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Review Article

A comparative evaluation of the clinical outcomes of one-piece versus two-piece dental implants: A systematic review

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Abstract

Introduction: One-piece dental implants integrate the implant and abutment into a single unit, offering simplicity and reduced surgical steps. Two-piece implants, with separate components, provide versatility in prosthetic design and enable more precise adjustments during restoration.[1] The question was whether there is a difference in the clinical outcomes of one-piece and two-piece dental implants? Thus, the purpose of this systematic review was to compare the clinical outcomes of one-piece versus two-piece dental implant systems.

Materials and Methods: This study followed the "Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 and was registered at PROSPERO under registration code CRD42024510898. The PICO question was, "Do patients who received one-piece dental implants have similar clinical outcomes as the ones who received two-piece dental implants?"

Results: Electronic search of PubMed (including MEDLINE), Cochrane, Science Direct search engines and manual search revealed final 7 articles to be included in the systematic review. From all the studies a total of 282 patients were evaluated. The outcome measures included were marginal bone level changes, periodontal health, presence of pathogenic microbiota, extent of osseointegration, survival rate, esthetics, biological and technical complications and peri-implant diseases. Discussion: Dental implants restore function and esthetics, with one-piece and two-piece systems showing comparable survival rates and clinical outcomes. Studies suggest minor differences in bone loss, with one-piece implants potentially reducing microgap-related issues but facing technical complications. Proper planning, patient factors, and advanced techniques like computer-assisted surgery are crucial for long-term success.

Conclusion: No significant difference was found between the two systems in terms of clinical outcomes.

Keywords: One-piece dental implants, Two-piece dental implants, Clinical outcomes

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1. Introduction

Dental implants are a reliable solution for replacing missing teeth, providing both functional and esthetic rehabilitation. Their long-term success is primarily dependent on osseointegration, a concept first introduced by Brånemark in 1952. He described it as a direct connection between bone and the implant without any intervening soft tissue, later redefining it in 1969 as a direct structural and functional connection between ordered living bone and the surface of a load-carrying implant.[1,2]

Several factors influence osseointegration, including systemic health, bone quality, implant material, surface treatment, and loading protocols—whether immediate, conventional or delayed.[3] Implant stability plays a critical role in determining the success of osseointegration and is classified into:

1. Primary stability, which refers to the mechanical engagement of the implant with the cortical bone and is influenced by bone quality, surgical technique, and implant design.
2. Secondary stability, which is achieved through bone remodeling at the bone–implant interface.[4]

Stability can be assessed using both invasive and non-invasive methods. Invasive methods include torque tests, reverse torque, and seating torque, whereas non-invasive

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techniques include radiographic analysis, resonance frequency analysis (RFA), Periotest, and percussion tests.[5] Marginal bone levels, which are crucial for assessing peri-implant health, are commonly monitored using radiographic techniques such as RVG, IOPA, and CBCT.[6]

The emergence profile, which is the transmucosal zone extending from the implant shoulder to the mucosal margin, significantly impacts esthetics. Important contributing factors include the presence of papillae, the height of the mucosal margin, and peri-implant soft tissue changes.[7,8]

Peri-implant diseases are commonly categorized into:

1. **Peri-implant mucositis:** A reversible inflammatory condition of the soft tissues without bone loss.
2. **Peri-implantitis:** A condition marked by progressive bone loss around the implant, which often requires intervention.[9]

Dental implants are broadly classified into two-piece and one-piece systems. Two-piece implants consist of separate endosseous and transmucosal components, which can be connected either during the initial surgery or at a later stage. These implants offer flexibility, allowing for either submerged or transmucosal healing, based on the clinical scenario.[10–12]

One-piece implants, on the other hand, incorporate the abutment as an integral extension of the implant body. These were introduced to offer a mechanically robust design that allows for both minimally invasive and conventional prosthetic approaches, particularly in single-tooth replacements.[13] The unibody construction eliminates the microgap typically seen in two-piece implants, potentially reducing bacterial colonization and marginal bone loss. One-piece implants offer several advantages, such as a strong, unified structure, simplified surgical procedures (flap or flapless), and easier prosthetic workflows. Additionally, the implant–prosthetic interface is located farther from the bone, which may be beneficial in certain clinical situations. They can be placed immediately in fresh extraction sockets or after healing, and are suitable for immediate loading when high primary stability is achieved.[14–15]

These implants have demonstrated predictable outcomes, with reduced bone loss and less peri-implant inflammation. However, a notable limitation is the esthetic compromise due to the possible visibility of the polished supracrestal component through the peri-implant mucosa, particularly when placed in esthetic zones.[16]

There are few clinical studies which compare these two implant systems. Therefore, the purpose of this systematic review was to compare the clinical outcome of the one-piece versus two-piece implant systems.

