SYSTEMATIC REVIEW

Immediate versus early loading of single dental implants: A systematic review and meta-analysis

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Since 1990, implants placed in completely edentulous mandibles have been loaded immediately[1-9] or early[10-12] in selected patients.[13] For single implant-supported crowns, similar success rates have been reported for both protocols and for conventional loading protocol,[14-19] especially when implants are placed with adequate length and with insertion torques greater than 32 Ncm.[20,21] These protocols have also become widely accepted after the introduction of a chemically modified titanium surface topography.[22,23] Despite this, little is known about the differences between survival rates and marginal bone loss in these 2 loading protocols in single implant crowns.

ABSTRACT

Statement of problem. Patients prefer to be rehabilitated as soon as possible if the risk of implant failure is not increased. However, whether immediate loading of single implants is riskier than early loading is not clear.

Purpose. This systematic review and meta-analysis investigated whether the immediate loading protocol has more clinical disadvantages than the early loading protocol for single dental implants in terms of the marginal bone loss and survival rate of single implant crowns.

Material and methods. Two reviewers conducted an advanced electronic database search, with no language or date restriction, in Medline/PubMed, Embase, and the Cochrane Library up to May 2016. Studies were chosen by title and abstract for screening in accordance with the following inclusion criteria: dental implants studies; cohort studies (prospective and retrospective) and randomized controlled trials; samples involving partially edentulous patients; immediate loading implants; early loading implants; and n≥10 participants.

Results. Of the 5710 studies initially identified, 5 fulfilled the inclusion criteria. A meta-analysis yielding risk differences (RD) and mean differences (MD) with a 95% confidence interval (CI) was performed. The trials included showed no significant differences between early and immediate loading protocols in single implant crowns with regard to survival rate at 1 and 3 years (RD, −0.00; 95% CI, −0.04 to 0.04; P=.990 for 1 year and P=.980 for 3 years) or marginal bone loss at 1 year (MD, 0.09; 95% CI, −0.02 to 0.19; P=.110) and 3 years (MD, −0.23; 95% CI, −0.47 to 0.01; P=.060).

Conclusions. This systematic review showed no significant differences between early and immediate loading protocols in single implant crowns with regard to survival rate or marginal bone loss at 1 or 3 years. (J Prosthet Dent 2018;120:25-34)

A prospective cohort trial with early loaded single implants determined a marginal bone loss of 0.42 mm and a survival rate of 94.44% after 3 years for maxillary anterior teeth.[24] Similar results were stated by a prospective clinical trial with a marginal bone loss of 0.97 mm and a survival rate of 94% for early loaded single maxillary implants.[25] Both studies concluded that an early loading protocol was safe and predictable for

patients.[25] Another retrospective study[26] of single implants, anterior and premolar maxillary crowns, loaded immediately reported a marginal bone loss of 0.33 mm (mesially) and 0.28 mm (distally) and a survival rate of 86.4% after 2.5 years.

A systematic review that compared loading protocols for single implant crowns[27] found only 1 study comparing early and immediate loading, with 17

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Clinical Implications

The immediate or early loading of implants should be considered for single implant-supported crowns. When implants are placed with high insertion torque, neither immediate nor early loading jeopardizes implant success.

implants evaluated after 1 year.[28] One of 7 immediately loaded implants failed, but none in the early loading group, without significant differences between these 2 interventions. This study did not include an analysis of marginal bone loss. The authors asserted that conclusions could not be drawn because of the insufficient number of trials. Another recent systematic review reported single implants crowns loaded immediately versus conventionally.[29] The authors found no statistically significant differences between these 2 protocols in a comparison of the marginal bone loss and survival rate of multiple dental implant crowns. In a systematic review, den Hartog et al[30] analyzed the immediate, early, and conventional loading of single implant crowns in the esthetic zone between natural adjacent teeth. Marginal bone loss and implant survival rate were measured in these 3 loading protocols were not compared. The authors suggested that a single implant crown in the esthetic zone between natural adjacent teeth would result in successful treatment.

A new analysis is justified by the lack of comparison and a gap in the studies involving the protocols of early and immediate loading. The purpose of this systematic review was to evaluate the marginal bone loss and survival rate of single implant crowns loaded immediately or early.

MATERIAL AND METHODS

This systematic review was conducted in accordance with the Preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement[31] and was registered in the International Prospective Register of Systematic Reviews (PROSPERO; National Institute for Health Research; http://www.crd.york.ac.uk/PROSPERO; registration number CRD42016043781).

The focus question was developed according to the Population (P), Intervention (I), Comparison (C), Outcome (O), and Study design (S) (PICOS) strategy, which was identified as follows: P=participants who had dental implants; I=early loading for a single implant crown; C=immediate loading for a single implant crown; O=survival rate and marginal bone loss; and S=randomized controlled trials (RCTs) and cohort studies (prospective and retrospective). These were used to guide the preparation of the search strategy. Thus, the focus

Table 1. Advanced electronic database search

Database	Search terms
PubMed	
Population (P)	(dental implantation, endosseous [MeSH terms]) OR dental implants [MeSH terms]) OR implantation*) OR implant) OR implants) OR dental implantation) OR blade implantation [MeSH terms]) OR implantation, blade [MeSH terms]) OR implantations, blade [MeSH terms]) OR dental implant [MeSH terms]) OR implants, dental [MeSH terms]) OR implant, dental [MeSH terms]
Intervention (I)	AND ((((Immediate Dental Implant Loading [MeSH terms]) OR immediate) OR function) OR load*))
Comparison (C)	AND ((((time) OR early) OR early dental implant loading) OR dental implant loading, early))
Outcome (O)	AND (((((((((((((((((survival [MeSH terms]) OR survival rate [MeSH terms]) OR survival analysis [MeSH terms]) OR intraoperative complications [MeSH terms]) OR postoperative complications [MeSH terms]) OR dental restoration failure [MeSH terms]) OR prosthesis failure [MeSH terms]) OR treatment failure [MeSH terms]) OR complication*) OR success*) OR failure*) OR esthetics, dental [MeSH terms]) OR dental esthetics [MeSH terms]) OR esthetics [MeSH terms]) OR esthetic) OR esthetic*) OR patient satisfaction) OR patient preference)))))
Study Design (S)	AND (((clinical trial) OR trial, clinical)
Embase	
Population (P)	"dental implantation endosseous"/exp OR "dental implants"/exp OR "dental implantation"/exp OR "dental implant"/exp OR "implants, dental" OR "implant, dental"
Intervention (I)	AND ("immediate dental implant loading"/exp OR immediate OR "function" OR "load")
Comparison (C)	AND ("time"/exp OR early OR "early dental implant loading" OR "dental implant loading, early")
Outcome (O)	AND ("survival"/exp OR "survival rate"/exp OR "survival analysis"/exp OR "intraoperative complications"/exp OR "postoperative complications"/exp OR "dental restoration failure"/exp OR "prosthesis failure"/exp OR "treatment failure"/exp OR "complication"/exp OR "success" OR "failure" OR "esthetics dental"/exp OR "dental esthetics" OR "esthetics"/exp OR esthetic OR esthetic OR "patient satisfaction"/exp OR "patient preference"/exp)
Cochrane Library	
Population (P)	dental implantation, endosseous OR dental implants OR implantation* OR implant OR implants OR dental implantation OR blade implantation OR implantation, blade OR implantations, blade OR dental implant OR implants, dental OR implant, dental
Intervention (I)	AND Immediate Dental Implant Loading OR immediate OR function OR load*
Comparison (C)	AND time OR early OR early dental implant loading OR dental implant loading, early
Outcome (O)	AND survival OR survival rate OR survival analysis OR intraoperative complications OR postoperative complications OR dental restoration failure OR prosthesis failure OR treatment failure OR complication* OR success* OR failure* OR esthetics, dental OR dental esthetics OR esthetics OR esthetic OR esthetic* OR patient satisfaction OR patient preference
Study Design (S)	AND clinical trial OR trial, clinical

