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Research Article

# Evaluate The Clinical Outcome Of Intentionally Tilted Dental Implants Supporting Fixed Restorations: A Systematic Review And Meta-Analysis

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**Abstract**

**Background and aim:** the aim of current Systematic Review and Meta-Analysis study was evaluate the clinical outcome of Intentionally Tilted Dental Implants Supporting Fixed Restorations.

**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 five years between 2016 and September 2021. odds-Ratio and mean differences with 95% confidence interval (CI), fixed effect model with Mantel-Haenszel method Inverse-variance method were calculated. The Meta analysis have been evaluated with the statistical software Stata/MP v.16 (The fastest version of Stata).

**Result:** 552 studies were selected to review the abstracts, the full text of 38 studies was reviewed. Finally, seven studies were selected. The odds ratio of success rate and survival rate between axial and tilted implants group was (OR, 0.11 95% CI -0.22, 0.44. P=0.50) and (OR, -0.13 95% CI -1.27, 1.01. P=0.83) There was no statistically significant difference between survival rate and success rate of axial and tilted implants.

**Conclusion:** The present Systematic Review and Meta-Analysis study showed that there is no difference in success rate, survival rate and marginal bone loss between Tilted and Axial dental implants, similar results observed.

**Key words:** Tilted Dental Implants, Fixed Restorations, Axial dental implants

**Introduction**

Osseointegrated implants are a good treatment option for rehabilitation of people who have lost their teeth(1). Studies have shown that the success rate of this method is between 92.5 to 96%, and their survival rate over 5 years has been reported between 95 to 99.4% (2, 3). Due to the lack of residual bone or poor bone quality in the jaws, especially in the premolar-molar region, this rehabilitation is

limited. One of the most important challenges in repairing edentulous patients is the pneumatization of the maxillary sinus and the presence of the mandibular nerve(4, 5). Implant placement often results in a longer distal cantilever that produces high stress on both implants and bone, which can reduce implant survival(6, 7). The use of implant placement in the zygoma or the tuberosity offer or short implants can be effective in advanced bone strengthening surgeries(8). Another option is to place a distally tilted posterior implant. This treatment modality places the implants in preexisting bone, improving bone anchorage and prosthetic support. Tilting the implants may have other advantages too, such as the possibility of placing long implants, which increases the bone-to-implant contact area as well as primary stability. It also increases the distance between anterior and posterior implants, which results in better load distribution and avoids long cantilevers (9-11). According to importance of subject, the aim of current Systematic Review and Meta-Analysis study was evaluate the clinical outcome of Intentionally Tilted Dental Implants Supporting Fixed Restorations.

## 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 five years between 2016 and September 2021. The reason for choosing studies in the last five 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 Prosthesis, Implant-Supported"[Mesh]) OR "Dental Implants"[Mesh]) AND "Contraceptive Effectiveness"[Mesh]) AND "Survival Rate"[Mesh]) AND ( "Mouth, Edentulous"[Mesh] OR "Jaw, Edentulous, Partially"[Mesh] OR "Jaw, Edentulous"[Mesh] )) AND ( "Prosthodontics"[Mesh] OR "Tooth Preparation, Prosthodontic"[Mesh] ).

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(12), and PICO strategy (Table1).

### Selection criteria
*Inclusion criteria:* Randomized controlled trials studies, controlled clinical trials, and prospective and retrospective cohort studies; maxillary implants or mandibular implants or both; report follow-up period; in English. In vitro studies, case studies, case reports and reviews were excluded from the study.

Table1. PECO strategy

| PECO strategy | Description |
| --- | --- |
| P | Population: Toothless patients who need implants. |
| I | Intervention: tilted dental implants |
| C | Comparison: axial dental implants. |
| O | Outcome: survival rate, Success rate, marginal bone loss in |

### Study selection, Data Extraction and method of analysis
The data have been extracted from the research included with regard to the study, years, study design, number of patients, number of implant, Follow-Up and Location of implant.

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Newcastle-Ottawa Scale (NOS) (13) used to assessed quality of the cohort studies and case-control studies, This scale measures three dimensions (selection, comparability of cohorts and outcome) with a total of 9 items. In the analysis, any studies with NOS scores of 1-3, 4-6 and 7-9 were defined as low, medium and high quality, respectively.

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.

Mean difference and odds ratio with 95% confidence interval (CI), fixed effect model and Inverse-variance and Mantel-Haenszel 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).