2. Materials and Methods

A comprehensive systematic review was carried out. This study followed the "Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 (PRISMA 2020), the Cochrane Handbook for Systematic Reviews of Interventions, version 5.1.0, and 4th Edition of the JBI Reviewer's Manual" and was registered at PROSPERO under registration code CRD42024510898.

2.1. Population, intervention, comparison, and outcome

1. **Population:** Studies including participants with partially or completely edentulous maxillary or mandibular arches
2. **Intervention:** Dental implants placed using one-piece system
3. **Comparison:** Dental implants placed using two-piece system
4. **Outcome:** Change in the clinical outcomes of implant in terms of implant stability, marginal bone loss, esthetics and peri-implant diseases after one-piece and two-piece implant placement

2.2. Inclusion criteria

In vivo, human studies including randomized controlled trials and clinical trials, prospective and retrospective clinical studies, case series with more than 5 cases, studies with full text articles were included. Studies published in only English language and from 2005 to 2024 were included.

2.3. Exclusion criteria

In vitro studies, animal studies, literature reviews, case reports, studies in which participants were given removable prosthesis and studies that provided only abstracts were excluded.

2.4. Search strategy

Studies were chosen in accordance with the review protocol's PICOS criteria. To find studies that might be eligible, two reviewers assessed the titles and abstracts. A third reviewer was approached for any questions.

The clinical outcomes were measured in terms of implant stability, marginal bone loss, esthetics and peri-implant diseases in the intervention and control groups. The PRISMA for conducting the systematic review was followed.

PubMed/ Medline, ScienceDirect, Cochrane databases were searched for the articles. Searches were conducted on all articles upto 2024 in English language. The following MeSH terms along with Boolean operators were entered in the advanced search of the databases.

A concept table was prepared based on the PICOS criteria of the review question and the search strategy was formulated according to it. **(Table 1)**

2.5. PubMed search strategy

((((((One-piece dental implants) AND (two-piece dental implants)) AND (clinical outcomes)) OR (bone loss)) OR (implant stability)) OR (esthetic outcome)) OR (periimplant diseases)

2.6. Cochrane and science direct search strategy

1. One-piece dental implants
2. Two-piece dental implants
3. Clinical outcome

The above-mentioned was the final search history for the databases accessed till May 2024.

2.7. Selection of studies

Each study's title and abstract were examined and evaluated critically by two separate reviewers. The methods used to apply the selection criteria included integrating the search results to eliminate duplicate entries, looking at titles and abstracts to eliminate articles that were obviously irrelevant, retrieving the full texts of articles that might be relevant, grouping and binding multiple articles from the same study, looking at the full texts of the articles to determine how closely the studies complied with the eligibility criteria, and establishing connections with other studies.

2.8. Data extraction

Data were independently gathered by two reviewers from the 7 included studies after focusing on the articles from all the databases. Disagreements were settled through conversation and a third reviewer resolved any differences through discussion.

Data was recorded and analysed in respective excel data extraction sheets.

The data extracted was entered under the following headers:

1. Study ID
2. Author and year of publication
3. Study design
4. Number of patients
5. Age of patients
6. Implant site
7. Total no. of implants
8. Patients with one-piece implants.
9. Patients with two-piece implants
10. Follow up duration [range]
11. Clinical outcomes

3. Results

3.1. Study selection

Electronic search of PubMed (including MEDLINE), Cochrane, Science Direct search engines for articles published from 01/01/2005 to 31/05/2024 revealed 2207 titles. Out of the 2207 articles obtained via electronic search, 243 articles were obtained from the PubMed database, 9 articles from Cochrane Central database and 1955 articles from the science direct search engine respectively. 2 articles were obtained through manual search of hard copies of the journals available in the institute library, making a total of 2209 articles. Total 1648 articles were left after elimination of duplicates using the Mendeley Desktop software and were subsequently taken into further consideration for the data selection process.

