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IMPLANT FAILURE AND MARGINAL BONE LOSS OF TILTED IMPLANTS IN COMPARISON WITH STRAIGHT IMPLANTS SUPPORTING FIXED DENTAL PROSTHESES: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Abstract :

The aim of current systematic review and meta-analysis study was evaluate Implant Failure and Marginal Bone Loss of Tilted Implants in Comparison with Straight Implants Supporting Fixed Dental Prostheses during the follow-up period of 3 to 10 years.

Key words: Marginal Bone Loss, Implant Failure, Tilted Implants, Straight Implants, Fixed Dental Prostheses

Introduction :

There are various solutions available to treat patients who have lost their teeth. Various types of implant - supported restorations can help these people(1). The results of studies have shown that after 5 years of using dental implants, satisfactory results have been observed, however, all previous evaluations have assumed that the implants are were placed and loaded in an axial direction(2). Tilted implants may be used in many cases for a variety of reasons. These implants are used to prevent damage to the anatomical structures and strengthen the jawbone(3). Anatomic structures could be engaged by tilting implants in such a way as to create more separation between anterior and posterior implants(4). Some studies have shown that Tilted implants may respond more favorably biomechanically than direct implants(5). However, there is a difference between the results. Clinical advice is that strong clinical evidence and adequate follow-up should be considered when using tilted implants. Studies showed no significant difference in marginal bone loss was found between tilted and axial implants in both jaws at 1-year evaluation (6). Previous meta-analysis studies (3, 7-9) have reviewed one-year follow-up, and it seems important to review and evaluate Implant Failure and Marginal Bone Loss of Tilted Implants. Therefore,

the present study was performed to evaluate the Implant Failure and Marginal Bone Loss of Tilted Implants in Comparison with Straight Implants Supporting Fixed Dental Prostheses.

Method: :

From the electronic databases, PubMed, Scopus, LILACS, Web of Science, EBSCO, LIVIVO, and Embase have been used to perform a systematic literature over the last ten years between 2011 and September 2021. Risk ratio and mean differences with 95% confidence interval, fixed effect model and Inverse-variance or Mantel-Haenszel method were calculated. The Meta analysis have been evaluated with the statistical software Stata/MP v.16 (The fastest version of Stata).

Result:

A total of 758 potentially relevant titles and abstracts were found during the electronic search. Finally, a total of thirteen publications fulfilled the inclusion criteria required for this systematic review. Risk ratio of implant failure between Tilted Implants and Straight Implants was 0.04 (RR, 0.04 95 % CI 0.03, 0.05; p=0.00) and Mean differences of Marginal Bone Loss between Tilted Implants and Straight Implants was 0.02mm (MD, 0.02mm 95 % CI 0.00mm, 0.05mm; p=0.03).

Conclusion:

In the present study, significant difference of Implant Failure and Marginal Bone Loss were observed between the Tilted Implants and Straight Implants.

Methods :

Search strategy :

From the electronic databases, PubMed, Scopus, LILACS, Web of Science, EBSCO, LIVIVO, and Embase have been used to perform a systematic literature over the last ten years between 2011 and September 2021. The reason for choosing studies in the last ten years is to be able to provide sufficient evidence in this area and use newer studies. Therefore, a software program (Endnote X8) has been utilized for managing the electronic titles.
Searches were performed with mesh terms:

("Dental Implants/adverse effects"[Mesh] OR "Dental Implants/classification"[Mesh] OR "Dental Implants/statistics and numerical data"[Mesh])) OR ("Dental Prosthesis"[Mesh] OR "Dental Prosthesis, Implant-Supported"[Mesh] OR "Dental Restoration, Temporary"[Mesh])) AND "Maxilla"[Mesh]) AND "Mandible"[Mesh]) AND "Survival Rate"[Mesh]) AND "Immediate Dental Implant Loading"[Mesh]) AND "Dental Marginal Adaptation"[Mesh].

Other databases were searched based on the following keywords:

“dental implants OR implants OR tilted implants OR straight implants OR fixed dental prostheses OR FDPs”, “Implant failure OR Implant success OR Implant Survival”, “marginal bone loss OR MBL OR bone loss”.

This systematic review has been conducted on the basis of the key consideration of the PRISMA Statement–Perfumed Reporting Items for the Systematic Review and Meta-analysis(10), and PICO strategy (Table1).

