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Systematic Review Article

Follow-up study of implant-tooth supported fixed dental prosthesis versus free-standing implant supported fixed dental prosthesis: A systematic review and meta-analysis

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ABSTRACT

Aim: This systematic review and meta-analysis was conducted to identify studies which compared tooth implant supported fixed dental prosthesis and exclusively implant supported fixed dental prosthesis for assessments of implant failure, prosthesis failure, abutment tooth failure and other biological and mechanical failures

Materials and Methods: A cumulative electronic and manual search were performed, and one hundred and forty-three articles published before May/June 2021 were identified. Out of these ninety-six were excluded and finally seven articles that met the inclusion criteria was included in the review.

Results: A database was established into which information extracted from each paper was tabulated. For the parameter of prosthetic stability. Overall relative risk calculated was 1.0328 with confidence interval of 0.9747 to 1.0987. p-value was 0.2623 and it was not significant. ANOVA test was run on the results which yielded f-ratio value of 0.49412 and accordingly the p-value is 0.49. Although marginal bone loss was less in tooth implant group, but the results were not significant at $p < .05$. Many authors were not clear about the implant failure in treatment groups. Overall, 20 implants failed in the study. 7 patients had some sort of sensory disturbance in mental region in Gunne's and Olsson's study.

Conclusion: Within the limitations of the current meta-analysis and systematic review, it is suggested that implant tooth supported fixed dental prosthesis can be an alternative and viable treatment option for the replacement of partially edentulous patient since no significant difference was observed in two designs of the prostheses.

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1. Introduction

The different ways in rehabilitation of partially edentulous jaws with implants have been published in literature. In addition to exclusively implant supported fixed dental prosthesis, tooth implant supported fixed dental prosthesis also promise a successful and predictable outcome.¹⁻³

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The biomechanical differences between natural teeth and implants have been previously recognized through in vivo and in vitro studies which has shown that both implant and tooth shares the load that was applied to tooth implant supported fixed dental prosthesis.^{4,5}

Implant tooth supported fixed dental prosthesis is recommended in only in situations where there is anatomical limitations (posterior region of mandible before mental foramen or maxillary sinus), financial restriction ,minimally invasive surgery, alveolar bone deficiency

requiring augmentation procedures, long pontic span or cantilever segments, nerve repositioning and splinting periodontally involved teeth or any event of implant failure.⁶⁻¹¹ It may also be used when few or unfavorable distribution of teeth remains as sole abutments to support a fixed dental prosthesis.^{12,13}

A key factor in an implant tooth fixed dental prosthesis is the differential mobility between the tooth and the implants. Teeth mobility is around 10 times greater than the mobility of the implants due to presence of periodontal ligament in tooth.¹⁴ Others advocated that a differential mobility of 5:1 between natural teeth and implant will eventually lead to tooth implant supported prosthesis borne completely on implants.¹⁵

This will lead to biological and mechanical complications like implant failure, prosthesis failure, tooth intrusion, prosthesis screw loosening, fixed dental prosthesis framework fracture, signs of peri implantitis such as deepening of peri implant pocket probing depth, implant marginal bone loss.^{16,17}

Several reports on tooth abutment intrusion in implant tooth supported fixed dental prostheses have been published. Consensus exists on tooth intrusion, debris impaction, impaction, impaired rebound memory, mechanical binding.¹⁸ After more than few decades of controversial results, implant tooth supported fixed dental prosthesis even today remains an unsolved issue. Implant tooth fixed dental prosthesis have demonstrated comparable results regarding the technical and biological complications between these two treatments.¹⁹ Both the rigid and non-rigid methods connection between teeth and implants have been employed in the past.²⁰⁻²² Abutment intrusion was reported more when non-rigid connectors was used.²³

The aim of this systemic review and meta- analysis was to identify studies which compared implant tooth supported fixed dental prosthesis and exclusively implant supported fixed dental prosthesis for assessments of implant failure, prosthesis failure, abutment tooth failure and other biological and mechanical failures. The big question has still not been answered despite several studies that have been conducted previously too, hence the systematic review was done to help allow for the answers for the same.

2. Materials and Methods

This systematic review was performed according to the guidelines of the PRISMA (Preferred Reporting Items for Systematic reviews and meta-analysis statement.)

