Clinical Decision Making Over One-Stage versus Two-Stage Implant Technique

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Abstract

AIM: This literature review focuses on the success rate, survival rate, soft and hard tissue impact, and complications of one-stage and two-stage implant systems.

METHODS: An electronic database search using selected search terms following PICO rules was conducted between December 2021 and January 2022 through PubMed to identify all up-to-date and relevant articles published in the last 10 years in English. A total of 28 articles met the eligibility criteria, which were collected and reviewed for analysis.

RESULTS: Of the 28 selected articles for review and systematic analysis, 15 were one-stage dental implant studies, and 13 were two-stage implant reports. The success rate of one-stage implants shown in the studies was slightly lower than that of two-stage implants. Contrarily, the survival rate of one-stage implants was higher than that of two-stage implants. Both soft and hard tissue impacts of one-stage implants were worse than those of two-stage implants. Finally, the complications of the two systems varied in nature and hence cannot be compared quantitatively.

CONCLUSION: Two-stage implants should be considered in the aesthetic zone to prevent unwanted gingival and bony resorption. In contrast, the choice of one-stage implant may be more preferable for posterior restoration since oral hygiene can be reinforced before crown cementation.

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1 Introduction

Dental implants have emerged as one of the best choices for aesthetic and functional tooth reconstruction. Implant treatment success is linked to patient condition, implant system, and surgical procedure selection. Osseointegration (i.e., the healing process that fuses dental implants with bone) is a complex process directly related to soft tissue healing and implant stability (Branemark et al., 1977; Terheyden et al., 2012; Ting et al., 2017). Both the one-stage and two-stage approaches are considered routine surgical methods in recent implant treatments (Gheisari et al., 2017).

The advantage of a one-stage surgery is that it reduces the treatment period and provides the patient with earlier aesthetic and functional improvements (Koutouzis et al., 2017). In order to provide patients with a shorter and less invasive treatment that prevents implant loading and prosthesis delivery postponement concurrently, the one-stage surgery involving non-submerged healing has progressively gained popularity (Ferrigno et al., 2002). The implant and the transmucosal abutment are placed within a single procedure, where the abutment is to remain exposed in the oral cavity awaiting loading over the osseointegration period (Giuseppe et al., 2018).

The two-stage approach is typically used where there is no immediate need for cosmetic improvement. In this technique, the fixture is placed below the level of the bone crest and soft tissue, where the flap is subsequently closed after the placement of the cover screw (Engquist et al., 2002). To minimise the risk of fibrin encapsulation and microbiological contamination, submerged healing in the absence of loading was proposed to facilitate the early stages of osseointegration (Albrektsson et al., 1986; Branemark et al., 1977). Such a two-stage approach includes a period of submerged healing to optimise the process of new bone formation and remodeling following implant placement (Branemark et al., 1977), and thus it is considered the gold standard procedure. The second surgical procedure in the two-stage approach is generally a minor one and hence causes limited discomfort for the patient. This also offers the opportunity to conduct soft tissue management around the healed implant, potentially resulting in a better long-term prognosis (Levine et al., 2014).

Implant success is commonly assessed by survival rates, prosthesis stability, radiographic bone loss, and the presence of infection in the peri-implant soft tissues (Albrektsson et al., 1986; Annibali et al., 2009; Buser et al., 1990; Misch et al., 2008; Smith & Zarb, 1989; Zarb & Albrektsson, 1998).

The aim of this literature review is to provide evidence that aids and supports clinicians in making evidence-based and patient-centric decisions when choosing between one-stage and two-stage implant systems in the clinical setting.

2 Methods

The search strategy for this literature review was formulated following the establishment of PICO criteria, which stands for Patient, Intervention, Comparison, and Outcome, to ensure the identification of all pertinent literature. In the context of this work, the PICO components are defined as follows: the population consists of patients with partial edentulous ridges seeking implant restoration; the intervention under examination is one-stage implant restoration; the comparison is with two-stage implant restoration; and the outcomes assessed include success rate, survival rate, soft tissue outcomes, hard tissue outcomes, and complications.

