Systematic Assessment of Clinical Outcomes in Bone-Level and Tissue-Level Endosseous Dental Implants

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Purpose: *The aim of the present systematic review was to address the following question: in patients treated with dental implants placed in pristine bone, what are the clinical and radiographic outcomes of bone-level (BL) implants in comparison to tissue-level (TL) implants after restoration with dental prostheses?* ***Materials and Methods:*** *Scanning of online literature databases from 1966 to January 2012, supplemented by hand searching, was conducted to identify relevant prospective randomized controlled trials, controlled clinical trials, and cohort studies. Sequential screenings at the title, abstract, and full-text levels were performed independently and in duplicate. A meta-analysis was conducted to compile data from the primary studies included in this systematic review.* ***Results:*** *The search strategy revealed a total of 5,998. Screening at the title level resulted in 752 papers, while screening at the abstract level yielded 92 publications. Full-text reading identified nine articles that fulfilled the inclusion criteria of this review. The pooled estimated difference between BL and TL implants in mean marginal bone loss was 0.05 mm (95% confidence interval [CI], –0.03 to 0.13 mm), with no statistically significant difference between the groups at 1 year after placement of the definitive prostheses. The relative risk of implant loss was estimated at 1.00 (95% CI, 0.99 to 1.02) at 1 year and at 1.01 (95% CI, 0.99 to 1.03) at 3 years after restoration, indicating no evidence of an increased risk of implant loss in BL compared to TL implants.* ***Conclusions:*** *No statistically significant differences in bone loss and survival rates were detected between BL and TL dental implants over a short-term observation period (1 to 3 years). Thus, both implant systems fulfill the requirements for the replacement of missing teeth in implant dentistry.* Int J Oral Maxillofac Implants 2012;27:1359–1374

Key words: *bone-level implants, bone loss, dental implants, implant outcomes, implant survival, systematic review, tissue-level implants*

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The use of osseointegrated dental implants to replace missing teeth has been proven to be successful in recent decades. Dental implants are available in different body designs, lengths/diameters, surface characteristics, and platforms. Conventionally, bone-level (BL), two-part implants were placed at the bone crest during the first-stage surgical procedure and allowed to heal submerged during the osseointegration period to minimize implant failures.[1] A second surgery was then performed to uncover the implants for the prosthetic reconstruction. Subsequently, BL implants were placed in a single-stage approach, with survival rates similar to those observed for the two-stage placement approach, to minimize morbidity and shorten treatment time.[2] Tissue-level (TL), one-part implants are typically placed transmucosally in a single-stage procedure, and the soft tissue attachment is established on the supracrestal part of the implant.[3]

Crestal bone resorption is typically observed around the neck of BL implants 1 year after surgical uncovering.[1,4] The characteristic "saucerization" seen around BL implants has vertical and horizontal components.[5] The

observed bone remodeling is thought to be related to the establishment of the biologic width around the implants.[6,7] In addition, it has been suggested that the microgap and the micromovement between the implant and the abutment in BL dental implant systems play a dominant role in the development of marginal bone loss and subsequent soft tissue recession.[4,8] The concept of platform switching (also called platform shifting or horizontal offset) was proposed to prevent bone resorption around BL implants. Clinicians have observed that when BL implants are restored with narrower prosthetic abutments, peri-implant marginal bone loss is minimized.[9] The centripetal displacement of the microgap and the associated microbial shift away from bone might protect against crestal bone destruction.

The transmucosal location of the microgap in TL implants seems to be advantageous because it is positioned at a distance from the bone crest.[3] However, long-term radiographic studies of TL dental implants also demonstrated peri-implant bone loss ranging from 0.6 to 1.0 mm during the first year of function and < 0.2 mm per year thereafter.[10,11]

The soft tissue collar around dental implants, consisting of the epithelial and connective tissue attachment, is of great importance with regard to protection of the underlying osseointegration.[12,13] The behavior of peri-implant soft tissue is influenced by marginal bone loss because of the underlying osseous support.[5]

Although both BL and TL implants have been used successfully for decades to replace missing natural teeth, the treatment outcomes of these two major implant types have not been evaluated with an evidence-based approach. A number of clinical trials have reported over the years on the short- and long-term clinical outcomes of both implant types. However, no firm conclusions, based on a systematic appraisal of the available literature, on the clinical performance of BL and TL implants have yet been drawn. Therefore, the present systematic review was carried out to investigate possible differences in clinical outcomes between TL and BL implants after at least 1 year of function. The answer to the following question was sought: In patients treated with dental implants placed in pristine bone, what are the clinical and radiographic outcomes of BL implants in comparison to TL implants after restoration with dental prostheses?

MATERIALS AND METHODS

Design of the Study

Before commencing the present systematic review, a comprehensive protocol was developed and successively approved by all authors. This detailed protocol incorporated several sections and research methods, including the search strategy, definition of eligibility, inclusion criteria, screening techniques, data extraction, quality assessment, and data synthesis/analysis.

Inclusion Criteria

1. All prospective controlled longitudinal studies reporting on clinical survival/success and radiographic outcomes of TL and BL osseointegrated dental implants were included (randomized controlled trials [RCTs], controlled clinical trials [CCTs], cohort studies, and case-control studies).
2. All included studies had to report on implants followed for at least 12 months after loading to observe long-term tissue behavior, rather than early tissue remodeling after loading.
3. Patients were partially or completely edentulous with fixed implant-supported prostheses supported by BL or TL implants. The arbitrary "cutoff" number of patients was set at 15 individuals per group (control/test, ie, a minimum of 30 patients in total for each study).
4. Studies with smokers and patients with a history of periodontitis were included.
5. Studies utilizing titanium endosseous implants with various surface modifications were included.

Exclusion Criteria

1. Case reports, case series, reviews, editorials, and retrospective studies were excluded.
2. Studies in patients with medical conditions possibly affecting implant therapy, such as cancer, uncontrolled diabetes mellitus, and intake of certain medications, were excluded.
3. Studies with transmandibular or zygomatic implants or with implants utilized for anchorage in orthodontics, for maxillofacial prostheses, or any other nondental use were also excluded.
4. Studies that reported on any form of soft tissue augmentation procedure done in conjunction with implant placement were excluded.
5. Studies that reported on simultaneous or staged implant placement in sites augmented laterally or vertically with bone augmentation techniques were excluded.
6. Studies of immediate loading or immediate implantation in extraction sites were excluded.
7. Studies that reported on implant-supported removable overdentures or partial dentures were excluded.
8. Studies that described the treatment of peri-implantitis were also excluded.

Types of Interventions. The following implant placement types were considered: (*1*) submerged two-stage placement of BL implants and (*2*) nonsubmerged single-stage placement of TL and BL implants.

Outcome Measures. Radiographically assessed marginal bone loss was considered as the primary outcome measure of the present systematic review. In addition, cumulative survival rates indicating that a certain percentage of implants were still present in the mouth at the end of the observation period were also regarded as an important outcome measure. Pocket probing depth (PPD), bleeding on probing (BoP), plaque scores, peri-implant soft tissue levels, and recession were considered secondary clinical outcomes.

