10]	⊗	⊙	⊗	⊗	⊗
Sennerby & Gottlow [12]	⊗	?	⊗	⊗	⊗
Rutkunas et al. [11]	?	⊗	?	?	?
Kawai & Taylor [13]	⊗	⊗	⊙	⊗	⊗
Jokstad & Carr [22]	⊗	⊗	⊙	⊙	⊙
Chiapasco [14]	⊗	?	⊗	⊗	⊗
Chen et al., [3]	⊙	⊙	⊙	⊙	⊙
Gallardo et al. [18]	⊙	⊙	⊙	⊗	⊙

⊙ = low risk; ⊗ = high risk; ? = unclear risk.

risk of bias, we perceive a hegemony showing similarity between the moments of loading. The tools used in this article have been widely applied in several umbrella reviews. Regarding methodological quality, we chose to use AMSTAR [6] instead of AMSTAR-2 [28] as the latter is indicated only to assess the methodological quality of systematic reviews of randomized controlled trials, and we have included systematic reviews that have also analyzed retrospective and prospective observational studies.

This risk of bias is mostly due to failures in the selection of studies, since many of them imposed restrictions that were not adequate to the selection criteria, such as: language restriction, publication date, sample size, format, or publication status. As for the data synthesis, in many studies there was no adequate meta-analysis, disregarding the heterogeneity between the works, sensitivity analysis or biases presented in the original studies. The result is that a poor quality of data analysis is observed. The exclu-

sion of articles in non-English language could be a negative point in some of the reviews. However, some authors argue that the exclusion of articles published in other languages does not seem to bias systematic reviews [29,30], therefore, it does not necessarily represent a methodological failure.

Another negative point to be highlighted from the methodological quality was that only one systematic review has presented the list of excluded articles, the others have only presented the list of the included ones. This failure may have occurred because such a list is not required in the PRISMA checklist [31], as well as representing an extra table and pages to be used in the publication, which may represent extra cost. On the other hand, the vast majority provided a previous design through the registration of the PROSPERO platform. This fact contributes to the transparency of science, since it anticipates the data that will be analyzed before knowing which variables could benefit one or another primary article.

Another point to be observed is that most of the studies do not specify whether the posterior or anterior region of the arches was studied, considering that bone density is lower in the posterior maxilla and about half the density in the anterior mandible [32], it is to be expected that dental implants may behave differently, depending on the location. In the same way, for studies using overdenture it was not always possible to specified whether the implants were stand-alone or interconnected. For a better success rate, it is believed that the implants should be interconnected, since, when isolated and under immediate load, the lateral forces received in a removable prosthesis could cause micromovements leading to an early failure in the implant-bone integration.

The issue about loading multiple dental implants seems to be recent because apparently, the authors started to worry about this subject from the year 2004, and the publications on the subject had a high increase in 2009. Considering that there are about ten years of scientific research on the different loading techniques, we can see an impressive number of primary articles, since one of the revisions included 120 primary studies on the subject. However, some reviews have stated that studies on immediate loading are still less than conventional loading, and methodological quality is still far from optimal [10,14].

The low methodological quality of the systematic reviews included the lack of consideration of external factors related to the patient (chewing, personal care, hygiene, etc.) and low time to follow the studies. The commercial trends can be considered as limitations to this research. Furthermore, considering the great methodological heterogeneity of systematic reviews and primary studies, and that practically all the studies with low risk of bias affirmed that the two techniques were similar, it became unnecessary to carry out meta-analysis with individual data.

Therefore, considering studies with methodological flaws and high risk of bias it cannot be affirmed that there is no difference between the techniques. However, when we consider only those that were methodologically correct, we can state that regardless the loading time, success rates are similar, which leads us to believe that this success is more related to an adequate technique of placement of these implants before loading guaranteeing the success in immediate or medium prosthetic loading, due to a high locking torque, as well as in late loading, leading to a good maturation of the implant.

5. Conclusion

Considering only systematic reviews that were methodologically sound, success rates of dental implants are similar regardless the loading time.

