Received: 16 November 2022 | Revised: 20 May 2023 | Accepted: 31 May 2023

DOI: 10.1111/clr.14109

REVIEW ARTICLE

CLINICAL ORAL IMPLANTS RESEARCH WILEY

Selection criteria for immediate implant placement and immediate loading for single tooth replacement in the maxillary esthetic zone: A systematic review and meta-analysis

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Abstract

Objectives: The aim of this study was to review available evidence for Type 1A (immediate implant placement and immediate loading) of single tooth replacement in the maxillary esthetic zone.

Materials and Methods: An electronic search was conducted utilizing the databases of MEDLINE, Embase, and Cochrane to identify publications reporting on the outcomes of Type 1A for single tooth replacement in the maxillary esthetic zone. The success and survival rates of the included articles were reported, which were further categorized according to the clinical criteria reported in Type 1A. Mean survival rates were univariately compared between risk groups and additionally between studies published before and since 2012 using bias-corrected and study size-weighed bootstrap tests. A study time-correcting meta-analysis was then performed to obtain an overall effect for the study pool.

Results: A total of 3118 publications were identified in the search, with a total of 68 articles included. A mean number of implants per study were 37.2 and mean follow-up was 2.8 years. All the included studies utilizing Type 1A report highly selective inclusion and exclusion criteria. Univariate risk group comparison determined that studies before 2012 report a significantly lower mean survival rate (difference of −1.9 percentage points [PP], 95% CI: [−0.3, −4.0], $p = .02$), facial gap dimension had an impact on survival rates (+3.1 PP [0.2, 5.3] for width >2 mm, $p = .04$), as well as presence of endodontic infection (+2.6 PP [0.9, 5.1], $p = .004$).

Conclusions: Type 1A has a high survival rate in studies reporting strict patient and site selection criteria. Further research is required to assess esthetic and functional success with Type 1A treatments.

KEYWORDS
dental implants, immediate dental implant loading, immediate dental implant placement, meta-analysis, systematic review

1 | INTRODUCTION

The use of dental implants for the replacement of missing or failing teeth in partially edentulous patients has been shown to be a clinically predictable option (Jung et al., 2012). Original protocols recommended the placement of dental implants in healed alveolar ridges coupled with long healing periods prior to restoration and loading of the dental implant (Albrektsson et al., 1981). The current body of evidence provides encouraging data on the placement of implants at the time of tooth extraction and, in some situations, in conjunction with the connection of an immediately delivered implant-supported prosthesis (Buser et al., 2017; Gallucci et al., 2018; Kan et al., 2018; Seyssens et al., 2021, 2022; Zhou et al., 2021).

Dating back to 2003, the International Team for Implantology (ITI) has periodically revisited the classification for timing of implant placement and loading protocols (Chen et al., 2004; Chen & Buser, 2009; Hämmerle et al., 2004) in preparation for their consensus conferences. In the most recent consensus conference, a systematic review highlighted the connection and inseparability of outcomes with regard to implant placement and loading protocols (Gallucci et al., 2018). With this, Type 1A implant protocols are defined as immediate placement of an implant on the same day of tooth extraction and immediate restoration/loading on the same day or up to 1 week following implant placement (Gallucci et al., 2018).

Immediate placement and loading of an implant are most desirable as it has significant patient-centered advantages in reducing the overall treatment time as well as reducing the number of interventions and associated morbidity (Chen & Buser, 2009; Cosyn et al., 2019; Noelken et al., 2014; Slagter et al., 2014). Furthermore, it may assist in preserving the hard and soft tissue morphology through the use of a provisional restoration, aiding in achieving an ideal esthetic outcome (De Rouck et al., 2009; Kan et al., 2018; Kan & Rungcharassaeng, 2001; Puisys et al., 2022; Zhou et al., 2021).

However, Type 1A protocols can be challenging due to the complexity and technique sensitivity of the surgical procedures (Cosyn et al., 2019; Levine et al., 2017; Morton et al., 2018). There is evidence that shows there is a higher risk for early implant loss when an implant is immediately loaded (Schrott et al., 2014). It is common to find suggestions in the literature of factors that would contraindicate using Type 1A protocols, such as the presence of an active infection, soft tissue defects, thin tissue phenotype, lack of the socket's facial bone wall following extraction, and the absence of a facial gap between the implant and facial bone wall often known as the horizontal defect dimension (HDD; Araújo et al., 2022; Cochran & Douglas, 1993; Levine et al., 2022). Additionally, inferior outcomes related to the clinical, radiographic, and esthetic results can be obtained when those factors are present at the implant site (Chen et al., 2019; Cosyn et al., 2019; Sanz-Sánchez et al., 2015; Zhang et al., 2017).

Due to the available evidence from systematic reviews reporting on the success of Type 1A implant protocols, conservative criteria for their predictable implementation of Type 1A protocols were recommended (Morton et al., 2018). When following the recommended criteria, very few patients and sites would be classified as suitable, therefore alternative protocols would be indicated. The scientific evidence to support such criteria requires periodic review to provide guidelines in managing sites that may present compromises in any of the individual criteria. It has also been reported that adjunctive procedures such as simultaneous socket grafting and/or connective tissue grafting in conjunction with Type 1A implant protocols could mitigate the associated esthetic risks following tooth extraction, however, these procedures carry their own inherent technical challenges (Araújo et al., 2022; Seyssens et al., 2021, 2022).

The complexity of treatment increases with the added risks associated with immediate loading; therefore, it is generally recommended to select this protocol only when patient-centered benefits are present (Morton et al., 2018). This is supported by the majority of literature that focuses on Type 1A protocols reported on implants placed in the anterior maxilla (Zhou et al., 2021). This has patient-centered advantages in addressing the psychosocial and esthetic effects of having a missing tooth in the esthetic zone (Gotfredsen et al., 2021; Huynh-Ba et al., 2018).

Despite the significant volume of literature addressing immediate implant placement and immediate loading, the survival rate of Type 1A protocols with regard to the characteristics of the patients and sites where the implant was placed and loaded has not been systematically reviewed. This systematic review aims to identify, review, analyze, and summarize the available evidence on the survival rate of immediate loading of an immediately placed implant in the maxillary esthetic zone. Furthermore, two approaches are shown and discussed on how to assess survival rates based on studies with different study duration. The null hypothesis for this study is that the patient and site selection criteria do not influence the overall survival rate of Type 1A implant protocols.

2 | MATERIALS AND METHODS

This systematic review was conducted following PRISMA (Preferred Reporting for Systematic Reviews and Meta-Analyses) guidelines (Liberati et al., 2009; Page et al., 2021). The study was registered with the International Prospective Register of Systematic Reviews (PROSPERO) database (CRD42021292749).

2.1 | Focus question

To identify studies for this review, the PICO question (population, intervention, comparison, and outcome) was formulated with patients who require replacement of a single tooth in the anterior maxilla (15–25 FDI) as the population; immediate implant placement and immediate loading with specific site selection criteria, such as intact socket walls, facial bone of at least 1 mm in thickness, no acute infection at the site, the availability of at least 3 mm of bone apical and lingual to the socket to provide primary stability, at least 35 Ncm insertion torque, and/or ISQ of 70; thick soft tissue phenotype as

the intervention; immediate implant placement and immediate loading without one or more site-specific factors for selection criteria as the comparison; and survival rate as the outcome. Thus, the PICO question was formulated: "In patients who require replacement of a single tooth in the anterior maxilla (15–25), does specific site selection criteria influence the survival outcome of an immediate implant placed with immediate loading?" The following sections provide a concise description of the specific methodological aspects of the study.

2.2 | Search strategy

The search strategy was developed using keywords and Mesh terms (Table 1). The electronic search was conducted utilizing the databases MEDLINE (PubMed), Embase, and Cochrane to identify publications in English up to January 14th, 2022. Due to the specificity of the PICO regarding the site selection, a comprehensive search strategy was formulated encompassing a complete list of articles for manual screening.

TABLE 1 Systematic search strategy for the focus question.

Focused question	**Does the site selection influence the outcome of an immediate implant placed with immediate loading?**	
PICO	Population	Patients who require replacement of a single tooth in the anterior maxilla 15–25 (FDI)
	Intervention	Immediate implant placement and immediate loading of single implant restorations using modern dental implants with a micro-rough surface with specific site selection criteria, including: • Intact socket walls; • Facial bone of at least 1 mm in thickness; • No acute infection at the site; • The availability of at least 3 mm of bone apical and lingual to the socket to provide primary stability; • At least 35 Ncm insertion torque and/or ISQ of 70; and • Thick soft tissue phenotype
	Comparison	Immediate implant placement and immediate loading of single implant restorations using modern dental implants with a micro-rough surface without one or more site-specific factors in the selection criteria
	Outcome	Evaluate the implants after a minimum follow-up of 12 months regarding: • Proportion of procedures that are executed successfully on selected patients vs. those that are moved to an alternate implant placement/loading protocol; • Survival of implants/ implant-supported crowns; and • Criteria influencing the survival/success of implants placed immediately and loaded immediately
Search Strategy	PubMed	(dental implantation, endosseous[MeSH] OR dental implants[MeSH] OR implantation OR implant OR implants) AND (dental prostheses, implant supported[MeSH] OR crown OR single crown OR single unit) AND (immediate implant OR immediate implantation OR immediate implant placement OR immediate placement OR immediate OR fresh extraction sockets OR immediate extraction sockets) AND (immediate dental implant loading[MeSH] OR immediate) AND (English[Language])
	Embase	("dental implantation, endosseous"/exp OR "dental implantation, endosseous" OR (("dental"/exp OR dental) AND ("implantation,"/exp OR implantation,) AND endosseous AND ("mesh"/exp OR mesh)) OR "dental implants"/exp OR "dental implants" OR (("dental"/exp OR dental) AND ("implants"/exp OR implants) AND ("mesh"/exp OR mesh)) OR "implantation"/exp OR implantation OR "implant"/exp OR implant OR "implants"/exp OR implants) AND ("dental prostheses, implant supported" OR (("dental"/exp OR dental) AND ("prostheses,"/exp OR prostheses,) AND ("implant"/exp OR implant) AND supported AND ("mesh"/exp OR mesh)) OR "crown"/exp OR crown OR "single crown" OR (single AND ("crown"/exp OR crown)) OR "single unit" OR (single AND ("unit"/exp OR unit))) AND ("immediate implant" OR (immediate AND ("implant"/exp OR implant)) OR "immediate implantation" OR (immediate AND ("implantation"/exp OR implantation)) OR "immediate implant placement" OR (immediate AND ("implant"/exp OR implant) AND placement) OR "immediate placement" OR (immediate AND placement) OR immediate OR "fresh extraction sockets" OR (fresh AND ("extraction"/exp OR extraction) AND sockets) OR "immediate extraction sockets" OR (immediate AND ("extraction"/exp OR extraction) AND sockets)) AND ("immediate dental implant loading"/exp OR "immediate dental implant loading" OR (immediate AND ("dental"/exp OR dental) AND ("implant"/exp OR implant) AND ("loading"/exp OR loading) AND ("mesh"/exp OR mesh)) OR immediate) AND ("English"/exp OR English) AND ("language"/exp OR language)
	Cochrane	(dental implantation, endosseous[MeSH] OR dental implants[MeSH] OR implantation OR implant OR implants) AND (dental prostheses, implant supported[MeSH] OR crown OR single crown OR single unit) AND (immediate implant OR immediate implantation OR immediate implant placement OR immediate placement OR immediate OR fresh extraction sockets OR immediate extraction sockets) AND (immediate dental implant loading[MeSH] OR immediate) AND (English[Language])
Database Search	MEDLINE (PubMed), Embase, and Cochrane	

Reference lists of the studies that had been included by the electronic search were screened and checked for cross-references. An attempt was made to identify gray literature by searching through the database of the U.S. National Library of Medicine (www.clinicaltrials.gov). In addition, the following journals were hand searched up to January 2022: Clinical Implant Dentistry and Related Research, Clinical Oral Implants Research, Clinical Oral Investigations, International Journal of Oral & Maxillofacial Implants, International Journal of Oral & Maxillofacial Surgery, Journal of Clinical Periodontology, and the Journal of Periodontology.

The search results were exported and imported on Covidence (Melbourne, Australia), a systematic review management, to organize and evaluate the papers.

2.3 | Selection criteria

All types of study designs were included, provided they met the following criteria:
Inclusion criteria:

- Studies on humans;
- At least 10 participants;
- Studies that report immediate implant placement with immediate loading (Type 1A);
- Modern, rough surface implants;
- Single implants placed in the esthetic zone, from 15 to 25 (FDI);
- Implant survival rate and Number of implant failures reported; and
- Minimal follow-up evaluation of 12 months.

Exclusion criteria:

- Animal or in-vitro studies;
- Studies using zirconia implants;
- Review articles;
- Implants with machine surfaces or hydroxyapatite (HA) coatings;
- Implant supporting fixed or removable, partial or full-arch reconstructions with multiple implants;
- Insufficient information on defined outcome criteria;
- Studies that did not report on both the implant placement and implant loading protocols;
- Implant placement and loading protocols other than Type 1A immediate implant placement and immediate loading;
- Studies containing data on several implant placement and loading protocols where the data on Type 1A was not able to be clearly separated;
- Studies with less than 12-month follow-up period; and
- Multiple publications on the same patient population.

Furthermore, only the study with the most extended follow-up was included in multiple publications with the same study population. However, previous studies were consulted only to retrieve information not provided in the most recent publication.

2.4 | Screening of studies and data collection

After duplicate records exclusion, two reviewers (L.H.G. and K.P.A.) independently screened the title and abstract to the outcomes. Then, the full texts were screened for meeting the inclusion criteria. Disagreements were resolved by discussion between reviewers and consultation with a third reviewer (A.H.) when required.

Data were extracted manually independently by the three reviewers (L.H.G., K.P.A., and A.H.) from the included studies and recorded on standardized forms. The following information was collected for further analysis:

- Author(s), year of publication, and study designs: randomized/nonrandomized controlled trial, retrospective study, case series, and experimental study;
- Number of implants and location;
- Follow-up in months;
- Survival rate, success rate, and patient dropout(s)/number of implant failures;
- Implant brand, implant dimensions, implant lengths, and implant design; and
- Inclusion and procedural criteria reported for Type 1A protocols.

Included studies were analyzed according to the risk assessment Tables 2 and 3 for Type 1A immediate implant placement and immediate restoration/loading in single tooth sites (Lambert et al., 2023); the selection criteria of each study were assessed regarding low-, medium-, or high-risk inclusions.

Data on noncompliance to the planned Type 1A treatment protocol were identified in prospective studies to perform an intention-to-treat analysis, which for the purpose of this review described the number of sites that were selected and/or included for Type 1A treatment that were not able to be completed as planned. The reasons for deviation from the originally planned treatment protocol were also collated.

2.5 | Quality assessment

The quality assessment of all the included studies was analyzed by two reviewers (L.H.G. and K.P.A.). The risk of bias was assessed in randomized controlled trials (RCT) using the Cochrane quality assessment tool RoB2 (Higgins et al., 2022; Sterne et al., 2019). For nonrandomized studies, the Newcastle–Ottawa Assessment Scale (http://www.ohri.ca/pro-grams/clinical_epidemiology/oxford.asp) was applied to evaluate the selection of the study groups, the comparability of the groups, and the ascertainment of the outcome of interest converting the Newcastle–Ottawa scales to Agency for

TABLE 2 Risk assessment for immediate implant placement in single tooth sites (Lambert et al., 2023).

	Low risk	Medium risk	High risk
Preoperative assessment			
Patient related			
Medical Status	Healthy, Uneventful healing		Compromised healing
Esthetic risk	Low/Medium esthetic risk	High esthetic risk	Significant esthetic compromise expected
Site related			
Gingival margin position	Absence of recession	Minor Gingival recession	Gingival recession ≥2 mm
Soft tissue quality	Thick gingival phenotype	Thin gingival phenotype or limited keratinized gingivae	Absence of keratinized gingivae
Bone anchorage	Sufficient bone anchorage to achieve primary stability		Lack of bone anchorage to achieve primary stability
Facial bone wall	≥1 mm facial bone thickness	Facial bone plate <1 mm thickness, or small fenestration or dehiscence defect	Significant fenestration or dehiscence of facial bone
Mucoperiosteal Flap	Sufficient alveolar bone for a flapless approach		Need for a flapped bone augmentation procedure
Socket position within alveolar envelope	Socket within the alveolar bone envelope		Socket and facial bone wall protruding out of the bone envelope
Presence of endodontic infection	Absence of infection	Chronic peri-apical infection	Acute infection
Presence of periodontal disease	Periodontally healthy	Controlled periodontal disease	Active periodontal disease
Planning Implant position	Ideal three-dimensional position with axis exiting through the cingulum or incisal edge		Facially positioned or over-angulated implant or excessive implant depth
Gap between facial bone and planned implant position	>2 mm	1–2 mm	<1 mm
Intra-operative assessment			
Extraction	Minimally invasive tooth extraction	Damage to surrounding soft tissue including severed/detached papillae	Significant damage to soft tissue and surrounding bone
Primary Implant Stability	Primary stability achieved		Lack of primary stability
Final implant position	Ideal three-dimensional position achieved		Facially positioned or over-angulated implant or excessive implant depth

Healthcare Research and Quality (AHRQ) standards (good, fair, and poor).

