Review

Survival rate and clinico-radiographic parameters around narrow-diameter dental implants for fixed dental prostheses in the posterior regions: A systematic review

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A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation;
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Abstract

Narrow-diameter dental implants (NDDIs) are suggested to be a reliable alternative to bone augmentation techniques, but the evidence regarding the feasibility of NDDIs in the posterior area is limited. This review investigated the survival rates of NDDIs, as well as peri-implant clinical and radiographic parameters for fixed dental prostheses in the posterior regions in comparison with standard-diameter dental implants (SDDIs). One investigator performed an electronic search of the English literature until December 2020 in the Web of Science, PubMed, Scopus, and EMBASE databases. The focused question was: "Do narrow-diameter dental implants restoring a fixed dental prosthesis demonstrate more alveolar bone loss as compared to standard-diameter dental implants in posterior maxillary and mandibular regions?"

The 9 studies selected for this review assessed a total of 498 patients (250 males and 206 females; 42 patients not described in terms of gender) aged 19–81 years, with 725 NDDIs and 260 SDDIs placed. The mean follow-up duration was 71 months (range: 12–176 months). A high survival rate of NDDIs was noticed (97.4%; range: 94.7–100%). The mean probing depth (PD) and bleeding on probing (BOP) scores ranged between 3.12 mm and 3.67 mm, and between 10.00% and 33.42%, respectively. However, the only study reporting the plaque index (PI) demonstrated a mean PI score of 1.39. The majority of the studies reported the mean marginal bone loss (MBL) scores below 1 mm.

In conclusion, NDDIs appear to be a feasible treatment option in patients requiring a fixed dental prosthesis in the posterior region, since they exhibit comparable survival rates to SDDIs, as well as a clinically acceptable peri-implant clinical and radiographic tissue response.

Keywords: marginal bone loss, diameter, narrow diameter, survival, systematic review

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Introduction

Countless clinical reports have revealed the excellent predictability and high success rates of dental implant therapy.[1–3] Additionally, the rehabilitation of the oral cavity by utilizing dental implants may yield an improved oral health-related quality of life (OHRQoL).[4,5] However, the atrophy of the alveolar crest with decreased bone height and width because of marginal periodontitis, denture wearing, neoplasia, malformation, and trauma makes the placement of dental implants challenging. In such scenarios, supplementary surgical protocols might be needed to increase an inadequate alveolar bone volume and remodel harmful sagittal, horizontal or vertical intermaxillary relationships.[6] In this aspect, numerous augmentation methods are suggested in the literature, based on the size and site of the defect, including lateral and/or vertical alveolar ridge augmentation and maxillary sinus floor augmentation.[6] However, these augmentation methods are costly and time-consuming, and require surgical skills to minimize patient morbidity and to prevent several complications, including wound dehiscence, hemorrhage, bone fractures, nerve damage, infections, postoperative pain, and augmentation or dental implant failure.[7,8] Moreover, augmentation methods might carry an increased risk of complications in medically compromised patients (i.e., patients utilizing antiresorptive drugs or having a history of radiation to the oral and maxillofacial region).[8]

Implant survival depends on the maintenance of optimal conditions of peri-implant tissues to achieve stability. After obtaining osseointegration, the failure of the implant is linked to the gradual loss of peri-implant bone tissue, which is due to inflammation in the area.[9] Therefore, it is essential to monitor the peri-implant bone levels at regular follow-ups after the implant treatment is completed. If no adequate oral hygiene instructions are being followed or the implant is overloaded, peri-implantitis and the loss of the implant may occur.[10]

Narrow-diameter dental implants (NDDIs) are becoming a growing scientific and clinical interest. With the use of NDDIs, patient morbidity may be decreased by avoiding augmentation or other invasive surgical procedures.[11] Until recently, the application of NDDIs has been limited to the replacement of teeth having narrow clinical crowns and/or for limited inter-implant or interdental spaces, including mandibular incisors and maxillary lateral regions.[12] Several studies have reported the survival rates of NDDIs being comparable to standard-diameter dental implants (SDDIs).[13,14] It might be postulated that dental implant survival is not associated with implant diameter. However, the utilization of NDDIs is avoided in the posterior regions due to biomechanical and prosthetic considerations.[12]