The initial electronic database search on PubMed/MEDLINE, Science Direct and Google Scholar resulted in 143 titles. After screening the abstracts, 47 relevant titles were selected by two independent reviewers and 96 were excluded for not being related to the topic. Hand searching of the reference lists of the selected studies did not deliver additional papers. Upon reading the full

texts, 5 studies were excluded for the following reasons: they were review articles, in vitro studies, meta- analysis, case series, case reports, clinical trials, retrospective studies, without control group and due to data duplication.

After pre-screening, application of the inclusion and exclusion criteria and handling of the question of our systematic review, seven studies remained (Figure 1: Prisma flowchart). They were used for data extraction and data analysis.

The study outcomes further divided from the included studies were as follows: Primary outcomes:

1. Prosthesis Stability
2. Implant Failure Secondary outcomes:
3. Biological complications- Marginal bone loss
4. Other technical complications PICOS Question

Patients: Partially edentulous patients Intervention: restored with implant tooth supported fixed dental prosthesis (ITSFPD) Comparison: Restored with implant supported fixed dental prostheses (FSIS) Outcome: Survival of fixed dental prostheses and/or implants and complications after an observation period of at least two years.

2.1. Inclusion criteria were:^{1,3,4,10,12,24-28}

1. Prospective clinical studies with a control group
2. Systemically and psychologically healthy individuals
3. Absence of para functional habits
4. Sound, caries free abutment teeth without any clinical or radiographic evidence of periodontitis or any other periodontal condition
5. Partial edentulism in either maxillary or mandibular arch
6. At least 10 patients included.
7. Observation period post implant loading of at least 2 years
8. Language of publication: English
9. Smoking less than 10 cigarettes per day
10. No previous experience of wearing partial dentures

2.2. Exclusion criteria

1. Invitro studies
2. Case series, reports
3. Retrospective studies
4. Studies without a control group. The studies that did not meet the inclusion criteria were excluded from the analysis.

2.3. Literature Search Strategy

Three electronic databases (Medline/PubMed, Cochrane Library, and Embase) were searched for articles published between January 1988 and May-June 2021. In addition, a search for grey literature was also performed. All the relevant articles were read in full text.

Manual search of the following journals was performed as well with following data base:

1. The International Journal of Prosthodontics, Quintessence Publishing.
2. Clinical Oral Implants Research, John Wiley & son ltd.
3. The International Journal of Oral and Maxillofacial Implants, Quintessence Publishing.
4. Journal of Prosthetic Dentistry, Elsevier

2.4. Search items used for the study

The search was performed using the terms (Implant* AND outcome OR survival OR failure* OR complication) AND (fixed dental prostheses OR fixed partial dentures), (Tooth-implant AND outcome OR survival OR failure* OR complication) AND (fixed dental prostheses OR fixed partial dentures), AND (tooth implant support* OR implant support* OR prosthesis) AND (tooth implant connection OR connecting teeth to implants OR combined tooth implant support) AND (biological complication* OR technical complication* OR tooth intrusion OR tooth fracture OR prosthesis fracture OR screw loosening OR implant failure).

2.5. Study selection

Two reviewers independently screened titles and abstracts for relevance. Potential full texts of articles were read and assessed according to inclusion criteria. Any disagreement was solved by discussion with a third reviewer and the fourth reviewer.

Case included was with loading implant after follow-up period between 12 or 24 months.(Table 1)

Study Observation time – 1990-2021.

2.6. Data analysis

The data was extracted from the selected articles and was recorded electronically in excel sheets. Relative risk was calculated for prosthetic failure. Mean and Analysis of Variance was calculated for marginal bone loss. Value of Central tendency was calculated for plaque index and probing depth.

All calculations were performed in SPSS (Statistical Package for Social Sciences) VERSION 26.0.0. Result was considered significant for $P < 0.05$.

3. Results

3.1. Study characteristics^{1,3,4,10,24–28}(Table 1)

Demographics and study outcomes

The study outcomes further divided from the included studies were as follows: Prosthesis stability

1. Implant failure
2. Marginal bone loss
3. Other complications

After careful screening 7 articles were found within the scope of this review and data meta-analysis was done.