Two calibrated reviewers independently screened the relevant titles of the studies found through the electronic & manual search after elimination of duplicates. 1613 articles were excluded after screening of the title. The articles thus eliminated were literature reviews, pilot study, case series including less than 5 patients, scoping reviews, articles with irrelevant title. Both reviewers agreed on elimination of these articles since they contained data that was irrelevant to this systematic review. Thus, total 35 articles were obtained after title screening. Total of 15 articles were further excluded after abstract screening. Out of the 20 articles, only 7 articles met the inclusion criteria and were thus included in this systematic review. **(Figure 1)**

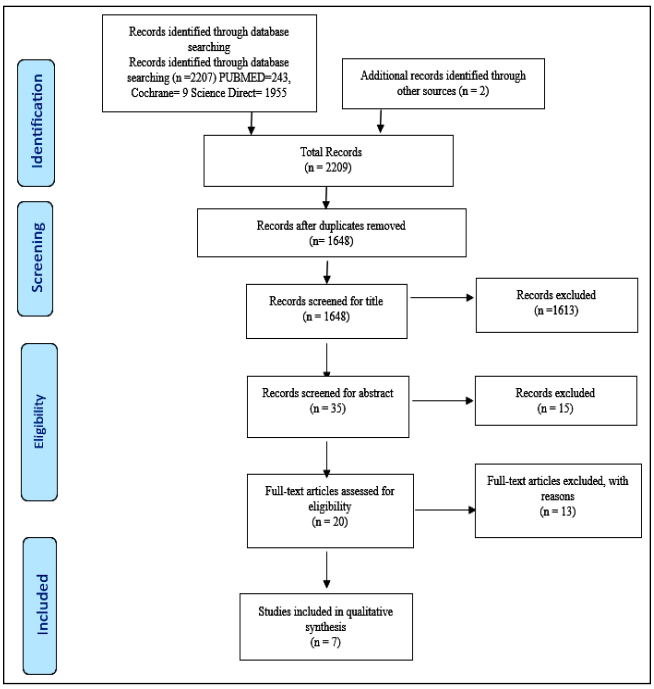

Figure 1: The preferred reporting items for systematic reviews and meta analyses flowchart

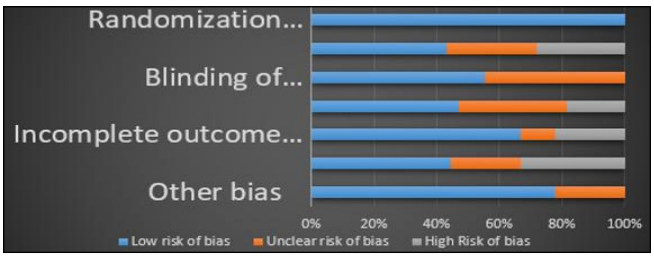

Figure 2: Summary plot for risk of bias

Table 1: Concept table

PICO	Population	Intervention	Comparison	Outcome
1	Edentulous maxillary or mandibular dental arches Completely edentulous maxillary or mandibular dental arches	One-piece implants One-piece abutments	Two-piece implants Conventional implants Submerged dental implants	Clinical outcome Implant stability Marginal bone loss Esthetics Peri-implant diseases

