E-ISSN 2250-0944
ISSN 2250-1150
doi: 10.31838/ijprt/15.01.63

Research Article

The Use of a Narrow Implant with Edentulous Patients: A Systematic Review

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Received: 09.02.25, Revised: 14.03.25, Accepted: 21.04.25

ABSTRACT
Background: Implant selection has been highly emphasized in fully edentulous patients, where using slender diameter implants has become a central area of interest in dental implantology, mainly where patients have limited bone width and height. New developments in implant technology have demonstrated that these implants are as effective as broader implants and may be used for tooth replacement.
Objectives: This systematically planned and executed article aims to discuss the difficulties involving complications in completely edentulous patients along with the success and failure rates of narrow diameter implants.
Methods: Electronic databases, including but not limited to MEDLINE and Google Scholar, were searched for articles with standard protocol as per the "PRISMA guidelines". The criteria for paper selection involved articles between 2020 and 2024, limited to peer-reviewed sources that dealt with the use of implants with lesser diameter in edentulous individuals. Nine papers were chosen from the initial search's 2035 results based on specific inclusion criteria.
Results: The analysis shows a high overall long-term success rate of small-diameter implants (SDIs), ranging from 94.6% to 100%, with minimal marginal bone loss. Studies report cumulative survival rates such as 99.4% at a two-year follow-up and 97.7% over 55 months. Marginal bone loss was low, with some studies showing mean values of 0.15 mm after 24 months and 0.14 ± 0.39 mm following functional loading over 1–4 years. Additionally, patient satisfaction was high, with some studies reporting that 99% of patients maintained good soft tissue health, and prosthetic survival rates reached 100%. The literature confirms that narrow implants are a viable solution for ridge resorption and for use in medically compromised patients.
Conclusion: With much higher survival rates than conventional, large implants, small-diameter implants are a good and safe option for edentulous patients undergoing prosthetic rehabilitation. This review adds knowledge to the current debate about the appropriate approaches to dental implantology, discussing how thin implants can be used in treatment and possible drawbacks.

Keywords: Narrow-diameter implants, Fully edentulous patients, Dental implantology.

INTRODUCTION

Implementing narrow-diameter implants in fully edentulous patients is now considered an essential topic in dental implantology (1). Thus, studying the effects of using narrow implants will be necessary as the need for tooth replacement remains high and as the options for efficient solutions that can operate without requiring much bone mass and height (2).

Recent developments in implant design and surgical procedures have opened the way for applying narrow-body implants in clinical practice (3, 4). These implants can provide a good solution to patients who may not be good candidates for wider implants because of some anatomical considerations (5). According to the literature, there are no significant differences between narrow-diameter implants and their broader equivalents for the success rate, so that they can be recommended for functional and esthetic rehabilitation of edentulous patients (6).

A rising body of literature endorses using narrow-diameter implants in different circumstances. Research conducted on these implants has demonstrated that they can provide similar survival rates as other implants of a similar size (7, 8). For example, Badaró et

al. (2022) systematically reviewed several studies. They reported that the "survival rates" of the "NDIs" were more than 90 per cent at the five-year follow-up (9). This finding is significant in light of the anatomical challenges presented by edentulous patients that disqualify them from using standard implants (9).

In addition, the adoption of narrow-diameter implants in treatment planning has been found to cause fewer complications (10). Malheiros et al. (2022) noted that patients with narrow- diameter implants had lower rates of peri- implantitis and other complications than the standard implants (11). It is the least invasive surgical procedure, and more surrounding bone and soft tissue can be maintained during implantation (12).

The use of implants with small diameters is not only restricted to the mandible since they have also been used in the maxilla (13). Walter et al. (2023) showed that installing narrow-diameter implants in the posterior maxilla improves implant stability and patient satisfaction (14).

Besides such clinical factors as implant survival rate and success, a patient's satisfaction level is also considered an essential marker of the overall effectiveness of dental implant treatment. Majid et al. (2024) also examined patient satisfaction levels after placing narrow- diameter implants in edentulous patients (15). This concurs with other studies indicating that patient-reported outcomes are paramount in dental implant studies (15).