Selection criteria :

Inclusion criteria: Prospective and retrospective cohort studies, Randomized controlled trials studies, controlled clinical trials; in human; edentulous mandible and maxilla; age>18 years; Follow up >3 years; in English. In vitro studies, case studies, case reports and reviews; Animal studies were excluded from the study.

Table 1. PICO strategy.

PICO strategy	Description
P	Population/ Patient: human participants with partial or fully edentulous
I	Intervention: tilted implants
C	Comparison: straight implants
O	Outcome: Implant Failure and Marginal Bone Loss

Data Extraction and analysis method :

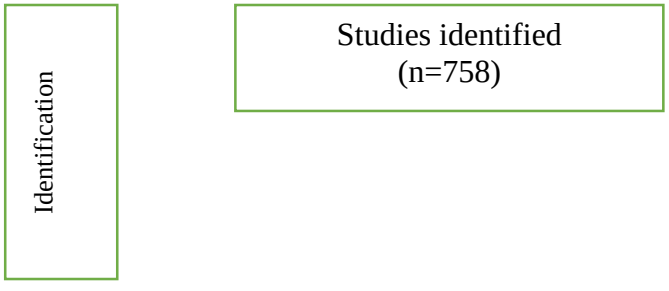
The data were extracted from the research included years, study design, type of implant, Number of implants, sample size, mean of age, follow-up period.

The quality of randomized studies included was assessed using Collaboration's tool(11). The scale scores for low risk was 1 and for High and unclear risk was 0. Scale scores range from 0 to 6. A higher score means higher quality. The quality of non-randomized studies included was assessed using ROBINS-I tool(12).

For Data extraction, two reviewers blind and independently extracted data from abstract and full text of studies that included. Prior to the screening, kappa statistics was carried out in order to verify the agreement level between the reviewers. The kappa values were higher than 0.80. Odds ratio and mean differences with 95% confidence interval (CI), fixed effect model and Mantel-Haenszel or Inverse-variance method were calculated. Random effects were used to deal with potential heterogeneity and I^2 showed heterogeneity. I^2 values above 50% signified moderate-to-high heterogeneity. The Meta analysis have been evaluated with the statistical software Stata/MP v.16 (The fastest version of Stata).

Results :

In the review of the existing literature using the studied keywords, 758 studies were found. In the initial review, duplicate studies were eliminated and abstracts of 732 studies were reviewed. At this stage, 590 studies did not meet the inclusion criteria, so they were excluded, and in the second stage, the full text of 142 studies was reviewed by two authors. At this stage, 129 studies were excluded from the study due to incomplete data, inconsistency of results in a study, poor studies, lack of access to full text, inconsistent data with the purpose of the study. Finally, thirteen studies were selected (Figure1).



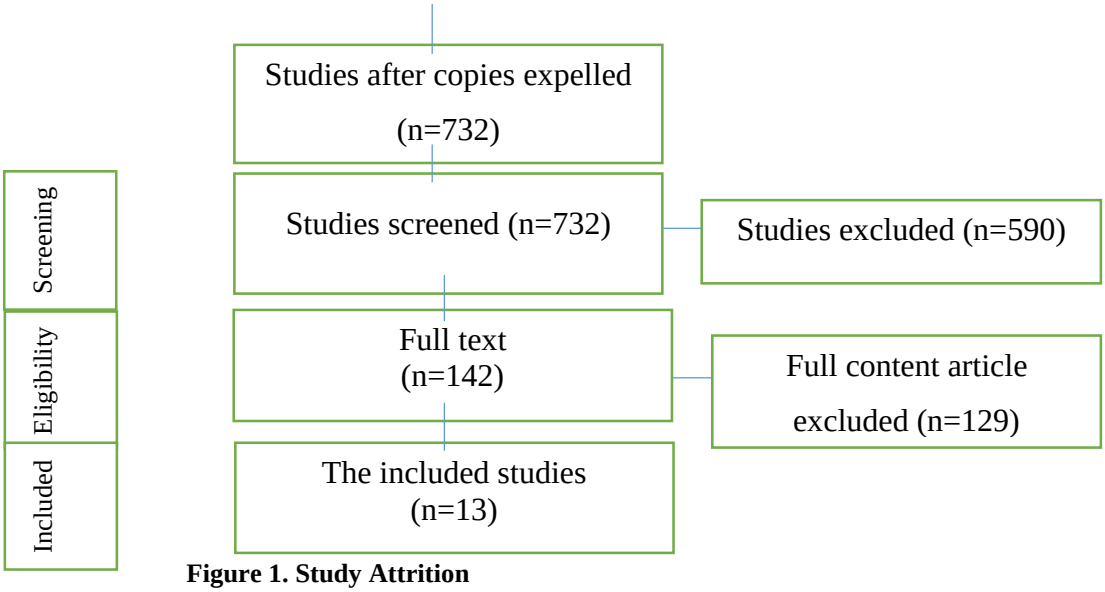


Figure 1. Study Attrition

Characteristics :