Table 2: Characteristics of the included studies

Study ID	Title	Intervention	Comparison	Study design	Outcome parameter assessed	Results	Conclusion
Kees Heijdenrijk, 2006[16]	Feasibility and Influence of the Microgap of Two Implants Placed in a Non-Submerged Procedure: A Five-Year Follow-Up Clinical Trial	*1P dental implants	†2P implants placed in the traditionally submerged procedure 2P implants placed in a non-submerged single-stage procedure	Prospective clinical trial	Periodontal health: ‡GS, §PS, calculus, ‖BS, PPD, mobility Radiographic: **CBL Microbiological: The presence and proportions of A.actinomycetemcomitans, P. gingivalis, P. intermedia, T. forsythensis, M. micros, F.nucleatum, and C. rectus	Significant difference in PS, GS and calculus score at T24 No significant difference at T36, T48, T60 No significant difference in mobility and CBS No association between presence of target microorganisms and clinical or radiographic parameters	The outcomes of 2P implants placed in submerged or non-submerged manner and 1P implants are similarly predictable with no effect of microgap on the amount of peri-implant bone loss
Daniel S. Thoma et al, 2013[7]	Prospective randomized controlled clinical study comparing two dental implant systems: demographic and radiographic results at one year of loading	Placement of 1P dental implant (BRA group)	Placement of 2P dental implant (STM group)	Prospective randomized controlled clinical study	Clinical assessment: Plaque control record, PPD, attachment level (mm) and ††BOP Radiographic assessment: CBL and osseointegration	Survival rate: 100% in BRA group and 98.5% in STM group Marginal bone level changes: Implant level analysis: 0.05 mm (±SD 0.32 mm) for BRA group and -0.27 mm (±0.52 mm) Patient level analysis: -0.06 mm (SD± 0.37 mm) for the BRA group and -0.25 mm (±0.35 mm) for the STM group.	Both systems demonstrated high survival rates within 1 year of loading. BRA group (1P dental implants) exhibited slightly less bone loss at both implant and patient level
Mariusz Duda et al. ,2015	One Piece Immediately Loaded Implants Versus 1 Piece or 2 Pieces Delayed: 3 Years Outcome	Placement of immediately loaded 1P implants	Placement of delayed loaded 1P and 2P implants	Retrospective study	Radiographic assessment: CBL, Implant survival rate	Statistically significant mean CBL between baseline, 6 months, 1 year, and 3 years in all groups. Less CBL in 2P than 1P. No statistically significant difference in CBL in immediate and delayed loaded 1P implants Survival rate: At one year, 85.7%(Group A), 91%(Group B), 100%(Group C)	2P implants showed less CBL compared with 1P implants in both maxilla and mandible. There was no statistical difference in CBL between immediate and delayed loaded 1P implants.

Study ID	Title	Intervention	Comparison	Study design	Outcome parameter assessed	Results	Conclusion
Ignacio Sanz-Martín et al., 2017	Randomized controlled clinical trial comparing two dental implants with different neck configurations	Placement of 1P implants with machined collar (TG group)	Placement of 2P implants with platform-switching connection (SP group)	Randomized controlled clinical trial	Clinical assessment: PPD, amount of keratinized tissue, ‡‡PI and mobility Esthetic assessment: §§PES Radiographic assessment: CBL Patient reported outcomes measures: Comfort, appearance, masticatory function, taste, and overall satisfaction. Adverse events: Implant related (biologic and mechanical complications) and non- implant related (death or life-threatening condition)	Survival rate: 100% in the TG group and 96.4% in the SP group CBL at 12 months: TG group 20.27 mm (SD 0.24 mm) and SP group 20.12 mm (SD 0.19 mm) No statistically significant difference between groups in terms of PPD, amount of keratinized tissue, PI, PES and soft tissue margin PROMs showed high degree of satisfaction with both groups	Both groups showed similar results at 12 months after loading. TG group showed lesser bone level changes before loading.
Felix B. Gamper et al., 2017,[17]	Randomized controlled clinical trial comparing one-piece and two-piece dental implants supporting fixed and removable dental prostheses: 4- to 6-year observations	Placement of 1P implants (S1)	Placement of 2P implants (S2)	Randomized controlled clinical trial	Biological outcomes: Full-mouth periodontal status including PPD, ||||CAL, PCR and BOP Radiographic assessment: CBL Technical outcomes: Fracture of implant, prosthetic screw, abutment or loosening of the components Esthetic outcomes: visibility of the crown margin, shimmering of the implant, the level of the peri-implant margo mucosae and modified papilla index	Survival rate: 96.9% S1 and 98.9% S2 Marginal bone level changes S2 > S1 Peri-implant disease : S1 7% and S2 8.1% Technical complications: S1 34.6% and S2 19.2%	Both systems show high survival rate. Marginal bone level changes are more in 2P than 1P. No significant differences in other parameters