2.6 | Statistical analysis

Cohen's kappa statistical analysis was performed to assess the level of agreement between the reviewers in the article screening process. Descriptive statistics such as mean and standard deviation (continuous data), percentages (count data), and data range were used to summarize demographics, number of implants, survival rates, success rates, study duration, failure time, and study dropouts.

2.6.1 | Main analysis

Survival rates were compared by inclusion criteria groups formed after the risk assessment. For interpretation of survival rates, one must always consider (average) study duration and study size, therefore the statistical assessment was done in two steps. First, mean survival rates and average study duration (both weighed by study sizes) were univariately compared between risk groups and additionally between studies published before and since 2012. As the distribution of the survival rates was skewed, non-normal, and with a lot of identical values (many having 100%), *p*-values for both survival rates and average study duration comparisons were calculated with the

TABLE 3 Risk assessment for immediate loading of an immediately placed single implant (Lambert et al., 2023).

	Low risk	Medium risk	High risk
Preoperative assessment			
Patient related			
Occlusal Scheme	No direct occlusal contacts	Minimal occlusal contact and/or shared guidance	Main determinant of anterior guidance
Occlusal Parafunction	Absent		Present
Site related			
Bone anchorage	Sufficient bone anchorage to resist loading forces		Insufficient bone anchorage to resist loading forces
Tooth Position	Incisor and premolars	Canine	Molars
Intra-operative assessment			
Primary Implant Stability	30–45 Ncm insertion torque	20–30 Ncm insertion torque	<20 Ncm insertion torque

help of bias-corrected and study size-weighed Bootstrap tests (Efron & Tibshirani, 1994) and presented with bias-corrected and study size-weighed bootstrap confidence intervals. In a second step, survival rates within the first 6 months, labeled as "early survival rates," were assessed using the very same techniques as from the first step and then compared to the previously obtained results. Roughly 90% of all implant losses occurred within the first 6 months so the results regarding early and overall survival rates should be comparable. Note that due to a non-negligible degree of missing observations, inclusion criteria could only be assessed in a univariate context.

2.6.2 | Secondary analysis

Survival rates were transformed in order to obtain comparable measures over time (i.e., study duration) and a meta-analysis was then performed to obtain an overall effect for the study pool. For the transformation of survival rates, an approach from epidemiology was used: For each study, incidence and survival rates, I_Y and S_Y, per observed implant-year were calculated as follows:

$$\text{Incidence rate per observed implant year} = I_Y = \frac{\text{Number of observed losses}}{\text{Total observed years in situ, all Impl.}}$$

$$\text{Survival rate per observed implant year} = S_Y = 1 - I_Y$$

For example, study A observing 10 implants with an average study time of 10 years, reported 1 loss after 9 years, that is, with reported survival of 90%, has an I_Y of 1/99 ≈ 1% (1 loss and 9 implants were observed 10 years in situ, and 1 was observed 9 years in situ), and thus an S_Y of ≈99%. Note that this approach is more accurate than simply reweighing raw survival rates by the product of implant x average study duration as the latter approach would put on par study A to a study B that observed 100 implants 1 year long with 10 losses (which would be clinically unacceptable). Observed implant-years had to be estimated by considering study dropouts and late implant losses (6+ months). If the timepoint of a loss or a dropout was unknown, it was assumed to have happened in the middle of the study duration.

Following the hands-on guide for meta-analysis (Harrer et al., 2021) and the suggestions from Spittal et al. (2015) to account for excessive zeros, a Poisson random-effects meta-analysis was used to systematically assess the transformed I_Y (and thus, S_Y) from all 68 studies. Notice that in order to obtain a better model fit, incidence rates were first logarithmized (using a continuity correction) and the resulting means and confidence intervals were re-transformed to the original scale. The Knapp–Hartung correction (Knapp & Hartung, 2003) was further applied to correct potential biases from small-sample studies. Mean S_Y as obtained from meta-analysis is then graphically presented along with its 95% confidence interval. In addition, a 95% prediction interval for the survival rate per observed implant-year of a single study is drawn. Between-study heterogeneity is then assessed using Higgins & Thompsons' I^2 statistic (Higgins & Thompson, 2002). An I^2 of 50%, for example, means that 50% of the total variance is caused by study heterogeneity. If all studies were comparable (and thus exchangeable), one would expect an I^2 of 0%.

An exact binomial test was used to assess the proportion of early and late failures.

All analyses in this report were performed with the statistics software R, version 4.0.2 (R Development Core Team, 2020). Throughout, *p*-values less than .05 were considered statistically significant. No correction for multiple comparisons was applied.

3 | RESULTS

3.1 | Study collection and study descriptives

A total number of 3118 publications were identified by the search. Following the title screening, 606 abstracts and 241 full-text articles were evaluated for inclusion (Figure 1). A Kappa score of 0.63 was obtained for eligibility assessment of full-text articles, which indicates a substantial interrater agreement. A total of 173 articles were excluded from the full-text screening for not meeting the inclusion criteria, with the reasons for exclusion listed in Table 4. A total of 68 articles were included for data extraction

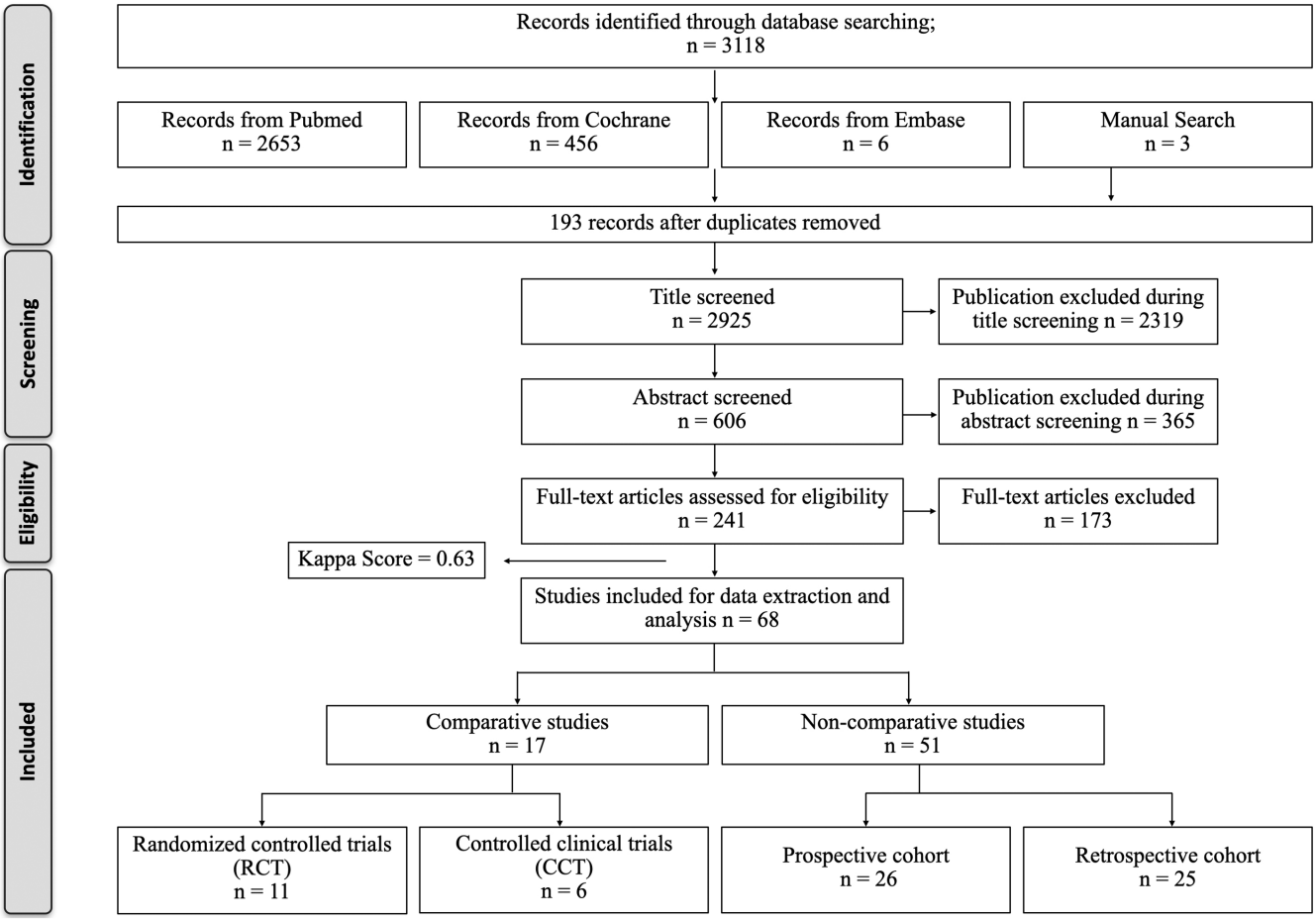

FIGURE 1 Search results and screening.

which comprised 11 randomized control trials (RCTs), six controlled clinical trials (CCTs), 26 prospective cohort studies, and 25 retrospective cohort studies.

The main characteristics of the included studies are reported in Table 5. Mean number of implants per study were 37.2 (SD: 22.9) and mean follow-up time was 2.8 years (SD: 2.3). Fifty-three implant failures were reported leading to survival rates ranging from 86.7% to 100% and 23 of the included 68 studies reported success rates ranging from 88.0% to 100%. Regarding the time of implant loss, the failure time is reported in 67 of 68 papers: From a total of 49 reported losses with known failure time, 43 (87.8%) are early losses compared to 6 losses later than 6 months (12.2%) (significantly more early failures, $p < .0001$). One paper reported four losses without further information regarding failure time. Dropout rates were reported in 25 papers ranging from 0% to 41.8%.

3.2 | Main analysis: Comparison of survival rates

The estimated weighed mean overall survival rate for implants placed with a Type 1A protocol is 97.7% (95% CI: 96.9%–98.4%) and weighed mean early survival rate is slightly higher with 98.3% (95% CI: 97.6%–98.8%), see Table 6.

Table 6 also presents the results of the univariate comparisons of inclusion criteria groups regarding survival rates, average study durations, and early survival rates.

Gap dimension showed a statistically significant impact on survival rates as weighed group means significantly differed: 95.9% of implants survived for gaps smaller than 2 mm versus 99.0% for gaps more than 2 mm ($p = .04$). Weighed early survival rates also statistically significantly differed (96.5% vs. 99.2%, $p = .04$) and weighed average study duration was comparable (2.5 years vs. 2.6 years, $p = .85$). The second significant impact was found for publication year: Before 2012 weighed mean survival rate was 96.3%, and since 2012, it raised to 98.2% ($p = .02$), even though publications from 2012 or later reported significantly larger study durations (2.9 years vs. 2.0 years before 2012, $p = .005$). Similar results were found regarding early mean survival rates (97.2% pre-2012 vs. 98.6% 2012 and later, $p = .04$). This might be an indicator that surgeons are getting more experienced with immediate implant placement over time, together with advances in implant technology, materials, surfaces, and surgical techniques. Studies including smokers had unexpectedly higher weighed mean survival rates than those excluding

TABLE 4 Full-text articles excluded.

Exclusion reason	Number of articles	References
Wrong study design	2	Brignardello-Petersen (2017)—review Locante (2001)—technique
Less than 1-year follow-up	11	Bavetta et al. (2019), Bell and Bell (2014), Calvo Guirado et al. (2007), Chu et al. (2020), Felice et al. (2011), Hui et al. (2001), Kotb et al. (2020), Rungcharassaeng et al. (2012), Saito et al. (2016), van Kesteren et al. (2010), Yoo et al. (2006)
Less than 10 sites	8	Carini et al. (2014), Crespi et al. (2007), Crespi et al. (2019), Juodzbalys and Wang (2010), Lorenzoni et al. (2003), Palattella et al. (2008), Peron and Romanos (2020), Shibly, Kutkut, and Albandar (2012)
Not single crowns	6	Anitua et al. (2016), Crespi et al. (2010b), Crespi et al. (2012), Degidi and Piattelli (2005), Miyamoto and Obama (2011), Nikellis et al. (2004)
Not separated Type 1a	14	Berberi (2021), Berberi, Tehini, et al. (2014), Boardman et al. (2016), Cannizzaro et al. (2016), Crespi et al. (2009), Esposito et al. (2015), Guarnieri et al. (2020), Locante (2004), Milillo et al. (2016), Norton (2004), Petrungaro (2017), Pozzi et al. (2015), Raes, Cosyn, et al. (2018), Testori et al. (2007)
Not separated sites(anterior/posterior/maxilla/mandible)	59	Aguirre-Zorzano et al. (2011), Amato et al. (2020), Amato et al. (2018), Avvanzo et al. (2009), Barone et al. (2016), Barone et al. (2006), Barone et al. (2015), Becker et al. (2011), Block et al. (2004), Blus and Szmukler-Moncler (2010), Chaushu et al. (2001), Clauser et al. (2020), Cornelini et al. (2008), Cornelini et al. (2005), Covani et al. (2004), Crespi et al. (2010a), de Carvalho et al. (2013), Degidi et al. (2008), Drago and Lazzara (2004), El-Chaar (2011), Ferrantino et al. (2021), Galli et al. (2008), Givens Jr. et al. (2015), Glauser et al. (2004), Grandi, Garuti, Guazzi, et al. (2012), Grandi et al. (2014), Grandi et al. (2015), Grunder et al. (1999), Horwitz et al. (2008), Hosseini et al. (2015), Hruska et al. (2002), Kniha et al. (2017), Kolinski et al. (2014), Kopp et al. (2013), Laviv et al. (2010), Levin (2011), Levin and Wilk (2013), Luongo et al. (2014), Malchiodi et al. (2010), Malchiodi et al. (2011), Maló et al. (2015), Meltzer (2012), Mura (2012), Noelken, Moergel, Kunkel, et al. (2018), Noelken et al. (2007), Noelken et al. (2014), Peñarrocha-Diago et al. (2012), Peron and Romanos (2016), Pozzi et al. (2021), Schwartz-Arad et al. (2007), Shibly, Kutkut, Patel, and Albandar (2012), Shibly et al. (2010), Siebers et al. (2010), Siormpas et al. (2014), Soardi et al. (2012), Vanden Bogaerde et al. (2005), Velasco-Ortega et al. (2018), Zafiropoulos et al. (2010), Zembić et al. (2012)
Immediate placement but not immediate loading	22	Arora and Ivanovski (2018b), Aslroosta et al. (2021), Benic et al. (2012), Bianchi and Sanfilippo (2004), Bilhan et al. (2011), Cecchinato et al. (2015), Covani et al. (2012), Evans and Chen (2008), Felice et al. (2015), Fugazzotto (2012), Garcia-Sanchez et al. (2021), Guarnieri et al. (2015), Heinemann et al. (2013), Hof et al. (2015), Jung et al. (2013), Koh et al. (2011), Lee et al. (2012), Malchiodi et al. (2016), Polizzi et al. (2000), Shi et al. (2020), Tadi et al. (2014), Wagenberg et al. (2013)
Immediate loading but not immediate placement	27	Anitua et al. (2008), Boedeker et al. (2011), Donos et al. (2019), Ericsson et al. (2000), Glibert et al. (2016), Hall et al. (2006), Kim et al. (2015), Lang et al. (2014), Lindeboom et al. (2006), Maló et al. (2003), Meizi et al. (2014), Mertens and Steveling (2011), Nissan et al. (2008), Ostman et al. (2010), Parel and Schow (2005), Proussaefs et al. (2002), Proussaefs and Lozada (2004), Rai et al. (2020), Rizkallah et al. (2013), Ryser et al. (2005), Sarnowski and Paul (2012), Simmons et al. (2016), Stacchi et al. (2018), Stanley et al. (2017), Vandeweghe et al. (2012), Vandeweghe et al. (2013), Vervaeke et al. (2013)
Survival rate not reported	4	Fürhauser et al. (2017), Groenendijk et al. (2021), Mangano et al. (2016), Roe et al. (2012)
Longer follow-up reported in a subsequently included publication	12	Brown and Payne (2011), Chan et al. (2019), Cooper et al. (2010), Cosyn et al. (2013), De Bruyn et al. (2013), De Rouck et al. (2008), De Rouck et al. (2009), Kan et al. (2003), Mijiritsky et al. (2009), Raes et al. (2011), Raes et al. (2012), Slagter et al. (2017)
Multiple publications with the same patient data	7	Canullo, Iurlaro, and Iannello (2009), Chu et al. (2018), Chu et al. (2015), Hartlev et al. (2014), Kolerman, Nissan, Mijiritsky, et al. (2016), van Nimwegen et al. (2018), Wang et al. (2020)
Socket shield technique	1	Hinze et al. (2018)
Included	68	Aguilar-Salvatierra et al. (2016), Arora and Ivanovski (2018a), Berberi, Noujeim, et al. (2014), Berberi, Sabbagh, et al. (2014), Bittner et al. (2020), Block et al. (2009), Bonnet et al. (2018), Bruno et al. (2014), Bushahri et al. (2021), Cabello et al. (2013), Calvo-Guirado et al. (2015), Calvo-Guirado et al. (2009), Canullo et al. (2010), Canullo, Goglia, et al. (2009), Canullo and Rasperini (2007), Cardaropoli et al. (2019), Cardaropoli et al. (2015), Cooper et al. (2014), Cosyn et al. (2011), Cosyn et al. (2016), Crespi et al. (2008), Cristalli et al. (2015), Degidi et al. (2013), Degidi et al. (2014), Di Alberti et al. (2012), Ferrara et al. (2006), Ganeles et al. (2017), Grandi, Garuti, Samarani, et al. (2012), Grandi et al. (2013), Groenendijk et al. (2020), Groenendijk et al. (2017), Groisman et al. (2003), Hartlev et al. (2013), Kan et al. (2011), Khzam et al. (2014), Kolerman, Nissan, Rahmanov, et al. (2016), Lombardo et al. (2016), Ma et al. (2019), Malchiodi et al. (2013), Mangano et al. (2012), Mangano et al. (2013), McAllister et al. (2012), Menchini-Fabris et al. (2019), Migliorati et al. (2015), Mijiritsky et al. (2021), Noelken et al. (2011), Noelken, Moergel, Pausch, et al. (2018), Norton (2011), Paul and Held (2013), Pieri et al. (2011), Raes, Eghbali, et al. (2018), Raes et al. (2017), Ribeiro et al. (2008), Rosa et al. (2014), Ross et al. (2014), Saedi Germi et al. (2020), Sato et al. (2017), Seyssens et al. (2020), Shanelec (2005), Slagter et al. (2021), Spinato et al. (2012), Tarnow et al. (2014), Tortamano et al. (2010), Valentini et al. (2010), Van Nimwegen et al. (2016), Vidigal Jr. et al. (2017), Yang et al. (2019), Zuiderveld et al. (2018)

smokers, however, this was not statistically significant (98.8% vs. 97.4%, $p = .06$). Studies with nonsmokers are of significantly larger weighed duration which is a possible confounding variable (3.2 years vs. 2.0 years, $p < .001$). The presence of chronic endodontic infection did not appear to negatively affect implant survival in Type 1A protocols with higher survival rates reported compared to those studies which excluded all endodontic infections (98.8% vs. 96.2%, $p = .004$). Weighed study duration in the analysis of endodontic infection was comparable (2.3 vs. 2.2 years, $p = .88$).