Thirteen studies (five Prospective and eight Retrospective cohort studies) have been included in present article. The number of patients with edentulous maxilla or Mandible or both was 1406 with 2676 Tilted Implants and 2796 Axial Implants. In all studies loading time was Immediate, except two studies that was Delayed. The range of follow-up period was between 3-10 years (Table2).

Table2. Summary of selected Studies data for systematic review and meta-analysis

Study. Years	Study design	Number of Patients	jaw		Loading time	Number of implants		Follow-up (years)
			Maxilla	Mandible		Tilted Implants	Axial Implants	
Hamilton et al.,2021 (13)	Prospective	115	√		Immediate	139	44	3
Agnini et al., 2020 (14)	Prospective	30	√	√	Immediate	156	156	3
Bruschi et al., 2019 (15)	Retrospective	25	√		Immediate	43	56	3
Toljanic et al., 2018 (16)	Retrospective	51	√		Immediate	64	38	5
Hopp et al., 2017 (17)	Retrospective	891	√		Immediate	1782	1782	5
Wentaschek et al.,2017 (18)	Retrospective	10	√		Immediate	20	40	5
Queridinha et al.,2016 (19)	Retrospective	60	√		Immediate	30	90	5

Barnea et al.,2016 (20)	Retrospective	29	√		Delayed	25	25	10
Krennmair et al., 2016 (21)	Retrospective	44		√	Delayed	40	124	3
Browayes et al., 2015 (22)	Prospective	20	√	√	Immediate	40	40	3
Agliardi et al., 2014 (23)	Prospective	32	√		Immediate	128	64	3
Agnini et al., 2014 (6)	Prospective	30	√	√	Immediate	37	165	5
Di et al., 2013 (24)	Retrospective	69	√	√	Immediate	172	172	3

Assessing risk of bias :

According to ROBINS-I tool, all studies presented Low risk of bias except two studies had moderate risk of bias (table3).

Table 3. Risk of bias assessment (non-Randomized studies).

Study. Years	confounding	selection of participants into the study	classification of interventions	deviations from intended interventions	missing data	measurement of outcomes	bias in selection of the reported result
Hamilton et al.,2021 (13)	-	+	+	-	-	+	+
Agnini et al. 2020 (14)	-	+	+	-	-	+	+
Bruschi et al. 2019 (15)	-	+	+	-	-	+	+
Toljanic et al. 2018 (16)	-	+	+	-	-	+	+
Hopp et al. 2017 (17)	-	+	+	-	-	+	+
Wentaschek et al.,2017 (18)	-	+	+	+	-	+	+
Queridinha et al.2016 (19)	+	+	+	-	-	+	+
Barnea et al.2016 (20)	-	+	+	-	-	+	+
Krennmair et al. 2016 (21)	-	+	+	+	-	+	+
Browayes et al. 2015 (22)	-	+	+	+	-	+	+
Agliardi et al. 2014 (23)	-	+	+	+	-	+	+
Agnini et al. 2014 (6)	-	+	+	+	-	+	+
Di et al. 2013 (24)							

Implant Failure :

Risk ratio of implant failure between Tilted Implants and Straight Implants was 0.04 (RR, 0.04 95 % CI 0.03, 0.05; p=0.00) with moderate to high heterogeneity (I^2=66.76%; p=0.00) (Figure2). This result shows statistically significant difference of Implant failure between Tilted Implants and Straight Implants.