Study ID	Title	Intervention	Comparison	Study design	Outcome parameter assessed	Results	Conclusion
João Pedro Justino de Oliveira Limírio et al., 2019[10]	A clinical comparison of 1P versus 2P implants: A systematic review and meta-analysis	Rehabilitation with 1P implants	Rehabilitation with 2P implants	Systematic review and meta-analysis	CBL Implant survival rates Prosthetic complications	Implant survival rate was 99.6% for 1P implants and 99.3% for 2P implants There is no statistically significant difference between the evaluated parameter in both the groups	No significant difference was found between 1P and 2P implants in terms of MBL, survival rate or prosthetic complications
Łukasz Zadrozny et al., 2023	Minimally Invasive Treatment of Lateral Incisors with Guided One-Piece or Two-Piece Titanium-Made Narrow Diameter Implants: A Retrospective Comparative Study with Up to Two Years Follow-Up	Placement of 1P narrow diameter titanium implants	Placement of 2P narrow diameter titanium implants	Randomized controlled clinical trial	Implant and prosthetic failures or complications Peri-implant bone level changes PES	No failures or complications CBL: Group 1 0.23 ± 0.11 and Group 2 0.18 ± 0.12 PES: Group 1 12.6 ± 0.97 and Group 2 12.2 ± 0.92	Both 1P and 2P narrow diameter implants show comparable clinical outcomes at 2-year follow-up

*1P: one-piece, †2P: two-piece, ‡GS: Gingival score, §PS: Plaque score, ||BS: Bleeding score, ¶PPD: Peridontal Probing Depth, **CBL: Crestal Bone Loss, ††BOP: Bleeding on Probing, ‡‡PI: Plaque Index, §§PES: Pink Esthetic Score, ||||CAL: Clinical Attachment Loss

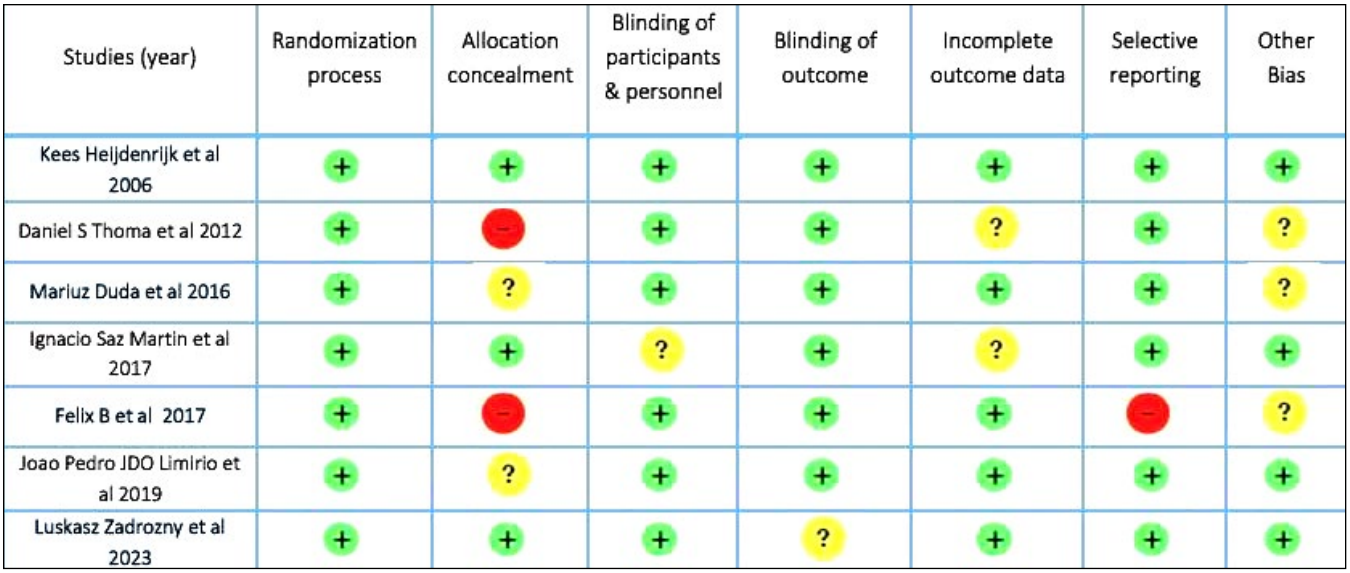

Figure 3: Traffic light plot for risk of bias+/green color: low risk of bias?/yellow color: some concerns−/red color: high risk of bias