3.3 | Meta-analysis

A Poisson random-effects meta-analysis was used to systematically assess the survival rates per observed implant-year S_Y from all 68 studies. An image of the result is shown in Figure 2 and a summary is shown in the first line of Table 7 (main model).

Forty-two studies reported an S_Y of 100% without losses compared to 26 studies with at least one loss. The lowest S_Y was reported in the study of Grandi et al., 2013 (91.3%).

The estimated mean survival rate per observed implant-year is 99.4% with a 95% CI of 99.0% to 99.7%. The estimated 95% prediction interval of a single study ranges from 95.3% to 100%. Finally, the measure of heterogeneity I^2 is 53% and significantly higher than zero ($p = .002$), indicating a "moderate level of heterogeneity" (Higgins & Thompson, 2002).

Further sensitivity analysis showed that estimation of mean survival rate per observed implant-year is quite robust to outliers. A recalculation removing influential studies of Groisman et al., 2003, Block et al., 2009, Grandi et al., 2013, and Cristalli et al., 2015 yielded a slightly higher mean S_Y of 99.5%, a narrower prediction interval of 97.5% to 100%, and a reduced measure of heterogeneity I^2 of 34% (line 2 in Table 7).

3.4 | Quality assessment

Figure 3 summarizes the risk for bias for the included RCTs. Most of the studies have some concern or high risk with regard to the randomization process, which is largely due to the time of the randomization and the concealment of allocation. Due to the nature of treatment, it is not possible to blind the patients or the clinicians delivering care. Another important aspect was the team involved in collecting and analyzing the final data, and most of the included articles had blinded outcome assessors. The outcome data are well reported in all included studies, demonstrating a low risk of bias.

The risk of bias for nonrandomized studies is presented in Table 8. Twenty of the 57 evaluated studies were qualified with good quality, and 35 articles were identified as fair. Additionally, two articles were qualified with poor quality. Most of the studies have some concerns regarding the selection of the patients with the outcome of interest not defined at the start of the study.

3.5 | Outcome analysis based on study inclusion criteria

Selection criteria that were found to be reported in each study and the corresponding risk assessments are summarized in Table 9 and included:

- Medical status;
- Gingival margin position;
- Soft tissue quality;
- Bone anchorage;
- Facial bone wall;
- Mucoperiosteal flap;
- Presence of endodontic infection;
- Presence of periodontal disease;
- Gap between the facial bone and implant;
- Damage during tooth extraction;
- Primary implant stability;
- Occlusal scheme; and
- Signs of parafunction.

3.5.1 | Medical status

The medical status of the patient as an inclusion or exclusion criterion for Type 1A protocols was reported in 63 of the included articles. Forty-one studies (Berberi, Noujeim, et al., 2014; Berberi, Sabbagh, et al., 2014; Bittner et al., 2020; Block et al., 2009; Bonnet et al., 2018; Bushahri et al., 2021; Canullo et al., 2010; Canullo, Goglia, et al., 2009; Cardaropoli et al., 2019; Cooper et al., 2014; Cosyn et al., 2011, 2016; Crespi et al., 2008; Ferrara et al., 2006; Grandi, Garuti, Samarani, et al., 2012; Groenendijk et al., 2017; Kan et al., 2011; Khzam et al., 2014; Lombardo et al., 2016; Ma et al., 2019; Mangano et al., 2013; McAllister et al., 2012; Menchini-Fabris et al., 2019; Migliorati et al., 2015; Mijiritsky et al., 2021; Noelken et al., 2011; Raes et al., 2017; Raes, Eghbali, et al., 2018; Ribeiro et al., 2008; Rosa et al., 2014; Saedi Germi et al., 2020; Sato et al., 2017; Seyssens et al., 2020; Spinato et al., 2012; Tarnow et al., 2014; Tortamano et al., 2010; Valentini et al., 2010; Van Nimwegen et al., 2016; Vidigal Jr. et al., 2017; Yang et al., 2019; Zuiderveld et al., 2018) included only healthy patients with no medical conditions and excluded patients with any smoking degree. All studies excluded heavy smokers (>10–15 cigarettes/day). Twenty studies (Arora & Ivanovski, 2018a, 2018b; Bruno et al., 2014; Cabello et al., 2013; Calvo-Guirado et al., 2009, 2015; Canullo & Rasperini, 2007; Cardaropoli et al., 2015; Cristalli et al., 2015; Degidi et al., 2013; Ganeles et al., 2017; Groenendijk et al., 2021; Hartlev et al., 2013; Kolerman, Nissan, Rahmanov, et al., 2016; Malchiodi et al., 2013; Mangano et al., 2012; Noelken, Moergel, Pausch, et al., 2018; Norton, 2011; Paul & Held, 2013; Pieri et al., 2011) allowed for patients categorized as light smokers

(<10–15 cigarettes/day) to be included. Three studies included patients with controlled diabetes (HbA1c < 7; Aguilar-Salvatierra et al., 2016; Grandi et al., 2013; Norton, 2011), with one of these studies (Aguilar-Salvatierra et al., 2016) also having patients with an HbA1c of up to 10 demonstrating lower implant survival and higher marginal bone loss in patients with poorly controlled diabetes.

3.5.2 | Gingival margin position

Gingival recession was reported as an exclusion criterion for Type 1A implant treatment protocol in 22 studies (Bittner et al., 2020; Block et al., 2009; Bruno et al., 2014; Cabello et al., 2013; Canullo et al., 2010; Cardaropoli et al., 2015, 2019; Cosyn et al., 2011, 2016; Cristalli et al., 2015; Di Alberti et al., 2012; Groisman et al., 2003; Kan et al., 2011; Khzam et al., 2014; Mangano et al., 2013; Migliorati et al., 2015; Raes, Eghbali, et al., 2018; Ross et al., 2014; Saedi Germi et al., 2020; Seyssens et al., 2020; Tarnow et al., 2014; Vidigal Jr. et al., 2017). Only two studies (Noelken, Moergel, Pausch, et al., 2018; Shanelec, 2005) reported that preoperative labial tissue deficiencies were present, and for which sub-epithelial connective tissue grafting was performed in some of them.

3.5.3 | Soft tissue quality

Soft tissue phenotype was considered as part of the inclusion criteria or study outcomes analysis in 25 studies (Bittner et al., 2020; Bushahri et al., 2021; Cabello et al., 2013; Calvo-Guirado et al., 2009, 2015; Canullo et al., 2010; Canullo, Goglia, et al., 2009; Canullo & Rasperini, 2007; Cosyn et al., 2011, 2016; Groenendijk et al., 2021; Kan et al., 2011; Malchiodi et al., 2013; Mangano et al., 2012, 2013; Migliorati et al., 2015; Raes, Eghbali, et al., 2018; Rosa et al., 2014; Ross et al., 2014; Saedi Germi et al., 2020; Shanelec, 2005; Spinato et al., 2012; Vidigal Jr. et al., 2017; Zuiderveld et al., 2018), of which eight studies excluded (Cosyn et al., 2011, 2016; Malchiodi et al., 2013; Mangano et al., 2012, 2013; Raes, Eghbali, et al., 2018; Saedi Germi et al., 2020; Spinato et al., 2012) sites with thin gingival phenotype. A minimum height of keratinized tissues ranging from 2 to 3 mm was required in four studies (Block et al., 2009; Calvo-Guirado et al., 2009, 2015; Cristalli et al., 2015). Sites with a thin soft tissue phenotype were included in 17 studies (Bittner et al., 2020; Bushahri et al., 2021; Cabello et al., 2013; Calvo-Guirado et al., 2009, 2015; Canullo et al., 2010; Canullo, Goglia, et al., 2009; Canullo & Rasperini, 2007; Groenendijk et al., 2021; Kan et al., 2011; Migliorati et al., 2015; Noelken, Moergel, Pausch, et al., 2018; Rosa et al., 2014; Ross et al., 2014; Shanelec, 2005; Vidigal Jr. et al., 2017; Zuiderveld et al., 2018). Connective tissue grafting in conjunction with Type 1A implant treatment protocols for phenotype modification and compensation for anticipated alveolar ridge dimensional changes associated with tooth extraction was reported in seven studies (Bonnet et al., 2018; Kolerman, Nissan, Rahmanov, et al., 2016; Migliorati et al., 2015; Noelken, Moergel, Pausch, et al., 2018; Shanelec, 2005; Vidigal Jr. et al., 2017; Zuiderveld et al., 2018).

3.5.4 | Bone anchorage

Sufficient bone anchorage for primary stability as a preoperative assessment and inclusion criteria with Type 1A protocols was reported in 37 studies. Nineteen of these studies specified a minimum distance of bone apical to the socket to allow for engagement with the implant beyond the apex of the tooth ranging from 3 to 5 mm (Aguilar-Salvatierra et al., 2016; Berberi, Noujeim, et al., 2014; Berberi, Sabbagh, et al., 2014; Bushahri et al., 2021; Calvo-Guirado et al., 2015; Canullo et al., 2010; Canullo, Goglia, et al., 2009; Cosyn et al., 2011, 2016; Crespi et al., 2008; Cristalli et al., 2015; Groenendijk et al., 2017, 2021; Kolerman, Nissan, Rahmanov, et al., 2016; Ma et al., 2019; Menchini-Fabris et al., 2019; Pieri et al., 2011; Ribeiro et al., 2008; Seyssens et al., 2020). A requirement for sufficient bone to be present but did not provide any indication of the preoperative assessment criteria to determine suitability was reported in 18 studies (Arora & Ivanovski, 2018a, 2018b; Block et al., 2009; Bruno et al., 2014; Cardaropoli et al., 2019; Degidi et al., 2014; Ferrara et al., 2006; Migliorati et al., 2015; Noelken, Moergel, Pausch, et al., 2018; Raes, Eghbali, et al., 2018; Rosa et al., 2014; Saedi Germi et al., 2020; Sato et al., 2017; Spinato et al., 2012; Tarnow et al., 2014; Tortamano et al., 2010; Valentini et al., 2010; Vidigal Jr. et al., 2017; Yang et al., 2019).

3.5.5 | Facial bone wall

The presence of an intact facial bone wall following tooth extraction was required in 42 studies (Arora & Ivanovski, 2018a, 2018b; Berberi, Noujeim, et al., 2014; Berberi, Sabbagh, et al., 2014; Bittner et al., 2020; Block et al., 2009; Cabello et al., 2013; Canullo et al., 2010; Canullo, Goglia, et al., 2009; Canullo & Rasperini, 2007; Cardaropoli et al., 2015, 2019; Cosyn et al., 2011, 2016; Crespi et al., 2008; Cristalli et al., 2015; Degidi et al., 2013; Ferrara et al., 2006; Grandi et al., 2013; Grandi, Garuti, Samarani, et al., 2012; Groenendijk et al., 2017; Kan et al., 2011, 2003; Khzam et al., 2014; Lombardo et al., 2016; Mangano et al., 2012, 2013; Menchini-Fabris et al., 2019; Paul & Held, 2013; Pieri et al., 2011; Raes, Eghbali, et al., 2018; Ribeiro et al., 2008; Ross et al., 2014; Saedi Germi et al., 2020; Sato et al., 2017; Seyssens et al., 2020; Shanelec, 2005; Spinato et al., 2012; Tarnow et al., 2014; Tortamano et al., 2010; Van Nimwegen et al., 2016; Vidigal Jr. et al., 2017; Yang et al., 2019). Seven studies allowed for small facial dehiscence or fenestration defects of up to 3 mm (Bonnet et al., 2018; Bruno et al., 2014; Bushahri et al., 2021; Hartlev et al., 2013; Ma et al., 2019; McAllister et al., 2012; Migliorati et al., 2015). Larger defects or complete lack of facial bone was reported in 11 studies (Calvo-Guirado et al., 2009; Cooper et al., 2014; Groenendijk et al., 2021; Kolerman, Nissan, Rahmanov, et al., 2016; Noelken et al., 2011; Noelken,

TABLE 5 Included study characteristics.

Study	Type of study	Comparison	Number of implant sites	Lost to follow-up	Excluded due to procedural complications	Intention to treat	Number of implants included
Bittner et al. (2020)	Randomized control trial	Bone Graft vs. No Graft	22	0	0	100	22
Block et al. (2009)	Randomized control trial	Type 1a vs. 4a	38	7	1	97	30
Bushahri et al. (2021)	Randomized control trial	Type 1a vs. 1c	20	2	0	100	18
(Canullo, Goglia, et al., 2009)	Randomized control trial	Platform match vs. platform shift	22	0	0	100	22
Canullo et al. (2010)	Randomized control trial	Disconnection vs. one abutment one time	32	0	7	78	25
Crespi et al. (2008)	Randomized control trial	Type 1a vs. 1c	20	0	0	100	20
Degidi et al. (2014)	Randomized control trial	Disconnection vs. one abutment one time	91	25	13	86	53
Migliorati et al. (2015)	Randomized control trial	SCTG vs. No SCTG	48	1	0	100	47
Pieri et al. (2011)	Randomized control trial	Platform match vs. platform shift	40	1	1	98	38
Slagter et al. (2021)	Randomized Control Trial	Type 1a vs. 1c	20	2	0	100	18
Zuiderveld et al. (2018)	Randomized Control Trial	SCTG vs. No SCTG	60	0	0	100	60
Berberi, Sabbagh, et al. (2014)	Controlled clinical trial	Type 1a vs. 4a	22	NR	NR	-	22
Cooper et al. (2014)	Controlled clinical trial	Type 1a vs. 4a	63	7	8	87	48
Di Alberti et al. (2012)	Controlled clinical trial	Type 1a vs. 4a	25	0	NR	-	25
Grandi et al. (2013)	Controlled clinical trial	Type 1a vs. 4a	25	0	0	100	25
Raes et al. (2017)	Controlled clinical trial	Type 1a vs. 4a	48	NR	NR	-	48
Raes, Eghbali, et al. (2018)	Controlled clinical trial	Type 1a vs. 4a	16	4	NR	-	12
Aguilar-Salvatierra et al. (2016)	Prospective cohort	Healthy vs. Diabetic	85	0	NR	-	85
Berberi, Noujeim, et al. (2014)	Prospective cohort	No comparison	20	NR	NR	-	20
Cabello et al. (2013)	Prospective cohort	No comparison	14	NR	NR	-	14
Calvo-Guirado et al. (2009)	Prospective cohort	No comparison	61	1	NR	-	60
Calvo-Guirado et al. (2015)	Prospective cohort	No comparison	71	NR	NR	-	71
Canullo and Rasperini (2007)	Prospective cohort	No comparison	10	0	NR	-	10
Cardaropoli et al. (2015)	Prospective cohort	No comparison	26	0	0	100	26
Cardaropoli et al. (2019)	Prospective cohort	No comparison	20	0	0	100	20
Cosyn et al. (2011)	Prospective cohort	No comparison	32	4	2	94	26
Cosyn et al. (2016)	Prospective cohort	No comparison	22	4	0	100	18
Cristalli et al. (2015)	Prospective cohort	No comparison	29	0	4	86	25
Ferrara et al. (2006)	Prospective cohort	No comparison	39	0	6	85	33
Ganeles et al. (2017)	Prospective cohort	No comparison	15	4	NR	-	11