## Result

In the review of the existing literature using the studied keywords, 552 studies were found. In the initial review, duplicate studies were eliminated and abstracts of 534 studies were reviewed. At this stage, 496 studies did not meet the inclusion criteria, so they were excluded, and in the second stage, the full text of 38 studies was reviewed by two authors. At this stage, 33 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, five studies were selected (Figure1).
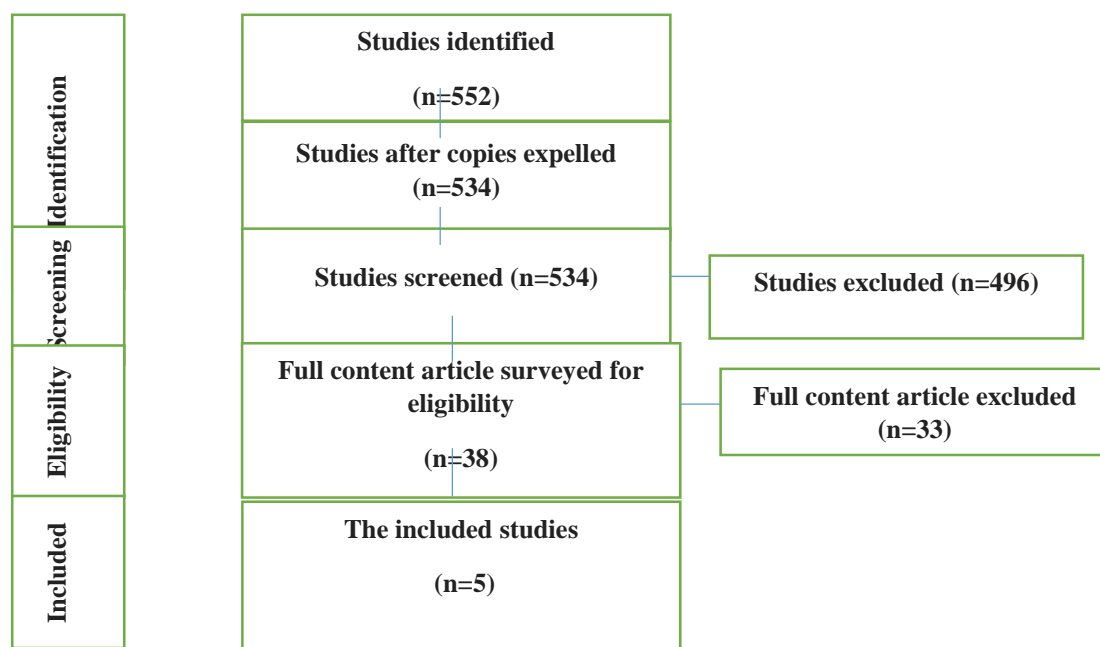


**Figure 1. Study Attrition**

### Characteristics

Five studies (four retrospective and one prospective cohort studies) have been included in present article. The number of patients a total was 1044 with 3972 implants. The number of Implants Tilted and

Implants Axial was 1969 and 2003, respectively. In two studies implants placed into Mandible and
maxilla and in three studies implants placed into posterior Maxilla. In all studies the follow-up period
was five years (Table2).

*Bias assessment*

According to NOS tool, two studies had a total score of 5/9 and three studies had a total score of 6/9.
All studies had moderate quality or medium risk of bias (Table3).

**Table2. Studies selected for systematic review and meta-analysis.**

| N | Study. Year | Study design | Number of patients | Number of implant | | Location of implant | | Follow-Up (years) |
|---|---|---|---|---|---|---|---|---|
| | | | | Tilted | Axial | Maxilla | Mandible | |
| 1 | EF Gherlone et al.,2018 (14) | Prospective | 29 | 64 | 64 | ✓ | ✓ | 5 |
| 2 | JA Toljanic et al.,2018 (15) | Retrospective | 51 | 64 | 38 | ✓ | ✓ | 5 |
| 3 | M Hopp et al.,2017 (16) | Retrospective | 891 | 1782 | 1782 | ✓ | - | 5 |
| 4 | E Barnea et al.,2016 (17) | Retrospective | 13 | 29 | 29 | ✓ | - | 5 |
| 5 | BMT Queridinha et al.,2016 (18) | Retrospective | 60 | 30 | 90 | ✓ | - | 5 |

**Table3. Risk of bias assessment (NOS tool)**

| | Selection (5 score) | Comparability (2 score) | Outcome (2 score) | |
|---|---|---|---|---|
| | | | | |

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| Study. Years | representative sample | Sample size | Non respondents | Ascertainment of the exposure | Based on design and analysis | Assessment of outcome | Statistical test | Total score |
|---|---|---|---|---|---|---|---|---|
| EF Gherlone et al.,2018 (14) | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 6 |
| JA Toljanic et al.,2018 (15) | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 5 |
| M Hopp et al.,2017 (16) | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 6 |
| E Barnea et al.,2016 (17) | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 6 |
| BMT Queridinha et al.,2016 (18) | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 5 |

