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REVIEW ARTICLE

CLINICAL OUTCOME OF PERI-IMPLANT SOFT AND HARD TISSUES AFTER IMMEDIATE IMPLANT PLACEMENT: A SYSTEMATIC REVIEW AND META-ANALYSIS

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ABSTRACT

Background: One of the most important challenges in dental implant placement is supporting and preserving soft tissue and bone structures. Numerous studies on fixation of soft and hard tissues at the single or double teeth site have reported immediate placement using a flapless protocol, while many studies have reported fewer results in molar extraction solutions. The current study aims to determine the clinical outcome of peri-implant soft and hard tissues following immediate implant placement.

Materials & Methods: This study was conducted in the Department of Orthodontics, College of Stomatology, Xi'an Jiaotong University, Xi'an, China, from January 2021 to September 2021. In this systematic review, the search strategy was to screen electronically all relevant, authentic articles on databases of Embase, LIVIVO, EBSCO, Web of Science, LILACS, Scopus, and PubMed, published from 2011 to September 2021. Risk ratio (RR) was determined for implant failure, and mean differences (MD) were determined for soft tissue, horizontal and vertical buccal bone resorption by 95% CI, Inverse-variance, and fixed effect model or Mantel-Haenszel method between the intervention (bone substitute material) and control (no bone substitute material) groups through Stata/MP v.16.

Results: Risk ratio of implant failure was similar in intervention and control group 0.02 (RR=0.02; 95%CI=-0.04 to 0.08; p=0.49). Mean differences were statistically greater in intervention than control group for soft tissue 1.65 mm (95%CI=1.05 to 2.25; p=0.00), horizontal bone resorption -0.47 mm (95%CI=-0.77 to -0.17 mm; p=0.00) and vertical buccal bone resorption -0.14 mm (95%CI=-0.24 to -0.03 mm; p=0.01).

Conclusion: Our findings revealed no significant difference in implant failure between an intervention (bone substitute material) and control (no bone substitute material) groups. Mean differences were statistically greater in the intervention than the control group for soft tissue, horizontal bone resorption, and vertical buccal bone resorption. Using bone substitute material can improve long-term peri-implant soft tissue, horizontal and vertical buccal bone resorption. It is recommended to use bone-substitute material with a thin buccal plate.

KEYWORDS: Bone; Tissues; Teeth; Bone Resorption; Bone Substitutes; Meta-analysis; Systematic Review; Risk Ratio.

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INTRODUCTION

One of the most important challenges in dental implant placement is supporting and preserving bone structures and soft tissues. It is also important to achieve long-term success and increase the survival of the implant.[1,2] Evidence suggests that bone resorption occurs after tooth extraction.[3,4] Studies have reported that after one year of tooth extraction or tooth loss, the alveolar crest shrinks by 50%.[5,6] It

has been reported that dehiscence defects or fenestrations can be observed even in normal individuals and that severe volume deficiency can result from bone resorption.[7]

Immediate implant placement refers to a dental implant positioning instantly at the site of a fresh cavity post tooth extraction and has been introduced as an admirable and predictable approach.[8] The advantages of this method are saving time, maintaining soft tissue contour, and reducing the number of surgeries.[9] However, peri-implant bone resorption and ridge preservation are debatable, and insufficient evidence has been provided in this regard, and all influencing factors should be investigated.[10,11] Immediate implant placement by flap method without linking the facial defect between the bone blade and implant surface can cause bone resorption.[12,13] Numerous studies on the fixation of soft and hard tissues at the single or double teeth site have reported immediate placement using a flapless protocol. Therefore, the current work aims to determine the clinical outcome of peri-implant hard and soft tissues following immediate implant placement.

The current study aims to determine the clinical outcome of peri-implant hard and soft tissues following immediate implant placement.

MATERIALS AND METHODS

This study was conducted in the Department of Orthodontics, College of Stomatology, the first affiliated stomatological hospital, Xi'an Jiaotong University, Xi'an, China from January 2021 to September 2021.