Search Strategy

The search strategy incorporated examinations of electronic databases, supplemented by hand searches. A search on MEDLINE and EMBASE using the Ovid interface was conducted from 1966 up to and including the 30th of January 2012. The search strategy used a combination of MeSH terms and text words. The initial electronic search strategies formulated for MEDLINE were adapted from Esposito and coworkers[14] and later modified as appropriate for EMBASE. The following key words/search terms and their combinations were used: transmucosal, submucosal, tissue level, bone level, submerged, nonsubmerged, one stage, 1 stage, single stage, two stage, 2 stage, one piece, 1 piece, two piece, 2 piece, single piece, one part, 1 part, single part, two part, microgap, micro gap, microleakage, micro leakage, micromovement, micro movement, marginal bone, implant abutment interface, platform switch$, platform shift$, horizontal offset, non matching implant abutment, butt joint connection, Morse taper connection, external hexagonal connection, internal connection, alveolar bone loss, bone resorption, bone remodeling, gingival recession, healing, implant, placement, dental implant, dental implantation. Filters for RCT and CCT were applied.

These terms were then combined as: population/exposure AND intervention AND types of studies. The Cochrane Oral Health Group's Trial Register and the Cochrane Central Register of Controlled Trials were also screened for related studies following adapted search strategies.

In addition, the following journals were considered potentially important and were hand-searched for the present review: *British Journal of Oral and Maxillofacial Surgery, Clinical Implant Dentistry and Related Research, Clinical Oral Implants Research, European Journal of Oral Implantology, Implant Dentistry, International Journal of Oral & Maxillofacial Implants, International Journal of Oral and Maxillofacial Surgery, International Journal of Periodontics & Restorative Dentistry, International Journal of Prosthodontics, Journal of Clinical Periodontology, Journal of Dental Research, Journal of Oral Implantology, Journal of Oral and Maxillofacial Surgery, Journal of Periodontology*, and *Journal of Prosthetic Dentistry*.

Assessment of Study Eligibility and Data Extraction

Sequential Search Strategy. The comprehensive nature of the search methodology would result in a large volume of published studies on the topic. As such, a sequential screening process was performed independently and in duplicate (by IV and CK) to increase the relevance of the extracted data. Following the initial literature search, all article titles were screened (IV and CK) to eliminate irrelevant publications, review articles, case reports, and animal studies. Next, studies were excluded based on data from screening of the abstracts (IV and CK). The final stage of screening involved full-text reading and was performed by two reviewers (IV and CK) using a predetermined data extraction form to confirm the study's eligibility based on the inclusion and exclusion criteria.

The level of agreement regarding inclusion of potential studies was calculated by kappa statistics for all steps of the screening process. During each stage, all disagreements were resolved by discussion, and, if necessary, a third reviewer was consulted (AH). If consensus on the exclusion of an article was not achieved, the article was included in the next stage of screening.

Assessment of Methodologic Quality. Quality assessment of all the included studies was performed independently and in duplicate by two reviewers (JV and CK) during the data extraction process. The technique of assessment of the methodologic quality of the included studies has been used in other systematic reviews.[15,16] Briefly, the quality appraisal evaluated the methodologic elements that might influence the outcomes of each study, including sample size and power calculation, baseline homogeneity, explicitness of both inclusion and exclusion criteria, randomization methods, standardization of outcome assessment, reproducibility of measurements, examiner calibration and masking, follow-up details, and similarity of dropouts between groups. The reviewers assigned an overall score to each study to indicate a low, medium, or high risk of bias. A trial with low risk of bias fulfilled all the proposed quality assessment criteria. A study with a high risk of bias satisfied only some or none of the evaluated methodology factors.

Confounding Factors. Confounding factors, including medical history, smoking, and periodontal status, were also screened to determine whether they had been included and the appropriate adjustments made for them in the primary statistical analysis.

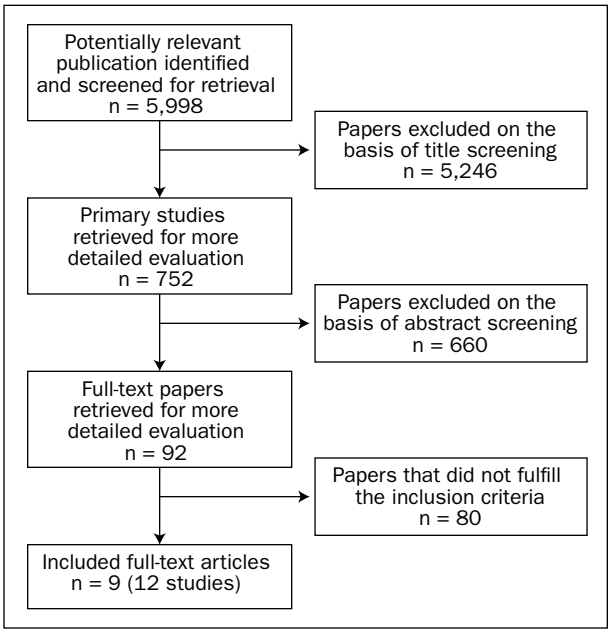

Fig 1 Flow chart of literature search and the selection of relevant clinical trials.

Data Extraction and Synthesis. Evidence tables were structured containing original data from the included studies. Descriptive analysis was undertaken to evaluate variations of the study characteristics, including populations, design, interventions, outcomes, and quality.

Statistical Analysis

A meta-analysis was performed to identify potential differences between BL and TL implants in relation to clinical and radiographic outcomes. To summarize and compare the studies included in this systematic review, primary data for continuous variable outcomes were pooled and analyzed using weighted mean differences and 95% confidence intervals (95% CI). The estimates of the effect were expressed as risk ratios and 95% CI for dichotomous variable outcomes. If a significant heterogeneity was not evident, the fixed effect model was adopted, whereas in cases of statistical heterogeneity, a random-effects meta-analysis was performed.

For each study, the outcome of interest was the mean difference between BL and TL implants. Means and standard deviations of both implant groups and for each outcome measure were required from all included studies to perform the meta-analysis. Forest plots were constructed to graphically present study-specific mean differences and summary estimates of the meta-analysis. All the meta-analyses were performed with STATA (StataCorp LP) statistical software, and the significance level was set at $P < .05$.

RESULTS

Study Characteristics

The electronic and manual searches of the literature provided 5,998 studies in total. Following screening of the article titles, 752 potentially relevant articles were identified. Independent screening of abstracts resulted in the selection of 92 publications for possible inclusion. Following full-text screening, 9 of the 92 studies met the predefined criteria and were included in the systematic review (Fig 1).

The nine studies consisted of four RCTs,[17–20] three CCTs,[21–23] and two prospective cohort studies.[24,25] Three of the publications were multicenter trials,[19,21,23] three were conducted in a private practice setting,[21,22,25] and six presented data from patients treated at respective university dental clinics.[17–20,23,24] Three additional publications fulfilled the inclusion criteria but were not eventually included because they covered the same patient populations of included studies at different time periods.[26–28]

The calculated interreviewer kappa values were 0.85 at the title level, 0.82 at the abstract level, and 0.92 for the final screening, indicating good agreement between the reviewers for all steps of the literature search strategy.[29]

Patient Characteristics

Table 1 describes the characteristics of the patients and interventions. In the four RCTs, 294 BL implants were placed in 153 patients and 273 TL implants were positioned in 161 patients. In the remaining prospective cohort studies, 244 patients received 501 TL implants and 239 individuals were treated with 631 BL implants. A few publications provided information on the smoking habits of patients. In the study of Åstrand and coworkers,[19] 7 of 28 patients (25%) were smokers (< 20 cigarettes daily), and two TL implants failed in smoking patients. In the study of Baelum and Ellegaard,[22] most of the participants (65%) were smokers, and TL and BL implants were equally distributed in smoking patients. In the study of Ozkan and coworkers,[24] 15 of 63 patients (23.8%) were light smokers (< 10 cigarettes/day), but the distribution of TL and BL implants among smokers was not provided. Bilhan et al excluded heavy smokers (> 20 cigarettes/day) from their study.[25]