Some studies comparing NDDIs to SDDIs have reported comparable dental implant survival rates for both implant options.[15,16] However, a few limitations have been suggested with the utilization of NDDIs that should be taken into account, including considerably lower fracture resistance in comparison with SDDIs, which increases the risk of dental implant failure.[17–20] According to Ivanoff et al., a decrease in implant diameter results in a decreased implant-to-bone contact region, yielding a smaller surface area; hence, a small diameter may undermine the osseointegration of NDDIs.[21] However, recent studies have demonstrated that NDDIs might be employed for the replacement of posterior and anterior teeth, with comparable clinical and radiographic results.[21,22]

Till today, the application of NDDIs has been limited to specifically defined indications – for teeth having relatively low occlusal loading, such as incisors, or to retain elements for overdentures. Before NDDIs can be recommended in a wider clinical setup, the assessment of the available evidence is essential.[23] There is no clinical evidence regarding clinical and radiographic parameters around NDDIs for fixed dental prostheses in the posterior regions in comparison with SDDIs. Therefore, this systematic review aimed to investigate the survival rates of NDDIs, as well as peri-implant clinical and radiographic parameters for fixed dental prostheses in the posterior maxillary and mandibular regions in comparison with SDDIs.

Material and methods

The current systematic review was constructed in agreement with the guidelines provided in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.[24]

Focused question and study outcomes

The focused PICO question was as follows[25]: "Do narrow-diameter dental implants (intervention) restoring a fixed dental prosthesis (patient) demonstrate more alveolar bone loss (outcome) as compared to standard-diameter dental implants (comparison) in posterior maxillary and mandibular regions?"

The survival rates of NDDIs were the primary outcome, while peri-implant clinical (i.e., the plaque index (PI), probing depth (PD) and bleeding on probing (BOP)) and radiographic (marginal bone loss (MBL)) parameters constituted the secondary outcomes.

Patient selection and intervention

The current review included studies with patients scheduled for the placement of a minimum of one NDDI into the maxilla and/or mandible with a narrow alveolar

ridge (i.e., an inadequate bone volume). Any simultaneous bone augmentation techniques were not allowed. Studies with only healthy participants, without any systemic condition that might influence bone metabolism and with the absence of local infection signs were included in the present review. No restrictions regarding patients' age or gender were imposed.

Only reports referring to dental implants of diameters ranging from 3.2 mm to 3.5 mm were included, without any restriction as to dental implant length. The indication for NDDI included the restoration of a fixed dental prosthesis.

Search strategy

The authors searched the Clarivate Analytics' Web of Science (all databases), MEDLINE/PubMed, Elsevier's Scopus, and EMBASE databases from January 1990 to December 2020 for suitable publications in English to address the focused question. A complete search was carried out with regard to articles that compared the alveolar bone loss levels after restoring a fixed dental prosthesis with NDDIs and SDDIs. The following search terms were used in all databases: "small implant*" OR "small dental implant*" OR "small diameter implant*" OR "small diameter dental implant*" OR "narrow implant*" OR "narrow dental implant*" OR "narrow diameter implant*" OR "narrow diameter dental implant*" OR "standard implant*" OR "standard dental implant*" OR "standard diameter implant*" OR "standard diameter dental implant*" OR "regular implant*" OR "regular dental implant*" OR "regular diameter implant*" OR "regular diameter dental implant*" OR "diameter implant*" OR "diameter dental implant*" OR "mini implant*" OR "mini dental implant*".