*Success rate*

In two studies (16) (17) reported success rate of axial (95.7% and 89.6%) and tilted implants (96.1% and 93.1%). The odds ratio of success rate between two group was 0.11 (OR, 0.11 95% CI -0.22, 0.44. P=0.50) among two studies with low heterogeneity ($I^2$<0%; p=0.72). There was no statistically significant difference between success rate of axial and tilted implants (Figure2).
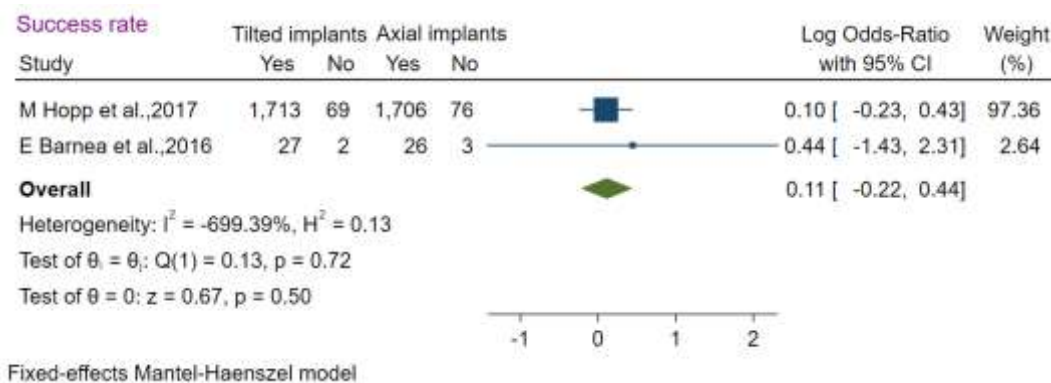


**Figure2. Forest plot showed success rate of axial and tilted implants.**

*Survival rate*

In two studies (14) (15) reported Survival rate of axial (100% and 85.71%) and tilted implants (98.44% and 86.2%). The odds ratio of success rate between two group was -0.13 (OR, -0.13 95% CI -1.27, 1.01. P=0.83) among two studies with low heterogeneity ($I^2$<0%; p=0.51). There was no statistically significant difference between survival rate of axial and tilted implants (Figure3).
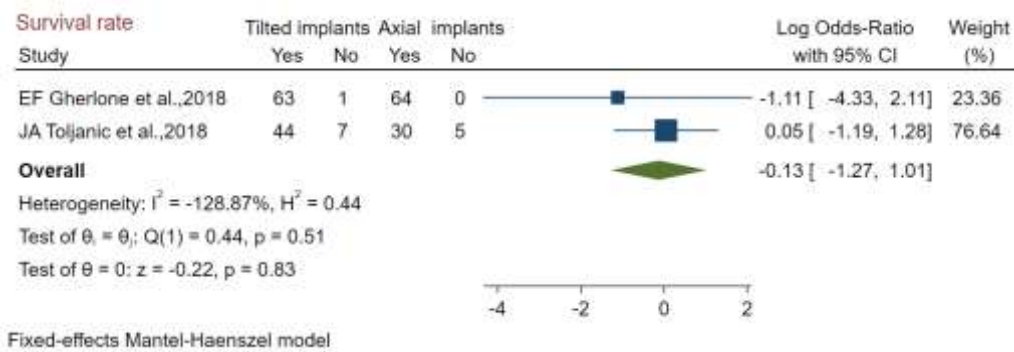
**Figure3. Forest plot showed survival rate of axial and tilted implants.**

*Marginal bone loss*

Mean differences of marginal bone loss between two group was 0.04mm (OR, 0.04 95% CI -0.01, 0.09) among five studies with moderate to high heterogeneity ($I^2$=71.26%; p=0.00) (Figure4).