However, it is necessary to consider the shortcomings and possible adverse effects of applying narrow-diameter implants (16). A few investigations have expressed concern over the mechanical characteristics of such implants and have proposed that they are more vulnerable to fracture under conditions of high load bearing (17, 18).

This present systematic review proposes to assess the credibility of using narrow-diameter implants in such scenarios, especially regarding their long-term performance in implant success and failure rates as well as possible complications. The results will help to develop the discussion on the current state of knowledge about the methods used in dental implantology. They will also explain to clinicians the advantages and disadvantages of using narrow implants for treating edentulous patients.

METHODS

Study Design

The standards of PRISMA-Preferred Reporting Items for Systematic Reviews and Meta- Analyses claim that this review systematically and systematically organizes and makes sense of the current knowledge. The purpose of this assessment is to provide the most recent data on the narrow-diameter implants by systematically reviewing the peer-reviewed articles that incorporate artificial intelligence in dental education and evaluating the quality of the selected articles using Newcastle-Ottawa Scale.

Focused question

Is it valid to use narrow-diameter implant with fully edentulous patient?

PIO Framework

P: In edentulous patients with reduced bone width and hight
I: the use of "narrow-diameter implants" O: lead to comparable implant survival rates and fewer issues during an extended period of observation.

Search Strategy

The study carried out a literature search on narrow implant with edentulous patients using MEDLINE, Google Scholar, and the Saudi Digital Library. A variety of keyword searches and combined them with appropriate Boolean operators were used, as follow : (("narrow diameter dental implants" OR "small diameter implants" OR "platform-switched narrow implants") AND ("primary implant stability" OR "marginal bone loss" OR "osseointegration" OR "implant complications" OR "implant survival rate" OR "implant success rate" OR "peri- implant mucosa" OR "bone density") AND ("edentulism" OR "full-arch prostheses" OR "full-arch rehabilitation"))

("success rate" AND "peri-implant mucosa") OR ("complication" AND "survival rate") OR ("conical dental implant-abutment connection" AND "dental implant platform switching") OR ("osseointegration" AND "bone density") OR ("fixed full-arch prostheses" AND "marginal bone loss") OR ("immediate loading" AND "full edentulism") OR ("small diameter" AND "implant") OR ("narrow diameter dental implants" AND "primary implant stability")

Only publications released between 2020 and 2024 were included in the October 2024 search. In order to classify the articles and remove duplicates, the references were imported into EndNote 21 software (Clarivate, Philadelphia, PA, USA) after the review has been prepared according to the recommendations of PRISMA.

Inclusion and Exclusion criteria

This systematic review's inclusion criterion covered English-language research that: (1) peer-reviewed journal articles; (2) had a reported systematic review, and observational studies; (3) had an integration of AI in the dental field of education; (4) scored at least 5 out of 9 on the Newcastle-Ottawa Scale (NOS). The study excluded reports, technical notes, conference abstracts, and papers that ignored ethical concerns with AI in dental education, and studies on various AI models.

Data collection process

To enhance reliability, two individuals (SA and MA) independently assessed titles and abstracts for review before obtaining full-text articles through electronic search. These papers were thoroughly evaluated to ensure that the inclusion and exclusion criteria were met, with minor discrepancies established through discussion.

Quality assessment

The review used Newcastle-Ottawa Scale (NOS) that involved rating of studies in terms of selection, comparability and outcome. Each study received up to nine stars, with a cutoff value of 5/9 or higher being adequate. Each study was assessed for quality and any disagreement was made through consensus.

Data synthesis

We provided tables that present the overall findings in the articles that we retrieved. Key information including authors, publication year, methodology, study location, population and quality assessment score.