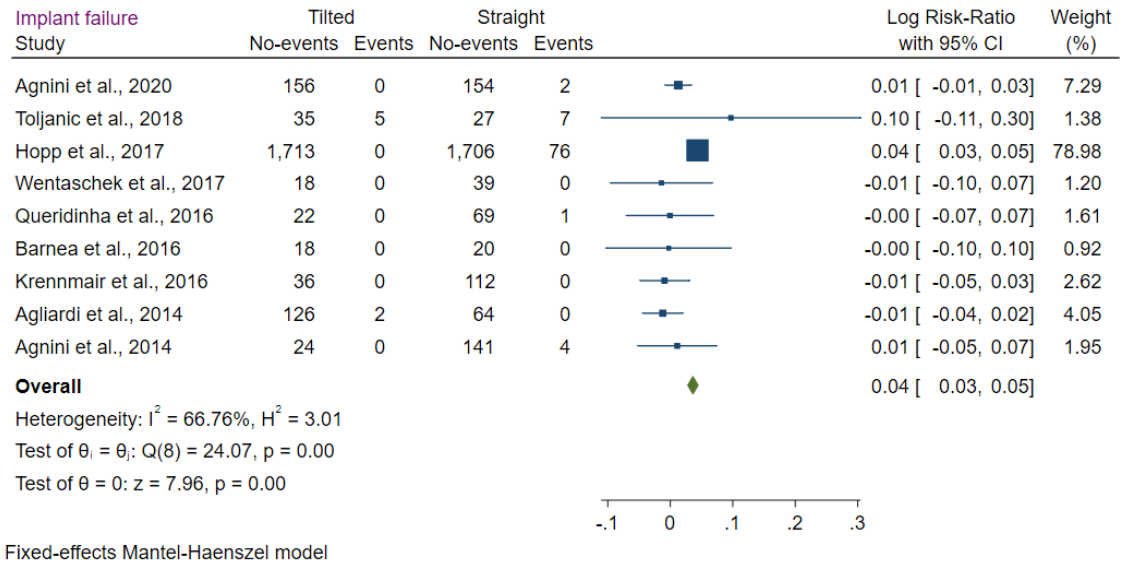


Figure 2. The Forest plot showed implant failure between Tilted Implants and Straight Implants

Marginal Bone Loss :

Mean differences of Marginal Bone Loss between Tilted Implants and Straight Implants was 0.02mm (MD, 0.02mm 95 % CI 0.00mm, 0.05mm; p=0.03) with moderate to high heterogeneity (I^2 =62.37%; p=0.00) (Figure3). There was statistically significant difference of Marginal Bone Loss between two groups.

Discussion :

The aim of current systematic review and meta-analysis study was evaluate Implant Failure and Marginal Bone Loss of Tilted Implants in Comparison with Straight Implants Supporting Fixed Dental Prostheses during the follow-up period of 3 to 10 years. Meta-analysis showed that there was a significant difference in terms of implant failure between tilted and straight implants. The survival rate for tilted implants was about 96%. There was a significant difference in terms of Marginal Bone Loss between tilted and straight implants. It is important to note here that implant tilting entails considerable clinical heterogeneity.