The periodontal condition of patients was not discussed in six publications, while one study excluded patients with periodontitis.[19] In the Baelum and Ellegaard trial,[22] 57 BL and 201 TL implants were placed in periodontally compromised patients. All participants received periodontal therapy, including surgery, to eliminate pathologically deep pockets and were considered able to maintain high standards of oral hygiene at the time of implant insertion.[22]

The observation period ranged from 1 to 3 years in five studies with 671 BL and 454 TL implants in total.[18,19,21,22,24] Two studies with 119 BL and 90 TL implants reported 1-year results,[17,20] while one publication projected results over 5 and 10 years utilizing Kaplan-Meier estimates.[22] In the latter study, the 57 BL implants were observed for an average of 5.6 years (range, 0 to 10.6 years), while the 201 TL implants were followed for an average of 6.1 years (range, 0 to 14 years).[22] In another study, 78 BL implants (two different systems) and 29 TL implants were followed for 2 years.[25]

Intervention Characteristics

Eight different implant systems were utilized in the nine publications that fulfilled the inclusion criteria of this systematic review (Table 1).

BL Implant Systems. The most commonly used BL system was the Brånemark System (Nobel Biocare). In all, 276 Brånemark implants were placed in 195 patients.[18,19,21,23,25] The standard Brånemark machined surface was used in three studies, one trial used implants with the rough TiUnite surface,[25] and in one publication, the implant surface characteristics were not reported.[18]

Astra BL implants (Astra Tech Dental Implant Systems, Astra Tech) were utilized in three studies.[17,22,25] The Astra implant system is provided with a platform-switched abutment connection, with the manufacturer claiming that less bone loss will occur compared with conventional butt-joint connections.[30] In total, 145 Astra implants were positioned in 95 patients. A titanium oxide–blasted surface was used in two trials,[22,25] but no information was provided on surface characteristics in another study.[17]

Four additional BL systems were used in the remaining studies: the Frialit System (Friatec)[24]; the Ankylos System (Ankylos, Friadent), which is characterized by a rough-surfaced body with a progressive thread design and a machined neck[20]; the Camlog System (Camlog Biotechnologies)[24]; and the Oneplant System (Oneplant, Warantec), which has a sandblasted, acid-etched surface and a microthreaded neck.[20] In total, 45 Frialit, 35 Ankylos, 53 Camlog, and 38 Oneplant implants were placed in 63, 68, 63, and 68 patients, respectively.[20,24]

BL implants were customarily placed with a two-stage surgical protocol. However, BL implants were inserted in a single-stage surgical procedure in three of the included publications: 80 BL implants were placed in 29 patients by Becker et al,[21] 120 BL implants were placed in one group of 30 patients by Engquist et al,[23] and two groups of 38 and 35 BL implants were positioned in 68 patients by Shin et al.[20]

TL Implant Systems. The most frequently used TL implant system was the Straumann Dental Implant System (Straumann), which was utilized in seven studies.[17–19,21,22,24,25] In all, 652 Straumann implants were positioned in 315 patients. In two of the publications, 155 original titanium plasma–sprayed implants were placed in 53 patients.[19,21] Bilhan et al[25] placed 29 implants with a sandblasted, large grit, acid-etched surface (SLA, Straumann) in 26 patients. In another trial, Ozkan et al placed 105 Straumann implants but did not provide information on the surface characteristics or implant design.[24]

Two additional TL systems were used in the remaining studies. In one publication, 34 Lifecore TL implants (Lifecore Biomedical), characterized by a surface blasted with calcium phosphate ceramics, were placed in 68 patients.[20] Finally, the Brånemark conical TL implant (Nobel Biocare) was used in one publication, without further information regarding surface characteristics.[23] All TL implants were placed in all patients of the included trials in a nonsubmerged, single-stage protocol.

Outcome Variables

Outcome variables of the included studies are detailed in Table 2.

Primary Outcome Characteristics. Radiographic changes expressing marginal bone levels (MBLs) were provided in all studies incorporated in this systematic review. In most trials, MBL changes were evaluated from placement of the prosthesis to the time of various follow-up examinations (usually 1, 2, or 3 years). Two trials reported additional MBL measurements at implant insertion.[19,23] One study evaluated the proportion of implants with bone loss over longer observation periods utilizing Kaplan-Meier statistics.[22] The authors concluded that 95% of the BL implants and 94.4% of the TL implants did not show radiographic bone loss ≥ 3.5 mm at 5 years after insertion. The corresponding values at the 10-year examination remained stable for BL implants and dropped to 86.4% for the TL group.[22]

A random-effects meta-analysis was performed on bone loss from baseline to 1 year after placement of the definitive prosthesis because there was evidence of statistical heterogeneity (chi-squared = 977.9, degrees of freedom [df] = 9, $P < .001$, $I^2 = 99.1\%$). The weighted mean difference and 95% CI of MBL changes between BL and TL implants of the studies are presented in Fig 2. For trials that used two different BL implant systems[20,24,25] or placed a BL implant system in both single- and two-stage protocols,[23] individual differences were calculated in relation to the same TL implant group in each respective study (Fig 2). The pooled estimated difference between BL and TL implants in mean bone loss was 0.05 mm (95% CI: −0.03 to 0.13 mm), with no significant difference ($P = .2$) between the two implant groups (Fig 2). A meta-analysis on mean differences in MBL at 3 years after functional loading was not performed because of insufficient data from the included publications.

Table 1 Trial, Population, and Intervention Characteristics of the Included Studies

Study	Study design	Country	Recruitment	Implant manufacturer, type, surface	No. of surgeries
Kemppainen et al (1997)[17]	RCT parallel	Finland	University dental clinic	AST, BL, TiOB ITI, TL, TPS	Two One
Becker et al (2000)[21]	Not randomized MC (3 C)	USA	Private offices	BRS, BL, MAC BRS, BL, MAC ITI, TL, TPS	Two One One
Moberg et al (2001)[18]	RCT parallel	Sweden	University dental clinic	BRS, BL, MAC ITI, TL, TPS	Two One
Åstrand et al (2004)[19] (Åstrand et al [2002][27])	RCT, MC (5 C) Split-mouth	Sweden	University dental clinic	BRS, BL, MAC ITI, TL, TPS	Two One
Baelum and Ellegaard (2004)[22] (Ellegaard et al [1997][26])	Not randomized case-control	Denmark	Private office	AST, BL, TiOB ITI, TL. TPS	Two One
Engquist et al (2005)[23] (Engquist et al [2002][28])	CCT, MC (2 C) parallel	Sweden	University hospital dental clinics	BRS, BL, MAC BRS, BL, MAC BRS, TL, MAC	One Two One
Shin et al (2006)[20]	RCT	South Korea	University hospital dental clinics	1PL, BL, Microthreads ANK, BL, MAC neck LIF, TL, Rough neck	One One One
Ozkan et al (2007)[24]	Not randomized	Turkey	University dental clinic	FRI, BL, Unclear CAM, BL, Unclear ITI, TL, Unclear	Two Two One
Bilhan et al (2010)[25]	Not randomized	Turkey	Private office	AST, BL, TiOB BRS, BL, TU ITI, TL, SLA	Two Two One

ANK = Ankylos (Dentsply Friadent); AST = Astra (Astra Tech); BRS = Brånemark (Nobel Biocare); C = center; CAM = Camlog; CCT = controlled clinical trial; FPD = fixed partial denture; FRI = Frialit (Dentsply Friadent); IMP = implant; ITI = ITI (Straumann); LIF = Lifecore; MAC = machined; MC = multicenter; RCT = randomized controlled trial; SC = single crown; SLA = sandblasted/acid-etched (Straumann); TiOB = TiOblast (Astra Tech); TPS = titanium plasma-sprayed; TU = TiUnite (Nobel Biocare); 1PL = Oneplant (Warantec).