RESULTS

In this systematic review, a total of 2035 articles were found from different sources such as, 1530 from PubMed, 225 from Saudi Digital library, and 280 from Google Scholar. Out of the 1065 studies that were screened, 1045 studies were excluded based on reasons that included lack of control for confounding factors, inadequate sample size and study limitations. Consequently, 20 papers were considered for the review process, and 2 papers were removed from the pool because the type of studies identified them incorrectly. Out of 18, 9 of them are excluded because of technical notes and reports, 9 of them were selected for the final analysis (Fig. 1). The studies conducted in these cases reveal a high cumulative survival rate of narrow-diameter implants for edentulous patients, and the overall success rate varies between 94.6% and 100%. Additionally, the trials demonstrated that patients are content with edentulous instances that have been functionally and aesthetically repaired, and that narrow implants are possible in terms of marginal bone loss.

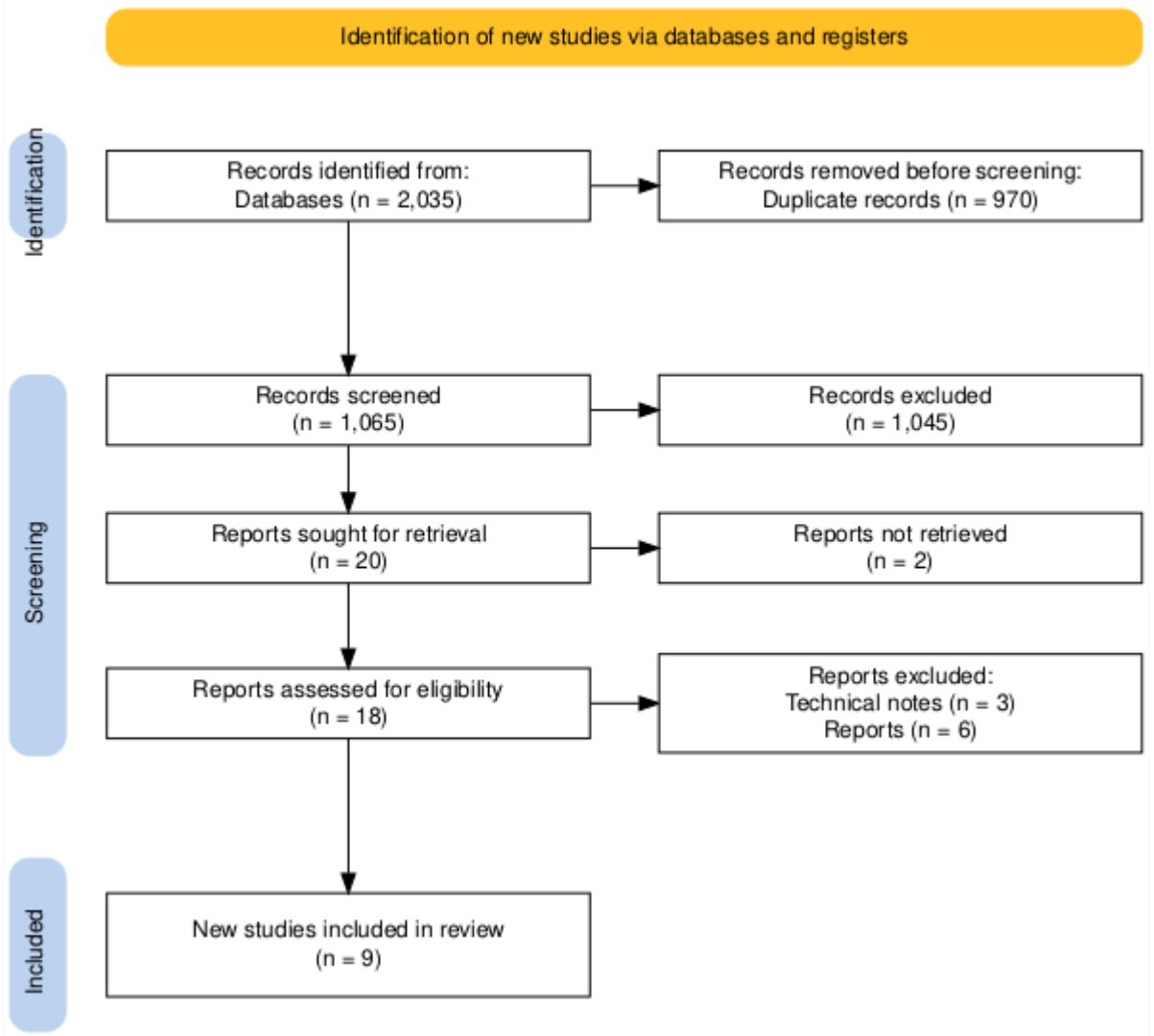

Figure 1: PRISMA CHART

Table 1 lists previous research on using narrow-diameter implants in the edentulous population (19-28). The studies in the table differ regarding the research design and methodology, geographical location, and patient characteristics. They include prospective and retrospective studies emphasizing various types of narrow implants and their performance. Several investigations describe high cumulative survival rates of narrow implants. For example, one study described a cumulative survival rate of 99.4% for "narrow implants" with a 2-year "follow-up"; another study described a "survival rate" of 97.7% with a "follow-up" of 55 months. The studies continue to reveal a small amount of marginal bone loss in patients who receive narrow implants. For example, one of the studies pointed to 0.15 mm mean MBL (marginal bone loss) after 24 months, which indicates good osseointegration around implants. It is also said that the prosthetic survival rates are high; some studies have even revealed a 100% prosthetic survival rate when they were fixed with narrow implants. The studies presented in the paper focus on such aspects of care as well-maintained soft tissues and overall patient satisfaction. For instance, one study showed that 99% of the patients had good soft tissue health. Several investigations were made comparing narrow implants with standard diameter implants regarding implant failure and marginal bone loss, and It was shown that the two types of implants did not significantly differ from one another, which means that narrow implants can be used as an option in some clinical conditions.

The study's findings lend credence to the application of "narrow-diameter implants" in various clinical settings, such as in the presence of ridge atrophy or when patients have medical contraindications, as an efficient and predictable way to restore lost function and