The titles and abstracts for the eligible studies were screened by two authors. If the abstract did not contain relevant data in terms of eligibility criteria, the article was excluded. If the title of the article was relevant, but the abstract was not available, the article was chosen for a thorough reading of the text. Then, the identification of full-text articles that fulfilled the eligibility criteria was performed. The manual search of the reference lists of clinical studies was carried out to identify papers that might have been missed during the electronic search. The following journals were selected for manual searching: *Journal of Periodontology*; *Journal of Clinical Periodontology*; *Journal of Periodontal Research*; *Clinical Oral Implants Research*; *Clinical Implant Dentistry Related Research*; *European Journal of Oral Implantology*; *International Journal of Implant Dentistry*; *Journal of Periodontal and Implant Science*; *International Journal of Periodontics and Restorative Dentistry*; *Implant Dentistry*; *Journal of Oral Implantology*; and *Implantologie*. Articles that fulfilled the selection criteria were analyzed for data extraction.

Data extraction

The following data from the selected studies were extracted and tabulated: the author(s), year and journal of publication; the methodological design of the study; the gender and mean age [years] of the study participants; the total number of dental implants placed into the maxilla and/or mandible; implant diameter [mm]; the placement depth of dental implants; follow-up duration [months]; the survival rate of the dental implant [%]; and the outcome of the study. The information gathered was based on the focused question proposed for the current systematic review.

Eligibility criteria

The inclusion criteria were as follows: studies on the survival rates of dental implants under functional loading; studies that analyzed peri-implant clinical and radiographic parameters; studies having at least 12 treated patients; studies with a mean follow-up duration with regard to dental implant survival of a minimum of 1 year after implant placement; and studies published in the English language. The following methodological designs were included:

– prospective: cohort, non-randomized controlled and randomized controlled studies;
– retrospective: single-cohort and controlled trials.

The exclusion criteria comprised studies having a mean follow-up period <1 year, studies discussing simultaneous bone augmentation techniques, the utilization of mini dental implants (MDIs) for orthodontic anchorage, reviews, expert opinions, case reports, case series, animal studies, or in vitro studies, studies with <12 patients, and studies published in languages other than English.

Risk of bias/quality assessment

Two investigators evaluated the quality of the included studies.

The quality assessment of randomized controlled trials was carried out using the revised recommendations of the Consolidated Standards of Reporting Trials (CONSORT) statement.[26] The estimation of quality for each included randomized controlled trial was based on the Cochrane Handbook for Systematic Reviews of Interventions.[27] In summary, the following sections were taken into account: reporting bias (selective reporting); attrition bias (incomplete outcome data); detection bias (blinding of outcome assessors); performance bias (blinding of research subjects); selection bias (randomization and allocation concealment); and other bias. For each of the above sections, the reports were categorized as having a high, low or unclear risk of bias. Overall, the reports were regarded as having a high risk of bias if ≥1 criterion was not fulfilled, a low risk of bias if all criteria were fulfilled, and an unclear risk of bias if ≥1 criterion was partly fulfilled.

For assessing the quality of non-randomized and observational studies, the grading Newcastle–Ottawa Scale (NOS) was used.[28] This scale utilizes a star system to assess reports with regard to 3 comprehensive aspects[29]: the identification of either the outcome or exposure of interest (maximum 3 stars); the comparability of study groups (maximum 2 stars); and the selection of research groups (maximum 4 stars).

Additional analysis

Due to deficient high-quality evidence, limited data presented in some studies and the discrepancy between the methods used, the utilization of advanced statistical analyses was felt inappropriate. The data quality also precluded any statistical bias evaluations. The secondary outcomes of the present review are presented narratively.

Results

Study selection

The search of electronic databases (MEDLINE/PubMed (n = 1,517), Scopus (n = 346), Web of Science (n = 252); and EMBASE (n = 158)) yielded 2,273 relevant publications for consideration. After screening titles and abstracts, 29 studies were chosen for full-text review; after the removal of duplicates, 1,686 studies did not meet the inclusion criteria and were excluded. The screening of titles and abstracts resulted in the exclusion of 20 more studies. Overall, 9 studies were finally selected for the present systematic review (Fig. 1). All studies were conducted at private dental clinics, healthcare centers or universities.