Mean follow-up (months)	Total number of failures	Early failures <6 m	Late failures 6 m+	Survival rate (%)	Success rate (%)	Success criteria reported	Implant details	Implant diameters	Implant lengths	Implant design
12	0	0	0	100	NR	N	BioMet 3i Certain	3.25–5 mm	8.5–15 mm	BL, T
24	4	NR	NR	86.7	NR	N	BioMet 3i Certain	3.25–4 mm	11.5–13 mm	BL, T
30	2	2	0	88.9	NR	N	Neobiotech IS II active	3.5–4.5 mm	11.5–13 mm	BL, T
25	0	0	0	100	NR	N	Sweden & Martina Global	5.5 mm		BL, T
36	0	0	0	100	100	N	Sweden & Martina Global	5.5 mm	13 mm	BL, T
24	0	0	0	100	NR	Y	Sweden & Martina Outlink	3.75–5 mm	13 mm	BL, T
24	0	0	0	100	NR	N	Dentsply Ankylos	3.5–4.5 mm	14–17 mm	BL, T
24	0	0	0	100	NR	N	Straumann Tapered Effect	NR	NR	TL, T
12	1	1	0	97.4	97.35	Y	Samo Biomedica Smiler Cone	NR	NR	BL, T
60	0	0	0	100	NR	N	Nobel Active	NR	NR	BL, T
12	2	2	0	96.7	96.7	Y	Nobel Active	3.5–4.3 mm	15–18 mm	BL, T
60	2	2	0	90.9	NR	N	Dentsply Astra Tech TX	3.5–5 mm	11–15 mm	BL, P
60	3	3	0	93.8	NR	N	Dentsply Astra Tech TX	3.5–5 mm	11–17 mm	BL, P
12	0	0	0	100	100	Y	MIS Seven	3.3–4.2 mm	11.5–16 mm	BL, T
12	2	2	0	92	NR	N	JDentalCare, JDEvolution	3.7–5 mm	11.5–15 mm	BL, T
60	1	1	0	97.9	NR	N	Dentsply Astra Tech TX	3.5–5 mm	11–19 mm	BL, P
96	1	1	0	91	NR	N	Dentsply Astra Tech TX	3.5–5 mm	13–17 mm	BL, P
24	4	0	4	95.3	NR	N	Straumann Bone Level	3.3–4.1 mm	10–14 mm	BL, P
36	0	0	0	100	NR	N	Dentsply Astra Tech TX	NR	NR	BL, P
12	0	0	0	100	NR	N	Straumann, Bone Level/ Tissue Level	NR	NR	BL or TL, P
12	1	1	0	96.7	NR	N	Biomet 3i Certain	4–5 mm	13–15 mm	BL, P
36	0	0	0	100	NR	N	MIS Seven	4.2–5 mm	11.5–13 mm	BL, T
21.9	0	0	0	100	NR	N	Def Con TSATM	4 mm	13 mm	TL, T
12	0	0	0	100	NR	N	BioMet 3i T3	4–5 mm	11.5–15 mm	BL, T
12	0	0	0	100	NR	N	Straumann Bone Level Tapered	3.3–4.8 mm	10–14 mm	BL, T
36	1	1	0	96	NR	N	Nobel Replace	NR	NR	BL, T
60	1	1	0	94.4	NR	N	Nobel Active	NR	NR	BL, T
12	2	2	0	91.6	91.6	Y	Nobel Active	3.5–5 mm	11.5–18 mm	BL, T
28.1	2	2	0	94	NR	N	Friadent Frialit	3.8–5.5 mm	13–15 mm	BL, T
24	0	0	0	100	100	Y	Nobel Active	3.5–5 mm	10–15 mm	BL, T

(Continues)

TABLE 5 (Continued)

Study	Type of study	Comparison	Number of implant sites	Lost to follow-up	Excluded due to procedural complications	Intention to treat	Number of implants included
Grandi, Garuti, Samarani, et al. (2012)	Prospective cohort	No comparison	36	NR	NR	-	36
Groenendijk et al. (2021)	Prospective cohort	No comparison	100	2	NR	-	98
Groisman et al. (2003)	Prospective cohort	No comparison	92	NR	NR	-	92
Kan et al. (2011)	Prospective cohort	Thick vs. Thin Biotype	35	NR	NR	-	35
Ma et al. (2019)	Prospective cohort	No comparison	28	9	2	93	17
Malchiodi et al. (2013)	Prospective cohort	No comparison	64	0	NR	-	64
McAllister et al. (2012)	Prospective cohort	No comparison	61	13	2	97	46
Noelken et al. (2011)	Prospective cohort	No comparison	18	0	0	100	18
Rosa et al. (2014)	Prospective cohort	No comparison	24	6	NR	-	18
Sato et al. (2017)	Prospective cohort	No comparison	16	0	NR	-	16
Seyssens et al. (2020)	Prospective cohort	No comparison	22	3	NR	-	19
Tortamano et al. (2010)	Prospective cohort	No comparison	12	0	0	100	12
Yang et al. (2019)	Prospective cohort	Thin vs. Thick Facial Bone	50	0	NR	-	50
Arora and Ivanovski (2018a)	Retrospective cohort	Type 1a vs. 1c	20	-	-	-	20
Bonnet et al. (2018)	Retrospective cohort	No comparison	39	-	-	-	39
Bruno et al. (2014)	Retrospective cohort	No comparison	17	-	-	-	17
Degidi et al. (2013)	Retrospective cohort	No comparison	10	-	-	-	10
Groenendijk et al. (2017)	Retrospective cohort	No comparison	16	-	-	-	16
Hartlev et al. (2013)	Retrospective cohort	No comparison	55	-	-	-	55
Khzam et al. (2014)	Retrospective cohort	No comparison	15	-	-	-	15
Kolerman, Nissan, Rahmanov, et al. (2016)	Retrospective cohort	No comparison	34	-	-	-	34
Lombardo et al. (2016)	Retrospective cohort	No comparison	21	-	-	-	21
Mangano et al. (2012)	Retrospective cohort	No comparison	26	-	-	-	26
Mangano et al. (2013)	Retrospective cohort	No comparison	22	-	-	-	22
Menchini-Fabris et al. (2019)	Retrospective cohort	No comparison	76	-	-	-	76
Mijiritsky et al. (2021)	Retrospective cohort	No comparison	23	-	-	-	23
Noelken, Moergel, Pausch, et al., 2018	Retrospective cohort	No comparison	26	-	-	-	26
Norton (2011)	Retrospective cohort	No comparison	68	-	-	-	68
Paul and Held (2013)	Retrospective cohort	No comparison	31	-	-	-	31
Ribeiro et al. (2008)	Retrospective cohort	No comparison	46	-	-	-	46
Ross et al. (2014)	Retrospective Cohort	No comparison	47	-	-	-	47
Saedi Germi et al. (2020)	Retrospective Cohort	No comparison	18	-	-	-	18
Shanelec (2005)	Retrospective Cohort	No comparison	100	-	-	-	100
Spinato et al. (2012)	Retrospective Cohort	No comparison	45	-	-	-	45
Tarnow et al. (2014)	Retrospective Cohort	No comparison	34	-	-	-	34
Valentini et al. (2010)	Retrospective Cohort	No comparison	24	-	-	-	24
Van Nimwegen et al. (2016)	Retrospective Cohort	No comparison	51	-	-	-	51
Vidigal Jr. et al. (2017)	Retrospective Cohort	No comparison	53	-	-	-	53

Abbreviations: BL, bone level; NR, not reported; P, parallel/cylindrical; T, tapered; TL, tissue level.

Mean follow-up (months)	Total number of failures	Early failures <6 m	Late failures 6 m+	Survival rate (%)	Success rate (%)	Success criteria reported	Implant details	Implant diameters	Implant lengths	Implant design
12	1	1	0	97.2	97.2	Y	JDentalCare, JDEvolution	4.3–5 mm	13–15 mm	BL, T
12	0	0	0	100.0	93	Y	Nobel Active	3–4.3 mm	11.5–18 mm	BL, T
24	6	5	1	93.5	NR	N	Nobel Replace	3.5–6 mm	13–16 mm	BL, T
48	0	0	0	100	100	Y	Nobel Replace	NR	NR	BL, T
60	0	0	0	100	NR	N	Southern Co-Axis	4 mm	13–15 mm	BL, T
36	0	0	0	100	100	Y	NR	3.25–4.9 mm	10–16 mm	BL, T
24	1	1	0	97.8	NR	N	Nobel Active	4.3–5 mm	10–15 mm	BL, T
22	0	0	0	100	94	Y	Nobel Perfect	3.5–5 mm	16 mm	TL, P
58.56	0	0	0	100	100	Y	Nobel replace	3.5–5 mm		BL, T
12	0	0	0	100	NR	N	Neodent CM drive	3.5–5 mm	13–16 mm	BL, T
120	2	1	1	91	NR	N	Nobel Active	NR	NR	BL, T
18	0	0	0	100	NR	N	Straumann tapered effect	4.1 mm	12 mm	TL, P
12	0	0	0	100	NR	N	Nobel active, straumann bone level, dentium	NR	NR	BL, P or T
36	0	0	0	100	95	Y	Dentsply Astra Tech TX	NR	NR	BL, P
48	0	0	0	100	100	Y	Nobel Replace/Active	NR	NR	BL, T
12	0	0	0	100	NR	N	Nobel Replace	NR	NR	BL, T
18	0	0	0	100	NR	N	Dentsply Ankylos	3.5–4.5 mm	14-17 mm	BL, T
25	0	0	0	100	NR	N	Nobel Active	3.5–4.3 mm	NR	BL, T
33	1	1	0	98	NR	N	Nobel Replace	3.5–6 mm	13–16 mm	BL, T
23	0	0	0	100	NR	Y	Dentsply Astra Tech TX	3.5–5 mm	13–15 mm	BL, P
29	0	0	0	100	88	Y	MIS Seven	3.3–5 mm	13–16 mm	BL, T
24	1	1	0	95.2	NR	N	Bicon	NR	NR	BL, T
24	0	0	0	100	100	Y	Leone Implant System	4.1–4.8 mm	NR	BL, T
31.09	0	0	0	100	100	Y	Leone Implant System	3.3–4.8 mm	NR	BL, P
36	0	0	0	100	NR	N	Sweden & Martina, Outlink	3.75–4.1 mm	NR	BL, T
187.37	0	0	0	100	100	Y	Dentsply Xive, Frialit 2, MIS Seven	3.3–5.5 mm	13–15 mm	BL, T
30	0	0	0	100	100	Y	Dentsply, Astra Tech TX	3.5–5 mm	15–17 mm	BL, P
24	3	3	0	95.5	NR	N	Dentsply, Astra Tech TX	3.5–5 mm	11–17 mm	BL, P
40.8	0	0	0	100	100	Y	Nobel Perfect	NR	16 mm	BL, T
27.1	3	3	0	93.5	93.5	Y	Conexão	3.5–6 mm	10–15 mm	BL, T
60	0	0	0	100	100	Y	Nobel Replace	3.5–4.3 mm	13–16 mm	TL, T
12	0	0	0	100	NR	N	NR	NR	NR	NR
18	2	2	0	98	98	Y	Bränemark Mark IV	4 mm	13–18 mm	BL, P
32	0	0	0	100	NR	N	Zimmer Screw-Vent	3.7–4.7 mm	11.5–16 mm	BL, P
27	0	0	0	100	NR	N	NR	NR	NR	NR
34	0	0	0	100	NR	N	Dentsply, Astra Tech TX	4.5–5 mm	13 mm +	BL, P
48	2	2	0	96.9	NR	Y	BioMet 3i, Certain	3.25–4.5 mm	10-15 mm	BL, P
51	2	2	0	96.2	NR	N	NR	NR	NR	NR

TABLE 6 Comparison of weighed survival rates and weighed average study time by inclusion criteria and publication year.

	Entire timeline						Within first 6 months			
	Analyzed sample						Analyzed sample			
	Number of Studies	Number of Implants	Survival % (Overall survival)		Avg. study time (years)		Number of studies	Number of implants	Survival % (early survival)	
Overall	68	2531	97.708 (96.911; 98.442)		2.665 (2.272; 3.136)		67	2493	98.275 (97.571; 98.819)	
Medical status										
Healthy	41	1329	97.413 (96.026; 98.353)	p = .06	3.212 (2.706; 4.114)	p < .001*	40	1291	97.986 (97.117; 98.764)	p = .14
Smokers	20	808	98.806 (97.454; 99.578)		1.967 (1.513; 2.350)		20	808	99.010 (97.826; 99.660)	
Occlusal scheme										
Contacts	10	337	97.498 (95.142; 99.359)	p = .94	2.294 (1.722; 2.983)	p = .23	10	337	98.813 (95.763; 100.00)	p = .42
No contacts	47	1746	97.410 (96.322; 98.280)		2.861 (2.392; 3.565)		46	1708	97.892 (97.099; 98.584)	
Facial bone wall										
Defects	17	698	98.200 (96.543; 99.149)	p = .52	2.484 (1.773; 3.358)	p = .85	17	698	98.567 (97.228; 99.381)	p = .56
Intact	42	1342	97.660 (96.311; 98.576)		2.581 (2.160; 3.144)		41	1304	98.160 (97.253; 98.876)	
Soft tissue quality										
Excluded	8	245	98.387 (95.901; 99.590)	p = .83	3.155 (2.532; 4.567)	p = .10	8	245	98.776 (96.954; 99.682)	p = .98
Included	17	745	98.627 (97.538; 99.459)		2.293 (1.630; 3.051)		17	745	98.792 (97.751; 99.538)	
Gap dimension										
Less than 2 mm	8	341	95.918 (94.167; 97.838)	p = .04*	2.491 (2.084; 3.841)	p = .91	8	341	96.481 (95.125; 98.138)	p = .04*
More than 2 mm	12	472	99.014 (96.589; 100.00)		2.322 (1.433; 5.195)		12	472	99.153 (97.056; 100.00)	
Mucoperiosteal flap										
Flap	14	482	97.067 (95.355; 98.605)	p = .37	2.851 (1.996; 3.938)	p = .63	14	482	97.718 (96.230; 98.930)	p = .44
Flapless	49	1763	97.928 (96.733; 98.727)		2.601 (2.185; 3.275)		48	1725	98.319 (97.417; 98.994)	
Endodontic infection										
No Infection	18	618	96.162 (93.930; 97.851)	p = .004*	2.287 (1.869; 2.761)	p = .88	17	580	97.069 (95.644; 98.404)	p = .007*
Incl. chronic / excl. acute	24	910	98.892 (97.806; 99.579)		2.168 (1.674; 3.644)		24	910	99.121 (98.064; 99.663)	
Periodontal disease										
Excluded	43	1435	97.387 (96.113; 98.370)	p = .46	2.479 (2.035; 3.004)	p = .33	41	1397	98.210 (97.183; 98.995)	p = .87
Included	10	374	98.202 (95.781; 99.512)		3.201 (2.111; 6.526)		10	374	98.396 (96.154; 99.525)	
Insertion torque										
35 and more	24	841	97.517 (96.447; 98.485)	p = .54	2.541 (1.912; 3.422)	p = 34	24	841	98.216 (97.225; 99.041)	p = .99
Less than 35	19	575	98.117 (96.352; 99.218)		3.089 (2.297; 5.169)		19	575	98.261 (96.593; 99.302)	

TABLE 6 (Continued)

	Entire timeline						Within first 6 months				
	Analyzed sample						Analyzed sample				
	Number of Studies	Number of Implants	Survival % (Overall survival)		Avg. study time (years)		Number of studies	Number of implants	Survival % (early survival)	
Bone graft										
Autogenous	11	378	97.269 (94.778; 99.322)	p = .49	3.655 (2.642; 6.937)	p = .11	11	378	97.619 (95.455; 99.392)	p = .44
Xenograft	21	617	98.063 (96.614; 99.255)		2.481 (1.755; 3.459)		21	617	98.379 (97.116; 99.372)	
Soft tissue graft										
No	61	2171	97.604 (96.566; 98.407)	p = .31	2.723 (2.332; 3.296)	p = .44	60	2133	98.265 (97.530; 98.877)	p = .96
Yes	7	360	98.335 (97.224; 99.380)		2.318 (1.609; 3.376)		7	360	98.333 (97.222; 99.381)	
Publication year										
Before 2012	17	689	96.262 (94.270; 97.620)	p = .02*	2.028 (1.700; 2.460)	p = .005*	16	651	97.235 (95.878; 98.294)	p = .04*
From 2012	51	1842	98.249 (97.425; 98.912)		2.904 (2.416; 3.620)		51	1842	98.643 (97.951; 99.200)	

Note: Values are presented as means (95% CI). Comparisons as of bootstrap tests. Statistically significant p-values are marked with an asterisk ("*").