Conflict of interest

The authors declare they do not have any conflict of interest.

Ethics

It does not apply.

Source of funding

Authors themselves.

CRediT authorship contribution statement

Clovis Marinho Carvalho Heiderich: Data curation, Writing - original draft, Investigation. **Tamara Kerber Tedesco:** Conceptualization, Methodology, Data curation, Writing - review & editing. **Syrio Simão Netto:** Validation, Data curation. **Rafael Celestino de Sousa:** Validation, Writing - review & editing. **Sergio Allegrini Júnior:** Validation, Writing - review & editing. **Fausto M. Mendes:** Validation, Writing - review & editing. **Thais Gimenez:** Conceptualization, Methodology, Formal analysis, Writing - review & editing, Supervision.

References

- [1] Jenny G, Jauernik J, Bierbaum S, Bigler M, Gratz KW, Rucker M, et al. A systematic review and meta-analysis on the influence of biological implant surface coatings on periimplant bone formation. *J Biomed Mater Res A* 2016;104:2898–910.
- [2] Adell R, Eriksson B, Lekholm U, Branemark PI, Jemt T. Long-term follow-up study of osseointegrated implants in the treatment of totally edentulous jaws. *Int J Oral Maxillofac Implants* 1990;5:347–59.
- [3] Chen J, Cai M, Yang J, Aldhohrah T, Wang Y. Immediate versus early or conventional loading dental implants with fixed prostheses: a systematic review and meta-analysis of randomized controlled clinical trials. *J Prosthet Dent* 2019;122:516–36.
- [4] Aromataris E, Fernandez RS, Godfrey C, Holly C, Khalil H, Tungpunkom P. Methodology for JBI umbrella reviews; 2014.
- [5] Bougioukas KI, Liakos A, Tsapas A, Ntzani E, Haidich AB. Preferred Reporting Items for Overviews of systematic reviews including harms checklist: a pilot tool to be used for balanced reporting of benefits and harms. *J Clin Epidemiol* 2017;93:9–24.
- [6] Shea BJ, Grimshaw JM, Wells GA, Boers M, Andersson N, Hamel C, et al. Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews. *BMC Med Res Methodol* 2007;7:10.
- [7] Whiting P, Savovic J, Higgins JP, Caldwell DM, Reeves BC, Shea B, et al. ROBIS: a new tool to assess risk of bias in systematic reviews was developed. *J Clin Epidemiol* 2016;69:225–34.
- [8] Al-Sawai AA, Labib H. Success of immediate loading implants compared to conventionally-loaded implants: a literature review. *J Investig Clin Dent* 2016;7:217–24.
- [9] Grutter L, Belser UC. Implant loading protocols for the partially edentulous esthetic zone. *Int J Oral Maxillofac Implants* 2009;24(Suppl):169–79.
- [10] Gallucci GO, Morton D, Weber HP. Loading protocols for dental implants in edentulous patients. *Int J Oral Maxillofac Implants* 2009;24(Suppl):132–46.
- [11] Rutkunas V, Mizutani H, Puriene A. Conventional and early loading of two-implant supported mandibular overdentures. A systematic review. *Stomatologija* 2008;10:51–61.
- [12] Sennerby L, Gottlow J. Clinical outcomes of immediate/early loading of dental implants. A literature review of recent controlled prospective clinical studies. *Aust Dent J* 2008;53(Suppl 1):S82–8.
- [13] Kawai Y, Taylor JA. Effect of loading time on the success of complete mandibular titanium implant retained overdentures: a systematic review. *Clin Oral Implants Res* 2007;18:399–408.
- [14] Chiapasco M. Early and immediate restoration and loading of implants in completely edentulous patients. *Int J Oral Maxillofac Implants* 2004;19(Suppl):76–91.
- [15] Alsabeeha N, Atieh M, Payne AG. Loading protocols for mandibular implant overdentures: a systematic review with meta-analysis. *Clin Implant Dent Relat Res* 2010;12(Suppl 1):e28–38.
- [16] Sanz-Sanchez I, Sanz-Martin I, Figuero E, Sanz M. Clinical efficacy of immediate implant loading protocols compared to conventional loading depending on the type of the restoration: a systematic review. *Clin Oral Implants Res* 2015;26:964–82.
- [17] Chambrone L, Shibli JA, Mercurio CE, Cardoso B, Preshaw PM. Efficacy of standard (SLA) and modified sandblasted and acid-etched (SLActive) dental implants in promoting immediate and/or early occlusal loading pro-