An electronic database search was performed using PubMed to locate current and relevant articles published in English over the past decade that pertain to the aforementioned research questions.

The search terms for the first query, which compared one-stage and two-stage dental implants, included various combinations of related keywords. For instance, the search for terms related to dental or oral yielded a total of 1,541,341 hits. When searching specifically for implants, the number of hits amounted to 560,715. More refined searches, such as those that combined these terms with either "one stage" or "one-stage," yielded 484 hits, while the equivalent searches for "two stage" or "two-stage" returned 608 results. A comprehensive search that combined both restoration approaches resulted in a total of 142 hits. Furthermore, competing interests examined through the lens of complications yielded 27 results, while the search for failure and success produced 55 and 47 hits, respectively.

Subsequent queries regarding submerged versus non-submerged dental implants generated a total of 963 hits when any of the terms "submerged," "non-submerged," or "non submerged" were used alongside the keywords for dental implants. A more specific search considering complications returned 187 hits. Finally, the search focusing on tissue-level versus bone-level dental implants yielded a total of 2,172 hits, with complications resulting in an additional 513 hits.

In the selection process, specific inclusion criteria were established to ensure the relevance and quality of the studies reviewed. Only randomized control trials, original research articles, and clinical studies published within the last decade were considered for inclusion. Furthermore, all articles needed to be authored in English to maintain a consistent linguistic standard across the selected literature.

Conversely, certain exclusion criteria were implemented to filter out less relevant resources. This included the elimination of books, documents, non-human studies, meta-analyses, and systematic reviews, as these types of publications do not align with the objectives of this review. Additionally, any articles published over ten years ago were disregarded to focus on the most current research findings. After conducting a thorough electronic and manual search, 550 articles were initially identified; however, only 60 of those underwent full-text assessment following the application of the set criteria, leading to the exclusion of duplicates and irrelevant studies. Ultimately, 28 articles were selected for analysis in this review based on the defined selection criteria and the availability of pertinent outcomes.

2.1 Statistics

Descriptive statistics, frequency analysis, and content analysis were employed as part of the qualitative methodology to systematically analyze the textual content of the included studies. It is important to note that, given the narrative nature of this study, regression analysis and meta-analysis techniques were not deemed suitable for the analytical framework.

3 Results

Twenty-eight studies involving one-stage or two-stage implant procedures were selected for this literature review. To generate a systematic analysis of the efficacy of the two approaches in their respective clinical applications, the clinical parameters, including success rate, failure rate, periodontal soft tissue outcomes, hard tissue outcomes, and complications of the respective implant placement approaches, were compared. Fifteen out of 28 articles exclusively discussed the one-stage system, while the remaining articles included the two-stage

implant system (supplemental **Table S1**).

The number of patients included in the studies ranged from 18 (Meloni et al., 2020) to 252 (Negri et al., 2014). The age of the analysed patients ranged from 19 (Oliver, 2012) to 82.2 (Zuiderveld et al., 2018). Among the studies, the minimal number of implants placed was 21 (Guarnieri et al., 2015), while the maximum was 632 (Negri et al., 2014). The follow-up periods ranged from a minimum of 4 months (Esposito et al., 2015) to 10 years (Covani et al., 2012). The implant success rate was evaluated in 15 articles, with the lowest being 76% in the study by Cosyn et al. (2011) and the highest being 100% in several studies (Baer et al., 2013; Canullo et al., 2010; Corvino et al., 2020; Esposito et al., 2015; Mangano et al., 2013; Meloni et al., 2020; Naeini et al., 2018; Negri et al., 2014; Oliver, 2012; Tonetti et al., 2017) (**Table S2**). The implant survival rate was evaluated in all articles, with the lowest being 66.7% (Atieh et al., 2013) and the highest being 100% in various reports published by different research groups (**Table S3**).

