

OPTIMUM NUMBER OF ORAL IMPLANTS REQUIRED FOR FULL ARCH FIXED PROSTHESIS TO REHABILITATE COMPLETELY EDENTULOUS PATIENTS – A SYSTEMATIC REVIEW AND META-ANALYSIS.

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ABSTRACT

Statement of problem: Consensus is lacking regarding the optimal number of implants for supporting complete-arch prostheses with good survival rates and lower prosthetic complications and marginal bone loss.

Purpose: The purpose of this systematic review was to evaluate the influence of the number of implants used for complete-arch prostheses with at least 1 year of follow-up.

Materials and method: An electronic search was conducted for articles in English, listed with PubMed, Medline, Embase, Cochrane, Google scholar till December 2019. Review articles as well as references from different studies were also used to identify the relevant articles. The search from the electronic databases identified 1025 publications out of which 611 articles were excluded by reading the titles. After evaluation of abstracts, 137 articles were eligible for analysis. After the full text of these articles had been read, 34 studies were excluded for the following reasons: they were retrospective studies, in-vitro studies and animal studies, studies that did not identify the number of implants per jaw per patient, same design and population and inappropriate follow up period and there were insufficient data to rehabilitate completely edentulous patients with optimum number of oral implants. This resulted in a final number of 10 publications for the current systematic review.

Results: The implant survival rate in complete-arch prostheses with fewer than 5 implants was 98.7% for both jaws, 99% for the maxilla and 98.9% for the mandible. The implant survival rate in complete-arches prostheses with more than 4 implants was 96.6% for both jaws, 95.61% for the maxilla and 100% for the mandible.

Conclusion: there is no significant difference in longevity when fewer than 5 implants or more than 4 implants are used for complete-arch implant-supported prosthesis. Thus, the number of implants used in complete-arch prostheses does not influence implant survival rate, prosthesis complications or marginal bone loss in studies with a follow-up period of 5 to 15 years.

Keywords: Optimum number of implants, Implant survival rates, Full arch rehabilitation

INTRODUCTION:

Complete dentures are the most common prostheses for the rehabilitation of edentulous patients and can restore both function and esthetics. However, complete dentures have limitations, including discomfort, decreased masticatory efficiency and instability of the prosthesis, more specifically in mandibular dentures. All of these can directly affect the quality of life^[1].

Implants have revolutionized the way edentulous patients are rehabilitated and have immensely improved their quality of life. Dental technology has been in overdrive over the past decade to bring in a wide variety of prosthetic solutions to restore completely edentulous patients using implants.

Branemark et al^[2] suggested the use of a minimum of 6 to 8 implants in the mandible and up to 14 implants in the maxilla for each complete arch rehabilitation. Difficulties with the placement

of more than 4 implants per jaw include insufficient bone height and anatomic features such as the mandibular canal or maxillary sinus. Increasing the number of implants per jaw also increases cost^[3].

The “all-on-four” technique emerged to maximize the use of the remaining atrophic ridge. In this technique, 4 implants (2 axial anterior and 2 tilted distal) are placed to support an immediately loaded complete-arch prosthesis^[4]. Malo et al described this technique, with data for up to 10 years of follow-up, indicating long-term success. This arrangement with angled distal implants increases the support of the prosthesis and is intended to reduce the length of the cantilever.

Reducing the number of implants in complete-arch rehabilitation slightly increases stress in the abutment and bar-retaining screws. However, the biomechanics are similar in a prosthesis supported by fewer implants. Thus, a follow up is important for analyzing the longevity of implant-supported

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prostheses and the complications related to each type of prosthesis.

There are, however, several variables to be considered when discussing the number of implants utilized to support a complete-arch fixed restoration. These include the soft and hard tissue conditions of the edentulous jaw, distribution of the implants, anatomic risks, aesthetics and facial appearance, choice of material and design of prostheses, type of retention of the prostheses and type and timing of occlusal loading^[5].

Consensus regarding the ideal number of implants for complete-arch prostheses is currently lacking. The purpose of this systematic review is to evaluate the outcomes of complete-arch prostheses in studies with different numbers of implants.

AIM:

The aim of this systematic review is to evaluate the influence of the number of implants utilized to support complete-arch prostheses in the completely edentulous maxilla and mandible.

OBJECTIVES:

- To evaluate the optimum number of implants used for complete-arch implant-supported prostheses.
- To evaluate an implant survival rate and the complication rate for full arch implantsupported prostheses.

MATERIALS AND METHOD:

An electronic search was conducted for articles in English, listed with PubMed, Medline, Embase, Cochrane, Google scholar till December 2019.