The initial screening presented 441 articles. After deleting the duplicates, 427 articles were reviewed for their abstracts, excluding non-eligible 388 articles. Then, 32 articles were reviewed for their full text, which led to the exclusion of 23 non-eligible articles because of incomplete data, poor nature, inconsistency of findings in a study, inconsistent data with the study objectives, and no access to the full text. At last, nine articles entered the final analysis; six studies were able to meta-analyze, and the rest were used in the systematic review. (Figure1)

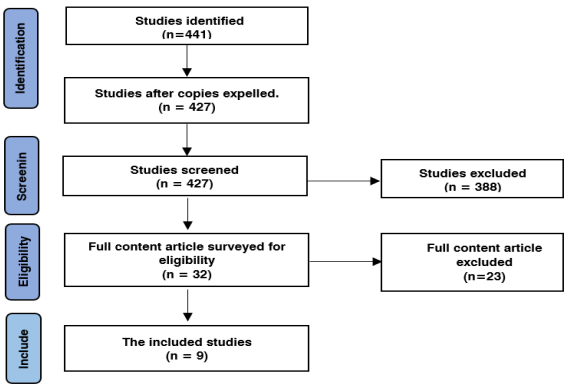

Figure 1. Study Attrition

Characteristics

Nine articles (RCTs) entered the final analysis. The sample included 203 implants of 196 patients in the intervention group and 183 implants of 190 patients in the control group. The follow-up period was six to 36 months. (Table 1)

Table 1. Articles enrolled in the systematic review and meta-analysis

Studies. Years	Number of Patients		Number of implants		Jaw		Bone substitute material	Control	Follow-up (months)
	Int.	Co.	Int.	Co.	Maxilla	Mandible			
Jacobs, et al., 2020[14]	19	14	19	14	√	-	Xenograft	None	10
Yuenyongorarn et al., 2020[15]	10	10	10	10	√		Xenograft	None	12
Bittner, et al., 2020[16]	16	16	16	16	√	-	Xenograft	None	12
Girlanda, et al., 2019[17]	11	11	11	11	√	-	Xenograft	None	6
Grassi, et al., 2019[18]	15	14	15	14	√	-	Xenograft	None	6
Mastrangelo, et al., 2018[19]	51	51	64	51	√	-	Xenograft	None	36
Paknejad, et al., 2017[20]	20	20	14	13	√	-	Xenograft	None	6
Daif, et al., 2013[21]	14	14	14	14	-	√	Alloplast	None	6
De Angelis, et al., 2011[22]	40	40	40	40	√	√	Xenograft	Coll. mem.	12
Total	196	190	203	183					

Int.= Intervention, Co.= Control, Coll. mem.= Collagen membrane

Assessing bias risk: Based on the Cochrane Collaboration tool, seven studies received a score of 5-6; the other two received a score of 4. According to the Cochrane Collaboration's tool scores, all enrolled articles exhibited high quality or low bias risk. (Figure 2)

Searching procedure: In this systematic review, the search strategy was to screen electronically all relevant, authentic articles on databases of Embase, LIVIVO, EBSCO, Web of Science, LILACS, Scopus, and PubMed, published from 2011 to September 2021, because we intended to gain enough evidence in this area over the last decade and become aware of newer efforts. Hence, the electronic titles were managed by Endnote X8 software.

The search was based on the main MeSH terms, as follows.

("Immediate Dental Implant Loading" OR "Dental Implants") AND "Survival") AND

("Bone and Bones" OR "Alveolar Bone Grafting" OR "Bone Retroversion")) AND

("Mandible" OR "Mandibular Prosthesis Implantation" OR "Mandibular Advancement" OR "Mandibular Prosthesis")) AND ("Dental Porcelain" OR "Metal Ceramic Alloys")) AND

("Randomized Controlled Trials as Topic" OR "Randomized Controlled Trial" [Publication Type])) AND "Healthy Volunteers") AND ("Mouth, Edentulous" OR "Jaw, Edentulous").