3.2. Demographics and study outcomes

We established a database into which we entered the information extracted from each paper. Out of 7 studies, 3 originated from Sweden, rest other (1 each) were from Belgium, Switzerland, Turkey and Egypt. 1 study was a randomized control trial. In these studies, overall, a total of 224 implants were evaluated for marginal bone loss, implant survival, tooth and implant mobility, prosthesis stability, tissue reactions, sensory disturbances, technical complications. 156 (44.83%) implant tooth supported fixed dental prostheses (ITSFPD) were compared with 192 (55.17%) implant supported fixed dental prostheses (FSIS)(Table 1). Follow-up duration of studies varied from 1 to 14 years, 5 implant systems were used which included Nobel BioCare (2), Modem Branemark (3), TSV Zimmer (2), ITIA Dental Implant system (1) and Gothenburg Sweden (1) system.

3.3. Prosthetic stability: (Table 2,Figure 2)

Gunne in his study found Prosthetic stability in 18 out of 20 in tooth implant (TI) group and 16 out of 20 in implant implant (II) group. Relative risk (RR) calculation shows a value of 0.88 with Confidence interval (CI) from 0.6831 to 1.1567. Similarly, in Olsson's data RR was 0.9 with CI of 0.7099 to 1.1409, Lindh's RR was 0.9583 with CI 0.8326 to 1.1030 and Bragger's RR was 0.9625 and CI of 0.8300 to 1.1161. Honsy's, Acka's as well as Mostafa's data RR was 1 with CI of 1 to 1. [Table 2, Figure 2] Overall relative risk calculated was 1.0328 with CI of 0.9747 to 1.0987. p-value was 0.2623 and it was not significant.

3.4. Marginal Bone loss: (Table 2,Figure 3)

Except from Bragger, data of mean marginal bone loss after 2 years of follow-up was available from rest 6 studies mean bone loss in tooth and implants are shown in Table 2, Figure 3. ANOVA test was run on the results which yielded f-ratio value of 0.49412 and accordingly the p-value is 0.49.

Although MBL was less in tooth implant (TI) group but the results were not significant at $p < .05$.

3.5. Implant failure:(Table 2)

Many authors were not clear about the implant failure in treatment groups. Overall, 20 implants failed in the study.

Table 1: Assessment of different studies included in the systematic review and meta-analysis

S.No.	Author and Year	Type of study	Origin	Subject No.(M/F)	Mean age (year)	Comparisons	Follow up duration	Implant system used	Follow up Criteria	Outcome
1	Gunne ⁴ et al 1992	RCT	Sweden	23; 8M, 15F	57.7	23 ITSFDP; 23 FSIS	10 Years	Nobel Biocare	Implant survival, MBL, Mobility bridge stability, Tissue reaction, sensory disturbances	TI is better in bridge survival, and had less MBL than II
2	Olsson ²⁸	NCRT with equal compare group	Sweden	23	58	23 ITSFDP; 23 FSIS	5 Years	Modern Branemark	Implant survival, Bridge stability, MBL, Mobility of teeth, Marginal tissue reaction, Sensory disturbance	Failure of TI>II; No difference in MBL between both groups
3	Hosny ²⁶ et al 2000	NCRT with equal compare group	Beigium	18; 12F, 6M	49.5	30 ITSFDP; 48 FSIS	1 year to 14 years	Branemark system	Implant outcome, marginal bone stability, Mechanical disturbance	No difference FSIS offer a more versatile solution
4	Lindh ¹⁰ et al 2001	Prospective comparative group	Sweden	26; 11M, 15F	49-84	26 II; 26 TI	2 years	Branemark system A, Nobel biocare AB, Gothenburg, Sweden	Implant success, Prosthesis stability, MBL, Tissue reactions, Mobility	More MBL in II than TI
5	Bragger ¹ et al 2001	Prospective three parallel group comparative study	Switzerland	85; 53F, 32M	55.7	Group II; 33 pts with 40 FDP; Group TT: 40 pts with 58 FDP; Group IT: 15 pts with 18 FPD	2-3 years	ITIA dental implant system	Plaque index, Gingival index, Recession, Probing pocket depth, Probing attachment level	TI> II=TI
6	Akca ⁴ et al 2008	Prospective parallel group comparative study with unequal group	Turkey	29; 13M, 16F	48.3	29 ITSFDP; 29 FSIS	2 years	TSV, Zimmer dental	Prosthetic stability, MBL	ITSFPD is better in terms of MBL Clinical outcome is same
7	Mostafa ²⁷ et al 2015	NRCT with equal compare group	Egypt	20	25-30	10 TI; 10 II Prosthesis	2 years	TSV, Zimmer dental	Plaque index, Bone probing depth, Bone level loss	TI=II