question was: "Does a single implant-supported crown immediately loaded render different results from those of early loaded ones when evaluating the implant survival rate and marginal bone loss?"

An extensive electronic database search (Table 1) with no date or language restrictions was performed in PubMed/Medline, Embase, and the Cochrane Library up to May 2016. References of the papers included were verified manually.
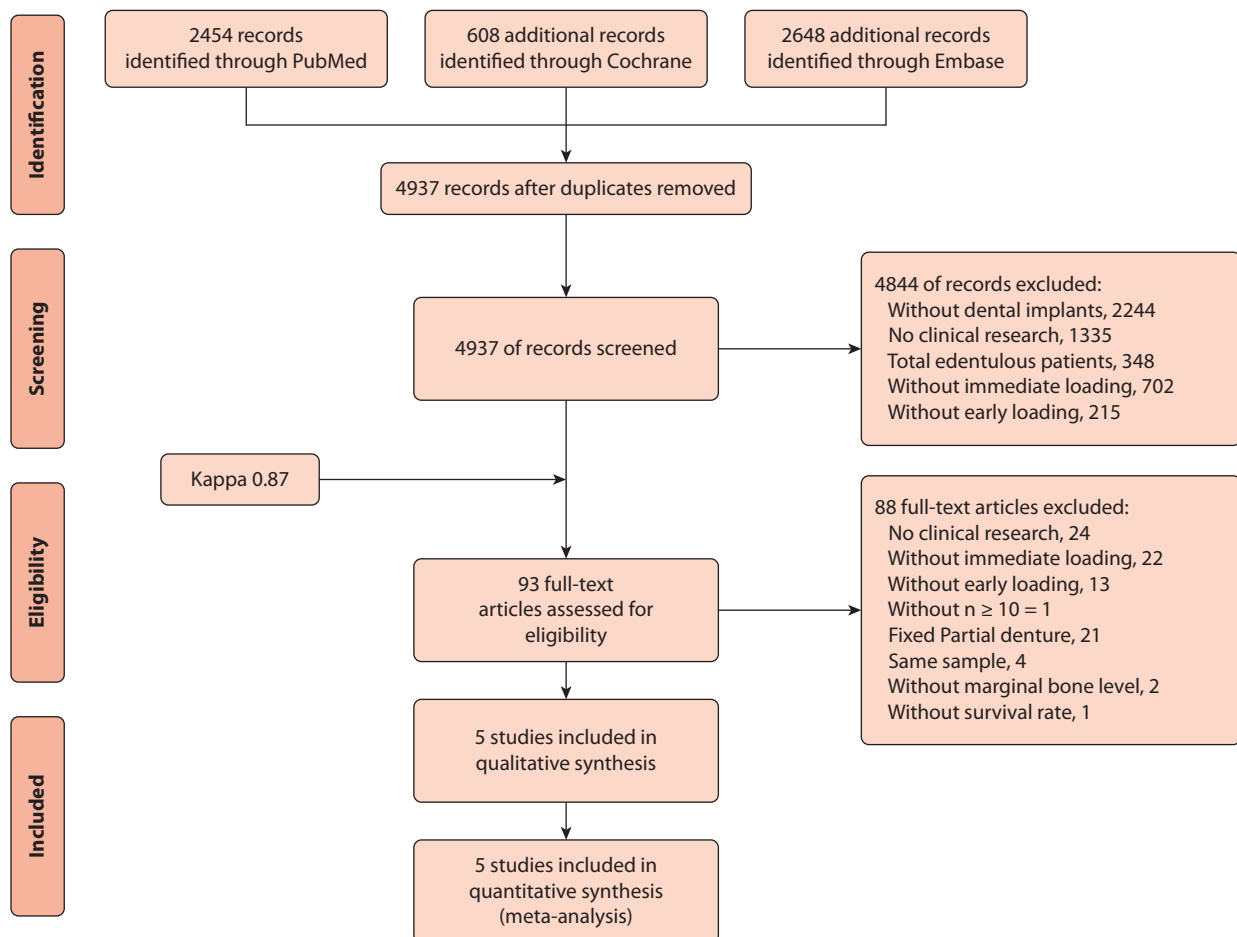
Figure 1. Information from all study selection phases based on PRISMA (Moher et al[32]).

Studies were chosen by title and abstract for screening in accordance with the following inclusion criteria: studies related to dental implants; cohort studies (prospective and retrospective) and RCTs; samples involving partially edentulous patients; studies related to immediate loading implants; studies related to early loading implants; and n≥10 participants. Papers without abstracts or abstracts with incomplete information were included for analysis.

Eligibility was determined after reading the complete text according to the exclusion criteria: studies without titanium dental implants; systematic reviews, article descriptions, interviews, protocols, in vitro studies and case reports; studies without immediate loading implants; studies without early loading implants; less than 10 participants (n<10); splinted implants; isolated groups (patients with diabetes, cardiac disease, bruxism, or irradiated bone); follow-up less than 6 months; studies without survival rates; studies without marginal bone loss reports; dropout rates higher than 30%.