As seen in Table 2, PICO strategy and Guidelines developed at the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) were employed for systematic review.[23]

Selection criteria: The eligibility steps were as follows: all randomized controlled trials (RCTs), retrospective and prospective cohort articles, controlled clinical trials; in human; edentulous maxillary and mandibular; in English. In vitro studies, case reports,

Study	Random generation of sequences	Concealment of Allocation	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete data on outcomes	Selective reporting	Total score
Jacobs, et al., 2020[14]	+	+	+	+	+	+	6
Yuenyongorarn, et al., 2020[15]	+	+	-	+	+	+	5
Bittner, et al., 2020[16]	+	+	-	+	+	+	5
Girlanda, et al., 2019[17]	+	+	+	+	?	+	5
Grassi, et al., 2019[18]	+	+	-	+	+	?	4
Mastrangelo, et al., 2018[19]	+	?	+	+	+	+	5
Paknejad, et al., 2017[20]	+	?	+	-	+	+	4
Daif, et, al., 2013[21]	+	+	+	+	?	+	5
De Angelis, et al., 2011[22]	+	+	+	+	?	+	5

Figure 2. Assessment of bias risk (Randomized clinical trials)

reviews, and case studies, total loss of the buccal bone wall were omitted.

Table 2. PICO OR PECO strategy

PICO strategy	Description
P	Population/ Patient: patients undergoing immediate implant placement
E	Intervention: bone substitute material
C	Comparison: Not using bone substitute material
O	Outcome: clinical outcome

Extraction and analysis of required data: The extracted data from the selected articles required for final analysis consisted of a year of publication, design of the study, number of implants, follow-up, sample size, intervention, and control group.

Collaboration's tool was recruited to determine the quality of randomized investigations,[24] indicating score 1 as low risk and 0 as high and unclear risks, with scores between 0 and 6; the higher the score, the higher the quality.

Two separate blind investigators reviewed all enrolled studies for abstract and full text to extract the data. The kappa statistics were performed before screening to confirm the agreement of the investigators, the results of which showed the kappa value of >0.80. Risk ratio (RR) and mean differences (MD) were determined by 95% confidence interval (95% CI), Inverse-variance, and fixed effect model or Mantel-Haenszel method between the intervention (bone substitute material) and control (no bone substitute material) groups. The heterogeneity (I^2) among the selected articles was calculated by the random effects so that the I^2 value of greater than 50% means moderate to high heterogeneity. Stata/MP v.16 software was used for the meta-analysis.

RESULTS

Dental implant failures: Three studies were included here. The intervention (bone substitute material) group showed the failure of four out 114 implants (3.50%). The control group showed the failure of six out of 101 implants (5.94%). Risk ratio of the implant failure between the two groups was 0.02 (RR= 0.02; 95% CI= -0.04 to 0.08; p=0.49), having low heterogeneity of I2=1.63% (p=0.36). No significant difference was statistically seen in the implant failure between the two groups. (Figure 3).

Soft tissue: Three studies included 101 implants in the intervention (bone substitute material) group and 95 in the control group. Mean differences of the soft tissue between bone substitute material and control groups was 1.65 (MD=1.65; 95% CI=1.05 to 2.25; p=0.00), having low heterogeneity of I2 =57.17% (p=0.10). A significant difference was statistically seen with greater in the intervention group. (Figure 4).