Table 2: Study Outcomes of included research articles and meta-analysis

S.No.	Out-come	Gunne	Ohsun	Hosny	Lindh	Bragger	Acka	Mostafa
1.	Prosthetic Stability	II-16/20 success TI-18/20 success	II-18/22 success TI-20/22 success	II-18/18 success TI-18/18 success	II- 23/25 success TI- 24/25 success	II-32/33 success TI-14/15 success	II- 15/15 success TI-34/34 success	II-10/10 success TI-10/10 success
2.	Implant Failure	8	10	Nil		2	Nil	Nil
3.	Marginal Bone loss (2 years)	II-1.1mm IT-0.7 mm	II-1mm IT-0.7 mm	II-2 mm IT-2 mm	II- 1.6mm IT-0.9 mm	NA	II- -0.29mm IT-0.19 mm	II- 0.71mm IT- 0.73 mm
4.	Plaque Index	NA	NA	NA	II- 0.8 IT- 0.7	II- 0.24 IT- 0.67	NA	II- 0.26 IT- 0.28
5.	Gingival Index	NA	NA	NA	NA	Implant- 0.47 Tooth- 0.56	NA	NA
6.	Sensory nerve disturbance	Partial sensory disturbance in mental region in 7 patients	Partial sensory disturbance in mental region in 7 patients	NA	NA	NA	NA	NA
7.	Probing depth	NA	NA	NA	NA	Implant- 2.56 mm Tooth- 2.61 mm	NA	Sign diff