Two calibrated authors (M.N.P., T.R.C.) evaluated the manuscripts and collected the data. The Cohen kappa test was used to assess the agreement between the authors (0.87). Discussion and data checking settled discrepancies and doubts. When no consensus was established, a third examiner (N.S.) was asked to decide.

The Cochrane collaboration tool was used for assessing risk of bias to analyze the included randomized clinical trials.[32] A third author (N.S.) resolved any disagreement between these reviewers. Quality analysis of each RCT was judged based on sample randomization; allocation concealment (both randomization and concealment accounting for bias of selection); blinding of personnel and participants (bias of performance); blinding of outcome collected (bias of detection); outcome incomplete (bias of attrition); selective data of reporting (bias of reporting); and other factors that caused bias. The risk of bias was classified according to the following criteria: low risk, if all criteria were met (bias that probably does not alter the results); unclear risk, if 1 or more criteria were partially met (bias that causes doubts about the results); and high risk, if 1 or more criteria were not met (bias that seriously compromises confidence in the results).
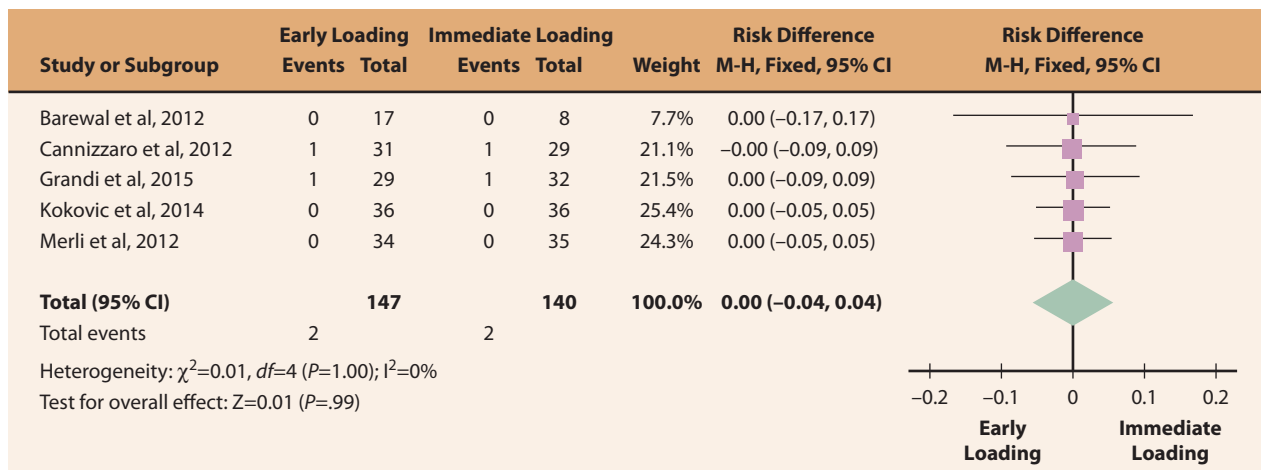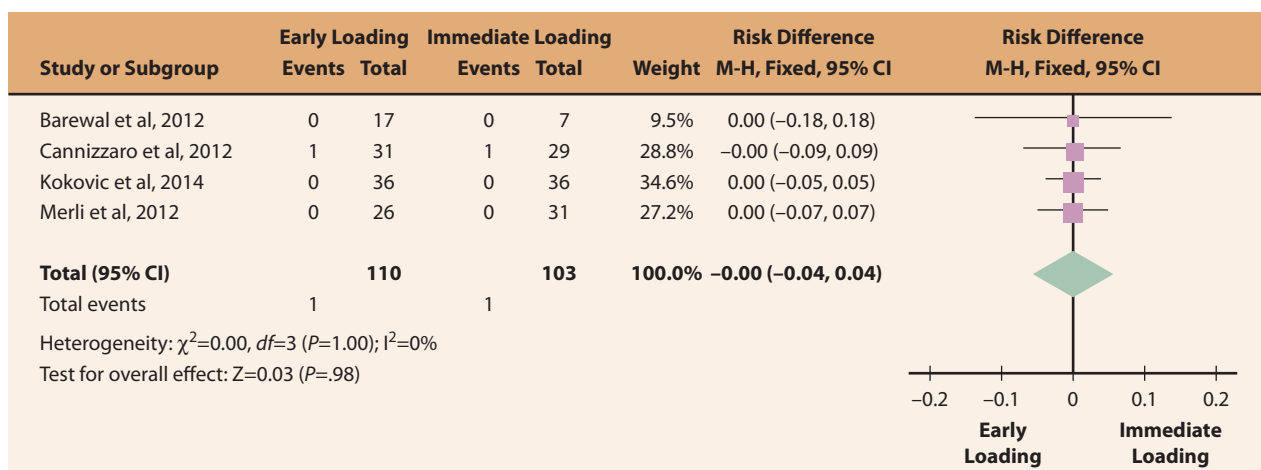
Figure 2. A, Forest plot of implant survival rate of 1 year with 5 included studies. B, Forest plot of implant survival rate of 3 years with 4 included studies.

Marginal bone loss and survival rate were evaluated. For this meta-analysis, the prosthetic loading protocols were classified as immediate loading, prosthesis connected to the implant up to 72 hours after implant placement[33-36]; or early loading, prosthesis connected to the implant after 72 hours[27,35] but not later than 3 months after implant placement.[7,19] A meta-analysis of continuous and binary outcome variables was computed for the RCTs when there were at least 2 studies comparing the same loading protocol and same outcome measures.[27]

For binary outcomes (implant survival rate), the estimate of the effect of an intervention was expressed as risk difference (RD)[27] for survival rate with a confidence interval (CI) of 95%.[29] For continuous outcomes (marginal bone loss), mean difference (MD) ±SD was used with a 95% CI. Outcomes were pooled using the fixed-effects model (Mantel-Haenszel-Peto test) or a random effects model (DerSimonian-Laird test). The I^2 statistical test

was used to express the heterogeneity of the studies as a percentage value. Values up to 25% were classified as indicating low heterogeneity, values of 50% as indicating medium heterogeneity, and values of ≥70% as indicating high heterogeneity. When significant heterogeneity was found ($P<.100$), the random effects model was used. For a low heterogeneity value, the fixed-effects model was used. The level of statistical significance was set at a P value of $<.005$.[30] Statistical software (Review Manager v5.0; Nordic Cochrane Centre; Cochrane Collaboration) was used for all analyses.