Subgroup meta-analysis showed Mean differences of marginal bone loss between two groups placed into maxilla and mandible was 0.04 mm (OR, 0.04 95% CI -0.01, 0.09) and 0.05 mm (OR, 0.04 95% CI -0.15, 0.25). Test of group differences showed there was no statistically significant difference between maxilla and mandible (p=0.92) (Figure4).
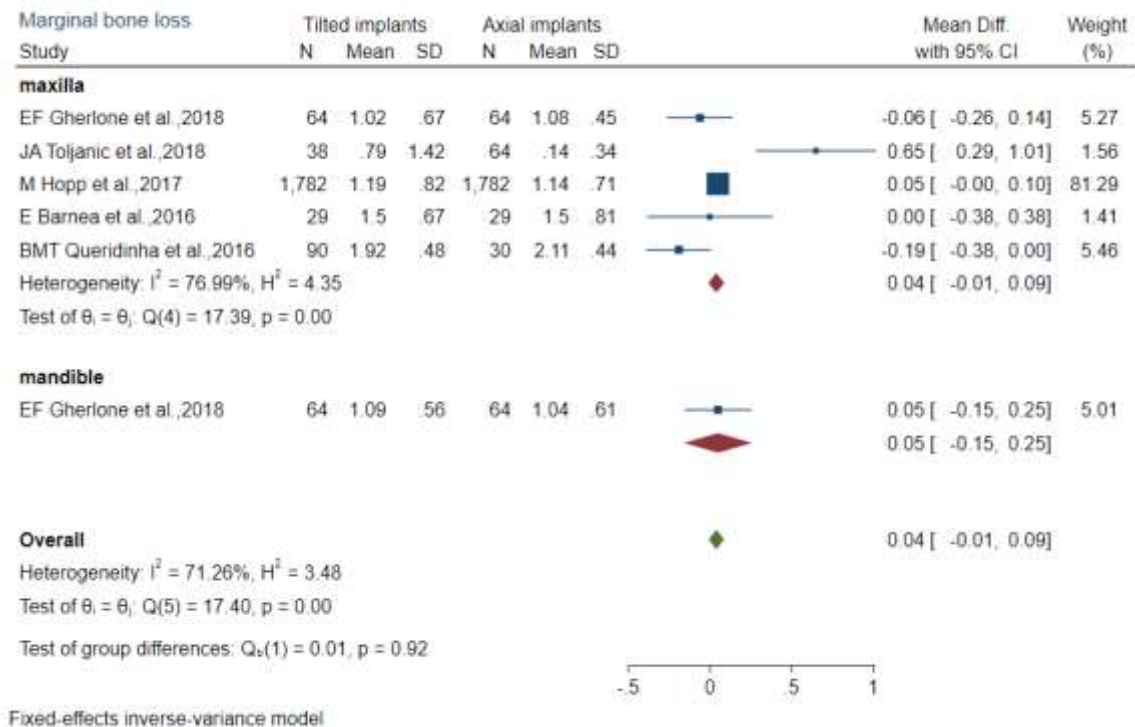


**Figure3. Forest plot showed Marginal bone loss of axial and tilted implants.**

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**Discussion**

The aim of current Systematic Review and Meta-Analysis was evaluate the clinical outcome of Intentionally Tilted Dental Implants Supporting Fixed Restorations. Meta-analysis showed that the survival rate for axial and tilted implants was similar after 5 years and no significant difference was observed, also the success rate was similar for both axial and tilted implants. Also, the mean difference between marginal bone loss between axial and tilted implants was about 4 mm. Factors such as piercings, diabetes, a history of periodontal disease, poor hygiene and limited bone volume can reduce implant survival(19). In the studies selected for meta-analysis, only two studies reported success rates and two studies reported survival rates, which in turn is a limitation due to the low heterogeneity between study results. Studies have not used the same criteria to assess implant success. Papaspyridakos et al.,2014(20) and Polido et al.,2018 (21) reported similar results to the present meta-analysis. According to the findings of the present study, tilted implants can be a suitable alternative to axial implants. The advantages of using tilted implants include the following: make it possible to place long implants and thus increase the bone-to-implant contact area and primary stability. The mean difference of marginal bone loss after 5 years of follow-up between axial and tilted implants was 0.4 mm, no difference was observed between the two groups. Studies have shown that the marginal bone lose around the implant reaches a maximum of 1.5 mm in the first year(22). The results of previous studies confirm the results of the present study (10, 11, 23). Stronger randomized trials are needed to achieve stronger results and evidence, as this allows real comparisons between them. RCT studies are needed to reach stronger evidence, as this allows for a real comparison between them. In addition, it will be useful to use dental advances to accurately measure implant angulation and standardize the degree of implant angulation to facilitate data comparison. Many new scientific approaches are currently used in dentistry(24). In implant surgery, a totally guided system using fixation screws with a flapless protocol has shown the greatest accuracy of all computer-aided implant surgery systems. The present study had some limitations, such as the quality of the studies was mediocre and the studies of randomized clinical trials were not found to be reviewed.

**Conclusion**

The present Systematic Review and Meta-Analysis study showed that there is no difference in success rate, survival rate and marginal bone loss between Tilted and Axial dental implants, similar results observed. Further studies are needed with Standard protocols, High sample size, and Follow-up courses at different time periods, to confirm the available results and provide sufficient evidence.

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