The periodontal outcomes examined in the studies include gingival recession, plaque index (PI), bleeding on probing (BOP), and pocket probing depth (PD). The marginal bone loss, as assessed by the parallel X-ray technique, was reported in 21 articles and considered as the hard tissue outcome, ranging from -2.06 to 1.5 mm (Cooper et al., 2014; Coyani et al., 2012). The reported complications include uncementing of the crown (Aguirre-Zorzano et al., 2011), those associated with surgical procedures, and chipping (Negri et al., 2014).

3.1 Implant success rate

Fifteen of the selected studies presented information on implant success rates (**Table S2**). The most commonly used criteria were proposed by Albrektsson et al. (1986) and included immobility, absence of peri-implant radiolucencies, absence of pain, absence of infections, and < 0.2 mm vertical bone loss per year after the first year. Some publications proposed to include marginal bone loss limited to $1 - 1.5$ mm for the first year after active loading in the implant success criteria (De Smet et al. (2002)), while others suggested a maximum of 0.2 mm marginal bone loss per year (Chaytor, 1993). PD and BOP were also included in some studies (Karoussis et al. (2004)).

One-stage dental implants. Nine studies documented the success rate of one-stage dental implants. Among these studies, the age range of the included patients was 19.5 to 75 years, with a follow-up period of 6 months to 10 years. The success rate ranged from 76% to 100%. The report published by Covani et al. (2012) observed 159 implants with a follow-up period of 10 years; the relatively low success rate was possibly attributed to the non-guided bone regeneration (GBR) technique, which resulted in an 87.9% success rate. Together with the GBR technique, which had a 94.1% success rate, the overall success rate was 91.8% in the study by Covani et al. (2012).

The shortest follow-up period among those observing the one-stage implants was 6 months, conducted by Baer et al. (2013), who reported a survival rate of 98.3%. The implants were maintained under moderate oral hygiene conditions, where plaque or mucosal inflammation could not be noted visibly (Baer et al., 2013). The longest follow-up period was 10 years, as reported by Covani et al. (2012), who documented an overall success rate of 91.8%. In the non-GBR group, the buccal bone level was more apical than in the GBR group, and 82% of implants showed marginal bone loss (Covani et al., 2012).

Two-stage dental implants. Six of the selected publications indicated the success rate of two-stage implants to be between 96.7% and 100%. The relatively low success rate of 96.7% was reported by Zuiderveld et al. (2018). The shortest follow-up period in the studies focusing on two-stage dental implants was 4 months, as reported by Esposito et al. (2015). The incidence of prosthetic complications in this research was notably higher, with a rate of 15% in the immediately restored implants and 2% in those receiving delayed restoration (Esposito et al., 2015). Among the analyzed studies, the longest follow-up period for two-stage implants was 3 years, as reported by three studies (Canullo et al., 2010; Negri et al., 2014; Tonetti et al., 2017).

One-stage and two-stage implants have success rates of over 76% and 96%, respectively, implying that the two-stage method may be more suitable for patients with occlusal challenges. However, the success rate is heavily influenced by soft tissue inflammation, which appears to occur more frequently in one-stage than in two-stage implant systems.

3.2 Implant Survival Rate

All 28 studies included for analysis in this review contained information on implant survival rate (**Table S3**). Implant survival is defined as the continued presence of the fixture in the oral cavity, contrasting with the Albrektsson success rate criteria published in 1986, which further include no peri-implant radiolucency, less than 0.2 mm of bone loss annually after the first year of clinical presentation, and the absence of persistent pain, discomfort, or infection. Of specific note, the study by Canullo et al. (2010) presented outcomes for two-stage dental implants, which demonstrated a survival rate of 100% without obvious post-surgical complications. Despite the statistically significant result regarding bone loss being clinically unremarkable, it should be noted that the marginal bone loss reported by Canullo et al. (2010) was lower than that observed by other authors. The lowest survival rate was reported by Atieh et al. (2013), at 66.7% for immediately restored implants and 83.3% for implants that received delayed restoration. The technical complication rate was notably high in the study by Atieh et al. (2013), with an incidence of 33.3% in the immediately restored implants and 25% in implants that received delayed restoration. Atieh et al. (2013) did not measure soft tissue inflammation and observed no statistically significant differences between the immediate and delayed restoration groups.