RESULTS

The highest level of scientific evidence needed to answer a clinical question comes from systematic reviews that analyze results from RCTs.[29] Thus, in this study 5 RCTs comparing early versus immediately loaded implants fulfilled the inclusion criteria. The meta-analysis of

Meta Analysis		Early Loading: 1 Year								
Model	Study Name	Statistics for Each Study						Event Rate and 95% CI	Weight (Fixed) Relative Weight	
		Event Rate	Lower Limit	Upper Limit	Z Value	P	Total			
	Barewal et al, 2012	0.972	0.678	0.998	2.479	.013	17/17		14.27	
	Canizzaro et al, 2012	0.968	0.804	0.995	3.346	.001	30/31		28.42	
	Grandi et al, 2015	0.966	0.792	0.995	3.274	.001	28/29		28.35	
	Kokovic et al, 2014	0.986	0.818	0.999	3.013	.003	36/36		14.48	
	Merli et al, 2012	0.986	0.809	0.999	2.973	.003	34/34		14.47	
Fixed		0.975	0.930	0.991	6.741	<.001				
Random		0.975	0.930	0.991	6.741	<.001				

Heterogeneity P=.970, I²=0

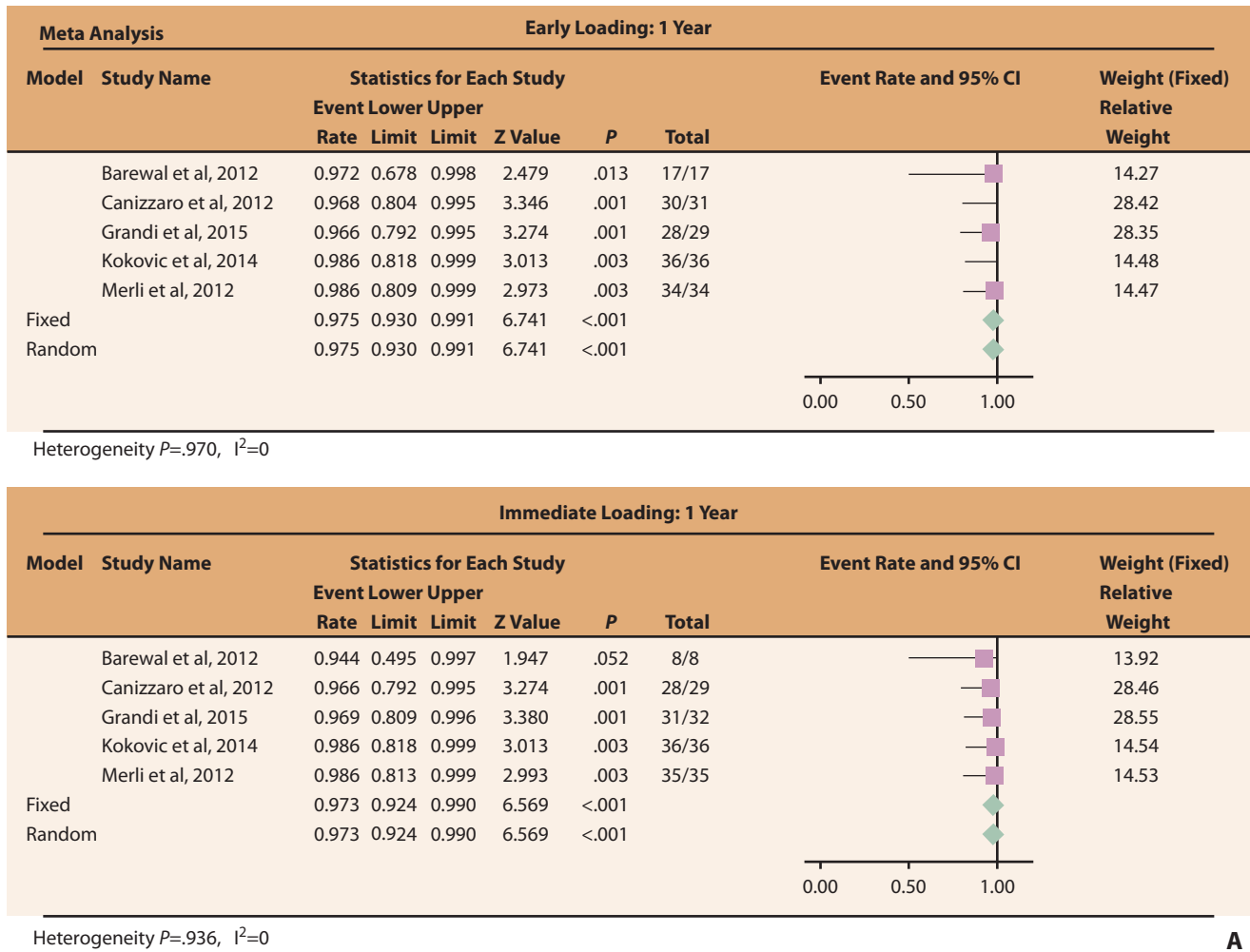|		Immediate Loading: 1 Year								
Model	Study Name	Statistics for Each Study						Event Rate and 95% CI	Weight (Fixed) Relative Weight	
		Event Rate	Lower Limit	Upper Limit	Z Value	P	Total			
	Barewal et al, 2012	0.944	0.495	0.997	1.947	.052	8/8		13.92	
	Canizzaro et al, 2012	0.966	0.792	0.995	3.274	.001	28/29		28.46	
	Grandi et al, 2015	0.969	0.809	0.996	3.380	.001	31/32		28.55	
	Kokovic et al, 2014	0.986	0.818	0.999	3.013	.003	36/36		14.54	
	Merli et al, 2012	0.986	0.813	0.999	2.993	.003	35/35		14.53	
Fixed		0.973	0.924	0.990	6.569	<.001				
Random		0.973	0.924	0.990	6.569	<.001				