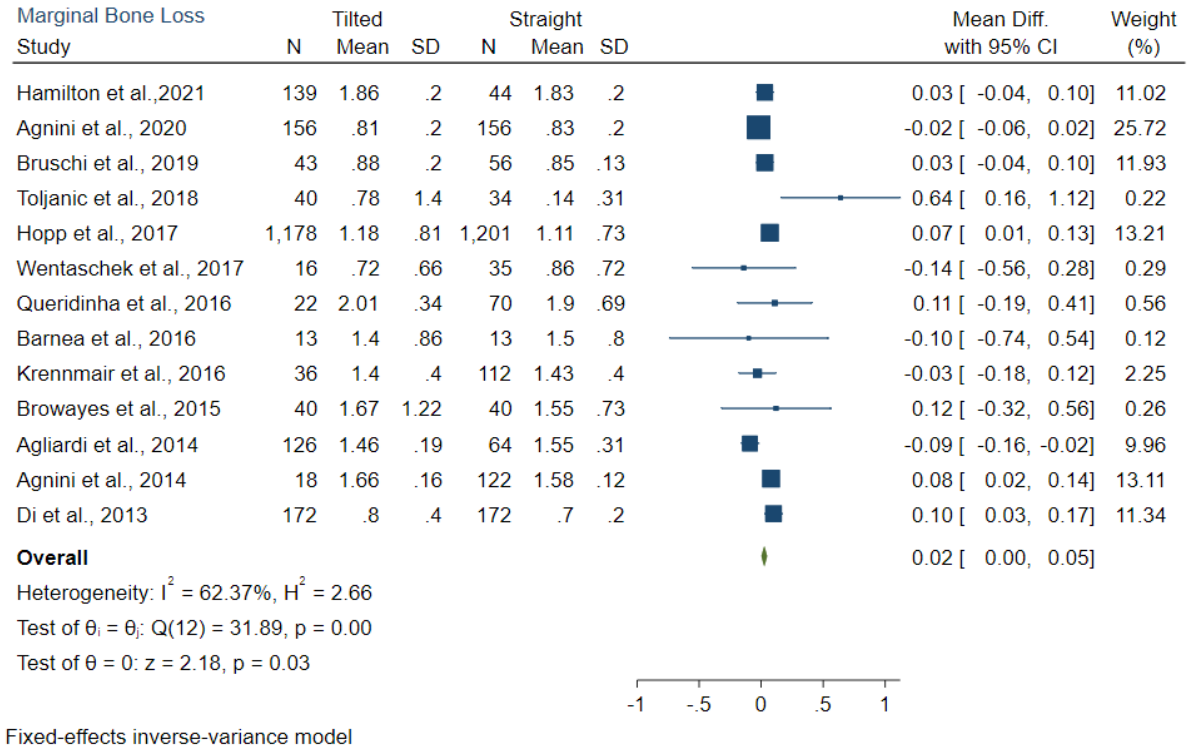


Figure 3. The Forest plot showed Mean differences of Marginal Bone Loss between two groups.

in a systematic review and meta-analysis of Alccayhuaman et al. (3) showed the risk ratio of implant failure was (0.95; 95% CI = 0.70 to 1.28; p > 0.05) and marginal bone loss between tilted and axial implants was (MD = 0.03 mm; 95% CI = −0.03 to 0.10 mm; p > 0.05), Which was contrary to the results of the present study. Mehta et al.,2021 (25) showed no significant mean difference (MD = −0.02; 95% CI; −0.09–0.06; P value = 0.69) was discovered between tilted and axial implants. Apaza Alccayhuaman et al.,2018 (3) reported no difference in the failure of tilted and straight implants was seen (RR = 0.95; 95% CI = 0.70 to 1.28; p = 0.74) and no difference in Marginal Bone Loss was seen between tilted and straight implants (MD = 0.03 mm; 95% CI = −0.03 to 0.10 mm; p = 0.32). Differences in the results of the present study with previous studies should be well investigated to provide better evidence. Older studies have been used in meta-analysis studies, however, in the present study, high heterogeneity was observed between the results, which needs further investigation. Monje et al. (7) Showed similar results to the present study. Tilted implants, It may include contain implants with a wide range of slopes, which can range from 15 to 90 degrees, also It is reasonable to assume that all tilted implants may not have the same prognosis(26). Agnini et al. (14), In a three years follow up evaluation, no significant difference was found in the marginal bone loss between the tilted and axial implants placed in both jaws. in patient-related factors affecting marginal bone loss changes, there was no relationship between age and gender validation of previous reports(27, 28). Monje et al. (29) result of meta-regression showed the mean marginal bone loss on the moderator "implant length" was found to be immaterial (P = 0.633). Subsequently, it might not be concluded that implant length had an impact on peri-implant MBL. In expansion, standardized differences in mean marginal bone loss on

the subgroups short (<10 mm) and standard (≥10 mm) implants, as decided by the meta-analysis (random-effect demonstrate), were found to be measurably inconsequential (P = 0.222). a meta-analysis of Chrcanovic et al. (8) showed There was no apparent significant effects of tilted dental implants on the occurrence of marginal bone loss (MD 0.03mm, 95% CI −0.03 to 0.08; P = 0.32). Cohort studies were used for meta-analysis in the present study because no Randomized controlled trials studies were found to be consistent with the aim of the study. It is noteworthy that in future studies, recommended that Randomized controlled trials studies be performed with the control group. Also more prospective studies are needed. Experimental signs of bias resulting from retrospective study designs were actually observed in the implant failure meta-analysis in the present study. Compared to direct implants, it was found that tilted implants have a lower risk of failure than retrospective studies, but a higher risk of failure than prospective studies.

Conclusion :

In the present study, significant difference of Implant Failure and Marginal Bone Loss were observed between the Tilted Implants and Straight Implants. The impact made on the quality of life of the patients by this alternative treatment modality is tremendous. Hence, it was concluded that tilted implants for restoring completely edentulous atrophic maxilla are a viable therapeutic option with significant differences in outcome compared to conventional implantology. In future, further randomized clinical trials should be carried out to assess the efficacy of tilted implants as a replacement for grafting procedures, short implants, or implants in specific anatomic areas.

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