One-stage dental implants. Sixteen studies reported one-stage implant survival rates ranging from 91.8% to 100%. The other 15 studies indicated survival rates greater than 95%, among which 6 reported 100% survival, potentially due to the use of graft materials for aesthetic restoration. The lowest survival rate reported by studies involving one-stage implants was 91.8%, attributed to bone loss and implant failure in the non-GBR group (Covani et al., 2012). Corvino et al. (2020) reported 100% survival along with the marginal bone loss results of their dental implants; however, the soft tissue parameter was not considered. The reported bone loss over the first year of service in the study by Corvino et al. (2020) was 0.48 mm, which remained loosely within the limits set by the Albrektsson criteria.

Two-stage dental implants. Twelve publications reviewed the survival rate of two-stage dental implants. The lowest survival rate was 66.7% for immediately placed implants and 83.3% for implants with delayed placements in the study by Raes et al. (2018). Meanwhile, the implant survival rates reported by the other studies were above 94.5%. Canullo et al. (2010) reported a survival rate of 100% along with data concerning the gingival index,

probing depth (PD), and marginal bone loss; it was found that the soft tissue parameters fell within the acceptable range for implant success, and the hard tissue resorption was clinically insignificant.

3.3 Soft tissue outcomes

Twelve of the analysed studies assessed the soft tissue outcomes (**Table S4**). The periodontal indices used by researchers include gingival margin, plaque index (PI), gingival index, bleeding on probing (BOP), probing depth (PD), etc. Peri-implant soft tissue parameters (i.e., PI, BOP, and PD $\geq$ 4 mm) were proposed by Mohammad et al. (2017) to compare implant success between smokers and non-smokers. Among the analysed studies, the most commonly used index was the gingival margin (reported by 7 studies), followed by PD and BOP (each reported by 6 studies).

One-stage dental implants. With regard to periodontal changes in one-stage dental implants, five publications reported marginal gingival recession, which ranged from 0.1 to 0.5 mm. Gingival recession was particularly severe in the mesial area compared to the distal area, as reported by Arora et al. (2017), although the 0.11 mm difference reported was probably clinically insignificant. The BOP rate of 24% reported in the study by Cosyn et al. (2011) was particularly high and exceeded that reported by other reviewed articles. The PI of one-stage implants was reported by Cosyn et al. (2011), and the results indicated that a normal PI could be achieved if good oral hygiene was maintained.

Two-stage dental implants. Five publications reported soft tissue results (i.e., BOP, PD, PI, and marginal recession) for two-stage implants. BOP and marginal bone loss were reported by Cooper et al. (2014), who followed two-stage implants for 5 years. Marginal gingival recession reported by Raes et al. (2018) suggested 0.44 mm and 0.27 mm gingival recession in the mesial and distal areas, respectively. BOP, however, was recorded at 13.6% by Cucchi et al. (2017), possibly due to implant placement immediately following extraction, which is associated with more severe tissue inflammation than the delayed insertion procedure. Raes et al. (2018) reported a BOP of 18.2% in implants placed using the two-stage procedure, and this high BOP rate was potentially due to the short follow-up period after surgery.

While both techniques demonstrated gingival inflammation and recession, two-stage implants appear to exhibit a lower BOP than the one-stage implant system, implying better gingival health associated with the two-stage approach.

3.4 Hard Tissue Outcomes

Twenty-one of the selected studies presented hard tissue outcomes (**Table S5**). The criteria used for defining successful implant therapy include a median marginal bone loss of 0.5 mm during healing, followed by an annual rate of vertical bone loss of less than 0.2 mm per year. The level of the bone crest surrounding the implant is of utmost significance in determining the successful osseointegration of implants, while the preservation of marginal bone height is highly important for the long-term survival of dental implants.

One-Stage dental implants. Among the twelve studies that evaluated the hard tissue outcomes of one-stage implants, all measured marginal bone loss using the parallel X-ray technique. The reported bone loss ranged from -1.26 to 1.24 mm. The 1.24 mm bone loss

was reported by Meloni et al. (2020), who evaluated the bone loss of unhealed crestal bone during implant surgery.