Heterogeneity P=.936, I²=0

A

Figure 3. A, Cumulative overall implant survival rate at 1 year, with 5 included studies, for early and immediately loading.
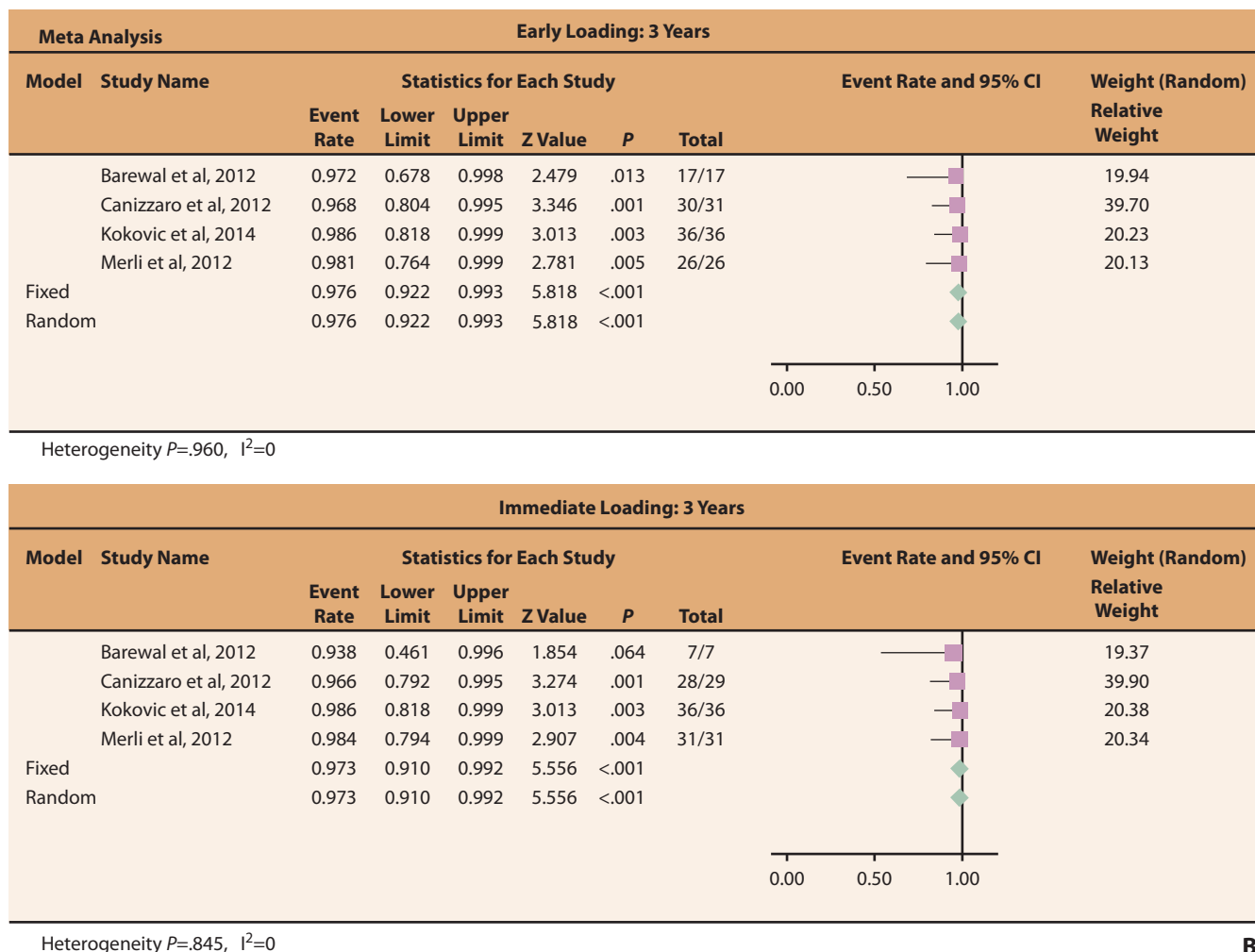
statistical data did not indicate differences between immediately and early loaded implants with regard to marginal bone loss or implant survival rate for single implant crowns.

This systematic review detected 2454 studies in PubMed/Medline, 608 in Cochrane Library, and 2648 in Embase, for a total of 5710 articles. After reading the titles and abstracts and removing duplicates, 93 studies were considered for full text analysis. Finally, 5 articles were included (Barewal et al,[3] Grandi et al,[13] Cannizzaro et al,[16] Merli et al,[35] and Kokovic et al[37]) (Fig. 1) for meta-analysis (Figs. 2-4) and risk of bias analysis (Fig. 5). The flowchart diagram[31] demonstrates the advanced search results and all reasons for excluding studies (Fig. 1). The Cochrane collaboration tool was used to analyze the risk of bias of the papers included. The methodological analysis of each paper is summarized in Figure 5. Among the 5 selected studies, only 1 (Kokovic et al[37]) had a high risk of bias; the other 4 studies (Barewall et al,[3] Grandi et al,[13] Cannizzaro et al,[16] and Merli et al[35]) had a low risk of bias.

The search included 5 RCTs, 2 with split-mouth design[16,37] and 3 with parallel groups,[3,13,35] published up to May 2016. For articles with the same samples,[15,34] the most recent publication was considered.[16,35]

Most of the studies used the same evaluation criteria: prosthetic complication, prosthesis failure; implant failure (peri-implantitis, prosthesis fractures); biological or peri-implant marginal bone level (measurements of intraoral radiographs with software).[3,13,16,35,37] Furthermore, the type of load preferred by the patients and the resonance frequency analysis (Osstell) were also analyzed.[16] Descriptions of the position of the implant in the dental arch, type of prosthetic fixation, and more details about each included RCT are presented in Table 2.

In this systematic review, the included trials did not reveal significant differences between early and immediate loading protocols in single implant crowns[27] regarding survival rate at 1[3,13,16,35,37] or 3 years[3,16,35,37] (RD, −0.00; 95% CI, −0.04 to 0.04; P=.990 for 1 year and P=.980 for 3 years) (Fig. 2). The overall survival rates at 1 year were 97.5% and 97.3%, respectively, and 97.6%

Meta Analysis								Early Loading: 3 Years			
Model	Study Name			Statistics for Each Study					Event Rate and 95% CI		Weight (Random) Relative Weight
		Event Rate	Lower Limit	Upper Limit	Z Value	P	Total				
	Barewal et al, 2012	0.972	0.678	0.998	2.479	.013	17/17				19.94
	Canizzaro et al, 2012	0.968	0.804	0.995	3.346	.001	30/31				39.70
	Kokovic et al, 2014	0.986	0.818	0.999	3.013	.003	36/36				20.23
	Merli et al, 2012	0.981	0.764	0.999	2.781	.005	26/26				20.13
Fixed		0.976	0.922	0.993	5.818	<.001					
Random		0.976	0.922	0.993	5.818	<.001					

Heterogeneity P=.960, I^2=0

								Immediate Loading: 3 Years			
Model	Study Name			Statistics for Each Study					Event Rate and 95% CI		Weight (Random) Relative Weight
		Event Rate	Lower Limit	Upper Limit	Z Value	P	Total				
	Barewal et al, 2012	0.938	0.461	0.996	1.854	.064	7/7				19.37
	Canizzaro et al, 2012	0.966	0.792	0.995	3.274	.001	28/29				39.90
	Kokovic et al, 2014	0.986	0.818	0.999	3.013	.003	36/36				20.38
	Merli et al, 2012	0.984	0.794	0.999	2.907	.004	31/31				20.34
Fixed		0.973	0.910	0.992	5.556	<.001					
Random		0.973	0.910	0.992	5.556	<.001					

Heterogeneity P=.845, I^2=0

B

Figure 3. (*continued*). B, Cumulative overall implant survival rate at 3 years, with 4 included studies, for early and immediately loading.