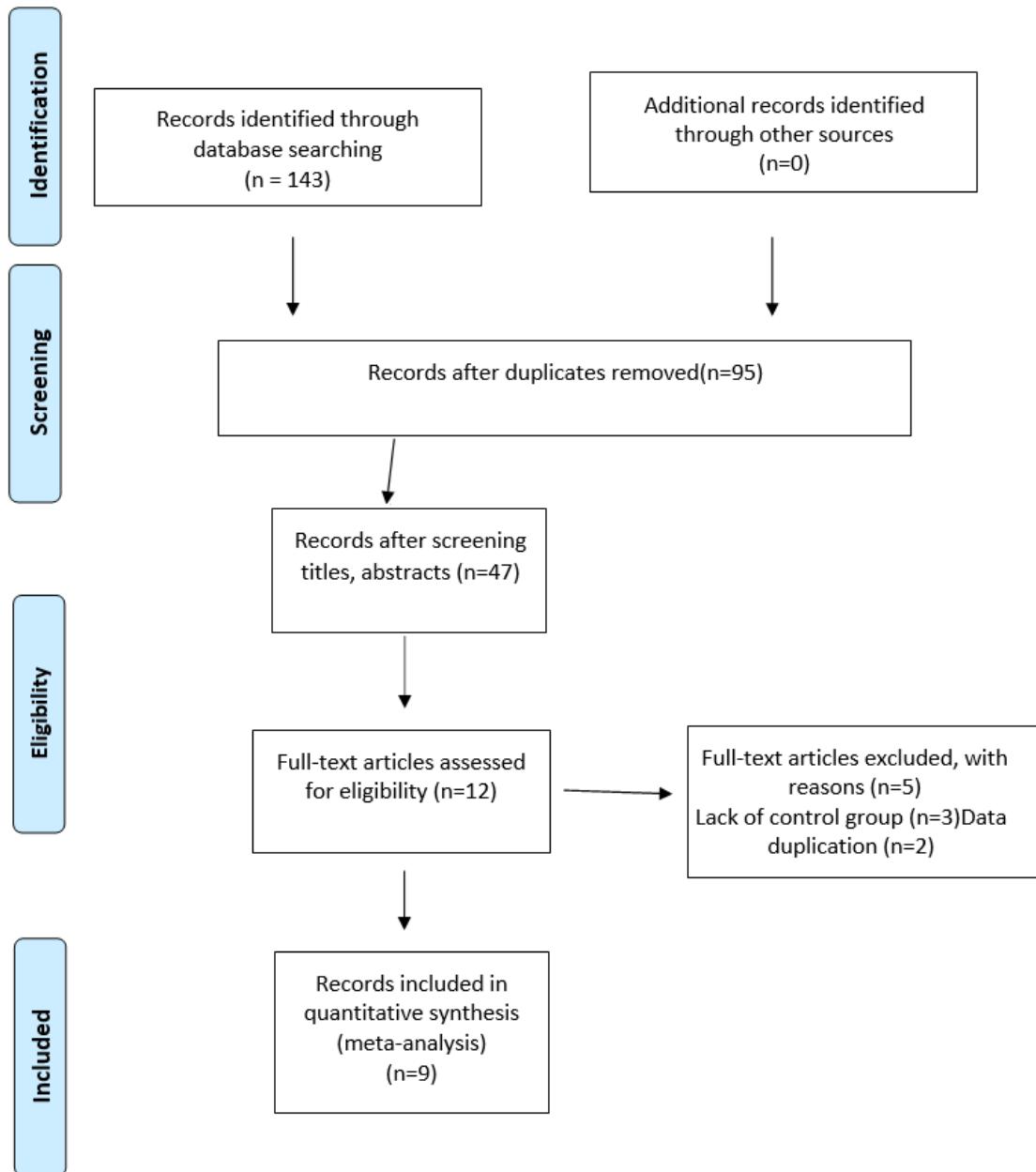


Figure 1: Prisma flowchart

3.5.1. Others

1. Plaque index – 0.63 in implant implant (II), 0.60 in tooth implant (TI) group from three studies.
2. Gingival index and probing depth in Bragger’s study was 0.47 and 2.56mm for implant implant (II) and 0.56 and 2.61 in tooth implant (TI) group respectively
3. Sensory disturbance – 7 patients had some sort of sensory disturbance in mental region in Gunne’s and Olsson’s study.

Risk of bias assessment elaborated in the Figure 4.

Figure 2 shows the Relative risk less than 1 shows less chance of implant failure in ITSFPD compared to FSIS denoted by central diamond, lower confidence interval and upper confidence interval is denoted by arrow marks.

Figure 3 shows the data of mean marginal bone loss after 2 years of follow-up from rest 6 studies. ANOVA test gave the f-ratio value of 0.49412 and accordingly the p-value was 0.49. Although MBL was less in TI group but the results were not significant at $p < .05$.