3.2. Study characteristics

This systematic review included 7 studies. **(Table 2)** depicts the characteristics of all the included studies. Amongst the included studies 2 were conducted in Spain, 2 in Switzerland, 1 in Israel, 1 in Brazil and 1 in Neatherlands. From all the studies a total of 282 patients were evaluated. The outcome measures included were marginal bone level changes, periodontal health, presence of pathogenic microbiota, extent of osseointegration, survival rate, esthetics, biological and technical complications and peri-implant diseases and the results obtained were as follows:

1. One-piece implants generally showed less bone loss, especially in the short term. Long-term differences were not significant.
2. Minor early differences in periodontal health were observed whereas no significant long-term variation was noted. Plaque and bleeding scores were high in both systems.
3. Target pathogenic oraganisms were detected but not linked to clinical complications.
4. Successful osseointegration was seen in both systems; not significantly affected by the presence of a microgap.
5. Both systems showed a high survival rate; One-piece: up to 100% and Two-piece: 97.5–100%.
6. Both systems showed comparable esthetic results. One-piece was preferred in minimally invasive cases. It was suggested that guided placement enhances outcomes.
7. Biological complications were slightly fewer in one-piece implants but poor hygiene contributed to complications in both systems.
8. Technical complications (e.g., screw loosening) were more common in two-piece implants. One-piece implants showed ceramic fractures in some cases.
9. No major differences were noted in peri-implant diseases. It was mainly dependent on hygiene.

3.3. Risk of bias

This assessment was conducted by using the recommended approach for assessing risk of bias using Cochrane ROB2. The tool is particularly useful to those undertaking systematic reviews that include randomized studies using the tool RevMan 5.4.1

We used the two-part tool to address the seven specific domains.

1. Bias due to randomisation
2. Bias in allocation concealment
3. Bias in blinding of participants & personnel
4. Bias in blinding of outcome
5. Bias due to missing data/incomplete data
6. Bias in selective reporting
7. Other bias

There was a good reliability between the two reviewers with a high kappa coefficient (k>0.89).

Out of the 7 articles, 3 showed low risk of bias, 2 showed moderate risk of bias and 2 showed high risk of bias.

The risk of bias has been summarized in the traffic light plot **(Figure 3)** and the summary plot **(Figure 2)**.

4. Discussion

Dental implants are essential for restoring the function and esthetics of missing teeth, offering several advantages over traditional dentures and fixed prosthesis. They provide a stable and durable foundation for prosthetic teeth by improving mastication and speech. By mimicking natural tooth roots, implants help preserve bone density and prevent the resorption that typically occurs after tooth loss. This preservation of bone structure maintains facial contours and prevents the sunken appearance often associated with missing teeth.

Its success primarily depends on the level of osseointegration which is the process by which the bone tissue integrates with the implant surface, providing a stable

and durable foundation for the dental restoration. It is critical for the long-term success and stability of the dental implants. Thus various implant designs and modifications have been suggested to improve the outcomes.

One-piece and two-piece dental implants have distinct characteristics and applications. One-piece implants, designed to address the structural weaknesses of two-piece systems, use titanium grade V for enhanced mechanical properties, especially in narrow diameter designs. They offer minimally invasive treatment options, often preferred by patients and eliminate the microgap at the implant-abutment interface, potentially reducing marginal bone loss (MBL). Two-piece implants, however, provide flexibility in prosthetic planning, allowing for screw-retained restorations which can be advantageous in managing complications. Despite these differences, studies indicate no significant disparity in MBL, implant survival rates or prosthetic complications between the two types. Both systems have demonstrated high survival rates and acceptable complication rates, with proper implant positioning and planning being crucial for long-term success. Advanced techniques like computer-assisted, template-based surgery enhance accuracy and esthetic outcomes.

The purpose of this systematic review was to determine if the use of one-piece and two-piece implant systems affect the clinical outcomes after long duration. The studies included in this review compare the clinical outcomes of these two implant systems.