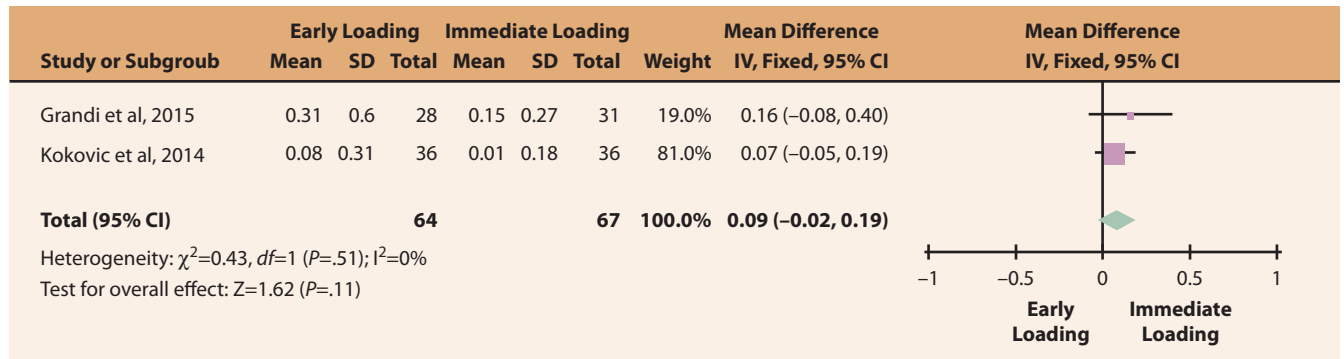for early and 97.3% for immediate loading at 3 years (Fig. 3).

The marginal bone loss for interproximal bone level was measured by standardized periapical radiographs made immediately after the implant placement and according to the follow-up of each study.[27] Two RCTs followed the implants for 1 year,[13,37] and 2 other studies for 3 years.[3,35] These studies were grouped separately for data analysis and did not reveal significant differences between early and immediate loading protocols in single implant crowns regarding marginal bone loss at 1 (MD, 0.09; 95% CI, −0.02 to 0.19; P=.110) (Fig. 4A) or 3 years (MD, −0.23; 95% CI, −0.47 to 0.01; P=.060) (Fig. 4B).
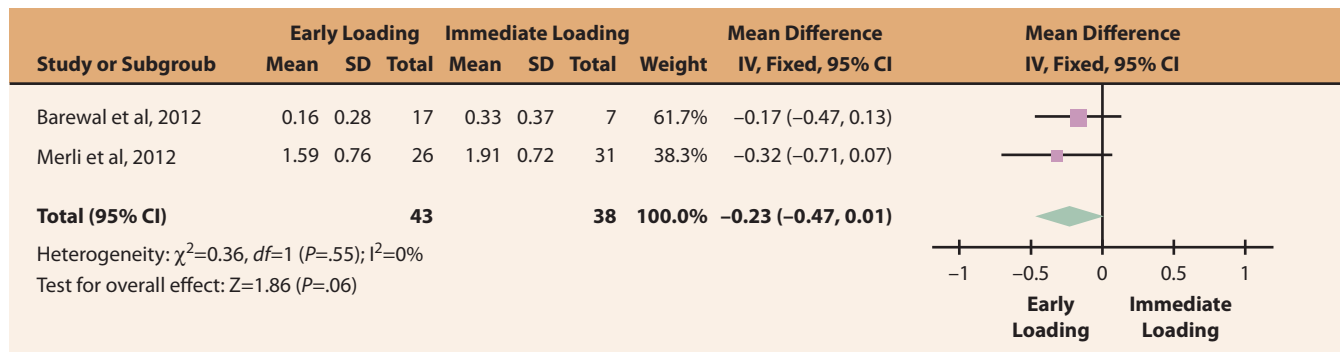
DISCUSSION

Immediate loading is defined as a prosthesis being placed in occlusion within 48 hours of implant surgery[7] or 72 hours after implant placement.[33] Early loading is defined as a prosthesis being in contact with the opposing dentition and placed at least 48 hours after implant surgery but not later than 3 months afterward.[7,9] As a chemically modified titanium surface has a substantial effect on the qualitative and quantitative aspects of bone healing, both loading protocols have become widely documented and accepted for situations ranging from complete-arch restorations to single implant-supported crowns.[1,2,5,6,17,23]

Because these 2 treatment modalities have been widely used, the advantages of using one over the other must be understood. When an implant is subjected to immediate loading, does the risk of marginal bone loss harm the survival rate of that implant? When an implant is subjected to early loading, must the clinician wait a few days after surgery before placing the restoration and is this really necessary, as the implant was placed with a high insertion torque greater than 32 Ncm? In this

Study or Subgroup	Early Loading			Immediate Loading			Weight	Mean Difference IV, Fixed, 95% CI
	Mean	SD	Total	Mean	SD	Total		
Grandi et al, 2015	0.31	0.6	28	0.15	0.27	31	19.0%	0.16 (−0.08, 0.40)
Kokovic et al, 2014	0.08	0.31	36	0.01	0.18	36	81.0%	0.07 (−0.05, 0.19)
Total (95% CI)			**64**			**67**	**100.0%**	**0.09 (−0.02, 0.19)**

Heterogeneity: χ^2=0.43, df=1 (P=.51); I^2=0%
Test for overall effect: Z=1.62 (P=.11)

A

Study or Subgroup	Early Loading			Immediate Loading			Weight	Mean Difference IV, Fixed, 95% CI
	Mean	SD	Total	Mean	SD	Total		
Barewal et al, 2012	0.16	0.28	17	0.33	0.37	7	61.7%	−0.17 (−0.47, 0.13)
Merli et al, 2012	1.59	0.76	26	1.91	0.72	31	38.3%	−0.32 (−0.71, 0.07)
Total (95% CI)			**43**			**38**	**100.0%**	**−0.23 (−0.47, 0.01)**

Heterogeneity: χ^2=0.36, df=1 (P=.55); I^2=0%
Test for overall effect: Z=1.86 (P=.06)

B

Figure 4. A, Forest plot of implant marginal bone loss at 1 year with 2 included studies. B, Forest plot of implant marginal bone loss at 3 years with 2 included studies.

systematic review, high insertion torque was not an inclusion criterion. The implant insertion torque in the included papers ranged between 20 and 45 Ncm.