Moergel, Pausch, et al., 2018; Norton, 2011; Rosa et al., 2014; Slagter et al., 2021; Valentini et al., 2010; Zuiderveld et al., 2018). The thickness of facial bone was only considered in eight studies (Bittner et al., 2020; Bushahri et al., 2021; Cardaropoli et al., 2019; Groenendijk et al., 2017; Kolerman, Nissan, Rahmanov, et al., 2016; Noelken, Moergel, Pausch, et al., 2018; Seyssens et al., 2020; Yang et al., 2019), with thicknesses ranging from 0 to 1.6 mm, and no studies reported a minimum of 1 mm facial bone thickness as an inclusion criterion.

3.5.6 | Mucoperiosteal flap

Flapless immediate implant placement was performed in 49 of the included studies (Arora & Ivanovski, 2018a, 2018b; Berberi, Sabbagh, et al., 2014; Bittner et al., 2020; Block et al., 2009; Bonnet et al., 2018; Bruno et al., 2014; Bushahri et al., 2021; Cabello et al., 2013; Canullo et al., 2010; Canullo, Goglia, et al., 2009; Canullo & Rasperini, 2007; Cardaropoli et al., 2015, 2019; Cosyn et al., 2016; Crespi et al., 2008; Degidi et al., 2013; Ferrara et al., 2006; Grandi et al., 2013; Grandi, Garuti, Samarani, et al., 2012; Groenendijk et al., 2017, 2021; Groisman et al., 2003; Hartlev et al., 2013; Kan et al., 2011; Khzam et al., 2014; Ma et al., 2019; Malchiodi et al., 2013; Menchini-Fabris et al., 2019; Migliorati et al., 2015; Mijiritsky et al., 2021; Noelken et al., 2011; Noelken, Moergel, Pausch, et al., 2018; Paul & Held, 2013; Pieri et al., 2011; Ribeiro et al., 2008; Rosa et al., 2014; Saedi Germi et al., 2020; Sato et al., 2017; Seyssens et al., 2020; Shanelec, 2005; Slagter et al., 2021; Spinato et al., 2012; Tarnow et al., 2014; Tortamano et al., 2010; Van Nimwegen et al., 2016; Vidigal Jr. et al., 2017; Yang et al., 2019; Zuiderveld et al., 2018). The use of a minimal mucoperiosteal flap was reported in three studies (Berberi, Noujeim, et al., 2014; Cosyn et al., 2011; Cristalli et al., 2015), with a further 11 studies reporting raising a full-thickness mucoperiosteal flap for the purpose of extraction and immediate implant placement (Calvo-Guirado et al., 2009; Cooper et al., 2014; Di Alberti et al., 2012; Ganeles et al., 2017; Kolerman, Nissan, Rahmanov, et al., 2016; Mangano et al., 2012, 2013; Norton, 2011; Raes, Eghbali, et al., 2018; Ross et al., 2014; Valentini et al., 2010).

3.5.7 | Presence of endodontic infection

Eighteen studies reported the presence of endodontic infection as an exclusion criteria (Berberi, Noujeim, et al., 2014; Berberi, Sabbagh, et al., 2014; Block et al., 2009; Canullo & Rasperini, 2007; Cosyn et al., 2016; Degidi et al., 2013; Ferrara et al., 2006; Groisman et al., 2003; Hartlev et al., 2013; Khzam et al., 2014; Kolerman, Nissan, Rahmanov, et al., 2016; Pieri et al., 2011; Ribeiro et al., 2008; Spinato et al., 2012; Tarnow et al., 2014; Tortamano et al., 2010; Valentini et al., 2010; Zuiderveld et al., 2018), with eight studies excluding acute infection (Canullo et al., 2010; Canullo, Goglia, et al., 2009; Cardaropoli et al., 2015, 2019; Cosyn et al., 2011; Degidi et al., 2014;

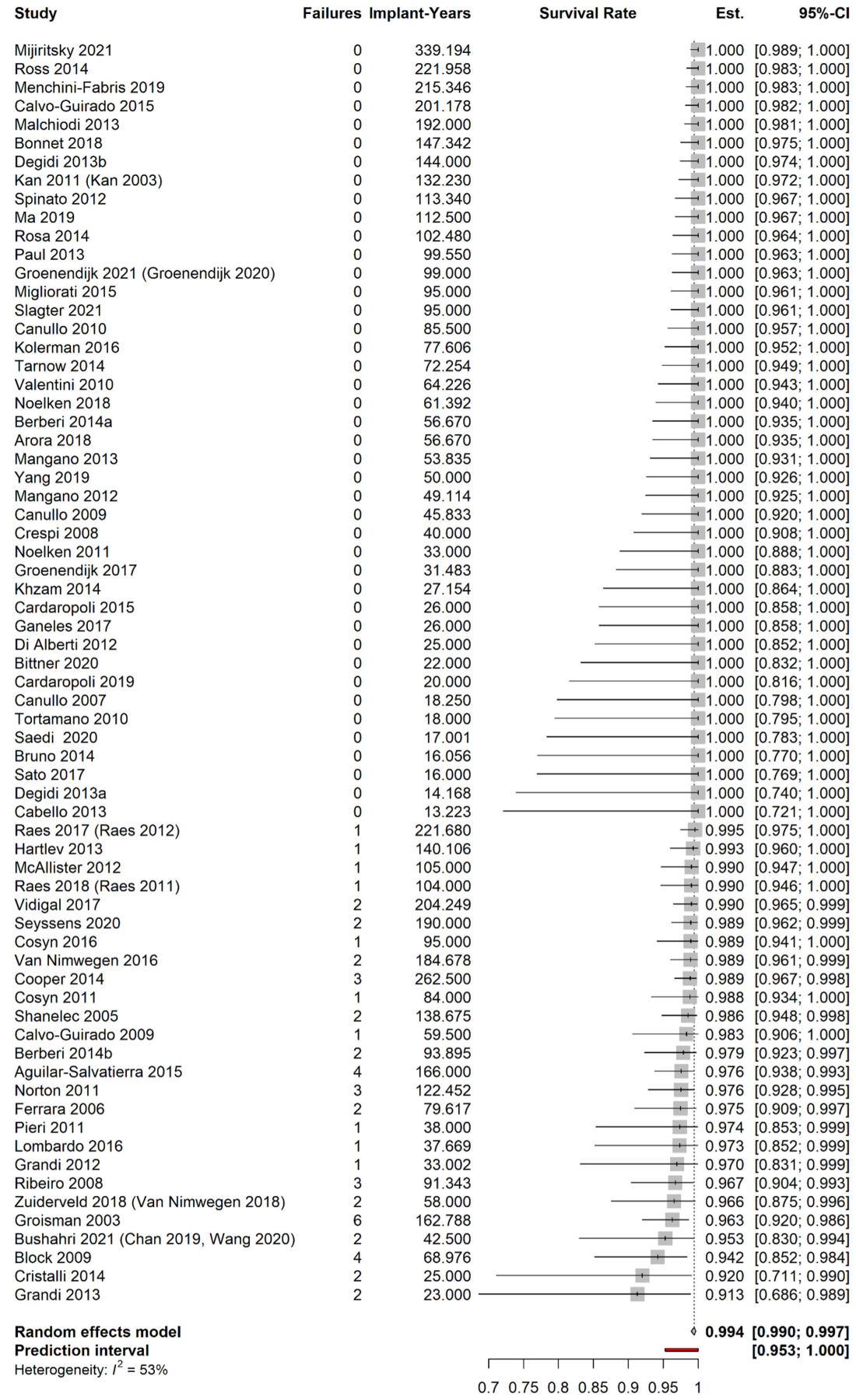

FIGURE 2 Estimated survival rate per observed implant-years for each study with calculated mean survival rate and prediction interval from meta-analysis.

TABLE 7 Results of the meta-analysis (first line) with an additional sensitivity analysis. Influential studies removed: Groisman et al. (2003), Block et al. (2009), Grandi et al. (2013), and Cristalli et al. (2015).

Analysis	Mean S_Y + 95% CI	PI	Heterogeneity I^2 + 95% CI
Main model	99.4% (99.0%; 99.7%)	(95.3%; 100%)	53% (25%; 74%)
Influential studies removed	99.5% (99.1%; 99.7%)	(97.5%; 100%)	34% (0%; 64%)

Note: Mean S_Y = Estimated mean survival rate per observed implant-year.
Abbreviations: I^2 = heterogeneity measure; PI, prediction interval.

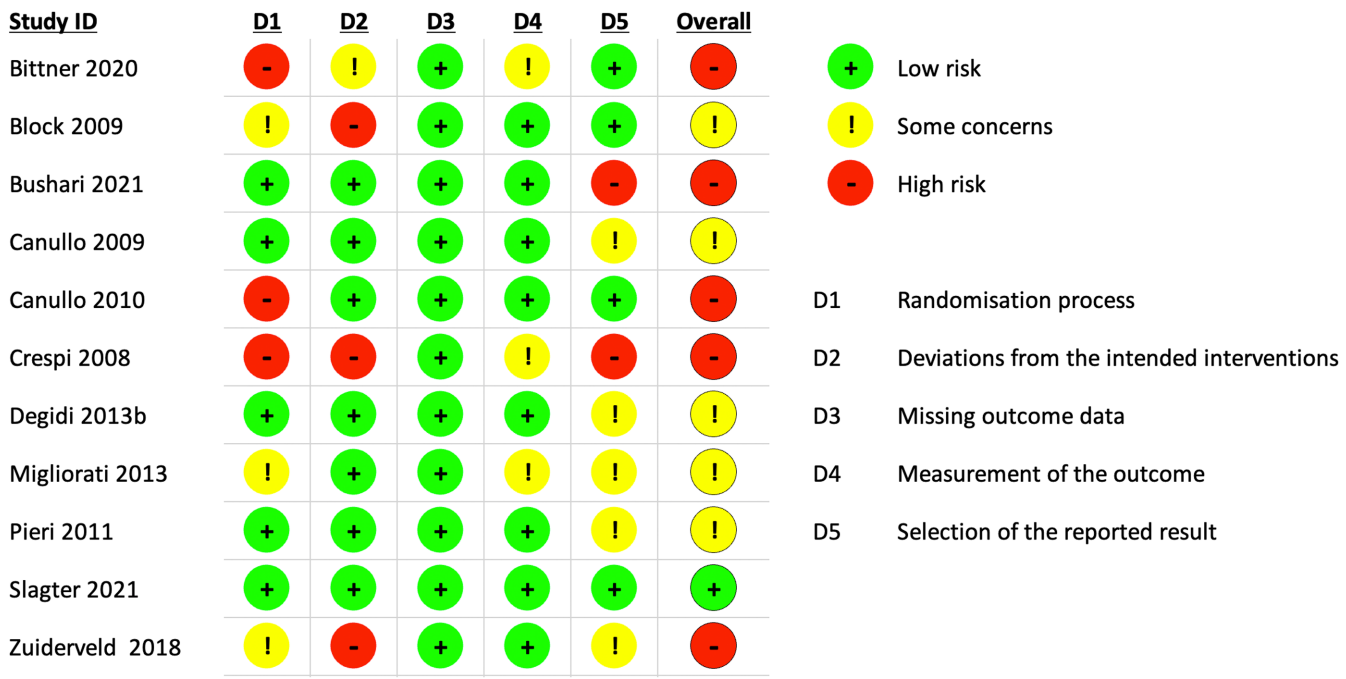

FIGURE 3 Risk of bias assessment for randomized control trials using the Cochrane RoB2 tool.

McAllister et al., 2012; Yang et al., 2019) and sixteen studies included sites with chronic infection and only excluded acute endodontic infection (Arora & Ivanovski, 2018a, 2018b; Bittner et al., 2020; Calvo-Guirado et al., 2009; Crespi et al., 2008; Cristalli et al., 2015; Di Alberti et al., 2012; Grandi et al., 2013; Grandi, Garuti, Samarani, et al., 2012; Groenendijk et al., 2017, 2021; Kan et al., 2011; Malchiodi et al., 2013; Mangano et al., 2012; Migliorati et al., 2015; Mijiritsky et al., 2021; Noelken, Moergel, Pausch, et al., 2018). Studies including chronic endodontic infection often reported that some sites with apical fenestration of the labial cortical bone were included. However, no reports mentioned the presence of a chronic draining fistula and breach of the labial mucosa as being included.

3.5.8 | Presence of periodontal disease

The presence of periodontal disease was an exclusion criterion in 43 studies (Aguilar-Salvatierra et al., 2016; Arora & Ivanovski, 2018a, 2018b; Berberi, Noujeim, et al., 2014; Berberi, Sabbagh, et al., 2014; Bittner et al., 2020; Block et al., 2009; Bonnet et al., 2018; Bushahri et al., 2021; Cabello et al., 2013; Canullo et al., 2010; Canullo & Rasperini, 2007; Cardaropoli et al., 2019; Cosyn et al., 2016; Degidi et al., 2013; Ferrara et al., 2006; Groenendijk et al., 2017, 2021; Groisman et al., 2003; Hartlev et al., 2013; Khzam et al., 2014; Lombardo et al., 2016; Ma et al., 2019; Mangano et al., 2012, 2013; McAllister et al., 2012; Migliorati et al., 2015; Noelken, Moergel, Pausch, et al., 2018; Pieri et al., 2011; Raes et al., 2017; Raes, Eghbali, et al., 2018; Ribeiro et al., 2008; Rosa et al., 2014; Saedi Germi et al., 2020; Sato et al., 2017; Seyssens et al., 2020; Spinato et al., 2012; Tarnow et al., 2014; Tortamano et al., 2010; Valentini et al., 2010; Vidigal Jr. et al., 2017; Yang et al., 2019; Zuiderveld et al., 2018), with only 10 studies including patients with a history of treated periodontal disease (Calvo-Guirado et al., 2015; Cosyn et al., 2011; Cristalli et al., 2015; Di Alberti et al., 2012; Grandi et al., 2013; Grandi, Garuti, Samarani, et al., 2012; Kan et al., 2011; Kolerman, Nissan, Rahmanov, et al., 2016; Malchiodi et al., 2013; Mijiritsky et al., 2021) and 1 study excluding periodontal acute infection (Cardaropoli et al., 2015).

TABLE 8 Risk of bias assessment for nonrandomized studies using the Newcastle–Ottawa scale.

Authors & Year	Type of study	Selection	Comparability	Outcome	AHRQ
Berberi, Tehini, et al. (2014)	Controlled clinical trial	**	*	**	Fair
Cooper et al. (2014)	Controlled clinical trial	***	**	***	Good
Di Alberti et al. (2012)	Controlled clinical trial	*	*	**	Poor
Grandi et al. (2013)	Controlled clinical trial	**	*	**	Fair
Raes et al. (2017)	Controlled clinical trial	***	**	**	Good
Raes, Eghbali, et al. (2018)	Controlled clinical trial	**	*	**	Fair
Aguilar-Salvatierra et al. (2016)	Prospective cohort	**	*	**	Fair
Berberi, Noujeim, et al. (2014)	Prospective cohort	**	*	**	Fair
Cabello et al. (2013)	Prospective cohort	**	*	**	Fair
Calvo-Guirado et al. (2009)	Prospective cohort	**	*	**	Fair
Calvo-Guirado et al. (2015)	Prospective cohort	**	*	**	Fair
Canullo and Rasperini (2007)	Prospective cohort	**	*	**	Fair
Cardaropoli et al. (2015)	Prospective cohort	**	*	**	Fair
Cardaropoli et al. (2019)	Prospective cohort	**	*	**	Fair
Cosyn et al. (2011)	Prospective cohort	**	*	***	Fair
Cosyn et al. (2016)	Prospective cohort	**	*	**	Fair
Cristalli et al. (2015)	Prospective cohort	**	*	**	Fair
Ferrara et al. (2006)	Prospective cohort	**	*	***	Fair
Ganeles et al. (2017)	Prospective cohort	**	*	***	Fair
Grandi, Garuti, Samarani, et al. (2012)	Prospective cohort	**	*	**	Fair
Groenendijk et al. (2021)	Prospective cohort	***	*	**	Good
Groisman et al. (2003)	Prospective cohort	**	*	***	Fair
Kan et al. (2011)	Prospective cohort	***	*	***	Good
Ma et al. (2019)	Prospective cohort	**	*	**	Fair
Malchiodi et al. (2013)	Prospective cohort	***	*	***	Good
McAllister et al. (2012)	Prospective cohort	**	*	***	Fair
Noelken et al. (2011)	Prospective cohort	**	*	***	Fair
Rosa et al. (2014)	Prospective cohort	**	*	**	Fair
Sato et al. (2017)	Prospective cohort	**	*	**	Fair
Seyssens et al. (2020)	Prospective cohort	***	*	***	Good
Tortamano et al. (2010)	Prospective cohort	***	*	***	Good
Yang et al. (2019)	Prospective cohort	***	**	**	Good
Arora and Ivanovski (2018a)	Retrospective cohort	***	*	***	Good
Bonnet et al. (2018)	Retrospective cohort	**	*	***	Fair
Bruno et al. (2014)	Retrospective cohort	***	*	**	Good
Degidi et al. (2013)	Retrospective cohort	*	*	***	Poor
Groenendijk et al. (2017)	Retrospective cohort	**	*	**	Fair
Hartlev et al. (2013)	Retrospective cohort	***	*	**	Good
Khzam et al. (2014)	Retrospective cohort	***	*	**	Good
Kolerman, Nissan, Rahmanov, et al. (2016)	Retrospective cohort	***	*	***	Good
Lombardo et al. (2016)	Retrospective cohort	***	*	***	Good
Mangano et al. (2012)	Retrospective cohort	**	*	***	Fair
Mangano et al. (2013)	Retrospective cohort	**	*	***	Fair
Menchini-Fabris et al. (2019)	Retrospective cohort	***	**	***	Good