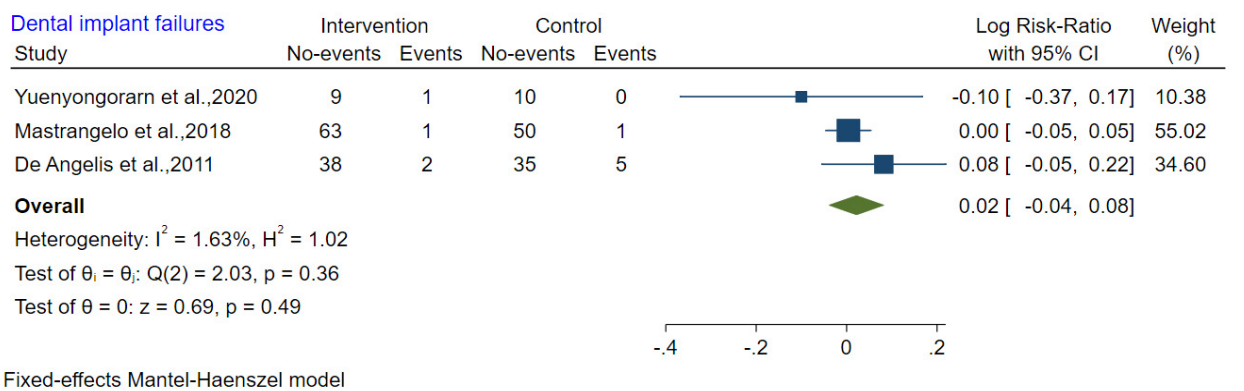

Figure 3. Forest plot for dental implant failures between bone substitute material and not using bone substitute material