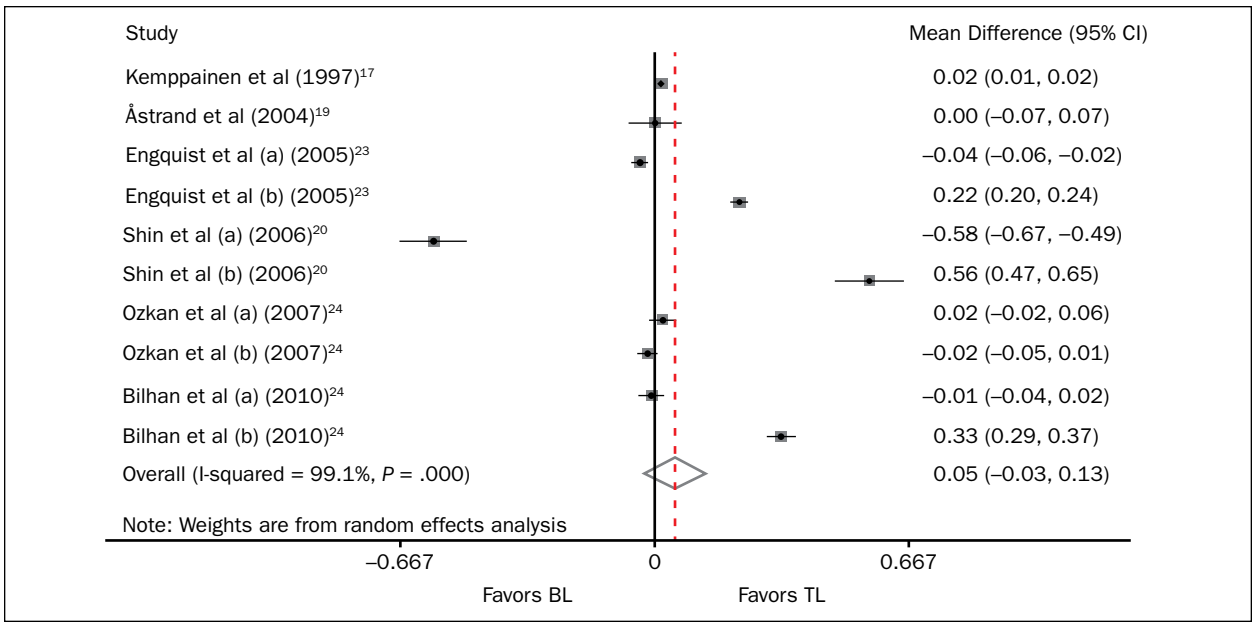

Fig 2 Meta-analysis of mean marginal bone loss at 1 year after restoration. Mean differences and 95% CI (in mm) for BL minus TL implants are presented for each study. For trials that employed two different BL implant systems[20,24,25] or placed a BL implant system in both single- and two-stage protocols,[23] individual weighted mean differences (a, b) were calculated.

Survival rate was defined as the percentage of implants present over the observation period in each study. A fixed-effects meta-analysis was conducted on implant survival at both 1 and 3 years after functional loading, because no evidence of statistical heterogeneity was detected (chi-squared = 3.48, df = 8, *P* = .90,

No. of pts	Gender	Age (y) (range)	No. of IMP	Implantation site	Type of prosthesis	Prosthesis placed (mo)
37 45	16 M, 21 W 17 M, 28 W	22 (18–37) 23 (19–51)	46 56	Most in the anterior maxilla	SC	7
29 29 25	9 M, 20 W 11 M, 18 W 15 M, 10 W	(23.0–74.0) (24.0–82.0) (40.0–83.0)	78 80 78	Unclear	Unclear	Maxilla: 6 Mandible: 3–4
20 20	10 M, 10 W 11 M, 9 W	62.6 ± 7.0 (44.2–75.2) 64.0 ± 6.8 (440.2–77.2)	102 106	Edentulous mandible	Full-arch fixed prosthesis	≈ 7.5
28	13 M, 15 W	61.7 (36–76)	73 77	Partially edentulous maxilla (anterior teeth present)	FPD	≈ 7.0
32 108	8 M, 24 W 37 M, 71 W	58.1 (34–87) 59.5 (44–78)	57 201	Mostly maxillary molars and premolars	SC, FPD	3 –
30 30 22	17 M, 13 W 16 M, 14 W 9 M, 13 W	51 to > 70 41 to > 70 41 to > 70	120 120 88	Edentulous mandible	Full-arch fixed prosthesis	– 2 –
68	39 M, 29 W	48	38 35 34	Unclear	Unclear	Maxilla: 3 Mandible: 2
63	25 M, 38 W	46 ± 9 (18–63)	45 53 105	Posterior maxilla (91 imp), posterior mandible (112 imp)	81 FPD (153 imp), 50 SC	Maxilla: 6 Mandible: 3
26	9 M, 17 W	M: 52.6 W: 49.1	42 36 29	Unclear	Unclear	≈ 4

$I^2 = 0.0\%$ for implant survival at 1 year; chi-squared = 2.72, df = 7, $P = .91$, $I^2 = 0.0\%$ for implant survival at 3 years). For each study, the risk ratio and 95% CI of implant loss between BL and TL groups are presented in Figs 3 and 4 for 1 and 3 years, respectively. For trials that placed a BL implant system with both single- and two-stage protocols[21,23] or two different BL implant systems,[24] individual relative risks were calculated with respect to the same TL implant group in each respective study (Figs 3 and 4). The studies by Shin and coworkers[20] and Bilhan and coworkers[25] were excluded from the meta-analysis of implant survival at 1 year (Fig 3) because no implants failed in either trial. The relative risks of implant survival were 1.003 (95% CI: 0.99 to 1.02, $P = .78$) at 1 year and 1.005 (95% CI: 0.99 to 1.03, $P = .63$) at 3 years, with no statistically significant evidence of an increased risk of implant failure in BL compared to TL implants.

The statistical unit of analysis for the survival rate was the implant in four publications,[17,18,22,23] the patient in two studies,[19,24] and unclear in the remaining publications.[20,21,25] Censored implants and dropouts were not considered for the estimation of survival rates. One study reported a remarkably large number of censored implants during the 2- to 3-year evaluation period.[21] More specifically, 40 of 78 TL, 71 of 80 nonsubmerged BL, and 53 of 78 submerged BL implants in the respective clinical groups were withdrawn in the last year of the observation period for reasons not clearly discussed by the authors.

Secondary Outcome Characteristics. Most papers provided data on clinical periodontal parameters, including PPD, Plaque Index, BoP, and soft tissue recession. In general, no statistically significant differences in plaque accumulation, bleeding, or sulcus depth were reported between TL and BL implants in the primary investigations included in the present systematic review (Table 2). A meta-analysis of the secondary outcome measures was not performed because of insufficient data for compilation.