esthetics. The table shows a positive perspective on the employment of narrow implants for edentulous patients with high success rate, low complication rate, and good clinical results.

The quality of the studies concluded in this review is quite high The majority of the studies are scored 7 or 8 out of 8 on the Newcastle- Ottawa Scale (NOS). This high quality is evidence of rigorous methodology and of important results concerning the prognosis and safety of the narrow diameter implants in the edentulous patients. For instance, Mifsud (2021) and Woo (2016) established a high level of patient satisfaction and only a negligible amount of marginal bone loss and thus confirmed the effectiveness of narrow diameter implants in the dental implantology treatment. Kolerman and others in their study reported 100% survival of 75 immediately placed and repaired anterior mandibular implants following an 8-year follow-up, which supports the possibility of this treatment plan for patients with hopeless teeth in this area. Marginal bone loss (MBL) averaged 1.68 ± 1.01 mm at the 8- year follow-up, with smoking status significantly impacting MBL, as smokers exhibited greater bone loss compared to non-smokers (2.98 mm vs. 1.23 mm). Additionally, complete papillae formation was achieved in only 13.3% of cases, highlighting the challenges in aesthetic outcomes despite the high survival rates (19).

Woo and his colleagues reported that that narrow-diameter implants with a conical connection can achieve a 100% survival rate in the posterior edentulous region, with only "0.14 ± 0.39 mm" of mean bone loss following functional loading throughout a follow-up period of 1–4 years. "−3.29 ± 0.50" was the mean Periotest value, indicating stable implants. Furthermore, the present study revealed no significant differences on bone loss according to various factors, thus suggesting that narrow implants could be a treatment option as an alternative to wider implants in certain clinical scenario (20).

The effectiveness and high rate of success of the aforementioned treatment approach can be attributed to the 2-year follow up study that revealed 99.4% CSR of all the implants and 98.5% CSR of the NDIs, facilitated by the use of 3.3 mm titanium-zirconium NDIs coupled with the standard diameter implants in the immediate fixed full-arch rehabilitation. Also, there were no statistically significant differences between the four study groups in the overall mean 'MBL-marginal bone loss,' which was assessed at 0.51mm after one year of treatment and 0.73mm after two years of treatment. It is one of the approaches to a rapidly progressing treatment based on the study's conclusions that patients with severely atrophied jaws should be equipped with narrow-diameter implants (21).