The risk of bias analysis investigates the quality level of the included studies. The Cochrane collaboration tool for assessing risk of bias determined the methodological quality of the included studies. This tool demonstrated that only 1 study[37] showed a high risk of bias. Kokovic et al[37] did not mention the method used to seat the interim restorations. The other 4 studies presented a low risk of bias.[3,13,16,35] These studies performed a total of 274 implants, whereas the study with a high risk of bias reported on 72 implants. The risk of bias (Fig. 5) helps clinicians to perceive the differences among selected studies. Blinding or masking the study participants and personnel may reduce the risk of bias that occurs when knowledge of which intervention was received, rather than the intervention itself, affects outcomes and measurements.[32] Furthermore, blinding can be especially important in the assessment of subjective outcomes.[32]

In the present review, the authors appreciated the fact that the outcome measurements, marginal bone loss and implant survival rate, could not be influenced by an absence of blinding.

In this systematic review, the included trials did not demonstrate significant differences between immediate and early loading protocols in single implant crowns with regard to survival rate at 1 (P=.990) or 3 years (P=.980). The overall survival rates were 97.3% for immediate loading at 1 and 3 years and 97.5% for early loading at 1 and 97.6% at 3 years. Similar results were found by other studies.[13,15,16,35,37] A possible contributing factor to this absence of difference between these protocols is that the implants were loaded according to a randomized allocation. With this study design, implants are inserted with a high insertion torque, as the operator does not know if the implant will be immediately or early loaded. To achieve this high insertion torque, implant sites are under-prepared to various degrees according to bone quality.[15] Under-preparation of the implant site, which is characterized by not following the standard drilling sequence, has been discussed as a means of improving primary stability,[16,21] as this is assumed to be the most important determinant of success in early and immediate loading implants.[16] However, under-preparation of implant sites can cause a greater resorptive effect, resulting in a decrease of the secondary stability derived from remodeling the implant interface.[22] In this systematic review, in all 5 included studies, the surgeon was
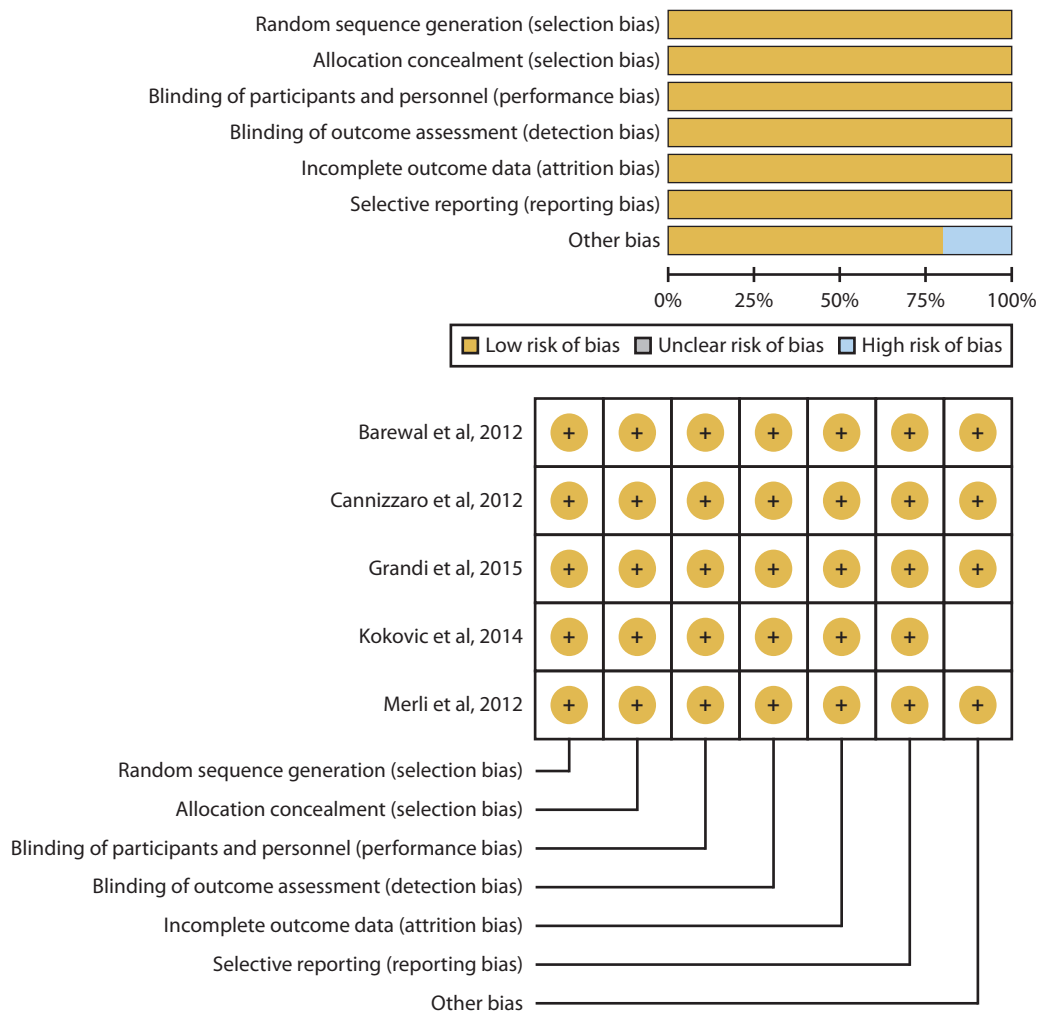
Figure 5. Results of risk of bias (Cochrane collaboration tool for assessing risk of bias) of 5 included RCTs.