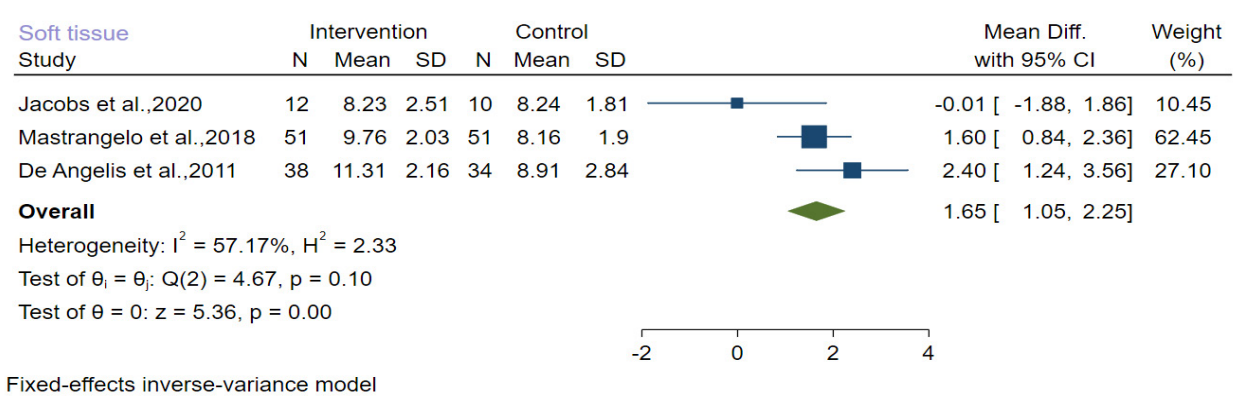

Figure 4. Forest plot for mean differences of soft tissue

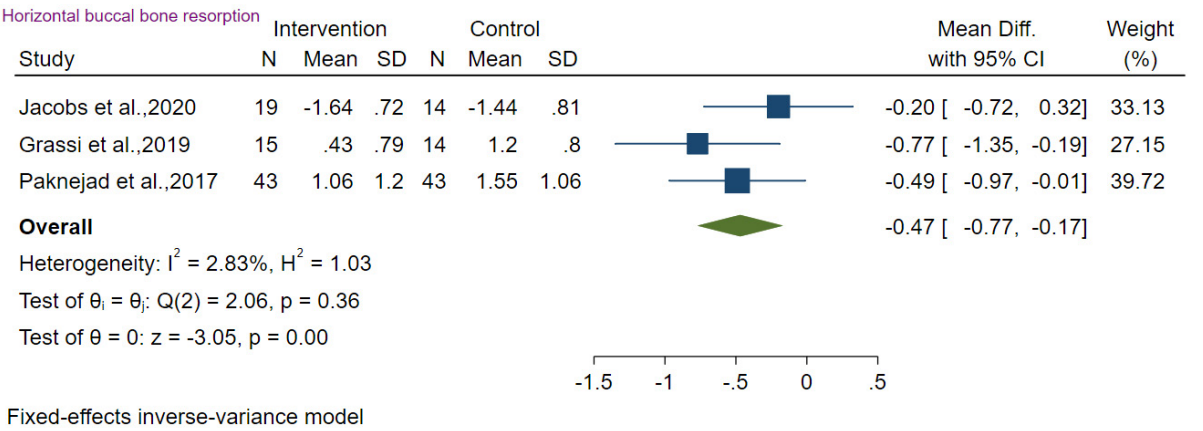

Figure 5. Forest plot for horizontal buccal bone resorption

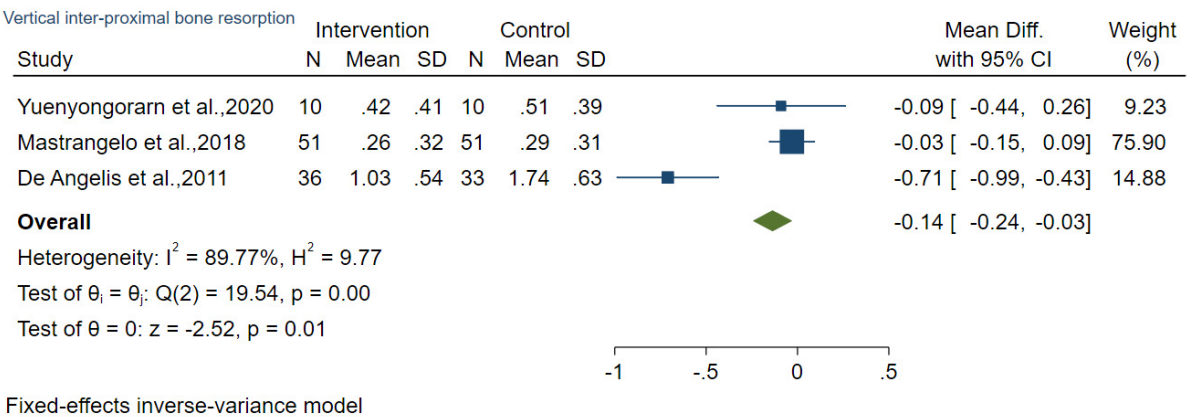

Figure 6. Forest plot for vertical buccal bone resorption

Horizontal buccal bone resorption

Three studies were included, with 77 implants in the intervention group and 71 in the control group. Mean differences of the horizontal buccal bone resorption between intervention and control groups was -0.47 mm (MD=-0.47 mm; 95% CI= -0.77 to -0.17 mm; p=0.00), having low heterogeneity of I2 =2.83% (p=0.36). A significant difference was statistically seen with greater in the intervention group. (Figure 5).

Vertical buccal bone resorption

Three studies were included, with 97 implants in the intervention group and 94 in the control group. Mean differences of the vertical buccal bone resorption between bone substitute material and control groups was -0.14 mm (MD=-0.14mm; 95% CI= -0.24 to -0.03mm; p=0.01), having high heterogeneity of I2 =89.77% (p=0.00). A significant difference was statistically seen with greater in the intervention group. (Figure 6).

DISCUSSION

The current systematic review and meta-analysis aimed to determine the clinical outcomes of peri-implant soft and hard tissues after immediate placement of the implant. According to De Angelis, et al.,[22] the overall side effects of using bone substitute material were higher than not using them.