In another cross-sectional study with standard length and short mini implants (MDI) in mandibular overdentures, the standard MDI group had a mean MBL of 0.338 mm and a success rate of 94.3% at the end of one year while the short MDI group presented a mean marginal bone loss of only 0.261 mm and a success rate of 92.6%. Short MDIs could be utilized for patients with highly resorbed alveolar ridges due to no significant differences in the MBL, survival, and success rates between the two study groups. Also, in terms of oral hygiene state, the short MDI group had more significant improvements than the conventional MDI group with lower plaque and bleeding scores (22).

In their study on Clinical comparison of short mini-implants (MDIs) for mandibular overdentures for patients with extremely resorbed alveolar ridges with standard length MDIs, Song et al., The two groups were then compared based on mean MBL and success rate; "the Short MDI group achieved a mean MBL of 0.261mm and a success rate of 92.6% while the Standard MDI group achieved a mean MBL of 0.338mm and a success rate of 94.3%".Since there were no statistically significant differences between the two groups' MBL, survival, or success rates, it may be said that patients with little bone volume could benefit from short MDIs. However, the Short MDI group has better oral hygiene status in comparison with the Standard MDI group in regards to the plaque and bleeding indexes (23).

The study by Swathi. Et al.,evaluated the early loading of narrow diameter implants' clinical and radiological characteristics in ten individuals with maxillary single edentulous spaces. According to the study's findings, the mean marginal bone loss after six months was
-0.55 mm, which is expected and suggests that the participants maintained good peri-implant

cleanliness. Additionally, the improved papilla index scores showed that the gingival zenith's position and implant papillae height were unaltered, indicating no recession. The study evidence also confirms the hypothesis that narrow diameter implant installed in healed ridges provide satisfactory esthetic results (24). Mattos CF, et al., in their study authors prove that for patients with insufficient bone volume, extra-narrow-diameter implants (2.8 mm) can offer satisfactory masticatory function and aesthetics: The paper details a case in which the maxillary anterior area received two implants, which allowed achieving satisfactory functional and esthetic results. The studies indicate that these implants are an effective solution in cases when standard diameter implants cannot be placed because of inadequate bone mass. Further, the literature reveals that the success rate of narrow- diameter implants is as effective as standard implants and there is minimal marginal bone loss observed (25).

This study aimed at evaluating the outcome and the prediction of immediately loaded screw-retained implant-supported restorations placed in the fully edentulous lower arch utilizing miniature, low-profile OT Equator abutments. Based on the results, the prosthesis survival rate equaled 100% as there was no implant failure within one year, and the implant survival rate was 95.0%. Furthermore, the marginal bone loss was small at 0.27 ± 0.14 mm over the same period, and statistical analysis confirmed that this was significant ($p = 0.0001$). Patient satisfaction increased significantly, as evidenced by the OHIP score dropping from 87.7 ± 6.0 prior to therapy to 23.6 ± 1.2 after a year (26).

According to the study, moderate atrophic edentulous moments can be treated with NDI (3.3 mm) without the need for substantial bone grafting and within three years of follow-up, the results are positive. The All-on-Four treatment planning method that uses four implant in each arch fitted the patient well and positively impacted her social life and overall health. Additionally, a small amount of bone loss was seen surrounding the implants, indicating that the implants had good long-term stability and osseointegration(27).

Lin IP, et al., in their study, which has been discussed above, the authors also mentioned that rehabilitating a broad edentulous posterior site (12–14 mm) with two small diameter implants is a feasible treatment option, particularly for patients with systemic diseases or ridge atrophy, as it eliminates the need for a lengthy bone graft procedure and improves plaque control due to improved prosthesis emergence profiles. The findings showed that the marginal bone around all the 12 implants remained stable and no more than 1 mm of resorption was noted during the follow-up time of up to 4 years. Furthermore, it was noted that the average buccal and lingual bone thickness were sufficient for implant placement which were 1.15mm and 1.86mm respectively hence confirming the implant integration (28).