Ozkan and coauthors reported mean implant sulcus depths of 2.16 mm and 1.87 mm for their two BL groups and 1.80 mm for their TL group 1 year after implant placement.[24] In the study of Kemppainen et al,[17] 73% of the BL and 69% of the TL implants presented PPDs of 2 to 3 mm at the 1-year examination. PPD of 3 to 4 mm were present in 2% of the BL and 1% of the TL group, while there were no peri-implant sulcus recordings deeper than 4 mm in any of the investigated groups.[17] Moberg et al reported that the frequency distribution of sites exhibiting sulcus depth ≤ 3.5 mm was 96% for the BL implants and 97.5% for the TL implants 3 years after implant insertion.[18]

Table 2 Outcome Characteristics of the Included Studies

Study	Implant data	No. of surgeries	No. of failed implants			Implant survival (%)		No. of implants with PIM
			NOS	PIM	CEN	1 y	3 y	
Kemppainen et al (1997)[17]	AST, BL	Two	1	–	–	97.8% (45/46)	–	Unclear
	ITI, TL	One	–	–	–	100% (56/56)	–	
Becker et al (2000)[21]	BRS, BL	One	1	1	71	97.5% (78/80)	97.5% (78/80)	Unclear
	BRS, BL	Two	1	2	40	96.2% (75/78)	96.2% (75/78)	
	ITI, TL	One	1	1	53	97.4% (76/78)	97.4% (76/78)	
Moberg et al (2001)[18]	BRS, BL	Two	1	1	5	–	(95/97) 97.9%	0
	ITI, TL	One		1	12	–	(93/94) 98.9%	2
Åstrand et al (2004)[19] (Åstrand et al [2002][27])	BRS, BL	Two	2	–	–	97.26% (71/73)	97.26% (71/73)	0
	ITI, TL	One	–	2		98.7% (76/77)	97.4% (75/77)	7 (9.1%)*
Baelum and Ellegaard (2004)[22] (Ellegaard et al [1997][26])	AST, BL	Two	–	18	–	100%	100%	39
	ITI, TL	One				99.5% (96.4%–99.9%)	95.0% (89.0%–99.3%)	
Engquist et al (2005)[23] (Engquist et al [2002][28])	BRS, BL	One	5	3	4	93.3% (112/120)	93.3% (112/120)	Unclear
	BRS, BL	Two	3		8	97.5% (117/120)	97.5% (117/120)	
	BRS, TL	One	5	1	4	93.2% (82/88)	93.2% (82/88)	
Shin et al (2006)[20]	1PL, BL	One	–	–	–	100%	–	Unclear
	ANK, BL	One	–	–	–	100%	–	
	LIF, TL	One	–	–	–	100%	–	
Ozkan et al (2007)[24]	FRI, BL	Two	–	–	–	100% (45/45)	100% (45/45)	0
	CAM, BL	Two	–	–	–	100% (53/53)	100% (53/53)	0
	ITI, TL	One	1	–	–	99.0% (104/105)	99.0% (104/105)	0
Bilhan et al (2010)[25]	AST, BL	Two	–	–	–	100% (42/42)	–	0
	BRS, BL	Two	–	–	–	100% (36/36)	–	0
	ITI, TL	One	–	–	–	100% (29/29)	–	0

ANK = Ankylos (Dentsply Friadent); AST = Astra (Astra Tech); BoP = bleeding on probing; BRS = Brånemark (Nobel Biocare); CAM = Camlog; CEN = censored (dropout, loss to follow-up, deceased patient); FRI = Frialit (Dentsply Friadent); ITI = ITI (Straumann); LIF = Lifecore; NOS = nonosseointegrated; PI = Plaque Index; PIM = peri-implantitis; PPD = probing pocket depth; 1PL = Oneplant (Warantec).
*Statistically significant difference.

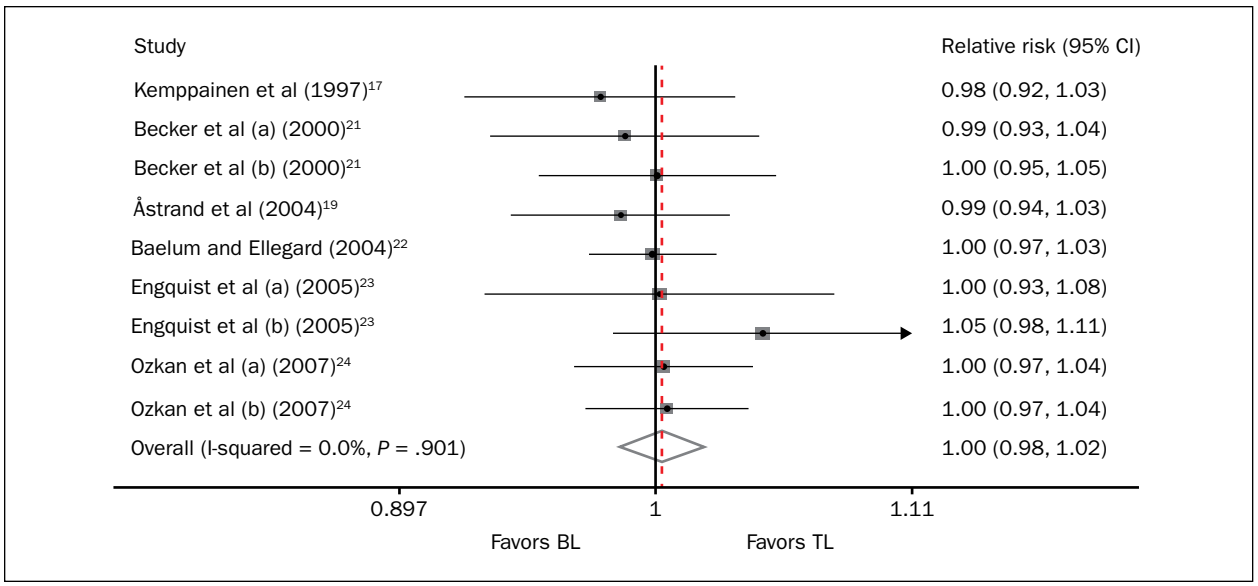

Fig 3 Meta-analysis of relative risk for implant loss at 1 year from functional loading. Relative risk and 95% CI for BL compared to TL implants are presented for each study. In studies that placed a BL implant system in both single- and two-stage protocols[21,23] or used two different BL implant systems,[24] separate relative risks (a, b) were calculated.