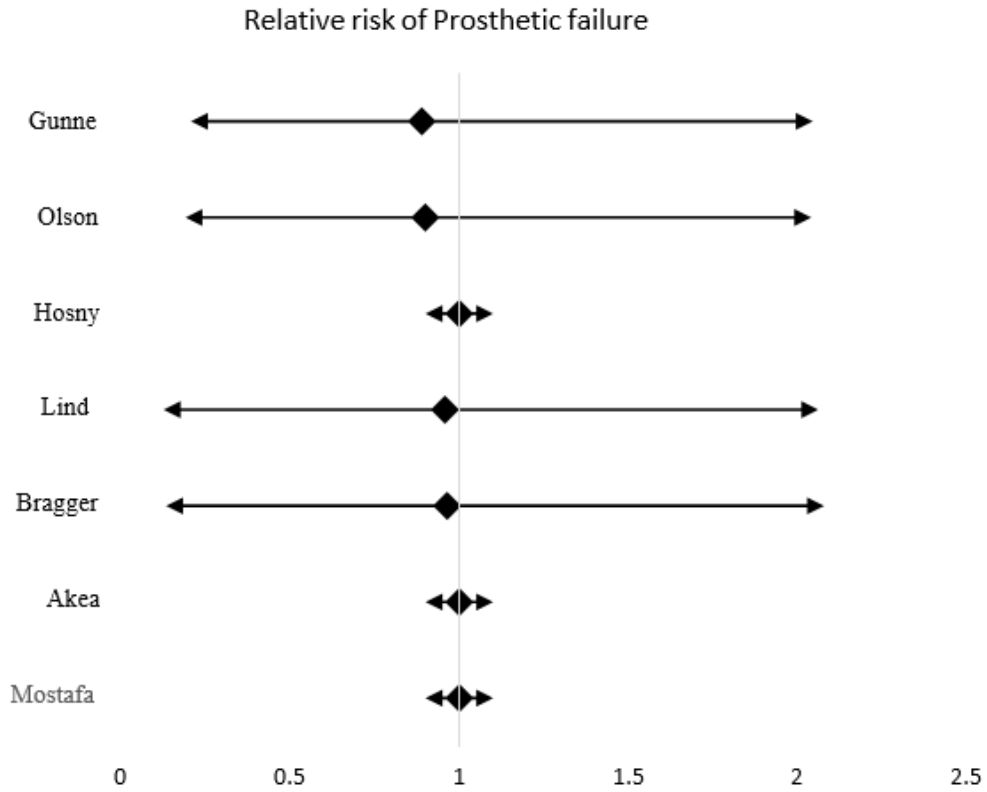


Figure 2: Relative risk calculation Prosthetic failure in different studies

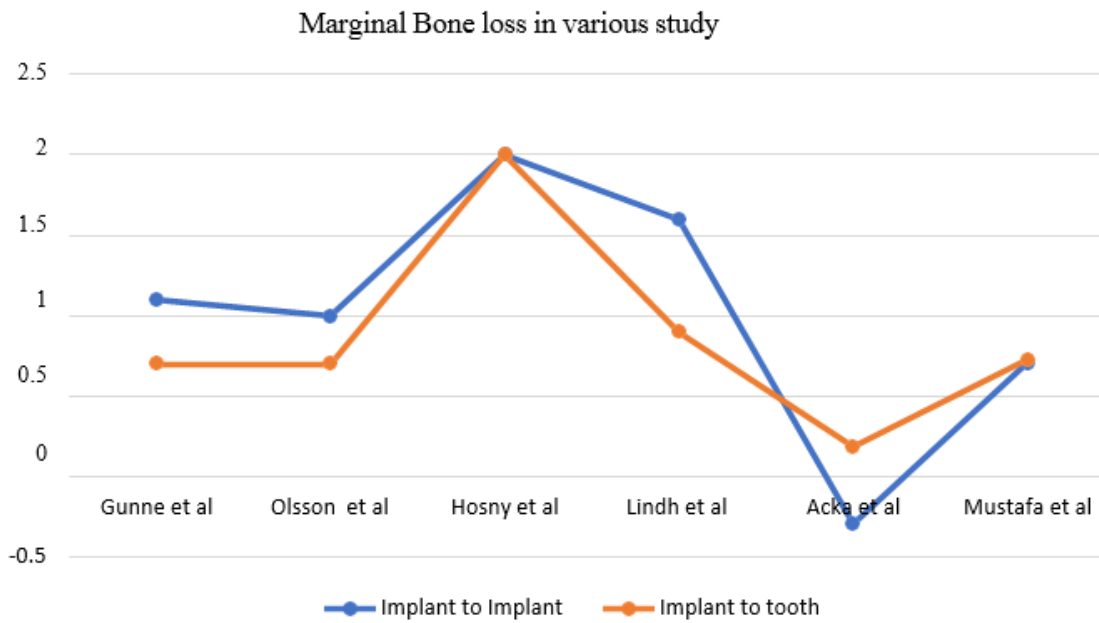


Figure 3: Marginal bone loss between II and IT prosthesis at the end of 2 years of follow-up

	Random sequence generation (SELECTION BIAS)	Allocation concealment (SELECTION BIAS)	Blinding of participants and personnel (Performance BIAS)	Blinding of outcome assessment (Detection BIAS)	Incomplete outcome data (Attrition BIAS)	Selective reporting (Reporting BIAS)	Other sources of bias (Other BIAS)
Gunne et al ,1992	+	+	+	+	+	+	+
Olsson et al , 1995	+	-	+	-	+	+	?
Hosny et al , 2000	+	+	+	-	+	-	?
Lindh et al , 2001	+	+	+	+	+	+	?
Bragger et al , 2001	+	+	+	+	+	-	+
Akca et al , 2008	+	+	+	+	+	+	?
Mostafa et al , 2015	+	-	-	?	+	+	?

Figure 4: Risk of bias assessment

4. Discussion

4.1. Prosthesis stability^{3,4,10,12,24–28}

The overall stability as observed from the review concluded with a non-significant p-value with the results compared from five authors included in the study. The range of the prosthesis failure varied up to 13%. All authors compared implant tooth supported fixed dental prosthesis (ITSFDP) and free-standing implant supported prosthesis (FSIS) for technical complications and clinical success. Five studies conducted by Gunne et al,³ Bragger et al,¹ Lindh et al,¹⁰ Acka et al,⁴ Olsson et al²⁸ compared prosthetic stability between implant tooth supported fixed dental prosthesis and free-standing implant supported fixed dental prosthesis. It was observed that in different studies around 11 prostheses were lost in FSIS, whereas 9 prostheses were lost in ITSFDP. In relation with clinical success the highest failure was recorded in the study³ where four implant tooth supported fixed dental prosthesis were lost over a span of 3 years. The study²⁶ demonstrated no significant difference between the prognosis of ITSFDP and FSIS. In the study conducted by Mostafa et al²⁷ observed abutment screw loosening in tooth-implant supported fixed dental prosthesis.