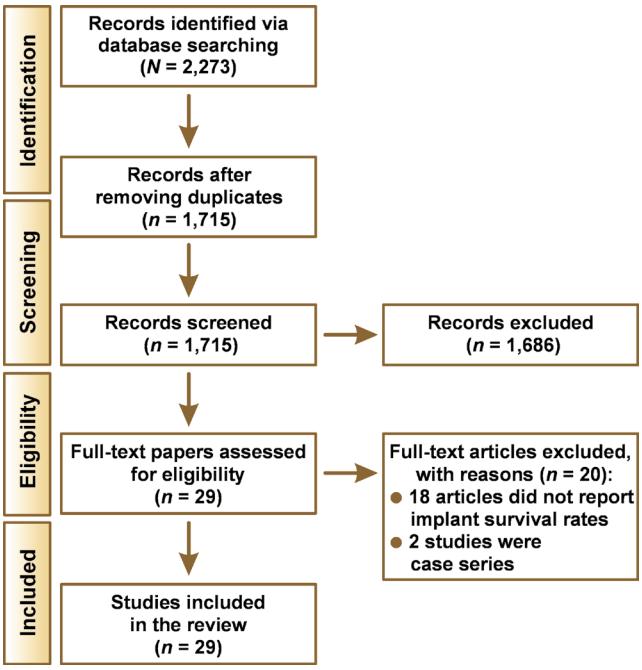

Fig. 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram for the literature search

General characteristics of the included studies

Table 1 depicts the general characteristics of the included studies. In the present review, 4 studies were retrospective clinical trials,[30–33] 2 were prospective clinical trials,[34,35] 2 were retrospective cohort studies,[36,37] and 1 study was a randomized controlled trial.[38] The majority of the clinical trials were published during the 2010s. These studies were carried out in Turkey, South Korea, Brazil, Portugal, Belgium, Italy, and China, and were published in the *International Journal of Implant Dentistry*, *Maxillofacial Plastic and Reconstructive Surgery*, *Clinical Oral Implants Research*, *Clinical Implant Dentistry Related Research*, *Journal of Oral Implantology*, *Implant Dentistry*, and *Journal of Periodontology*. A total of 498 participants were involved in the studies and included in the present review, with male participants (n = 250) slightly outnumbering female patients (n = 206). However, a study involving 42 participants did not mention the gender of patients.[30] Overall, the sample sizes ranged between 12 and 147, and the age range was 19–81 years. The total number of NDDIs was 725, while the total number of SDDIs was only 260, with 1 study not providing the number of NDDIs and SDDIs.[38] Overall, 380 implants were placed in the maxilla, whereas 366 implants were placed in the mandible. One study did not report the jaw(s) in which implants were placed.[37] The diameter of NDDIs ranged from 3.2 mm to 3.5 mm, while the diameter of SDDIs ranged from 3.5 mm to 4.1 mm. Overall, 8 studies applied bone-level dental implants, whereas only 1 study utilized tissue-level dental implants.[38]

Survival rate of NDDIs

All the included reports presented the survival rate of NDDIs. Overall, the survival rate of the NDDIs ranged from 94.7% to 100%. Out of a total of 725 NDDIs used, only 19 failed, which corresponds to an NDDI survival rate of 97.4% during the follow-up time, which ranged from 12 months to 176 months. A higher failure rate of NDDIs was observed in the maxillary arch (n = 11; 57.9%) as compared to the mandibular arch (n = 8; 42.1%).

Peri-implant clinical and radiographic parameters

Only one study assessed PI, PD and BOP,[36] while 2 studies evaluated only PD and BOP,[37,38] and 1 study evaluated only BOP.[30] Overall, the mean PD and BOP scores ranged between 3.12 mm and 3.67 mm, and between 10.00% and 33.42%, respectively. However, the only study reporting PI demonstrated a mean PI score of 1.39.[36]

Table 1. General description and implant-related characteristics of the included studies