One of the key parameters evaluated across multiple studies is marginal bone level (MBL) change, as it directly reflects peri-implant tissue stability. Several studies[17–19], including those by Thoma et al.[20] and Gamper et al.[21] consistently reported lower marginal bone loss in one-piece implants, particularly in the early post-placement period. This has been attributed to the absence of a microgap and the reduced abutment manipulation, which likely minimize early crestal bone remodeling.[22–25] However, Duda et al[26] observed higher bone loss in one-piece implants at the 1-year follow-up, suggesting that immediate placement and loading may influence early bone dynamics. The systematic review by de Oliveira Limírio et al.[10] concluded that the long-term differences in MBL between one-piece and two-piece systems were not statistically significant, indicating that multiple factors such as surgical protocol, loading strategy, and oral hygiene contribute to bone preservation.

Regarding periodontal health, findings were largely comparable between the two systems. The study by Heijdenrijk et al.[16] noted minor differences in periodontal parameters in the initial years, which were no longer evident at 3 years, indicating that patient oral hygiene and maintenance play a more critical role than implant design. Similarly, Sanz-Martín et al.[15] and Gamper et al.[21] reported high plaque and bleeding scores across both groups despite instructions, emphasizing the need for long-term supportive periodontal care in implant patients.

The presence of pathogenic microbiota was assessed in the study by Heijdenrijk et al.[16] which detected target organisms around both implant types. However, these microbial findings did not correlate with clinical symptoms, suggesting that microbial colonization alone may not be a sufficient predictor of peri-implant disease in the absence of additional risk factors.

Successful osseointegration was achieved in both implant systems across all reviewed studies. Although earlier theories suggested that the microgap in two-piece implants could hinder bone-implant integration[27,28,29] current evidence, including that from Sanz-Martín et al.[15] and Gamper et al.[21] Indicates that osseointegration is more influenced by surgical technique, loading protocol, and host response than by implant configuration alone.

Implant survival rates were high in both systems, ranging from 85.7% to 100%. Heijdenrijk et al.[16] reported a 100% success rate for one-piece and 97.5% for two-piece implants over a 5-year period. Despite slightly lower survival rates for immediately loaded one-piece implants in a study by Duda et al.[26] and others[30,31] differences were not statistically significant over time, reinforcing that with proper case selection and protocol adherence, both systems yield predictable results.. This is contradictory to the studies conducted by Hahn et al. and Buchs et al.[32,33] possibly because they placed implants in healed extraction sockets as against the immediately placed implants in this study.

In terms of esthetic outcomes, both systems provided satisfactory results.[28,29] One-piece implants are often favoured in cases requiring minimally invasive treatment and where bone augmentation is to be avoided. The study by Zadrozny et al.[34] emphasized the importance of proper implant positioning and the role of computer-assisted template-based surgery in enhancing esthetic predictability.

When evaluating biological complications, several studies, including Gamper et al.[21] found fewer biological issues in one-piece systems, potentially due to reduced manipulation of the peri-implant soft tissue and absence of a microgap. Nonetheless, Sanz-Martín et al.[15] noted high incidence of peri-implant inflammation in both groups, which may be attributed more to hygiene neglect than implant design. Hence, biological complications remain closely tied to maintenance protocols rather than structural differences.

Conversely, technical complications such as screw loosening and prosthetic component issues were more frequent in two-piece implants, as seen in the studies by Sanz-Martín et al.[15] and Gamper et al.[21] One-piece implants, while eliminating the abutment interface, were occasionally associated with ceramic fractures, possibly due to their integrated design and limited prosthetic flexibility.

While no study reported definitive cases of peri-implantitis, several highlighted the presence of mucositis indicators such as increased plaque and bleeding scores. These findings suggest that peri-implant disease susceptibility is more closely associated with patient factors and hygiene than with the implant type itself.

The limitation of this systematic review was that the difference in the implant designs and systems used in the various clinical studies under consideration might lead to a variability in the results. Studies with longer follow-up periods are required for better evaluating the outcomes.

5. Conclusion

Within the limitations of this systematic review, it can be concluded that no significant difference was found between the two systems in terms of clinical outcomes. Both the systems can be used in the replacement of missing teeth for supporting removable or fixed prosthesis with high survival rates and comparable clinical outcomes after loading. Longer follow-up periods would be recommended for further evaluation of the two systems.

6. Source of Funding

None.

7. Conflict of Interest

None.

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