Thus, the aim of this systematic review was to assess outcomes of NDI placed in fully edentulous patient regarding implant success rate and possible issues. Nine articles were chosen from the initial 2035 retrieved articles in accordance with the systematic review's inclusion criteria. The results obtained show high overall implant survival rate of the narrow- diameter implants varying between 94.6 and 100%.

The review highlighted several key points:

- High Survival Rates: Narrow-diameter implants have shown to have very high survival rates, with most studies citing rates greater than 90% over the mean time of 1 to 5 years.
- Minimal Marginal Bone Loss: The reviews' featured research made it abundantly evident that narrower implants were the cause of the minimal bone loss that was seen; some of the studies even demonstrated that the mean bone loss over long-term follow-up was less than one millimeter.
- Patient Satisfaction: Patient satisfaction was excellent, and many patients who received narrow diameter implants reported an improvement in their quality of life in relation to their oral health.
- Clinical Viability: Narrow implants were deemed suitable in several clinical situations such as in the presence of ridge atrophy, medically compromised patients, and ideal for restoration of function and form.
- Fewer Complications: Because narrow-diameter implants are less intrusive and cause less damage to soft tissue and bone than normal implants, their adoption in treatment plans was associated with fewer problems.

A comprehensive evaluation and meta-analysis of comparative studies shows that "narrow- diameter implants" are a practical option for replacing missing teeth in the edentulous patient group. This review contributes to the ongoing discourse on best practices in dental implantology, emphasizing the potential benefits and limitations of narrow implants in clinical settings.

Table 1: Study characteristics

uthor, ear	tudy esign	ampl e ize	easurements sed	catio n	Population characteris tic	llo w-p eriod	indings	ualit y
Woo, 2016 (20)	P etrospectiv e linical study e	66	-ray, eriotest	Korea	Sixty-six ndividuals had a total of 98 narrow implants nserted. The atients' ages anged from 19 to 76 years (37 men and 29 women)	–4 ears	All the examined variables had no significant changes in bone loss. he increase in one loss after functional loading was .14 ± 0.39 m. Periotest one stability as −3.29 ± .50 after 4 ears.	out f 8 - igh
skan, 2020 21)	A Retrospecti ve Clinical Study	42	-ray, Soft Tissue ealth	Turkey	In this study, 171 implants, ncluding both normal diameter implant and narrow diameter mplant (NDI), ere provided to 42 consecutive patients. In ine with the Straumann® Pro Arch oncept, all 24 maxillae and 19 mandibles ere restored sing a fixed-full arch prosthesis.	55 month s	The survival rate was onitored for a total of 55 months. Four mplants were ost as a result, three in the maxilla and one in the andible, for a 97.7% overall mplant survival rate. he findings of the investigation ndicated that lted and axial implants did ot significantly differ in terms of implant survival. 98.9% of patients had	out f 8 - igh

							ealthy soft ssues at 24 onths, and e average terproximal arginal bone ss was 0.15 m. Finally, e designed rosthesis had a 100% survival rate.	
ifsud , 021 (22)	andomize d Controlled Trial	15	linical ssessment	United tates of meric a	Out of all the patients 15 ere placed in the STL nplant group. or the rest of he patients, a delayed loading rocedure was employed..	12 month s	Between baseline and three months and between baseline and welve months following surgery, atients' overall satisfaction increased significantly (F2,44 = 81.006, P <.001).	out f 8 - igh
Fatih Mehmet, 2021 (23)	rospective	28	-ray, Clinical ssessment	urkey	The study involved 28 patients with an average age of 52, of which 37 jaws were rebuilt using fixed full- arch prosthesis supported by 179 implants. he frequency of comorbidities , cumulative survival rate (CSR), implant success, marginal bone loss (MBL), and that of the	years	oncerning the two year follow-up the easured CSR or the narrow mplants was 98.5% while the CSR estimated on l the implants was 99.4%. The ean between he eyes (MBL) easuring from the National DN level was 0.63 mm at one year of follow-up and 02 mm at vo years. The ap was	out f 9 - igh