MBL change (mm) from prothesis to reevaluation (± SD)					
1 y	3 y	Reevaluation	PI (3 y)	BoP (3 y)	PPD
Maxilla: 0.14 ± 0.10 Mandible: 0.10 ± 0.09	–	1 y	25%	26%	2-3 mm 1 y: 73%
Maxilla: 0.12 ± 0.09 Mandible: 0.09 ± 0.03	–		34%	29%	2-3 mm 1 y: 69%
Maxilla: –0.16 Mandible: –0.43*	–	1–2 y	Unclear	Unclear	Unclear
Maxilla: –0.11 Mandible: 0.07	–	0–1 y			
Maxilla: 1.31* Mandible: 0.98*	–	2–3 y			
–	1.2 mm: 8.9% (8/90) ≥ 1.2 mm: 5.4% (5/93)	1 y 3 y	37% 36%	14% 20%	> 3 mm: 4.0%* > 3 mm: 2.5%*
0.2 ± 0.09 (n = 28) 0.2 ± 0.16 (n = 28)	0.1 ± 0.09 (n = 26) 0.2 ± 0.25 (n = 26)	1 y 3 y	11.9% 7.5%	7.9% 9.1%	– –
< 3.5 mm: 100%	< 3.5 mm: 100%	1 y 5 y 10 y	Unclear	5 y: 51.0% 10 y: 90.5%	(≥ 4.0 mm) 5 y: 45.5% 10 y: 75.4%
< 3.5 mm: 100%	< 3.5 mm: 95.7% (83.8%–98.9%)			5 y: 45.5% 10 y: 69.5%	(≥ 4.0 mm) 5 y: 59.6% 10 y: 76.5%
0.09 ± 0.05 (n = 106) 0.35 ± 0.06 (n = 107) 0.13 ± 0.08 (n = 76)	0.18 (n = 106) 0.27 (n = 96) 0.26 (n = 71)	1 y 2 y 3 y	Unclear	Unclear	Unclear
0.18 ± 0.16 1.32 ± 0.27 0.76 ± 0.21	– – –	1 y	Unclear	Unclear	Unclear
0.19 ± 0.11 0.16 ± 0.08 0.17 ± 0.08	0.28 ± 0.16 0.25 ± 0.11 0.26 ± 0.13	1 y 2 y 3 y	61.5% 40.0% 42.9%	BoP 0: 46.2% BoP 0: 60.0% BoP 0: 54.3%	2.16 ± 0.36 1.87 ± 0.36 1.80 ± 0.23
0.46 ± 0.07 0.80 ± 0.08 0.47 ± 0.07	– – –	1 y 2 y	– – –	– – –	– – –

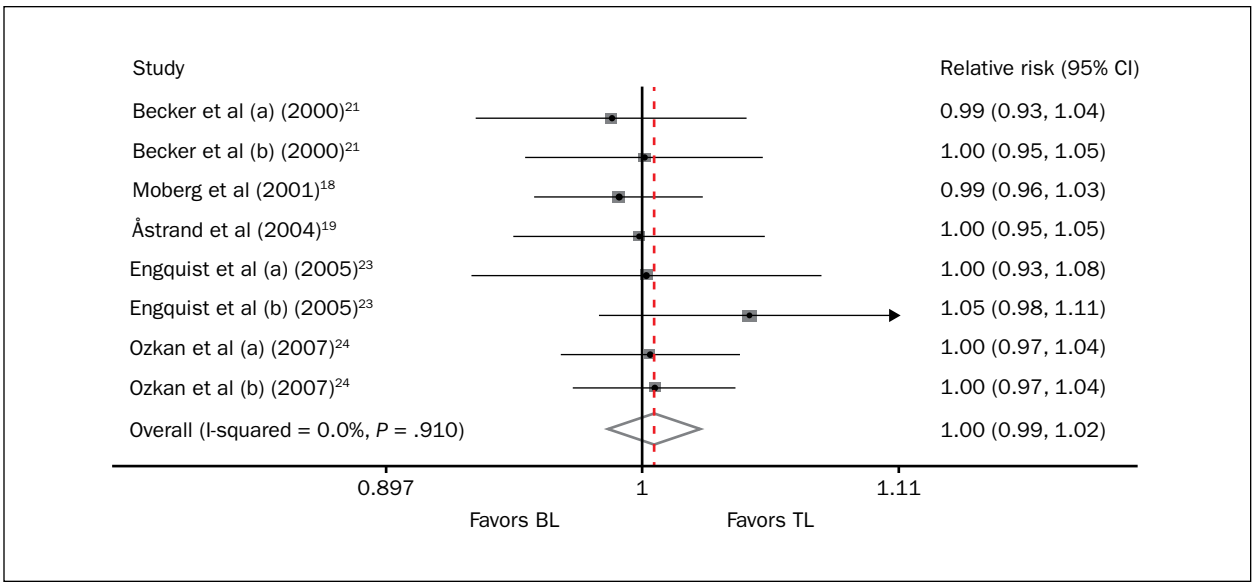

Fig 4 Meta-analysis of relative risk for implant loss at 3 years after placement of the definitive prostheses. Relative risk and 95% CI for BL compared to TL implants are presented for each study. In studies that placed a BL implant system in both single- and two-stage protocols[21,23] or placed two different BL implant systems,[24] individual relative risks (a, b) were calculated.

Table 3a Results of the Quality Assessment of the Included Studies

Study	Sample size/power calculation	Ethical approval	Informed consent	Inclusion criteria explicit
Kemppainen et al (1997)[17]	Unclear	Unclear	Unclear	Yes
Becker et al (2000)[21]	Unclear	Unclear	Yes	No
Moberg et al (2001)[18]	Unclear	Unclear	Yes	No
Åstrand et al (2004)[19] (Åstrand et al [2002][27])	28 pts per group to detect a 0.3-mm change in BL (90% power, $P = .05$)	Yes	Yes	Yes
Baelum and Ellegaard (2004)[22] (Ellegaard et al [1997][26])	Unclear	Unclear	Unclear	Unclear
Engquist et al (2005)[23] (Engquist et al [2002][28])	Unclear	Unclear	Yes	Yes
Shin et al (2006)[20]	Unclear	Unclear	Unclear	Yes
Ozkan et al (2007)[24]	Unclear	Yes	Yes	Yes
Bilhan et al (2010)[25]	Unclear	Unclear	Yes	Yes

BL = bone level; IMP = implant; Pt = patient.

Table 3b Results of the Quality Assessment of the Included Studies

Study	Standardized radiographic assessment	Reproducibility of measurements
Kemppainen et al (1997)[17]	Custom film holders and bite blocks for standardized intraoral x-rays Radiographic measurements independently performed by two EXM (mean values calculated)	Surgeries performed by the same surgeon Radiographic measurements of the two observers coincided < 0.4 mm in 80% of the sites
Becker et al (2000)[21]	BL changes mesially and distally measured with electronic software on digitized x-rays	X-rays evaluated by one EXM
Moberg et al (2001)[18]	Radiographic measurements on panoramic and intraoral x-rays using the thread distance	Each of the two surgeons and the two prosthodontists treated half cases in each IMP group
Åstrand et al (2004)[19] (Åstrand et al [2002][27])	Modified Eggen holder Radiographic measurements independently performed by two EXM Mean values used if difference was ≤ 0.5 mm, a consensus was obtained by the two EXMs if difference was ≥ 0.5 mm	Unclear
Baelum and Ellegaard (2004)[22] (Ellegaard et al [1997][26])	BL changes mesially and distally (using the thread distance) rounded to the nearest 0.5 mm	Unclear
Engquist et al (2005)[23] (Engquist et al [2002][28])	Modified Eggen holder Radiographic measurements independently performed by two EXM Mean values used if difference was ≤ 0.5 mm, a consensus was obtained by the two EXM if difference was ≥ 0.5 mm	Unclear
Shin et al (2006)[20]	Parallel technique BL changes mesially and distally measured to the nearest 0.01 mm with electronic software on digitized x-rays	All surgical prosthetic procedures performed by the same clinician
Ozkan et al (2007)[24]	Occlusal index attached to standard film holder for standardized intraoral x-rays Radiographic measurements independently performed by two EXM (mean values calculated) BL changes evaluated with electronic software on digitized x-rays using known thread distances	All surgeries performed by the same clinician
Bilhan et al (2010)[25]	BL changes evaluated under 7× magnification on digitized x-rays using known thread distances	Unclear

Examiner calibration was unclear for all studies.
BL = bone level; EXM = examiner; IMP = implant; Pt = patient; x-ray = radiograph.