TABLE 8 (Continued)

Authors & Year	Type of study	Selection	Comparability	Outcome	AHRQ
Mijiritsky et al. (2021)	Retrospective cohort	***	*	***	Good
Noelken, Moergel, Pausch, et al., 2018	Retrospective cohort	***	**	***	Good
Norton (2011)	Retrospective cohort	**	*	***	Fair
Paul and Held (2013)	Retrospective cohort	**	*	***	Fair
Ribeiro et al. (2008)	Retrospective cohort	***	*	***	Good
Ross et al. (2014)	Retrospective cohort	**	*	***	Fair
Saedi Germi et al. (2020)	Retrospective cohort	***	*	***	Good
Shanelec (2005)	Retrospective cohort	**	*	***	Fair
Spinato et al. (2012)	Retrospective cohort	**	*	***	Fair
Tarnow et al. (2014)	Retrospective cohort	**	**	***	Fair
Valentini et al. (2010)	Retrospective cohort	**	*	***	Fair
Van Nimwegen et al. (2016)	Retrospective cohort	***	**	***	Good
Vidigal Jr. et al. (2017)	Retrospective cohort	**	**	***	Fair

Note: The asterisks are part of the Newcastle Ottowa Scale (NOS) for risk of bias assessment, so are described in the manual for NOS: https://www.ohri.ca/programs/clinical_epidemiology/oxford.asp

3.5.9 | Facial gap (horizontal defect dimension—HDD)

The presence of a gap between the implant and facial bone wall was reported in 56 studies (Arora & Ivanovski, 2018a, 2018b; Berberi, Noujeim, et al., 2014; Berberi, Sabbagh, et al., 2014; Bittner et al., 2020; Block et al., 2009; Bonnet et al., 2018; Bruno et al., 2014; Bushahri et al., 2021; Cabello et al., 2013; Calvo-Guirado et al., 2009; Canullo et al., 2010; Canullo, Goglia, et al., 2009; Canullo & Rasperini, 2007; Cardaropoli et al., 2015, 2019; Cosyn et al., 2016; Cristalli et al., 2015; Degidi et al., 2013; Di Alberti et al., 2012; Ferrara et al., 2006; Grandi et al., 2013; Grandi, Garuti, Samarani, et al., 2012; Groenendijk et al., 2017, 2021; Groisman et al., 2003; Hartlev et al., 2013; Kan et al., 2011; Khzam et al., 2014; Kolerman, Nissan, Rahmanov, et al., 2016; Lombardo et al., 2016; Ma et al., 2019; Mangano et al., 2012; Migliorati et al., 2015; Mijiritsky et al., 2021; Noelken et al., 2011; Noelken, Moergel, Pausch, et al., 2018; Norton, 2011; Paul & Held, 2013; Pieri et al., 2011; Raes, Eghbali, et al., 2018; Rosa et al., 2014; Ross et al., 2014; Saedi Germi et al., 2020; Sato et al., 2017; Seyssens et al., 2020; Shanelec, 2005; Slagter et al., 2021; Spinato et al., 2012; Tarnow et al., 2014; Tortamano et al., 2010; Valentini et al., 2010; Van Nimwegen et al., 2016; Vidigal Jr. et al., 2017; Yang et al., 2019; Zuiderveld et al., 2018). The size of the gaps varied between 1 and 4 mm, with most studies reporting placing biomaterial into the gap. Biomaterials utilized for socket grafting in conjunction with Type 1A protocols included deproteinized bovine bone mineral xenograft (22 studies—Arora & Ivanovski, 2018a; Arora & Ivanovski, 2018b; Bittner et al., 2020; Bonnet et al., 2018; Bruno et al., 2014; Canullo, Goglia, et al., 2009; Canullo & Rasperini, 2007; Cardaropoli et al., 2015; Cardaropoli et al., 2019; Cosyn et al., 2011; Cosyn et al., 2016; Cristalli et al., 2015; Degidi et al., 2013; Grandi et al., 2013; Grandi, Garuti, Samarani, et al., 2012; Groenendijk et al., 2017; Groenendijk et al., 2021; Khzam et al., 2014; Migliorati et al., 2015; Paul & Held, 2013; Seyssens et al., 2020; Valentini et al., 2010; Vidigal Jr. et al., 2017), autogenous bone (11 studies—Berberi, Noujeim, et al., 2014; Berberi, Sabbagh, et al., 2014; Ferrara et al., 2006; Ganeles et al., 2017; Groisman et al., 2003; Kan et al., 2011; Malchiodi et al., 2013; Mijiritsky et al., 2021; Noelken et al., 2011; Noelken, Moergel, Pausch, et al., 2018; Rosa et al., 2014), autogenous bone and xenograft mixture (six studies—Norton, 2011; Pieri et al., 2011; Shanelec, 2005; Slagter et al., 2021; Van Nimwegen et al., 2016; Zuiderveld et al., 2018), human allograft (six studies—Block et al., 2009; Bushahri et al., 2021; Kolerman, Nissan, Rahmanov, et al., 2016; Ross et al., 2014; Saedi Germi et al., 2020; Tarnow et al., 2014), alloplastic graft materials (three studies—Canullo et al., 2010; Lombardo et al., 2016; Mangano et al., 2012), and alloplastic/allograftor/xenograft on the same study (three studies—McAllister et al., 2012; Sato et al., 2017; Yang et al., 2019). Only one study reported placing large implants to minimize the gap between the implant and the extraction socket's facial bone wall (Ferrara et al., 2006).

3.5.10 | Extraction

Minimally traumatic extraction techniques to minimize damage to the surrounding alveolar bone and soft tissues were reported in 59 studies (Arora & Ivanovski, 2018a, 2018b; Berberi, Noujeim, et al., 2014; Bittner et al., 2020; Block et al., 2009; Bonnet et al., 2018; Bruno et al., 2014; Bushahri et al., 2021; Cabello et al., 2013; Canullo et al., 2010; Canullo, Goglia, et al., 2009; Canullo & Rasperini, 2007; Cardaropoli et al., 2015, 2019; Cosyn et al., 2011, 2016; Crespi et al., 2008; Cristalli et al., 2015; Degidi et al., 2013, 2014; Di Alberti et al., 2012; Ferrara et al., 2006; Grandi et al., 2013; Grandi, Garuti,

TABLE 9 Reported study criteria for inclusion/exclusion categorized based on risk assessment.

Authors & year	Medical status—standardized reporting	Occlusal scheme	Occlusal parafunction included or excluded (I/E/NR)	Pre-op gingival margin position	Soft tissue quality (thin phenotype)—include I or exclude E	CTG performed at time of implant placement (Y/N)	Bone Anchorage standardized	Facial Bone Wall presence—small defects up to 3 mm, large 3 mm +	Facial Bone Wall thickness
Bittner et al. (2020)	Healthy Patients	No Contacts	NR	E	I	N	NR	Intact Facial Bone	0.8 mm
Block et al. (2009)	Healthy Patients	No Contacts	NR	E	NR	N	Sufficient Bone	Intact Facial Bone	NR
Bushahri et al. (2021)	Healthy Patients	No Contacts	NR	NR	I	N	≥4 mm bone height	Small Defects Included	1 mm
Canullo, Goglia, et al. (2009)	Healthy Patients	No Contacts	NR	NR	I	N	≥3 mm bone height	Intact Facial Bone	NR
Canullo et al. (2010)	Healthy Patients	No Contacts	NR	E	I	N	≥4 mm bone height	Intact Facial Bone	NR
Crespi et al. (2008)	Healthy Patients	Limited Contacts	E	NR	NR	N	≥4 mm bone height	Intact Facial Bone	NR
Degidi et al. (2014)	Light Smokers	No Contacts	E	NR	NR	N	Sufficient Bone	Intact Facial Bone	NR
Migliorati et al. (2015)	Healthy Patients	No Contacts	NR	E	I	Y	Sufficient Bone	Small Defects Included	NR
Pieri et al. (2011)	Light Smokers	No Contacts	E	NR	NR	N	≥4 mm bone height	Intact Facial Bone	NR
Slagter et al. (2021)	NR	NR	NR	NR	NR	N	NR	Large defects Included	NR
Zuiderveld et al. (2018)	Healthy Patients	No Contacts	NR	NR	I	Y	NR	Large defects Included	NR
Berberi, Sabbagh, et al. (2014)	Healthy Patients	Limited Contacts	NR	NR	NR	N	≥5 mm bone height	Intact Facial Bone	NR
Cooper et al. (2014)	Healthy Patients	No Contacts	NR	NR	NR	N	NR	Large defects Included	NR
Di Alberti et al. (2012)	NR	Full Contact	NR	E	NR	N	NR	NR	NR
Grandi et al. (2013)	Diabetes and Light Smokers	No Contacts	NR	NR	NR	N	NR	Intact Facial Bone	NR

Mucoperiosteal flap	Presence of endodontic infection	Presence of periodontal disease	Presence of buccal gap (Y/N)	Gap dimensions (mm)	Graft material (none, auto, allo, xeno)	Extraction	Primary implant stability—insertion torque	Primary implant stability—resonance frequency analysis
Flapless	Chronic Infection Included	Periodontal disease excluded	Y	$\bar{x}$ =2.9 mm	Xenograft or None	Flapless	>20Ncm	NR
Flapless	Absence of infection	Periodontal disease excluded	Y	NR	Allograft	Minimally traumatic using periotomes	NR	>71 ISQ
Flapless	NR	Periodontal disease excluded	Y	$\bar{x}$ =2.7 mm	Allograft	Minimally traumatic	≥30	NR
Flapless	Absence of Acute Infection	NR	Y	>1 mm	Xenograft	Minimally traumatic using periotomes	32-45Ncm	NR
Flapless	Absence of Acute Infection	Periodontal disease excluded	Y	>1 mm	Alloplastic	Minimally traumatic using periotomes	32-45Ncm	NR
Flapless	Chronic Infection Included	NR	NR	NR	NR	Minimally traumatic	>25Ncm	>60 ISQ
Flapless	Absence of Acute Infection	NR	Y	2 mm	NR	Minimally traumatic	≥25Ncm	≥60 ISQ
Flapless	Chronic Infection Included	Periodontal disease excluded	Y	NR	Xenograft	Minimally traumatic	NR	NR
Flapless	Absence of infection	Periodontal disease excluded	Y	NR	Autogenous and Xenograft mix	Minimally traumatic using periotomes	≥40Ncm	NR
Flapless	NR	NR	Y	NR	Autogenous and Xenograft mix	Minimally traumatic using periotomes	NR	NR
Flapless	Absence of infection	Periodontal disease excluded	Y	NR	Autogenous and Xenograft mix	Minimally traumatic	≥45Ncm	NR
Flapless	Absence of infection	Periodontal disease excluded	Y	NR	Autogenous	NR	≥32Ncm	NR
Full-Thickness Flap	NR	NR	NR	NR	None	NR	NR	NR
Full-Thickness Flap	Chronic Infection Included	Treated Periodontal Disease Included	Y	2 mm	NR	Minimally traumatic using periotomes	≥40Ncm	>60 ISQ
Flapless	Chronic Infection Included	Treated Periodontal Disease Included	Y	NR	Xenograft	Minimally traumatic	≥45Ncm	NR

TABLE 9 (Continued)

Authors & year	Medical status—standardized reporting	Occlusal scheme	Occlusal parafunction included or excluded (I/E/NR)	Pre-op gingival margin position	Soft tissue quality (thin phenotype)—include I or exclude E	CTG performed at time of implant placement (Y/N)	Bone Anchorage standardized	Facial Bone Wall presence—small defects up to 3 mm, large 3 mm +	Facial Bone Wall thickness
Raes et al. (2017)	Healthy Patients	No Contacts	NR	NR	NR	N	NR	NR	NR
Raes, Eghbali, et al. (2018)	Healthy Patients	No Contacts	NR	E	E	N	Sufficient Bone	Intact Facial Bone	NR
Aguilar-Salvatierra et al. (2016)	Diabetes	Limited Contacts	NR	NR	NR	N	≥5 mm bone height	NR	NR
Berberi, Noujeim, et al. (2014)	Healthy Patients	Limited Contacts	NR	NR	NR	N	≥5 mm bone height	Intact Facial Bone	NR
Cabello et al. (2013)	Light Smokers	No Contacts	I	E	I	N	NR	Intact Facial Bone	NR
Calvo-Guirado et al. (2009)	Light Smokers	NR	I	NR	I	N	NR	Large defects Included	NR
Calvo-Guirado et al. (2015)	Light Smokers	Limited Contacts	NR	NR	I	N	≥5 mm bone height	NR	NR
Canullo and Rasperini (2007)	Light Smokers	No Contacts	NR	NR	I	N	NR	Intact Facial Bone	NR
Cardaropoli et al. (2015)	Light Smokers	No Contacts	NR	E	NR	N	NR	Intact Facial Bone	NR
Cardaropoli et al. (2019)	Healthy Patients	No Contacts	NR	E	NR	N	Sufficient Bone	Intact Facial Bone	0.8 mm
Cosyn et al. (2011)	Healthy Patients	No Contacts	E	E	E	N	≥5 mm bone height	Intact Facial Bone	NR
Cosyn et al. (2016)	Healthy Patients	No Contacts	E	E	E	N	≥5 mm bone height	Intact Facial Bone	NR
Cristalli et al. (2015)	Light Smokers	Limited Contacts	E	E	NR	N	≥4 mm bone height	Intact Facial Bone	NR
Ferrara et al. (2006)	Healthy Patients	No Contacts	E	NR	NR	N	Sufficient Bone	Intact Facial Bone	NR
Ganeles et al. (2017)	Light Smokers	No Contacts	E	NR	NR	N	NR	NR	NR

Mucoperiosteal flap	Presence of endodontic infection	Presence of periodontal disease	Presence of buccal gap (Y/N)	Gap dimensions (mm)	Graft material (none, auto, allo, xeno)	Extraction	Primary implant stability—insertion torque	Primary implant stability—resonance frequency analysis
NR	NR	Periodontal disease excluded	NR	NR	NR	NR	NR	NR
Full-Thickness Flap	NR	Periodontal disease excluded	Y	<2 mm or >2 mm	None	Minimally traumatic	≥25Ncm	NR
NR	NR	Periodontal disease excluded	NR	NR	NR	NR	≥35Ncm	>60 ISQ
Minimal Mucoperiosteal Flap	Absence of infection	Periodontal disease excluded	Y	NR	Autogenous	Minimally traumatic using periotomes	≥32Ncm	NR
Flapless	NR	Periodontal disease excluded	Y	NR	None	Minimally traumatic with Benex	NR	NR
Full-Thickness Flap	Chronic Infection Included	NR	Y	1 mm	None	NR	NR	>64 ISQ
NR	NR	Treated Periodontal Disease Included	NR	NR	NR	NR	NR	>60 ISQ
Flapless	Absence of infection	Periodontal disease excluded	Y	NR	Xenograft	Minimally traumatic using periotomes	32-45Ncm	NR
Flapless	Absence of Acute Infection	Acute periodontal infection excluded	Y	NR	Xenograft	Minimally traumatic	≥50Ncm	NR
Flapless	Absence of Acute Infection	Periodontal disease excluded	Y	≥2 mm	Xenograft	Minimally traumatic	≥35Ncm	NR
Minimal Mucoperiosteal Flap	Absence of Acute Infection	Treated Periodontal Disease Included	NR	NR	Xenograft	Minimally traumatic using periotomes	≥35Ncm	NR
Flapless	Absence of infection	Periodontal disease excluded	Y	NR	Xenograft	Minimally traumatic using periotomes	≥35Ncm	NR
Minimal Mucoperiosteal Flap	Chronic Infection Included	Treated Periodontal Disease Included	Y	$\bar{x}$ =2.73 mm	Xenograft	Minimally traumatic using periotomes	≥35Ncm	NR
Flapless	Absence of infection	Periodontal disease excluded	Minimal	<1 mm	Autogenous	Minimally traumatic	NR	NR
Full-Thickness Flap	NR	NR	NR	NR	Autogenous	NR	≥35Ncm	NR

TABLE 9 (Continued)