Two-Stage dental implants. Nine studies examined mesial and/or distal bone loss using parallel radiography. The reported bone loss ranged from -2.06 to 0.57 mm, with the greatest bone loss reported by Corvino et al. (2020). Raes et al. (2018) revealed more severe bony resorption over the interdental marginal bone ridge.

The one-stage dental implant exhibited higher marginal bone resorption than the two-stage system in the present review. However, the observed higher bone resorption may be due to the specific surgical techniques and materials used by some authors.

3.5 Complications

Seven of the analysed studies provided results on implant complications. In a retrospective study conducted by Konstantinos et al. (2021), minor complications such as peri-implant mucositis were found in 53% of the implant sites, occurring more frequently in the maxilla (P = .001). The major biological complication was peri-implantitis, which affected 4.0% of the implants and occurred more commonly in the mandibular sites (P = .025). Peri-implant soft tissue hypertrophy was 2.79-fold (95% CI: 1.35–5.76, P ¡ .003) higher around implants supporting metal-acrylic resin prostheses than those supporting metal-ceramic prostheses, with the former type also showing significantly greater plaque accumulation (P ¡ .003). In this literature review, the complications reported by the analysed studies include uncementing of the crowns and several technical complications.

One-stage dental implants. Two publications noted complications including uncementation, cement remnants, and apical lesions associated with implant placement surgeries. Aguirre-Zorzano et al. (2011) reported 11 instances of crown uncementation, 10 instances of cement remnants, and 6 apical lesions out of 78 implants placed.

Two-stage dental implants. Three studies investigated complications associated with two-stage dental implants, and the complications were mostly related to technical challenges during the implant procedure. Raes et al. (2018) primarily observed technical complications due to aesthetic requirements and plaque retention. Additionally, abutment screw loosening was common when the occlusal table, interproximal contact, or implant site selection was not carefully evaluated prior to the procedures.

Both techniques have major and minor complications. The cement used in the one-stage system may influence periodontal health, as uncementation was a common problem within this system. On the other hand, despite the two-stage system being able to maintain better periodontal health, screw loosening or breakage over the long term casts a shadow over the use of this system.

4 Discussion

The aim of this review is to collect and evaluate the recent data available on one-stage and two-stage implant procedures to assist an evidence-based decision-making process in choosing the most suitable implant system for specific clinical conditions. Utilising the PubMed database, this review extracted and reviewed 15 one-stage dental implant articles and 13 two-stage implant studies. Success rates, survival rates, periodontal impacts, and

hard tissue influences are analysed and discussed systematically to address the differences between the two systems. According to the reviewed articles, the findings can be described as follows:

Both one-stage and two-stage implant systems are highly successful and provide aesthetic and functional restoration to patients with a partially edentulous ridge in a clinical oral environment. However, each system has specific limitations regarding success rate, survival rate, soft tissue impact, hard tissue outcomes, and complications. Concerning success rates, the two-stage implants performed slightly better than the one-stage implants in the available literature. In terms of survival rates, the two-stage implants also outperformed the one-stage implants. The impact on soft tissue differs significantly depending on abutment design, prosthetic contour, and patient oral hygiene. The two-stage system exhibits less soft tissue inflammation than the one-stage system. The impact on hard tissue is commonly assessed using parallel X-ray techniques, and the two-stage implant system was shown to result in less bony resorption than one-stage implants. Complications associated with one-stage implants include uncementation, cement remnants, and apical lesions. Meanwhile, the two-stage implant procedures were reported to be more complex, with screw loosening identified as a potential issue.

4.1 Success rates

The most commonly used criteria for evaluating success rates were proposed by Albrektsson et al. (1986) and included immobility, absence of peri-implant radiolucencies, absence of pain, absence of infections, and less than 0.2 mm vertical bone loss per year. The longest follow-up period among the studies reviewed in this work was 10 years, as reported by Covani et al. (2012), who documented an overall success rate of 91.8%. Covani et al. (2012) indicated that one-stage dental implants placed in combination with the guided bone regeneration (GBR) technique achieved a success rate of 94.1%, contributing to the overall success rate of 91.8%. For two-stage implants, six of the selected publications suggested that the success rate ranged from 96.7% to 100%.