					prosthesis component were also assessed.		.51 mm mandible 0.63 mm/maxilla 41 mm) at he year and .73 mm mandible 0.90 mm/maxilla 43 mm) at wo years. There was no statistical difference in the MBL between the oading process or the implant angulation..	
ing , 2022 24)	rospective	06	CBCT, Periapical Radiographs	Taiwan	After up to 4 years follow p, the crestal one status of twelve implants placed in six edentulous sites was evaluated using CBCT nd periapical radiographs.	years	ence, it made ense to place wo implants of the narrow or standard iameter in the posterior area of a single dentulous site s wide as 12–14 mm. hey are most suitable for patients with idge atrophy zones and/or systemic disorders.	out f 8 - igh
wathi, 023 (25)	rospective tudy	10	-ray, Clinical & Radiographic Analysis	India	Ten patients ith previously edentulous single maxillary nterior region	6 month s	The final estoration was done after hree months. The radiographic and clinical indings were assessed. lean marginal bone loss: -0.55 mm; No	out f 8 - igh

							significant papilla recession	
ahchouch e, 2023 (26)	rospective	102	X-ray, sseointegrati on	Algeria	This prospective and comparative study was onducted on 102 implant ites between December 2016 and larch 2021. It vas split into two groups: Immediate nplantation in both jaws including all extants were 48 cases and delayed implantation were 54 cases.	4 month s	did not obtain ny rejection in the 2 techniques. or immediate implantation: osseointegrati on (OI) was obtained especially at 4 months for most of the implants.	out f 8 - igh
larco, 023 (27)	etrospectiv e study etrospectiv e study	12	-ray, OHIP Score	Italy	A total of xty implants were given to twelve people. Patient follow-up lasted an average of 5.8 months, ith a range f 12 to 24 months. Each patient received an T Equator as a transitional abutment. Out of the 60 implants 4 were only fixated to the prosthetic structure	year	Two patients had a 95.0% implant survival rate, and three mplants failed a year after loading. There were very few echnical and biological ssues, and no prosthesis malfunctioned during the experiment. One year following the first loading, the marginal one level was 0.32 ± 2 mm. The HIP was 7.7 ± 6.0	out f 8 - igh

					using Seeger ystem without using screws.		before to herapy. At one year after therapy, the OHIP was 3.6 ± 1.2. Plaque was observed in 5% f implant sites, while BOP was positive in 8% of the overall implant sites after implant oading for one year.. The observed statistically significant difference was 64.1 ± 7.2; p = 0.0000.	
li-Ho Ahn, 2024 (28)	prospective , single-center, randomized controlled experiment that is single-blinded	21	-ray, Soft Tissue ealth	orea	ncluded seven f the twenty-one patients who were split up into the following groups:"cont rol (BLT NC SLActive®; Straumann), xperi- control roup (CMI IS-III Active® S-Narrow; Neobiotech), and the experimental group (CMI IS-III Active® Narrow; Neobiotech). In the full digital flow, two fixtures were inserted into each patient and provisioned	year	Excluding patients with low stability values n = 2, aulty fixtures n = 5 and dropout n = 1 the successful mplants within the patients ompleting the clinical rocedures was 100%. n the basis of overall mean and standard deviations for the control group, xperimental 1, and xperimental 2 patient failure rate were recorded 50.0%, 42.9%, and	out f 8 - igh

					h the surgical ay".		14.3%, respectively. Soft tissue, patient satisfaction, esthetic and marginal bone oss were not significantly different between the groups.	

- $F(2,44) = 81.006$, $p < 0.001$: This represents an ANOVA test result, indicating a statistically significant effect on patient satisfaction across three different time points.