Study	Study design	Number of participants, their gender (M+F) and mean age [years]	Number of implants – total, maxillary/ mandibular	Implant diameter [mm]	Placement depth	Follow-up duration [months]	Survival rate [%]	Study outcome
Eskan et al.[30] 2020, Turkey	retrospective clinical study	*n* = 42 – – –	171 NDDIs: 37 SDDIs: 134 98/73	NDDIs: 3.3 SDDIs: 4.1	bone level	55	100	NDDIs successfully treated total edentulous patients requiring immediate implant placement and loading
Woo et al.[31] 2016, South Korea	retrospective clinical study	*n* = 66 (37+29) 51.4 (19–76)	98 NDDIs: 98 42/56	NDDIs: 3.5	bone level	12–48	100	NDDIs must be considered an alternative for SDDIs to restore a posterior edentulous region
Garcez-Filho et al.[32] 2015, Brazil	retrospective clinical study	*n* = 21 (9+12) 55.5 (33–78)	40 NDDIs: 40 40/0	NDDIs: 3.3	bone level	120	97.0	NDDIs installed immediately after the split-crest procedure may successfully support prosthetic rehabilitation after long-time intervals
Maló and de Araújo Nobre[33] 2011, Portugal	retrospective clinical study	*n* = 147 (115+32) 47.5 (26–77)	247 NDDIs: 247 144/103	NDDIs: 3.3	bone level	12–132 (60)	95.1	the use of NDDIs for the prosthetic rehabilitation of the posterior regions of the jaws is viable, with good outcomes in the long term, irrespective of the surgical technique implemented
Lambert et al.[34] 2015, Belgium	prospective clinical study	*n* = 20 (5+15) – (21–70)	39 NDDIs: 39 0/39	NDDIs: 3.3	bone level	12	94.7	the use of NDDIs to restore partial edentation in sites with a limited horizontal thickness seems to be an effective treatment option that prevented guided bone regeneration in the majority of cases
Mangano et al.[35] 2013, Italy	prospective clinical study	*n* = 16 (9+7) 58.5 (48–69)	37 NDDIs: 37 14/23	NDDIs: 3.2	bone level	24	100	NDDIs can be used in fixed prosthetic rehabilitation in the posterior regions of both jaws with a predictable positive outcome
Shi et al.[36] 2018, China	retrospective cohort study	*n* = 67 (38+29) 35.6 (21–56)	114 NDDIs: 114 42/72	NDDIs: 3.3	bone level	96–176 (121)	97.0	NDDIs, being a predictable treatment option, have high survival rates, high patient satisfaction, and acceptable complication rates and MBL
Pieri et al.[37] 2017, Italy	retrospective cohort study	*n* = 107 (33+74) 61.0 (44–81)	239 NDDIs: 113 SDDIs: 126 –/–	NDDIs: 3.3 SDDIs: 3.5–4.0	bone level	60	99.1	fixed partial denture treatment in the posterior jaws with NDDIs was as reliable as with SDDIs, although NDDIs showed a higher risk of prosthetic complications
Tolentino et al.[38] 2016, Brazil	randomized controlled trial	*n* = 12 (4+8) 43.3 –	– NDDIs: – SDDIs: – 0/all	NDDIs: 3.5 –	tissue level	12	100	NDDIs may be equally used to support single crowns in the posterior area of the mouth

M – male; F – female; NDDIs – narrow-diameter dental implants; SDDIs – standard-diameter dental implants; MBL – marginal bone loss.

All the included studies reported MBL around NDDIs. The majority of the studies (n = 8) reported the mean MBL scores below 1 mm, except one report, which demonstrated a mean MBL score of 1.16 mm.[36]

Patient satisfaction

Out of the 9 included studies, only one study evaluated patient satisfaction, using a visual analog scale (VAS).[36] Approximately 90% and 85% of patients were satisfied with the esthetics and function of the NDDI and SDDI restorations, respectively. However, around 10% and 15% of patients were not satisfied with the esthetics and function of the restorations, respectively, mainly due to food impaction and buccal mucosal recession. The mean satisfaction score on VAS was 9.21 ±1.53.[36]

Study outcomes

The majority of the included studies (8/9) concluded that NDDIs were a reliable and predictable method to successfully treat patients that require immediate dental implant treatment for restoring the posterior maxillary and mandibular edentulous regions. According to 1 report, fixed partial denture therapy in the posterior region with the use of NDDIs was a reliable option, although a higher risk of prosthetic complications was observed as compared to SDDIs.