Generally, the success rate of one-stage implants was approximately 5% lower than that of the two-stage implant system. Possible factors contributing to this difference include the aesthetic requirements for one-stage implants used in anterior restorations and the combination with the GBR technique. Although the GBR technique is commonly used in aesthetic areas, it is associated with higher rates of infection, suture loosening, and pain, which are detrimental to achieving implant success. In the one-stage implant system, the abutment is exposed to the oral environment and has surrounding sutures, which may increase the risk of postoperative pain and other complications. The two-stage implant system, when combined with GBR, ensures that all placed materials are sutured with complete gingival coverage, thereby reducing the risk of operative complications.

The achievement of implant success is also influenced by patient tolerance and oral hygiene, which can be better maintained in a two-stage design than in a one-stage design due to its smoother surface and complete primary closure. In my limited clinical experience, one-stage dental implants were more prone to contamination and peri-implant gingivitis, which is consistent with the findings presented in this review.

4.2 Survival rates

Implant survival is defined as the continued presence of the fixture in the oral cavity, contrasting with the success criteria established by Albrektsson et al. (1986), which further

included immobile implants, the absence of peri-implant radiolucency, less than 0.2 mm bone loss annually after the first year of clinical service, and the absence of persistent pain, discomfort, or infection.

In this review, 16 studies reported the survival rate of one-stage implants, which ranged from 91.8% to 100%. Twelve publications reviewed the survival rate of two-stage dental implants. The lowest survival rate was 66.7% for immediately placed implants and 83.3% for implants with delayed placement, as reported in the study by Raes et al. (2018). In contrast, the survival rates found by other studies were all above 94.5%.

The survival rate of two-stage implants, as limited to this review, was several percentage points lower than that of one-stage dental implants. The possible cause for this difference was the mechanical loading of the implant abutment screw during the placements of two-stage implants, which can result in screw loosening or fracture, thereby decreasing the survival rate. The oral hygiene status during the immediate placement of two-stage implants after tooth extraction is also influential, since periapical infection may persist if curettage is not performed thoroughly during the extraction of infected teeth. A delayed placement of the implant ensures that the apical lesion is completely healed, although the width and height of the bone crest may be significantly decreased if preservation is not conducted properly. Two-stage implants have been widely used in recent years; subsequently, detailed research and follow-up on survival rates imply that this is a reliable restoration technique if carefully administered.

4.3 Periodontal outcomes

Five publications reported marginal gingival recession ranging from 0.1 to 0.5 mm. The bleeding on probing (BOP) result of 24% in the study by Cosyn et al. (2011) was particularly high, exceeding that reported by other reviewed articles. The plaque index (PI) for one-stage implants was reported by Cosyn et al. (2011), indicating that normal PI could be achieved if good oral hygiene is maintained.

Five publications reported soft tissue outcomes (i.e., BOP, probing depth (PD), PI, and marginal recession) of two-stage implants. BOP and marginal bone loss were reported by Cooper et al. (2014), who followed two-stage implants for five years. Marginal gingival recession reported by Raes et al. (2018) suggested 0.44 mm and 0.27 mm gingival recession at the mesial and distal areas, respectively.

4.4 Hard tissue outcomes

The criteria used for defining successful implant therapy include a median marginal bone loss of 0.5 mm during healing, followed by an annual rate of vertical bone loss of ¡0.2 mm per year. This suggests that the status of bone directly impacts the success rate of the implant.

The reported bone loss for one-stage implants ranged from -1.26 to 1.24 mm, with the 1.24 mm loss reported by Meloni et al. (2020), who evaluated the bone loss of unhealed crestal bone during implant surgery. For two-stage implants, nine studies examined mesial and/or distal bone loss using parallel radiography. The reported bone loss ranged from -2.06 to 0.57 mm, with the greatest bone loss reported by Corvino et al. (2020). Raes et al. (2018) revealed more severe bony resorption over the interdental marginal bone ridge.