Authors & year	Medical status—standardized reporting	Occlusal scheme	Occlusal parafunction included or excluded (I/E/NR)	Pre-op gingival margin position	Soft tissue quality (thin phenotype)—include I or exclude E	CTG performed at time of implant placement (Y/N)	Bone Anchorage standardized	Facial Bone Wall presence—small defects up to 3 mm, large 3 mm +	Facial Bone Wall thickness
Grandi, Garuti, Samarani, et al. (2012)	Healthy Patients	No Contacts	NR	NR	NR	N	NR	Intact Facial Bone	NR
Groenendijk et al. (2021)	Light Smokers	NR	E	NR	I	N	≥5 mm bone height	Large defects Included	NR
Groisman et al. (2003)	NR	No Contacts	NR	E	NR	N	NR	NR	NR
Kan et al. (2011)	Healthy Patients	NR	E	E	I	N	NR	Intact Facial Bone	NR
Ma et al. (2019)	Healthy Patients	No Contacts	E	NR	NR	N	≥4 mm bone height	Small Defects Included	NR
Malchiodi et al. (2013)	Light Smokers	No Contacts	E	NR	E	N	NR	NR	NR
McAllister et al. (2012)	Healthy Patients	NR	E	NR	NR	N	NR	Small Defects Included	NR
Noelken et al. (2011)	Healthy Patients	No Contacts	NR	NR	NR	N	NR	Large Defects Included	NR
Rosa et al. (2014)	Healthy Patients	NR	NR	NR	I	N	Sufficient Bone	Large Defects Included	Missing
Sato et al. (2017)	Healthy Patients	NR	E	NR	NR	N	Sufficient Bone	Intact Facial Bone	NR
Seyssens et al. (2020)	Healthy, excluded smokers	No Contacts		E	NR	N	≥5 mm bone height	Intact Facial Bone	0.8 mm
Tortamano et al. (2010)	Healthy Patients	No Contacts	NR	NR	NR	N	Sufficient Bone	Intact Facial Bone	NR
Yang et al. (2019)	Healthy Patients	No Contacts	NR	NR	NR	N	Sufficient Bone	Intact Facial Bone	0 to >1 mm
Arora and Ivanovski (2018a)	Light Smokers	No Contacts	NR	NR	NR	N	Sufficient available bone	Intact Facial Bone	NR
Bonnet et al. (2018)	Healthy Patients	No Contacts	NR	NR	NR	Y	NR	Small Defects Included	NR

Mucoperiosteal flap	Presence of endodontic infection	Presence of periodontal disease	Presence of buccal gap (Y/N)	Gap dimensions (mm)	Graft material (none, auto, allo, xeno)	Extraction	Primary implant stability—insertion torque	Primary implant stability—resonance frequency analysis
Flapless	Chronic Infection Included	Treated Periodontal Disease Included	Y	NR	Xenograft	Minimally traumatic	≥30Ncm	NR
Flapless	Chronic Infection Included	Periodontal disease excluded	Y	≥2 mm	Xenograft	Minimally traumatic	NR	NR
Flapless	Absence of infection	Periodontal disease excluded	Y	>1 mm	Autogenous	Minimally traumatic using periotomes	NR	NR
Flapless	Chronic Infection Included	Treated Periodontal Disease Included	Y	NR	Autogenous	Minimally traumatic	NR	NR
Flapless	NR	Periodontal disease excluded	Y	1.5–3	None	Flapless	NR	Mean of 65.1 ISQ + -4.38
Flapless	Chronic Infection Included	Treated Periodontal Disease Included	NR	NR	Autogenous	Minimally traumatic using periotomes	NR	NR
NR	Absence of Acute Infection	Periodontal disease excluded	NR	NR	Xenograft, Allograft or Alloplastic	NR	≥35Ncm	NR
Flapless	NR	NR	Y	NR	Autogenous	Minimally traumatic	NR	NR
Flapless	NR	Periodontal disease excluded	Y	NR	Autogenous	Minimally traumatic using periotomes	≥35Ncm	NR
Flapless	NR	Periodontal disease excluded	Y	NR	Alloplastic or Xenograft	Minimally traumatic	NR	NR
Flapless	NR	Periodontal disease excluded	Y	NR	Xenograft	Minimally traumatic using periotomes	≥35Ncm	NR
Flapless	Absence of infection	Periodontal disease excluded	Y	NR	NR	Minimally traumatic	NR	NR
Flapless	Absence of Acute Infection	Periodontal disease excluded	Y	2 mm	Xenograft or Alloplastic	Minimally traumatic	≥35Ncm	NR
Flapless	Chronic Infection Included	Periodontal disease excluded	Y	NR	Xenograft	Minimally traumatic using periotomes	≥30Ncm	NR
Flapless	NR	Periodontal disease excluded	Y	NR	Xenograft	Minimally traumatic using periotomes	≥30Ncm	NR

TABLE 9 (Continued)

Authors & year	Medical status—standardized reporting	Occlusal scheme	Occlusal parafunction included or excluded (I/E/NR)	Pre-op gingival margin position	Soft tissue quality (thin phenotype)—include I or exclude E	CTG performed at time of implant placement (Y/N)	Bone Anchorage standardized	Facial Bone Wall presence—small defects up to 3 mm, large 3 mm +	Facial Bone Wall thickness
Bruno et al. (2014)	Light Smokers	Limited Contacts	E	E	NR	N	Sufficient available bone	Small Defects Included	
Degidi et al. (2013)	Light Smokers	No Contacts	E	NR	NR	N	NR	Intact Facial Bone	NR
Groenendijk et al. (2017)	Healthy Patients	NR	E	NR	NR	N	≥4 mm bone height	Intact Facial Bone	0.9 mm
Hartlev et al. (2013)	Light Smokers	No Contacts	E	NR	NR	N	NR	Small Defects Included	NR
Khzam et al. (2014)	Healthy Patients	No Contacts	NR	E	NR	N	NR	Intact Facial Bone	NR
Kolerman, Nissan, Rahmanov, et al. (2016)	Light Smokers	No Contacts	E	NR	NR	Y	≥5 mm bone height	Large defects Included	<1 mm or deficient
Lombardo et al. (2016)	Healthy Patients	NR	E	NR	NR	N	NR	Intact Facial Bone	NR
Mangano et al. (2012)	Light Smokers	Limited Contacts	E	NR	E	N	NR	Intact Facial Bone	
Mangano et al. (2013)	Healthy Patients	Limited Contacts	NR	E	E	N	NR	Intact Facial Bone	NR
Menchini-Fabris et al. (2019)	Healthy Patients	NR	E	NR	NR	N	≥4 mm bone height	Intact Facial Bone	NR
Mijiritsky et al. (2021)	Healthy Patients	No Contacts	E	NR	NR	N	NR	NR	NR
Noelken, Moergel, Pausch, et al. 2018	Light Smokers	No Contacts	NR	I	I	Y	Sufficient Bone	Large defects Included	0–1.5 mm
Norton (2011)	Diabetes & Light Smoker	No Contacts	NR	NR	NR	N	NR	Defects Included	NR
Paul and Held (2013)	Light Smokers	No Contacts	NR	NR	NR	N	NR	Intact Facial Bone	NR
Ribeiro et al. (2008)	Healthy Patients	No Contacts	NR	NR	NR	N	≥3 mm bone height & ≥5 mm Bone Width	Intact Facial Bone	NR

Mucoperiosteal flap	Presence of endodontic infection	Presence of periodontal disease	Presence of buccal gap (Y/N)	Gap dimensions (mm)	Graft material (none, auto, allo, xeno)	Extraction	Primary implant stability—insertion torque	Primary implant stability—resonance frequency analysis
Flapless	NR	NR	Y	$\bar{x}$ =1.5 mm	Xenograft	Minimally traumatic	≥35Ncm	≥65 ISQ
Flapless	Absence of infection	Periodontal disease excluded	Y	NR	Xenograft	Minimally traumatic	≥25Ncm	>60 ISQ
Flapless	Chronic Infection Included	Periodontal disease excluded	Y	2 mm	Xenograft	Minimally traumatic	≥40Ncm	NR
Flapless	Absence of infection	Periodontal disease excluded	Y	<2 mm	None	Minimally traumatic using periotomes	≥30Ncm	NR
Flapless	Absence of infection	Periodontal disease excluded	Y	NR	Xenograft	Minimally traumatic	≥30Ncm	NR
Full-Thickness Flap	Absence of infection	Treated Periodontal Disease Included	Y	NR	Allograft	Minimally traumatic using periotomes	≥32Ncm	NR
NR	NR	Periodontal disease excluded	Y	NR	Alloplastic	Minimally traumatic	NR	NR
Full-Thickness Flap	Chronic Infection Included	Periodontal disease excluded	Y	NR	Alloplastic	Minimally traumatic	NR	NR
Full-Thickness Flap	NR	Periodontal disease excluded	NR	NR	NR	Minimally traumatic	NR	NR
Flapless	NR	NR	NR	NR	None	Minimally traumatic using magnetic mallet	NR	NR
Flapless	Chronic Infection Included	Treated Periodontal Disease Included	Y	2 mm	Autogenous	Minimally traumatic using periotomes	≥32Ncm	NR
Flapless	Chronic Infection Included	Periodontal disease excluded	Y	NR	Autogenous	Minimally traumatic	NR	NR
Full-Thickness Flap	NR	NR	Y	1 mm	Autogenous and Xenograft mix	Minimally traumatic using periotomes	≤25Ncm	NR
Flapless	NR	NR	Y	1.5–2.5 mm	Xenograft	Flapless	NR	NR
Flapless	Absence of infection	Periodontal disease excluded	NR	NR	NR	Flapless	NR	NR

TABLE 9 (Continued)

Authors & year	Medical status—standardized reporting	Occlusal scheme	Occlusal parafunction included or excluded (I/E/NR)	Pre-op gingival margin position	Soft tissue quality (thin phenotype)—include I or exclude E	CTG performed at time of implant placement (Y/N)	Bone Anchorage standardized	Facial Bone Wall presence—small defects up to 3 mm, large 3 mm +	Facial Bone Wall thickness
Ross et al. (2014)	NR	No Contacts	NR	E	I	N	NR	Intact Facial Bone	NR
Saedi Germi et al. (2020)	Healthy Patients	NR	NR	E	E	N	Sufficient Bone	Intact Facial Bone	NR
Shanelec (2005)	NR	No Contacts	NR	I	I	Y	NR	Intact Facial Bone	NR
Spinato et al. (2012)	Healthy Patients	No Contacts	NR	NR	E	N	Sufficient Bone	Intact Facial Bone	NR
Tarnow et al. (2014)	Healthy Patients	No Contacts	E	E	NR	N	Sufficient Bone	Intact Facial Bone	NR
Valentini et al. (2010)	Healthy Patients	No Contacts	NR	NR	NR	N	Sufficient Bone	Large defects Included	NR
Van Nimwegen et al. (2016)	Healthy Patients	No Contacts	NR	NR	NR	N	NR	Intact Facial Bone	NR
Vidigal Jr. et al. (2017)	Healthy Patients	No Contacts	E	E	I	Y	Sufficient Bone	Intact Facial Bone	NR

Risk Categorization:

	Low Risk
	Medium Risk
	High Risk

Abbreviations: E, excluded; I, included; N, no; NR, not reported; Y, yes.

Samarani, et al., 2012; Groenendijk et al., 2017, 2021; Groisman et al., 2003; Hartlev et al., 2013; Kan et al., 2011; Khzam et al., 2014; Kolerman, Nissan, Rahmanov, et al., 2016; Lombardo et al., 2016; Ma et al., 2019; Malchiodi et al., 2013; Mangano et al., 2012, 2013; Menchini-Fabris et al., 2019; Migliorati et al., 2015; Mijiritsky et al., 2021; Noelken et al., 2011; Norton, 2011; Paul & Held, 2013; Pieri et al., 2011; Raes, Eghbali, et al., 2018; Ribeiro et al., 2008; Rosa et al., 2014; Ross et al., 2014; Saedi Germi et al., 2020; Sato et al., 2017; Seyssens et al., 2020; Shanelec, 2005; Slagter et al., 2021; Spinato et al., 2012; Tarnow et al., 2014; Tortamano et al., 2010; Van Nimwegen et al., 2016; Vidigal Jr. et al., 2017; Yang et al., 2019; Zuiderveld et al., 2018). Six Studies (Bittner et al., 2020; Ma et al., 2019; Paul & Held, 2013; Ribeiro et al., 2008; Ross et al., 2014; Spinato et al., 2012) reported that the extractions were performed via a flapless approach, while only one study reported that a mucoperiosteal flap was raised prior to tooth extraction (Valentini et al., 2010). The use of periotomes for syndesmotomy as part of the extraction process was reported in 24 studies (Arora & Ivanovski, 2018a, 2018b; Berberi, Noujeim, et al., 2014; Block et al., 2009; Bonnet et al., 2018; Canullo et al., 2010; Canullo, Goglia, et al., 2009; Canullo & Rasperini, 2007; Cosyn et al., 2011, 2016; Cristalli et al., 2015; Di Alberti et al., 2012; Groisman et al., 2003; Hartlev et al., 2013; Kolerman, Nissan, Rahmanov, et al., 2016; Malchiodi et al., 2013; Mijiritsky et al., 2021; Norton, 2011; Pieri et al., 2011; Rosa et al., 2014; Saedi Germi et al., 2020; Seyssens et al., 2020; Shanelec, 2005; Slagter et al., 2021; Van Nimwegen et al., 2016), with one study reporting the use of a magnetic mallet (Menchini-Fabris et al., 2019) and another utilizing a vertical extraction system (Cabello et al., 2013). No studies reported the use of piezo surgery as part of the extraction process.

3.5.11 | Primary stability

The implant insertion torque value was the most commonly reported criteria for evaluation of primary implant stability in 42 of the included

Mucoperiosteal flap	Presence of endodontic infection	Presence of periodontal disease	Presence of buccal gap (Y/N)	Gap dimensions (mm)	Graft material (none, auto, allo, xeno)	Extraction	Primary implant stability—insertion torque	Primary implant stability—resonance frequency analysis
Full-Thickness Flap	NR	NR	Y	NR	Allograft	Flapless	≥35Ncm	NR
Flapless	NR	Periodontal disease excluded	Y	NR	Allograft	Minimally traumatic using periotomes	≥35Ncm	NR
Flapless	NR	NR	Y	NR	Autogenous and Xenograft mix	Minimally traumatic using periotomes	NR	NR
Flapless	Absence of infection	Periodontal disease excluded	Y	$\bar{x}$ =2.14 mm	None	Flapless	≥35Ncm	NR
Flapless	Absence of infection	Periodontal disease excluded	Y	NR	Allograft	Minimally traumatic	≥35Ncm	NR
Full-Thickness Flap	Absence of infection	Periodontal disease excluded	Y	NR	Xenograft	Flap elevation	≥40Ncm	NR
Flapless	NR	NR	Y	NR	Autogenous and Xenograft mix	Minimally traumatic using periotomes	≥35Ncm	NR
Flapless	NR	Periodontal disease excluded	Y	NR	Xenograft	Minimally traumatic	≥35Ncm	NR

studies (Aguilar-Salvatierra et al., 2016; Arora & Ivanovski, 2018a, 2018b; Berberi, Noujeim, et al., 2014; Berberi, Sabbagh, et al., 2014; Bittner et al., 2020; Bonnet et al., 2018; Bruno et al., 2014; Bushahri et al., 2021; Canullo et al., 2010; Canullo, Goglia, et al., 2009; Canullo & Rasperini, 2007; Cardaropoli et al., 2015, 2019; Cosyn et al., 2011, 2016; Crespi et al., 2008; Cristalli et al., 2015; Degidi et al., 2013, 2014; Di Alberti et al., 2012; Ganeles et al., 2017; Grandi et al., 2013; Grandi, Garuti, Samarani, et al., 2012; Groenendijk et al., 2017; Hartlev et al., 2013; Khzam et al., 2014; Kolerman, Nissan, Rahmanov, et al., 2016; McAllister et al., 2012; Mijiritsky et al., 2021; Norton, 2011; Pieri et al., 2011; Raes, Eghbali, et al., 2018; Rosa et al., 2014; Ross et al., 2014; Saedi Germi et al., 2020; Seyssens et al., 2020; Spinato et al., 2012; Tarnow et al., 2014; Valentini et al., 2010; Van Nimwegen et al., 2016; Vidigal Jr. et al., 2017; Yang et al., 2019; Zuiderveld et al., 2018). A minimum insertion torque threshold of 30–45 Ncm was used for immediate loading in 34 studies (Aguilar-Salvatierra et al., 2016; Arora & Ivanovski, 2018a, 2018b; Berberi, Noujeim, et al., 2014; Berberi, Sabbagh, et al., 2014; Bonnet et al., 2018; Bruno et al., 2014; Bushahri et al., 2021; Canullo et al., 2010; Canullo, Goglia, et al., 2009; Canullo & Rasperini, 2007; Cardaropoli et al., 2019; Cosyn et al., 2011, 2016; Cristalli et al., 2015; Di Alberti et al., 2012; Ganeles et al., 2017; Grandi, Garuti, Samarani, et al., 2012; Groenendijk et al., 2017; Hartlev et al., 2013; Khzam et al., 2014; Kolerman, Nissan, Rahmanov, et al., 2016; McAllister et al., 2012; Mijiritsky et al., 2021; Pieri et al., 2011; Rosa et al., 2014; Ross et al., 2014; Saedi Germi et al., 2020; Seyssens et al., 2020; Spinato et al., 2012; Tarnow et al., 2014; Valentini et al., 2010; Van Nimwegen et al., 2016; Vidigal Jr. et al., 2017; Yang et al., 2019). Five studies used 20–25 Ncm as the minimum insertion torque threshold for immediate loading (Crespi et al., 2008; Degidi et al., 2013, 2014; Norton, 2011; Raes, Eghbali, et al., 2018). One study assessed Type 1A with a relatively low insertion torque of less than 25 Ncm (Bittner et al., 2020). Three studies reported a relatively high minimum insertion torque at or above 45 Ncm (Cardaropoli et al., 2015; Grandi et al., 2013; Zuiderveld et al., 2018). Resonance frequency analysis (RFA) for determination of primary stability and suitability for loading

was reported in 10 studies (Aguilar-Salvatierra et al., 2016; Block et al., 2009; Bruno et al., 2014; Calvo-Guirado et al., 2009, 2015; Crespi et al., 2008; Degidi et al., 2013, 2014; Di Alberti et al., 2012; Ma et al., 2019), with minimum thresholds ranging from 60 to 71 ISQ (implant stability quotient).