Although the p value wasn't found to be significant, but it can be concluded with the included studies, that tooth implant supported prostheses can serve as a viable treatment option, since the range of prostheses failure according to the meta analyses is lesser than implant implant prostheses.

4.2. Implant failure:^{3,4,10,12,24–28}

The overall implant failure rate for the current systematic review from all the included articles ranges up to 11.5% over the span of 1992-2021. The highest failure rate was encountered where the observed study time by Olsson et al²⁸ was for five years. The article comprised of 23 patients, with Kennedy's Class I dentulous situation in the mandibular arch, opposed to a maxillary complete denture. A total of 69 implants were placed of which, total of 8 implants were lost, with a cumulative failure rate of 12%. This study concluded the better prognosis of type 2-tooth-implant supported prosthesis over, type 1-implant-implant supported prosthesis. On the other hand, the studies conducted by Lindh et al,¹⁰ Mostafa et al²⁷ reported 3- 4% of overall failure.

There was another study done by Fobbe et al²⁵ that observed the overall survival of implant-tooth supported prosthesis to be better over an observation span of 11.2 years.

The several studies included for the analyses showed better success rate in tooth-implant supported prostheses for implant survival within the specified follow up period.

4.3. Marginal bone loss^{3,4,10,12,24–28}

Four studies conducted by Gunne et al,³ Acka et al,⁴ Lindh et al,¹⁰ Hosny et al,²⁶ compared marginal bone loss (MBL) between implant tooth supported and free-standing implant supported fixed dental prosthesis. Taking into consideration of marginal bone loss, the metaanalysis evaluated 4 studies depicting the same.

The study by Gunne et al.³ found the MBL in ITSFPD, 0.3-0.1 mm while in FSIS- 0.7-0.2. However very marginal difference was found in support of ITSFPD when compared to FSIS. All authors compared implant tooth supported and free-standing implant supported fixed dental prosthesis for technical complications and clinical success. It was observed that in different studies around 11 prostheses were lost in ITSFPD, whereas 9 prostheses were lost in FSIS. In relation with clinical success, marginal bone loss (MBL) was assessed in various studies. It was found that 0.18 to 0.7mm MBL was reported in patients with ITSFPD, whereas in cases with FSIS, the MBL was observed to be 0.09 to 0.7mm. But in relation to each study, MBL was observed to be less in ITSFPD than FSIS. Technical and clinical complications like sensory disturbance, abutment loosening, fistula formation, periimplantitis, loss of facing, loss of cementation, loss of occlusal wear; were assessed in both the groups. It was observed that cases of peri implantitis, sensory disturbance, abutment tooth fracture, abutment screw loosening was more in FSIS as compared to ITSFPD. The marginal bone loss values reported in this review after 24 months of loading, however, remain within the range for implant success.

4.4. Other complications

Five studies conducted by Gunne et al.,³ Bragger et al.,¹ Lindh et al.,¹⁰ Acka et al.,⁴ Olsson et al.²⁸ compared various types of complications (sensory disturbance, abutment loosening, fistula formation, Periimplantitis, loss of facing, loss of cementation, loss of occlusal wear) between Implant tooth supported and free- standing implant supported fixed partial denture prosthesis. Although the difference was elicited was not significant. Sensory disturbance of 19% was noted in the study, done by Gunne et al.³

The inclusion of only seven studies may have influenced the intervention effect, as each study only comprised of a limited number of implants and prostheses. In addition, substantial heterogeneity was noted despite the stringent selection criteria employed in this review. It is also acknowledged that implants are not independent units and that data analysis based on abutment tooth/implant rather than the participant may underestimate the outcomes and complications associated with tooth implant and implant implant supported prostheses.

In addition, the possible limitation includes that the present review attempted an exhaustive search with no language re-strictions through published and grey literature in the search for outcome comparisons which may have influenced the study outcomes.

5. Conclusion

Within the limitations of the current meta- analysis and systematic review.

1. No significant difference was observed between several studies included in the review between tooth implant and implant supported prosthesis.
2. Therefore, it can be suggested that, tooth implant supported prosthesis can be considered an adjunctive /alternative and viable treatment option for the replacement in cases of partially edentulism.

6. Conflict of Interest

None.

7. Source of Funding

None.

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