Table 2. Study characteristics of 5 randomized controlled trials

Study Year	Follow-up Period	Initial No. of Patients	Age Range (y)	No. of Implants	Implant Immediately Loaded (mm)	Implant Early Loaded (mm)	Prosthetic Fixation
Barewal et al, 2012[3]	3 y	40	20–82	40 (immediate, early, and delayed)	8 initial, 7 after 3 y	17	Screw-retained crown
Cannizzaro et al, 2012[16]	6 mo and 4 y	30 (28 after 1 y)	18–57	60	29 initial, 28 after 1 y*	31 initial, 30 after 1 y	Cemented crown
Grandi et al, 2015[13]	1 y	105 (103 after 1 y)	21–73	105 (35 of them were conventional loading)	35 initial, 32 after 1 y, 31 after reallocation	35 initial, 34 after 1 y, 28 after reallocation	Screw-retained crown
Kokovic et al, 2014[37]	1 and 5 y	12	20–62	72	36	36	–
Merli et al, 2012[35]	3 y	69 (49 after 3 y)	19–72	69 initial, 57 after 3 y	35 initial, 31 after 3 y	34 initial, 26 after 3 y	Screw-retained crown

CI, confidence interval; E, early loaded; I, immediately loaded; SD, standard deviation. *One implant randomized to immediate loading was actually early loaded at 6 weeks.

free to decide whether or not to under-prepare the implants sites. Furthermore, in 3 of the 5 studies, implants were inserted at torques greater than 40 Ncm,[13,16,35] which could explain the higher survival rates reported in these studies.

In contrast, an RCT[21] demonstrated a survival rate of 95.5% when single implant crowns were immediately loaded at low torques (≤25 Ncm). According to Ottoni et al,[20] the failure was lower when a torque of 32 Ncm was used to insert an implant, whereas torques of 20 and 45 Ncm were associated with greater failure rates. According to this study, implant survival rates were independent of bone quality, site, implant length but were related to insertion torque. A torque of 32 Ncm is deemed necessary to achieve osseointegration in immediately loaded implants.[20,27]

Two recent systematic reviews[14,18] did not find significant differences regarding the implant survival rate with early and immediate loading. Different from this review, these 2 studies included splinted implants.[27]

In this review, the included trials did not reveal significant differences between early and immediate loading protocols in single implant crowns regarding marginal bone loss at 1 (P=.110) (Grandi et al,[13] Kokovic et al[37]) or 3 years (P=.060) (Barewal et al,[3] Merli et al[35]). These results are in accordance with some studies[3,13,15,16,34,37] but contrast with the results of a study[11] that reported, for immediately loaded implants, higher values of bone loss than early loaded ones.[11,37] However, in that study, they compared immediate versus early loaded dental implants from single crowns to 4-unit fixed partial

dentures. Results similar to this agree that immediate loading stimulates the bone–implant interface that causes a functional remodeling of bone structures, resulting in a differentiation of cells, which may increase bone loss around implants.[12,29] Marginal bone loss in immediately loaded implants occurs with a high intensity during the first 30 days.[29] This phenomenon can be explained by the early colonization of bacteria at the abutment–implant interface, known as a "microgap."[10,29] However, as demonstrated in a recent study, bone loss around implants can be caused by some other factors, such as the implant design, healing and remodeling processes, surgical trauma, ability and experience of the surgeon, and patient-related factors.[20,29]

In conclusion, the difference between these techniques (immediate and early loading) did not affect the survival rate of implants for 1year and 3 years, or even the marginal bone loss at 1 or 3 years. Thus, the immediate or early loading of the implants should be considered.

Although the authors search of studies was made without restrictions of date, type of study, or language, a limitation of this review was the small number of studies included, which could be insufficient to detect any significant difference. In addition the studies included were short term and long-term follow up and assessment of such protocols is required. In the search strategy, non-peer reviewed articles were not sought. Thus, future studies should be conducted comparing these loading protocols with long-term observations and standardized surgical techniques.

Table 2. *(Continued)* Study characteristics of 5 randomized controlled trials

Implant Distribution /Sites	Occlusal Contact with the Opposite Dentition: Early Loading	Occlusal Contact with the Opposite Dentition: Immediate Loading	Survival Rate: Immediate Loading	Survival Rate: Early Loading	Marginal Bone Loss: Immediate Loading	Marginal Bone Loss - Early Loading	Dropout
Maxilla: I=1; E=10; mandible: I=7; E=8; molar: I=3; E=8; premolar: I=5; E=10	Established single central contact in maximum intercuspation, without contacts in excursive movements	Established single central contact in maximum intercuspation, without contacts in excursive movements	100%	100%	Mesial -0.37 (SD 0.38); distal -0.29 (SD 0.37)	Mesial -0.20 (SD 0.29); distal -0.13 (SD 0.27)	2 participants (5%), 1 at immediate group, 1 at delayed group
Inserted in maxilla: I=17; E=16; inserted in fresh extraction sockets: I:9; E=9; elevated flap: I=8; E=5; incisor sites: I=2; E=1; canine sites: I=2; E=2; premolar sites: I=11; E=14; molar sites: I=15; E=13*	6 wk after surgery with slight static contact and absence of eccentric contacts	On same day of surgery with slight static contact and absence of eccentric contacts	1 implant failed (96.55%)	1 implant failed (96.77%)	-0.37 (SD 0.35); 95% CI 0.11–0.22	-0.31 (SD 0.36); 95% CI 0.11–0.22	0 participants (0%)
Mandibles: I=7; E=13; incisor sites: I=8; E=3; canine sites: I=2; E=1; premolar sites: I=22; E=16: molar sites: I=3; E=15; non-augmented extraction sockets: I=4; E=1; augmented extraction sites: I=21; E=11	3 wk after surgery; nonocclusal loading	On same day of implant placement; nonocclusal loading	1 implant failed (96.87%)	1 implant failed (96.55%)	0.15 (SD 0.27); 95% CI -0.12–0.42	0.31 (SD 0.60); 95% CI -0.29 −0.91	2 participants (1.90%) immediate group
Posterior edentulous mandible	24 h after surgery	6 wk after surgery	No implant failure occurred (100%)	No implant failure occurred (100%)	0.01 (SD 0.18)	0.08 (SD 0.31)	0 participants (0%)
Inserted in fresh extraction socket: I=13; E=16; inserted in fresh extraction site filled with Bio-Oss: I=8; E=7; inserted in mandible: I=12; E=13; In anterior area: I=2; E=5	6 wk after implant placement; absence of centric or eccentric contacts	72 h after implant placement; absence of centric or eccentric contacts	No implant failure occurred (100%)	No implant failure occurred (100%)	1.91 (SD 0.72)	1.59 (SD 0.76)	4 participants (6.6%), 1 at immediate group, 3 at early group

CONCLUSIONS

Within the limitations of this systematic review, the following conclusions were drawn:

1. No significant differences were found in terms of survival at 1 or 3 years between early and immediate loading protocols for single implant-supported crowns.
2. No significant differences were found in terms of marginal bone loss at 1 or 3 years between early and immediate loading protocols for single implant-supported crowns.

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