Exclusion criteria explicit	Baseline homogeneity	Randomization method	Allocation concealment
Yes	Gender, age, IMP location, prosthetic needs	Not specified	Unclear
Yes	Gender, age	No randomization	Unclear
Yes	Gender, age, IMP location, prosthetic needs	Not specified	Unclear
Yes	Gender, age, IMP location, prosthetic needs	Split mouth Block size of 4	Unclear
Unclear	Two nonmatched groups (32 and 108 pts)	Unclear	Unclear
Yes	Gender, age, IMP location, prosthetic needs	No randomization	No
Yes	Gender, IMP location	Pts were randomized in blocks	No
Yes	Prosthetic needs	No randomization	No
Yes	Unclear	No randomization	No

Similarity of dropouts and reasons for dropouts	Statistical unit	Risk of bias	Other potential sources of heterogeneity and methodological issues
No dropouts	IMP	High	Randomization inadequately defined Unfavorable IMP positioning in nine cases
Radiographic evaluation not performed for many IMPs Significant number of drop-outs, inadequate info provided	Unclear	High	Each center was assigned one group Cumulative survival rates were based on minimal no. of IMP at the 3-y eval Significant number of dropouts
TL group: two pts died (12 IMP) BL group: one pt died (5 IMP), one pt did not attend the x-ray exam (5 IMP)	IMP	High	Randomization inadequately defined Unclear radiographic exam
Two pts died	Patient	Medium	Potential reproducibility problems between five centers The number of pts was reduced from 50 to 28 pts per group, thus decreasing the power to detect a change in bone level from 0.3 to 0.2 mm (90% power, $P = 0.05$)
Several dropouts, but no numbers provided	IMP	High	IMP placement in periodontally compromised pts Unclear radiographic standarization Extremely wide range of observation periods Possible effect of unreported dropouts in the outcomes of the study
10 of 108 pts were lost to follow-up: 5 dies, 1 severely ill, 3 uncooperative, 1 lost all IMP (unclear distribution among groups)	Relative frequency of IMP loss in each pt	High	No randomization or allocation concealment
No dropouts	Unclear	High	Randomization inadequately defined
No dropouts	Pt	High	No randomization
Unclear	Unclear	High	No randomization Unclear radiographic standarization

Tables 4 Confounding Factors and Postsurgical Patient Management in the Included Studies

Study	Smoking	Periodontitis	Systematic disease	Medication
Kemppainen et al (1997)[17]	Unclear	Unclear	Unclear	Unclear
Becker et al (2000)[21]	Unclear	Unclear	Unclear	Unclear
Moberg et al (2001)[18]	Unclear	Unclear	Unclear	Unclear
Åstrand et al (2004)[19] (Åstrand et al [2002][27])	7 of 28 pts were smokers (< 20 cigarettes/day)	No	Two pts diabetes One pt osteoporosis	Unclear
Baelum and Ellegaard (2004)[22] (Ellegaard et al [1997][26])	65% of 140 pts were smokers	Pts received periodontal treatment including Sx	During follow-up 10 pts developed systematic diseases (cardiovascular, diabetes, asthma, bronchitis)	Unclear
Engquist et al (2005)[23] (Engquist et al [2002][28])	Pts smoking ≥ 20 cigarettes/day excluded	Unclear	Unclear	Unclear
Shin et al (2006)[20]	Unclear	Unclear	Unclear	Unclear
Ozkan et al (2007)[24]	15 of 63 pts smoked < 10 cigarettes/day	Unclear	No	Unclear
Bilhan et al (2010)[25]	Heavy smokers (> 20 cigarettes/day excluded)	No history of periodontal Sx	Unclear	Unclear

CHX = chlorhexidine; D = denture; Pt = patient; S-removal = suture removal; Sx = surgical procedure.

Data on soft tissue recession after implant placement was provided by two publications.[18,19] In one study, the authors registered, at baseline, a visible crown margin in 18.3% of BL and 29.9% of TL implants.[19] At the 1-year examination, the buccal mucosa margin remained stable for BL implants, while in the TL group the recession progressed, leading to visible margins in 37.7% of the cases. In contrast, in the second trial, a more pronounced increase of mucosal margin recession was reported in BL implants, and at the 3-year examination the recession amounted to 2.4 mm for BL and 0.8 mm for TL implants.[18]

Complications

Only a few articles provided information on biologic and technical complications during the follow-up period. All peri-implantitis cases were considered biologic complications. In one study, two TL implants with peri-implantitis responded favorably to antimicrobial treatment but one BL implant was removed at 1 year.[18] In another study, peri-implantitis with purulent discharge and bone loss was reported for 7 of 77 TL implants (9.1%), while none of the BL implants exhibited any biologic complications.[19] In one of the trials that reported on periodontally compromised patients, 39 implants were treated surgically for peri-implantitis in 20 participants, but the number of affected implants in the BL or TL groups was not clarified.[22]

Methodologic Quality of the Studies

Data concerning quality assessment criteria of the included studies are presented in Table 3. The reviewers agreed that the included studies were at high risk of bias because they did not fulfill most of the quality assessment criteria presented in Table 3. Only one study was classified as being at medium risk because it satisfied several quality assessment criteria, including a prospective statistical power and sample size calculation (Table 3).[19]

Confounding Factors

Adjustment for the effect of confounding factors on implant survival rate was carried out in only one study (Table 4).[22] A multivariable full model was utilized, and the significance of eight covariates was evaluated using the partial likelihood ratio test.

Antibiotics	Healing management	Adverse events	Maintenance intervals
Pts received 2×10^6 IU phenoxymethyl penicillin 1 h before Sx (orally) and 3×10^6 IU daily for 10 d	CHX gluconate (0.12%) rinses S-removal after 14 d	No	Unclear
Unclear	S-removal after 7 d	Unclear	Unclear
Unclear	No D for 7–10 d post-Sx	One pt with parasthesia until 1y exam, one pt with parasthesia at final eval, three cases with tissue hyperplasia	Unclear
Pts received penicillin V (2 g twice daily) or clindamycin (300 mg twice daily) for 10 d	S-removal after 7–10 d CHX 0.1% 4×/d, then gel No D for 14 d	No	Unclear
Unclear	CHX 0.2% for 2 wk post-Sx	Unclear	3-mo recall by dental hygienist. Treatment provided as needed.
Pts received antibiotics for 7-10 d post-Sx	S-removal after 7–10 d CHX 0.1% 2×/d for 2 wk Soft diet post-Sx No D for 10 d post-Sx	Unclear	Unclear
Unclear	Unclear	Small tissue inflammation in one pt at 3-mo recall	Unclear
Unclear	Unclear	No	Unclear
Pts received antibiotics for 3 d post-Sx	CHX gluconate (0.2%) rinses S-removal after 7 d	Unclear	Unclear

The remaining studies either did not report on patient smoking habits[17,18,20,21] or failed to carry out an appropriate statistical analysis to adjust for smoking as a confounding factor.[19,23,24] The periodontal status of patients was provided in only one trial,[22] whereas two studies discussed the systemic diseases of their patient populations.[19,22] Therefore, based on the limited available information, it is not possible to evaluate the effect of possible confounding factors such as smoking, periodontal condition, and systemic diseases on implant clinical outcomes.