DISCUSSION

The research articles included in this systematic review have pointed to the usefulness of NDIs in the treatment of edentulous patients particularly those with anatomical constraints, low bone volume. The survival rates observed in this review, which range from 94.6% to 100% as observed in many studies here, align with the findings who, in their meta-analysis, reported similar success rates (28). These findings establish NDI as a viable option to be adopted as with the standard diameter implant (SDIs) when effective solutions for patients exist with compromised bone anatomy.

Mifsud 2021, presented a high level of patient satisfaction with immediate loading protocols for NDIs, which reinforces the evidence that NDIs can be used to enhance clinical outcomes without affecting patient comfort. This also agrees with the general literature on the need for a patient-centered approach in implant dentistry. For example, immediate loading minimizes treatment time, which may contribute to an improved overall experience and quality of life for the patients.

Woo (2016) and Eskan (2020) reported the evidence of minimum MBLs associated with NDIs: 0.14 mm and 0.15 mm, respectively. These results correspond to the conclusion of researcher, who underlined that NDIs preserve the peri-implant bone and soft tissue (29). This is a very important feature in those cases where the procedure of bone augmentation is not possible. The mechanical stability of NDIs, also pointed out by works of Swathi (2023) and Fatih Mehmet (2021) provides evidence of their versatility for different clinical situations, like immediate loading and atrophic ridge conditions. This amount of versatility further cements the findings of (30), who recommended the use of NDIs in anatomically demanding situations.

Other essential areas of focus were the patient-reported outcomes. Marko, in 2023, reported significant improvements in the quality of life measured (OHIP) as supported (31, 32). Together, these studies suggest the contribution of NDIs in improving oral function and aesthetic satisfaction, which results in the overall satisfaction of the patient. Generally, high satisfaction is associated with improved compliance with treatment and long-term success. Patient feedback is, therefore, a very significant component of the assessment of implant outcomes.

Despite these encouraging results, the reviewed studies also underlined some of the limitations of NDIs. In this respect, Ji-Ho Ahn (2024) and Mahchouche (2023) have indicated that although NDIs can achieve the same success rate as SDIs, their mechanical properties may pose a risk of complications in conditions of excessive loading. The findings revealed the importance of strict indications for patient selection and planning, as highlighted
(30). For example, if a patient has a history of parafunction, higher occlusal forces will interfere with the long-term survival of the NDIs and thereby require the prescription of an occlusal guard or some other alternative.

In addition, the studies of Ping (2022) and Marko (2023) represented well-rounded prosthetic planning where the load was well- distributed. The findings make clinicians aware of incorporating biomechanical assessments in

the treatment processes. Digital advances in CAD/CAM technologies have huge potential to further enhance the precision and success rate in NDI placements.

Limitations

The systematic review identified some limitations that could affect the generalization of its findings:

1. Heterogeneity in Study Design:

From randomized controlled trials to retrospective analyses, the methodologies used by included studies are quite different from one another, which can result in biases and problems regarding comparability.

2. Short Follow-up Periods:

All the studies had follow-up periods of more or less five years only, and this hinders being able to assess long-term efficacy and complications.

3. Heterogeneity of the Patient Population:

There would be variability in age, health status, and anatomic conditions of patients, influencing outcomes and generalization to larger populations.

4. Limited Scope of Literature:

The review excluded relevant data from non-English publications by focusing on studies published in English, hence not being comprehensive.

5. Technological Variability:

The implant design differences, surface treatments, and different surgical techniques in each study may affect the reproduction of the results in varied clinical settings.

CONCLUSION

NDIs showed a high survival rate with very few complications and significant patient satisfaction, hence presenting a viable alternative to traditional implants. However, clinicians should make judicious assessment of various factors related to the patient and procedural protocols for the optimization of results. Comprehensive treatment planning with biomechanical evaluations, as well as the integration of digital technologies, will provide additional predictability and longevity in the treatments of NDI.

Long-term, multicenter, randomized controlled trials with uniform methodologies, along with research on NDI placement integrating advanced digital tools and patient-specific customization, as well as studies involving large populations and various implant systems, are essential to overcome the limitations of existing literature and expand knowledge on the potential and limitations of NDIs in contemporary dental practice.

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