Bone loss is usually the result of poor oral hygiene, continuous gingival inflammation, and excessive occlusal stress. One-stage dental implants demonstrated a greater average bone loss, consistent with the challenges of maintaining oral hygiene in the one-stage compared with the two-stage implants. The one-stage system has the abutment exposed in the oral

environment, and most machined implant surfaces create an immediate pocket for bacterial colonisation. If good oral hygiene cannot be maintained, one-stage dental implants will be more susceptible to gingival inflammation than the two-stage system prior to crown delivery, resulting in greater marginal bone loss than that observed with two-stage implants.

4.5 Complications

For one-stage dental implants, Aguirre-Zorzano et al. (2011) reported 11 cases of crown uncementation, 10 instances of cement remnants, and 6 apical lesions out of 78 implants placed. Uncementation is primarily the result of cement washout, which is common when using conventional zinc oxide eugenol cement or glass ionomer cement in ceramic crowns. Cement remnants are frequently observed when using resin cements, which are difficult to remove once cured. Apical lesions result from infected extraction pockets that are poorly curetted.

For two-stage dental implants, complications were predominantly related to technical challenges during the implant procedure. Raes et al. (2018) mainly observed technical complications due to aesthetic requirements and plaque retention. Additionally, abutment screw loosening was common when the occlusal table, interproximal contact, or implant site selection was not carefully evaluated prior to the procedures.

One-stage and two-stage implants exhibit different types of complications due to the varied crown-retaining procedures. The two-stage system has a higher rate of screw loosening in certain products that exhibit poor resistance to rotational forces, while one-stage implants present a higher likelihood of uncementation due to washouts. Improved abutment design should lower the risk of screw loosening, and new-generation cements may provide better retaining ability than conventional products.

The limitation of this review is that few studies focus on the comparison of one-stage and two-stage implant systems. Differences in implant procedures and brands are also variables that increase the difficulty of analysing outcomes qualitatively and quantitatively in a pooled manner. Moreover, the definitions of one-stage and two-stage implants vary across many studies, which originally indicated immediate or delayed implant placement after tooth extraction. However, such confusion caused by the usage of terminology in the selected articles was clarified based on the implant brand and procedures described in the respective articles during the present review to avoid misunderstanding. Finally, soft tissue and hard tissue parameters were not documented by professional periodontists, which may result in deviations due to non-standardisation.

Based on the findings of this review, the two-stage system appears to provide better hygiene and less gingival inflammation, and thus is considered more suitable for anterior aesthetic restoration than the one-stage system. The one-stage system, on the other hand, is suitable for posterior restoration, where dentists can take time to evaluate gingival and plaque control conditions before placing the final restoration.

Conclusions

Within the limits of this review, the one-stage and two-stage dental implant systems are clinically highly successful and offer promising prosthetic options for both mechanical and aesthetic restoration. Given the higher incidence of gingivitis associated with the one-stage system, two-stage implants should be considered in aesthetic zones to prevent unwanted gingival and bony resorption. One-stage implants, on the other hand, though slightly more

likely to induce peri-implant gingivitis, are excellent for posterior restoration since oral hygiene reinforcement can be implemented prior to the actual cementation of the crown. Excessive occlusal force on posterior teeth often leads to the loosening of the abutment screw in the two-stage implant system, whereas this issue is mitigated in one-stage dental implants. Cement remnants can be avoided through a proper cementation protocol and the use of new-generation cements.

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Ethical approval

No ethical approval was required for this study as it did not involve human participants, animal subjects, or sensitive data. This study falls under the category of data collection without participant identification.

Consent for publication

Not applicable.

Authors' contributions

The author(s) declare that all the criteria for authorship designated by the International Committee of Medical Journal Editors have been met. More specifically, these are: (a) Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND (b) Drafting the work or revising it critically for important intellectual content; AND (c) Final approval of the version to be published; AND (d) Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Competing interests

The author(s) declare that there are no competing interests related to this work.

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