Risk of bias/quality assessment

Table 2 presents the assessment of the quality of the studies included in the systematic review. One study was of excellent quality,[38] 3 studies were of good quality[34,35,37] and 5 studies were of moderate quality.[30–33,36]

Discussion

The present systematic review aimed to investigate the clinical and radiographic parameters around NDDIs for fixed dental prostheses in the posterior maxillary and mandibular regions in comparison with SDDIs. There is a dearth of literature on clinical studies, particularly randomized controlled trials, regarding the survival rates of NDDIs for fixed dental prostheses in the posterior regions. Hence, the present review also included observational studies. Due to the scarcity of randomized controlled trials, a huge variation in the quality assessment was observed among the included studies. Moreover, an enormous variety was noticed in survival follow-up duration. Most of the studies did not mention the reasons for implant success and implant failure. Hence, the abovementioned factors have to be taken into account while interpreting the outcomes of the current review in comparison with other reviews that included randomized controlled trials only.

In the present systematic review, MDIs were not included to perform a more precise search. This explicit differentiation between NDDIs and MDIs was established to avoid confusion. The Glossary of Oral and Maxillofacial Implants (GOMI) definition of MDIs and the threshold of an implant diameter >3 mm were applied.[39] According to the authors of the present review, a dental implant having a diameter >3 mm is best considered to be an NDDI, which is considerably different from a MDI. This adoption of the GOMI definition and a 3-millimeter implant diameter threshold is recommended for future studies to differentiate between NDDIs and MDIs.

In the present review, the survival rates of NDDIs seem to be comparable to those of SDDIs (>3.5 mm in diameter). Most of the included studies demonstrated survival rates >97%, and no report presented a survival rate below 94%. This may indicate a reliable alternative treatment option; yet, the assessment of the success of NDDI applications should not be performed exclusively based on the identification of dental implant survival.[40] The measurement of peri-implant clinical and radiographic parameters, implant success and indications should also be taken into consideration.[41] Several extrinsic and intrinsic factors might affect the stability of peri-implant clinical and radiographic parameters. Vital intrinsic factors include the quality and quantity of surrounding soft and hard tissue. However, dental implant design, the total number of implants placed, implant angulation, and depth of insertion constitute the implant-related extrinsic factors.[40]

The survival rates of NDDIs for fixed dental prostheses could also be influenced by the higher fracture and failure risk.[20] The former results from their small surface area in contact with the alveolar bone tissue in comparison with SDDIs. Because of those risks, NDDIs are preferably employed only in scenarios with a reduced ridge thickness or in cases having limited space.[42–44] In the present review, an overall survival rate of around 98% was reported, comparable to what is reported in other studies related to SDDIs, i.e., 97%[45] and 99%.[46] The NDDIs survival rates reported in the present study are well above the success criterion proposed by Albrektsson et al. in 1986, which is 85% at a 5-year follow-up and 80% at a 10-year follow-up.[47] The decreased pain linked to NDDIs is an additional advantage. However, this decreased pain perception might be more related to the diminished number of surgical steps, as a bone grafting procedure is not necessary for placing NDDIs.[48]

Vitamin D pleiotropism is of great interest in contemporary dentistry for clinicians who perform dental implant procedures, since it contributes to bone metabolic processes and modulates the immune system.[49–51] It is assumed that the appropriate amount of vitamin D is positively associated with the process of osseointegration. Several reports demonstrate that this prohormone is potentially vital for the process of postsurgical tissue repair, as well as the integration of the dental implant with bone and peri-implant bone homeostasis after a dental prosthesis is placed.[52]

Table 2. Assessment of the quality of the studies included in the systematic review