- ocols: a systematic review of prospective studies. *Clin Oral Implants Res* 2015;26:359–70.
- [18] Gallardo YNR, da Silva-Olivio IR, Gonzaga L, Sesma N, Martin W. A systematic review of clinical outcomes on patients rehabilitated with complete-arch fixed implant-supported prostheses according to the time of loading. *J Prosthodont* 2019;28:958–68.
- [19] Cordaro L, Torsello F, Rocuzzo M. Implant loading protocols for the partially edentulous posterior mandible. *Int J Oral Maxillofac Implants* 2009;24(Suppl):158–68.
- [20] Rocuzzo M, Aglietta M, Cordaro L. Implant loading protocols for partially edentulous maxillary posterior sites. *Int J Oral Maxillofac Implants* 2009;24(Suppl):147–57.
- [21] Papaspyridakos P, Chen CJ, Chuang SK, Weber HP. Implant loading protocols for edentulous patients with fixed prostheses: a systematic review and meta-analysis. *Int J Oral Maxillofac Implants* 2014;29(Suppl):256–70.
- [22] Jokstad A, Carr AB. What is the effect on outcomes of time-to-loading of a fixed or removable prosthesis placed on implant(s)? *Int J Oral Maxillofac Implants* 2007;22(Suppl):19–48.
- [23] Engelhardt S, Papacosta P, Rathe F, Ozen J, Jansen JA, Junker R. Annual failure rates and marginal bone-level changes of immediate compared to conventional loading of dental implants. A systematic review of the literature and meta-analysis. *Clin Oral Implants Res* 2015;26:671–87.
- [24] Xu L, Wang X, Zhang Q, Yang W, Zhu W, Zhao K. Immediate versus early loading of flapless placed dental implants: a systematic review. *J Prosthet Dent* 2014;112:760–9.
- [25] Zygiogiannis K, Wismeijer D, Aartman IH, Osman RB. A systematic review on immediate loading of implants used to support overdentures opposed by conventional prostheses: factors that might influence clinical outcomes. *Int J Oral Maxillofac Implants* 2016;31:63–72.
- [26] Schrott A, Riggi-Heiniger M, Maruo K, Gallucci GO. Implant loading protocols for partially edentulous patients with extended edentulous sites—a systematic review and meta-analysis. *Int J Oral Maxillofac Implants* 2014;29(Suppl):239–55.
- [27] Schimmel M, Srinivasan M, Herrmann FR, Muller F. Loading protocols for implant-supported overdentures in the edentulous jaw: a systematic review and meta-analysis. *Int J Oral Maxillofac Implants* 2014;29(Suppl):271–86.
- [28] Shea BJ, Reeves BC, Wells G, Thuku M, Hamel C, Moran J, et al. AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. *BMJ* 2017;358:j4008.
- [29] Moher D, Pham B, Klassen TP, Schulz KF, Berlin JA, Jadad AR, et al. What contributions do languages other than English make on the results of meta-analyses? *J Clin Epidemiol* 2000;53:964–72.
- [30] Juni P, Hohenstein F, Sterne J, Bartlett C, Egger M. Direction and impact of language bias in meta-analyses of controlled trials: empirical study. *Int J Epidemiol* 2002;31:115–23.
- [31] Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ* 2009;339:b2535.
- [32] Turkyilmaz I, Tozum TF, Tumer C. Bone density assessments of oral implant sites using computerized tomography. *J Oral Rehabil* 2007;34:267–72.