3.5.12 | Occlusion

Occlusal criteria for immediate loading was reported in 57 studies, with 47 studies reporting no occlusal contacts on immediately loaded restorations (Arora & Ivanovski, 2018a, 2018b; Bittner et al., 2020; Block et al., 2009; Bonnet et al., 2018; Bushahri et al., 2021; Cabello et al., 2013; Canullo et al., 2010; Canullo, Goglia, et al., 2009; Canullo & Rasperini, 2007; Cardaropoli et al., 2015, 2019; Cooper et al., 2014; Cosyn et al., 2011, 2016; Degidi et al., 2013, 2014; Ferrara et al., 2006; Ganeles et al., 2017; Grandi et al., 2013; Grandi, Garuti, Samarani, et al., 2012; Groisman et al., 2003; Hartlev et al., 2013; Khzam et al., 2014; Kolerman, Nissan, Rahmanov, et al., 2016; Ma et al., 2019; Malchiodi et al., 2013; Migliorati et al., 2015; Mijiritsky et al., 2021; Noelken et al., 2011; Noelken, Moergel, Pausch, et al., 2018; Norton, 2011; Paul & Held, 2013; Pieri et al., 2011; Raes et al., 2017; Raes, Eghbali, et al., 2018; Ribeiro et al., 2008; Ross et al., 2014; Seyssens et al., 2020; Shanelec, 2005; Spinato et al., 2012; Tarnow et al., 2014; Tortamano et al., 2010; Valentini et al., 2010; Van Nimwegen et al., 2016; Vidigal Jr. et al., 2017; Yang et al., 2019; Zuiderveld et al., 2018). Limited occlusal contacts were reported in nine studies (Aguilar-Salvatierra et al., 2016; Berberi, Noujeim, et al., 2014; Berberi, Sabbagh, et al., 2014; Bruno et al., 2014; Calvo-Guirado et al., 2015; Crespi et al., 2008; Cristalli et al., 2015; Mangano et al., 2012, 2013), with only one study (Di Alberti et al., 2012) reporting that the immediate restorations were in full occlusal contact.

3.6 | Intention-to-treat analysis

Only 23 studies reported whether all included patients were able to complete the prospectively assigned treatment protocol, or whether treatment protocols had to be varied due to intra-operative criteria not being met (Bittner et al., 2020; Block et al., 2009; Bushahri et al., 2021; Canullo et al., 2010; Canullo, Goglia, et al., 2009; Cardaropoli et al., 2015, 2019; Cooper et al., 2014; Cosyn et al., 2011, 2016; Crespi et al., 2008; Cristalli et al., 2015; Degidi et al., 2014; Ferrara et al., 2006; Grandi et al., 2013; Ma et al., 2019; McAllister et al., 2012; Migliorati et al., 2015; Noelken et al., 2011; Pieri et al., 2011; Slagter et al., 2021; Tortamano et al., 2010; Zuiderveld et al., 2018). The most common reasons for not completing the planned Type 1A protocol were fracture of the facial bone during extraction and lack of desired insertion torque during immediate implant placement. The successful completion of the intention to treat with a Type 1A protocol ranged from 85% to 100%. The intention-to-treat analysis is hampered by the heterogeneity in the timepoint in which studies consider a patient/site to be included as a prospective participant of a Type 1A protocol.

4 | DISCUSSION

4.1 | Quality of included studies and validity of methods

This report summarizes the results and comparisons regarding reported survival rates from 68 included papers. Of the 68 studies, 11 RCTs were included for review. This systematic review aimed to assess the impact-specific patient and site characteristics reported for a single intervention, Type 1A immediate implant placement, and immediate loading of single implants in the maxillary esthetic zone. When assessing the impact of patient characteristics, an RCT study design is not directly applicable with only the treatment groups which were of Type 1A treatment protocol included in this analysis and carry the same weight as a prospective cohort study. The inclusion of study designs other than RCTs is appropriate within the design of this systematic review and provides clinically relevant data for descriptive reporting. The authors acknowledge that with the inclusion of lower-quality case series and retrospective studies, there is an inherent risk of bias; however, even these studies report using strict patient and site selection criteria.

Statistical assessment of survival rates from studies with different time horizons without detailed information on failures and dropouts and with missing data is not an easy task as there are multiple pitfalls. Performing a meta-analysis on raw survival rates without any correction for study duration would yield an easily interpretable, but highly problematic outcome as studies lasting 10 years would be put on the same level as studies lasting 1 year (same study size). On the other hand, performing a meta-analysis with study duration correction as presented in this paper—it has its origins in epidemiology—, the corrected outcomes ensure a fair comparison, but may feel strange as they are not in the usually reported spheres. In an iterative procedure, the authors thus agreed to additionally assess data in a simpler way in form of univariate (multivariate was not possible due to the small database) group-wise mean comparisons with cautious interpretation and to present these results in the first place along with the results from the time-corrected meta-analysis as complementary analysis.

As the distribution of the survival rates was skewed, non-normal, and with a lot of identical values (many having 100%), *p*-values for comparisons of both survival rates and average study duration were calculated with the help of bias-corrected bootstrap tests and presented with bias-corrected bootstrap confidence intervals. Bootstrap tests are tests that are based on resampling and are superior to common mean tests as they have a bias correction and do not follow parametric distributions. However, as it is common for nonparametric/semi-parametric methods, bootstrap tests lack statistical power compared to parametric alternatives, and also, study heterogeneity is not specifically modeled. Due to missing

combinations, a multivariate analysis was not possible so further confounding effects cannot be ruled out, as discussed further below.

Coming back to the here presented meta-analysis, the obtained heterogeneity measure I^2 of 53% can be interpreted as "moderate" (Higgins & Thompson, 2002) and is particularly low for a meta-analysis of this size. Eliminating the four most influential studies leads to an even lower I^2 of 34%.

Another limitation of this design and results, which may be an indicator for the lack of statistically significant differences, is that although the criteria reported have different thresholds, which formed the basis of our analysis, many patients in the study may be quite far beyond the threshold values, that is, the study may report a minimum threshold of 25 Ncm insertion torque, however, one site may have been at 25 Ncm, with the remaining sites all above 40 Ncm and this would not be reported. The search strategy used in this study limited the results to publications in English only which may exclude some relevant data.

4.2 | Implant survival with type 1A treatment protocols

The estimated weighed mean overall survival rate for Type 1A protocols for single implants in the maxillary esthetic zone is 97.7%, which is consistent with other systematic reviews (Atieh et al., 2009; Chen & Buser, 2014; Cosyn et al., 2019; Gallucci et al., 2018; Garcia-Sanchez et al., 2022; Pommer et al., 2021; Slagter et al., 2014; Zhou et al., 2021).

The short-term mean follow-up time of all included studies at 32 months or 2.7 years (2.3; 3.1) should be considered when assessing the survival outcomes of Type 1A protocols. The rate of failures is also not linear, with the majority of failures occurring during the initial healing period prior to osseointegration. This may be related to immediate loading protocols employed, and this is often attributed to the patients who experience early failures, however, similar rates of early implant failures are reported with unloaded implants as a result of surgical- and patient-related factors (Clauser et al., 2022).

Systematic reviews which only included longer studies with longer follow-up durations include very few studies and report comparable survival rates with Type 1A protocols (Pommer et al., 2021). As the vast majority of failures with Type 1A protocols reported within the study timeframes occurred early within the first 6 months, it could be questioned as to whether the treatment protocol will continue to have an outcome effect in the long term once osseointegration has been established (Schrott et al., 2014).

Univariate bootstrap tests show that studies before 2012 report a significantly lower survival rate. This is not surprising when looking at the proportions of studies reporting incidences. Before 2012, 9 of 17 or 52.9% report a loss, while since 2012, only 17 of 51 = 33.3% report a loss. A reason is surely that clinicians have grown in experience and the technology and clinical techniques have advanced, however, one should not forget the impact of publication bias, that is, studies that are not published due to "inadequate" results due to increasing commercial pressures.

4.3 | Reported patient and site selection criteria for type 1A treatment protocols

All the included studies utilizing a Type 1A treatment protocol report highly selective inclusion and exclusion criteria. The only site-specific criteria which were found to influence survival in this systematic review was the size of the facial gap, however, this is based on only 20 of the included 68 studies, and the presence of chronic endodontic infection. Sites that presented with a gap of over 2 mm between the socket facial bone wall and implant at the time of implant placement were associated with higher implant survival rates (99.0% vs. 95.9%, $p = .04$). This finding may be related to the negative effects of facial implant positioning and using wider implant diameters that completely fill the socket. On the other hand, all studies reporting gaps ≥2 mm were published from 2012 and later so the higher survival rates here might also be related to advances in implant technology and more proficient surgery experience.

The significantly lower survival rate in studies that did not include patients with endodontic infections (96.2% vs. 98.9% for studies with patients with infections) is surprising and unexpected. Although the parameter may be slightly confounded with publication year and gap dimension as most studies including infection have a gap dimension ≥2 mm, there may be other, unknown associated factors that might affect implant survival. Current evidence indicates that placement of immediate dental implants into extraction sites with chronic peri-apical infections, provided appropriate clinical procedures are performed to debride the socket prior to implant placement (Chen et al., 2018; Chrcanovic et al., 2015; Fugazzotto, 2012; Waasdorp et al., 2010; Zuffetti et al., 2017).

Statistically significant differences were not found between survival rates for all the other reported patient and site characteristics. This can indicate that the site characteristics may not influence to a large degree the survival of implants. It also must be considered that survival is a relatively weak outcome measure and does not give an indication of clinically significant parameters such as esthetics, peri-implant tissue health, surrounding bone volume, alveolar ridge dimensions, and patient-reported outcome measures.

Few studies reported individual inclusion criteria which are considered higher risk for complications with Type 1A protocols.

Where higher-risk anatomical criteria were included, such as large defects of the facial bone wall and gingival recession, there was a tendency toward performing adjunct procedures such as connective tissue grafting, and/or raising full-thickness mucoperiosteal flaps to facilitate guided bone regeneration procedures.

4.4 | Intention-to-treat analysis (ITT) for type 1A treatment protocols

The intention-to-treat analysis is important for understanding how often can a chosen procedure be successfully completed in a given site/patient (Hollis & Campbell, 1999). As also reported in previous systematic reviews (Schrott et al., 2014), most studies did not include patients until the intervention has been successfully completed. As

such they do not report sites in which the intervention was aborted due to procedural complications or intra-operative assessments that deemed the site no longer suitable to continue with immediate implant placement or immediate loading. It is also not reported how many patients were screened as potential participants that did not meet the inclusion criteria and the reasons for exclusion.

Two studies reported a relatively high proportion of sites that did not meet the procedural criteria to continue with a Type 1A protocol. Cristalli et al., 2015 reported 4 of 28 sites having defects in the facial plates following extraction rendering an intention to treat of 86% (Cristalli et al., 2015). Ferrara et al., 2006 reported 6 of 39 implants that did not have sufficient primary stability to continue with immediate loading with an ITT of 85%, which may be related to the implant design utilized in the study (Ferrara et al., 2006).

4.5 | Clinical significance

This article highlights the importance of strict patient and site selection for Type 1A implant protocols since the literature on compromised sites is lacking. The risk assessment table provides a framework for clinicians to identify when sites may be indicated for Type 1A protocols when low-risk factors are present. The assessment categories and thresholds are based on the current knowledge and understanding of the clinical and preclinical literature regarding implant survival, as well as esthetic and biological outcomes (Araújo et al., 2022; Buser et al., 2017; Chappuis et al., 2013; Levine et al., 2022). Several of the risk assessment criteria for Type 1A, such as thickness of facial bone, soft tissue phenotype, esthetic risk, gingival margin position, and presence of a facial gap, are specifically targeted at achieving optimal esthetics in recognition of the dimensional alveolar ridge changes that occur following tooth extraction that can lead to compromised esthetic outcomes (Chen & Buser, 2009, 2014; den Hartog et al., 2008; Morton et al., 2014; Yang et al., 2019), and are unlikely to be influential in survival outcomes.

The risk thresholds are slightly more conservative than those reported as minimum inclusion criteria in the literature in recognition that the studies may include only very few patients who were close to this threshold, and the mean values in these studies, which the success and survival are based on, may be considerably higher. The risk assessment table should be periodically reviewed, and thresholds updated as new literature becomes available.

4.6 | Clinical recommendations

The studies included in this review on Type 1A immediate implant placement and loading protocols demonstrated high- to short-medium-term survival rates. The quantity and quality of evidence appear to be sufficient to justify these protocols as routine in sites and patients can be considered as low risk of complications. According to previously published validation criteria (Gallucci et al., 2009, 2018; Zhou et al., 2021), the literature included in the current systematic review would support that Type 1A protocols in the anterior maxilla can be considered clinically and scientifically validated when strict selection criteria are followed. Since the reported studies all had strict patient- and site-specific selection criteria for Type 1A protocols, the patient population and sites that this literature is applicable to may be limited, and further studies are required to expand upon the indications for this protocol.

Survival rates were used in this systematic review as they are the most commonly reported outcome measure in the dental literature. However, clinical decision-making needs to encompass factors that can influence implant success including the potential for esthetic, biological, mechanical, and technical complications. Until literature is present to demonstrate acceptable implant esthetic and survival outcomes of Type 1A implant treatment in compromised sites, to obtain predictable results it would be recommended to follow strict patient and site selection.

Where sites are presenting with local anatomical characteristics which are considered moderate-risk factors, such as thin facial bone, thin soft tissue phenotype, and minor gingival recession, adjunctive treatments such as connective tissue grafting (CTG) tend to be used, which suggests that they may be required to provide successful esthetic outcomes. Several systematic reviews have specifically assessed the influence of CTG on esthetic parameters reporting an improvement in soft tissue profile and less mucosal recession where CTG is used in conjunction with Type 1A protocols (Atieh & Alsabeeha, 2020; Seyssens et al., 2021).

Due to the lack of published studies, where patients and sites are identified as having high-risk factors, Type 1A protocols cannot be recommended for routine use.

Type 1A protocols are technically challenging and this may influence the ability to achieve the necessary procedural criteria to successfully complete the planned intervention. The experience of the clinician should be taken into consideration when electing to underate a Type 1A protocol, and should only be performed by experienced clinicians, particularly if sites present with any moderate-risk factors.

In this systematic review, 51 of the 68 included studies included reported grafting the gap between the implant and the facial bone wall when it was greater than 1 mm. The presence of a facial gap larger than 2 mm was univariately associated with increased survival rate and greater facial bone thickness when filled with bone substitutes, which is consistent with other literature (Atieh et al., 2009; Levine et al., 2022). Although regeneration of bone can occur without the placement of biomaterials into the gap, grafting is recommended to minimize the postextraction dimensional alveolar ridge changes (Araújo et al., 2022).

5 | CONCLUSION

Within the limitation of the present systematic review and range of studies included, Type 1A immediate implant placement and immediate loading for single implants in the maxillary esthetic zone has a

high survival rate. All the included studies demonstrated strict inclusion and exclusion criteria which highlights the importance of appropriate patient and site selection. A risk assessment tool is proposed based on the reported inclusion criteria, which can assist clinicians in identifying suitable sites indicated for Type 1A implant placement and loading protocols. Due to the limitations in using survival analysis for clinical decision-making, further research is required to assess esthetic and functional success with Type 1A protocols.

AUTHOR CONTRIBUTIONS

AH, LG, KA, JW, DM, WM, GG, and DW conceived the ideas and developed the methodology; LG and KA performed title and abstract screening; AH assisted in the screening as the third reviewer; AH, LG, and KA performed the full-text screening and data extraction; LM performed the statistical analysis; AH, LG, KA, JW, DM, WM, GG, and DW reviewed the statistical analysis; AH, LG, and KA lead the writing; AH, LG, KA, JW, LM, DM, WM, GG, and DW revised the manuscript critically for important intellectual content; and AH gave the final approval of the version to be submitted.

ACKNOWLEDGEMENTS

Open access publishing facilitated by The University of Western Australia, as part of the Wiley - The University of Western Australia agreement via the Council of Australian University Librarians.

CONFLICT OF INTEREST STATEMENT

The authors report no conflicts of interest related to this research.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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How to cite this article: Hamilton, A., Gonzaga, L., Amorim, K., Wittneben, J.-G., Martig, L., Morton, D., Martin, W., Gallucci, G. O., & Wismeijer, D. (2023). Selection criteria for immediate implant placement and immediate loading for single tooth replacement in the maxillary esthetic zone: A systematic review and meta-analysis. *Clinical Oral Implants Research*, *34(Suppl. 26)*, 304–348. https://doi.org/10.1111/clr.14109