DISCUSSION

In recent decades, BL and TL dental implants have been successfully employed to replace missing natural teeth. However, in spite of the broad use of both implant types worldwide, there is no systematic comparison of the outcomes in the literature. This systematic review investigated possible differences in clinical and radiographic outcomes between TL and BL implants placed in pristine bone. MBLs were considered as the primary outcome of the present systematic review because peri-implant crestal bone loss has been proposed by several investigators as a benchmark of implant success.[3,11,16,31] All the primary studies included in this systematic review provided relevant radiographic data. Assessment of MBL changes was based on radiographic findings 1 and 3 years after restoration. However, several methodologic differences were observed between the clinical studies with respect to the evaluation of radiographic MBL changes, and only four trials provided adequate information on the standardization of the radiographic assessment.[17,19,23,24]

The meta-analytic processing of available data revealed no significant differences in peri-implant bone level changes between BL and TL implants at 1 year after restoration. Based on radiographic observations from six primary studies included in the present systematic review,[17,19,20,23–25] the pooled estimated difference between BL and TL implants in mean bone loss was 0.05 mm (95% CI: –0.03 to 0.13 mm), with no significant difference ($P = .2$) between the two implant groups (Fig 2).

A mean bone loss of ≤ 1.5 mm is generally accepted as a result of osseous remodeling during the first year of implant function; thereafter, an annual bone loss not exceeding 0.2 mm is consistent with successful implant treatment.[31] The reported MBL changes in the included publications 1 year after restoration ranged from –0.43 to 1.32 mm for BL and 0.11 to 1.31 mm for TL implants (Table 2), which are within the accepted limits of bone loss.[31] The 3-year MBL changes ranged between 0.10 and 0.28 mm for BL and 0.20 to 0.26 mm for TL implants (Table 2). These values correspond to a mean annual bone loss of approximately 0.09 mm, which is below the suggested threshold value of 0.2 mm.[31] Unfortunately, insufficient data from the included publications prohibited analysis of mean MBL differences at 3 years after functional loading.

Implant survival rates were also regarded as an important outcome measure of the present systematic review. The reported 3-year postloading survival rate ranged from 93.3% to 100% for BL implants and was identical for TL implants (93.2% to 99%) (Table 2).[18,19,21–24] Meta-analysis of data from six primary studies included in this systematic review[17,19,21–24] revealed no evidence of an increased risk of implant failure in BL compared to TL implants at 1 year after placement of the definitive prostheses (Fig 3). Similarly, based on observations from five primary studies,[18,19,21,23,24] the meta-analysis failed to detect an increased risk of implant failure in BL compared to TL implants at 3 years after functional loading (Fig 4).

Meta-analysis of the secondary outcome measures was not feasible because the included publications did not provide adequate data for statistical processing. However, most papers reported clinical periodontal parameters, including PPD, Plaque Index, BoP, and soft tissue recession. With the exception of one study of periodontally compromised patients,[22] PPD values ranged between 2 and 4 mm in the remaining trials during the observation period of 1 to 3 years (Table 2). Half of the included studies provided data on the peri-implant indices regarding plaque and inflammation (Table 2).[17,18,22,24,25] Although high plaque levels may influence the amount of bone resorption in relation to the vertical position of the implant-abutment connection, no correlation was reported between plaque scores and MBL in the statistical analysis of the primary studies. Finally, no statistically significant differences in clinical parameters were reported between BL and TL implants in the original statistical analyses of the studies included in this systematic review.

The concept of platform switching or horizontal offset has been proposed to reduce peri-implant marginal bone loss in BL implants. Utilization of a reduced-diameter prosthetic abutment shifts the microgap and the microbial presence horizontally, away from the surrounding tissues, acting as a protective mechanism against the resorption of peri-implant marginal bone.[9] Among the BL implants used in the included studies, only the Astra and Ankylos systems incorporated a platform-switched abutment connection. The Astra System was utilized in three studies included in the present systematic review,[17,22,25] and the radiographic evaluation of MBL changes demonstrated no statistically significant differences in comparison to TL implants (Fig 2).[17,25] However, the Astra system showed favorable effects on bone loss in comparison with conventional BL abutment connections (Fig 2),[25] a behavior that might be attributable to the platform-switching effect. These observations are in agreement with the meta-analytic results of a recent publication reporting 0.24 mm of MBL change for Astra BL, 0.75 mm for Brånemark BL, and 0.48 mm for Straumann TL implants at 5 years after functional loading, with statistically significant differences between these systems.[32]

The Ankylos System was employed in a study comparing three systems: one TL implant with a roughened neck, one BL implant with a machined neck (Ankylos), and one BL implant with a microroughened neck.[20] Unexpectedly, the Ankylos System featuring the protective platform switch presented the most significant bone loss at the 1-year examination, in comparison to the other two implant systems (Fig 2). The authors attributed the differences in MBL between groups to the microstructure of the implant neck rather than to the pattern of abutment connection.[20] Additionally, in contrast to the subcrestal insertion recommended by the manufacturer, the Ankylos implants were placed crestally in this specific study.

Essentially, the majority of the available primary clinical studies present mostly indirect evidence to address the association between the basic two implant types and outcome variables. Other differences between BL and TL dental implants, including surface morphology (threading or roughness), type of abutment connection (flat or Morse taper), and platform switching/horizontal offset (inherent or prosthetically established), may influence implant success and other outcome variables. Only one study presented direct evidence regarding this association.[23] The authors stated that survival rates and MBL changes were not statistically significantly different between TL and BL implants manufactured by the same implant company. Therefore, clinical outcomes in this trial are clearly associated with the TL or BL feature, because the remaining technical characteristics of the implants were identical.

The surgical placement of BL implants following single- or two-stage surgical procedures may also affect MBL of this implant type. However, in two studies that used both submerged and nonsubmerged healing

conditions with BL implants, no differences in survival rates and MBL changes were detected (Figs 2 to 4).[21,23] This conclusion is consistent with findings from other studies that support that healing of BL implants is independent of the surgical protocol utilized.[33,34]

The trials included in the present systematic review were characterized by marked heterogeneity in the study designs, which rendered an assessment of methodologic quality difficult. Most of the studies did not provide detailed data on randomization methods and allocation concealment. However, masking of the assessors would be nearly impossible because abutment and implant characteristics are obvious during both clinical and radiographic assessments. Other issues that impaired the strength of evidence of the incorporated studies include a lack of proper radiographic standardization, insufficient reproducibility of the measurements, and inadequacies in statistical analysis and power calculation. In four publications, detailed information on standardized radiographic measurements and reproducibility methods were provided.[17–19,23] In only one study, a sample size calculation was performed to allow detection of 0.3-mm differences in MBL changes with 90% power and a 5% level of significance.[19] Three of the included publications analyzed implant survival and success rate data on a patient level.[19,23,24] Three other studies used the implant as a statistical unit,[17,18,22] increasing the risk to exhibit favorable implant survival percentages because the prevalence calculated on implant-based results is diluted by the large number of implants placed in the sample population.[35] In two studies, it was not clear whether the statistical analysis was implant- or patient-based.[20,21] The studies included in the present systematic review were judged to be at high risk of bias because they failed to fulfill basic quality assessment criteria, with the exception of one publication that was classified as being at medium risk.[19]

CONCLUSIONS

1. The meta-analysis performed in the present systematic review did not identify a statistically significant difference in mean marginal bone loss between bone-level and tissue-level implants at 1 year after placement of the definitive prostheses.
2. Similarly, there was no evidence of a statistically significant increased risk of implant loss in bone-level compared to tissue-level implants at both 1 and 3 years after functional loading.
3. The meta-analytic results of bone loss and implant survival rates, in addition to the descriptive analysis of secondary clinical outcomes evaluated in this systematic review, indicate that both implant types meet the requirements for tooth replacement in implant dentistry.
4. The strength of evidence of this systematic review is moderate to low because of risks of bias and significant variations observed in the included primary investigations.

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