Study	Selection	Comparability	Outcome	Score	Quality
Eskan et al.[30]	***	*	*	5	moderate
Woo et al.[31]	***	*	*	5	moderate
Garcez-Filho et al.[32]	***	*	*	5	moderate
Maló and de Araújo Nobre[33]	**	*	*	4	moderate
Lambert et al.[34]	***	**	*	6	good
Mangano et al.[35]	**	**	**	6	good
Shi et al.[36]	**	*	*	4	moderate
Pieri et al.[37]	***	**	*	6	good
Tolentino et al.[38]	***	***	***	9	excellent

Moreover, its function of reducing peri-implant inflammation is of particular importance.[53] At the interface between the dental prosthesis and the implant, vitamin D causes the induction of regional cells of the immune system, i.e., the formation of 1-alpha-hydroxylase by monocytes.[53] Hence, the authors of this study recommend the use of appropriate concentrations of vitamin D in such patients, as vitamin D treatment remarkably increases bone levels at the implant site, which might be a crucial factor in the long-term survival of dental implants.[54]

Another crucial factor that influences the predictability of NDDIs is MBL over time.[20] According to Assaf et al., the predictability of NDDIs depends not only on their diameter, but also on MBL, which should be within comparable limits as those reported for SDDIs.[12] According to the findings of the present review, the majority of the included studies reported the mean MBL scores below 1 mm. These findings are in agreement with the published literature, which reports an acceptable MBL of 2 mm in the 1st year after the placement of the dental implant, followed by 0.2 mm per annum.[55,56]

The implant type, primarily the surface macrostructure and microstructure, appears to influence the survival rate of the dental implant and implant restoration designs.[12] Maló and de Araújo Nobre highlighted these 2 factors, and reported more cases of failure while using screw-shaped dental implants having smooth surfaces as compared to taper-shaped and surface-treated dental implants.[33] They also determined a potential predisposing factor for dental implant failure with partial rehabilitation in comparison with complete edentulous and single-tooth rehabilitation. However, their report had some inherent limitations – varying loading techniques, including immediate loading, were utilized, as well as varying dental implant lengths (10–15 mm).[33]

A decrease in diameter means a decrease in the implant-to-bone contact surface.[12] According to reports, implants with wider diameters exhibit greater pull-out forces and removal torques. This explains the fact why clinicians choose an SDDI when sufficient width is available, since the outcomes are in favor of SDDIs in regard to mechanical strength, initial stability and the available surface of osseointegration.[21,57]

Patient-centered results are mostly overlooked, despite the obvious consequences on the success of dental implant treatment.[58] The majority of the included studies (8/9) did not report patient-centered results (i.e., patient satisfaction). Patient satisfaction, and the restoration of esthetics and function are the primary goals when treating the edentulous patient with the use of dental implants, and hence new reports should evaluate these vital parameters of dental implant therapy.[59] In this context, the establishment of a well-defined success benchmark is necessary for reporting and evaluating prosthetic, dental implant and patient-centered results along with technical and biological complications.

Limitations

It is imperative to recognize the limitations of the present review. Though there has been a significant increase in the number of reports examining the behavior of NDDIs in comparison with SDDIs for fixed dental prostheses in the posterior regions in recent years, there is a scarcity of randomized controlled/clinical trials. Furthermore, the difficulty of blinding study investigators, subjects and outcome assessors may be considered a bias of this systematic review. Hence, the outcomes of this study should be interpreted with caution due to a low number of randomized controlled/clinical trials, and further clinical trials should be conducted to better answer the question as to fixed prosthodontics treatment using NDDIs in the posterior regions. Despite this, the NDDIs applied for fixed prosthodontics therapy in the posterior regions demonstrate high survival rates and clinically favorable peri-implant clinical and radiographic parameters.

Conclusions

Within the limitations of the present review, NDDIs appear to be a feasible treatment option in patients requiring a fixed dental prosthesis in the posterior region, since they exhibit comparable survival rates to SDDIs, as well as a clinically acceptable peri-implant clinical and radiographic tissue response.

Ethics approval and consent to participate

Not applicable.

Data availability

All data generated and/or analyzed during this study is included in this published article.

Consent for publication

Not applicable.

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