Dental implant failures

Our meta-analysis showed 3.5% (4/114) dental implant failures in the intervention (bone substitute material) group versus 3.5% failures in the control group (6/101). The risk ratio of the implant failure showed no significant difference between the two groups. In the present study, the probability of survival was about 97%, which corresponds to the immediate placement of implants in single or double root canals; other studies have reported similar findings.[25] In the clinical trial study, only one implant failure occurred in the intervention group.[6] Reasons for implant failure include poor oral hygiene, obesity, smoking, poor eating habits, and diseases such as diabetes. In the study of Ketabi et al.,[26] the implant survival rate was reported to be 98%, consistent with the present study; this study was performed on the immediate placement of implants in molar extraction sockets.

Soft tissue

Our meta-analysis showed statistically significant mean differences in soft tissue in the intervention

(bone substitute material) versus control groups, with a greater value for the intervention group. However, a study that reported the implant failure time test, as a result, was not found, and only one study reported complications. Due to the lack of evidence, more studies are needed to confirm these results in order to provide sufficient and stronger evidence. Complications include mucositis around the implant, prosthesis complications, pre-implants, and postoperative pain. The greater risk of adverse effects can be attributed to reducing agents and a technique-sensitive protocol.

Horizontal buccal bone resorption

Our meta-analysis showed statistically significant mean differences in horizontal buccal bone resorption in the intervention (bone substitute material) versus control groups, with a greater value for the intervention group. The findings showed no clear histological explanation for horizontal buccal analysis when using bone substitute material.[27] All available RCT studies have reported the results of using xenograft, with a slow analysis rate.[28] Reducing horizontal buccal bone resorption (≤2 mm) provides many benefits to patients.[29] In the present study, the existing RCTs from 2011 to 2021 were examined, the quality of included articles exhibited a high, and a slight heterogeneity was found among the study findings. Urban, et al., 2012 investigated immediate implant placement in molar extraction sites using different approaches for peri-implant bone.[30]

Their results also indicated a mean bone loss of −0.48 mm in 76 patients without significant differences between the bone regenerative techniques.[30] The findings of a recent study by Nölken et al., 2019 are similar to those of the present study; however, there is no strong evidence for the positive effect of this method on bone regeneration or osteointegration.[31] Immediate implant placement at the extraction site cannot significantly prevent horizontal resorption when a full-thickness flap rises and the gap around the implant does not close.

Vertical buccal bone resorption

Our meta-analysis showed statistically significant mean differences in vertical buccal bone resorption in the intervention (bone substitute material) versus control group, with a greater value for the intervention group. The meta-analysis found that bone substitute material has no reducing influence on vertical buccal bone resorption. However, these results also require further studies; the limited diagnostic function of CBCT should also be considered.[32] The slow resorption rates of radiopaque material can reduce the power of clinical and radiographic determinations of vertical buccal bone resorption in the bone substitute material vs. the control group.[33]

Limitations

Our study limitations included the following. The time of implant failure was not reported in any study, which must be considered in future studies to provide more evidence and better results. Only one study reported complications. The sample size was low in all studies. Therefore, the accuracy of the consolidated estimates was limited. Incompatible methods were found in the studies. RCT studies were found to require little further study. In previous meta-analysis studies, observational and experimental studies have also been used, in which the results in favor or against the use of bone substitute material have not been determined due to insufficient evidence.[34,35]

CONCLUSION

Our findings revealed no significant difference in the implant failure between the intervention (bone substitute material) and control (no bone substitute material) groups. Mean differences were statistically greater in the intervention than the control group for soft tissue, horizontal bone resorption, and vertical buccal bone resorption. Using bone substitute material can improve long-term peri-implant soft tissue, horizontal buccal bone resorption, and vertical buccal bone resorption. The biphasic bone graft material shows, in comparison to autogenous bone, less horizontal resorption. It is recommended to use bone-substitute material with a thin buccal plate.

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CONFLICT OF INTEREST
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All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.