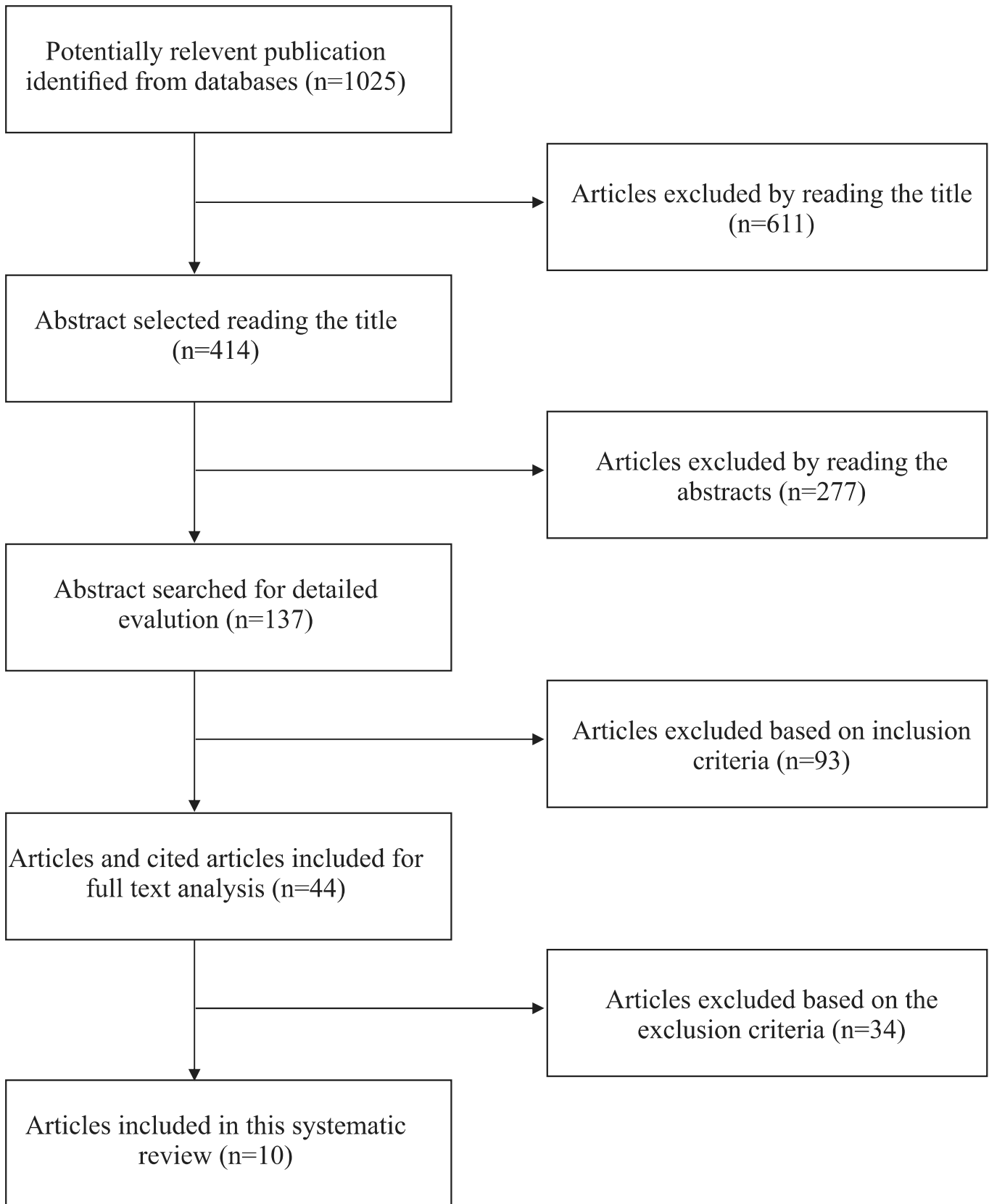
The search methodology applied was combination of MeSH terms and keywords like Dental implants, Number of Implants, Implant supported completely full arch fixed prostheses, Implant survival rates, Biological complication, Mechanical complication, Edentulous mandible, Edentulous maxilla. Review articles as well as references from different studies were also used to identify the relevant articles.

Inclusion Criteria:

- Minimum follow-up period of at least one year
- Studies on completely edentulous patients for both arches
- The number of implants placed per jaw per patient
- Study should include a minimum of 10 patients rehabilitated with a full fixed prosthesis in one or both jaws supported by implants
- Studies report on Implant survival rate and Complications
- Prospective studies
- Randomized controlled trials (RCTSs)

Exclusion Criteria:

- Non-clinical studies
- Retrospective studies
- Animal subjects
- Case reports and case series
- In vitro studies
- Studies that did not identify the number of implants per jaw per patient



Flow-chart of the search strategy

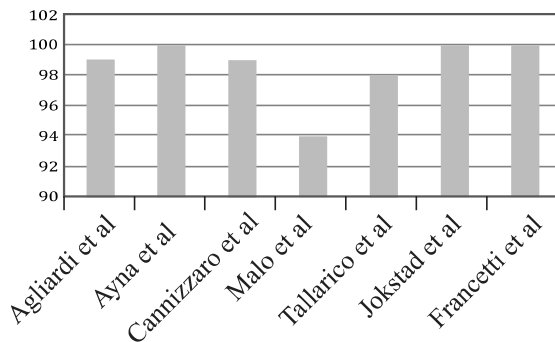
Summary of the included studies for implant survival rates and complications in implant prosthesis

Sr. No.	Author (year)	Total no. of patients	Region of rehabilitation	Total number of implants	Number of implants per jaw	Follow up(years)	Implant survival rate %	Loading	Retention	Mechanical complication	Biological complication
1	Agliardi et al, 2010	173	Maxilla, Mandible	692	4	5 Years	Maxilla 98.36 Mandible 99.73	Immediate provisional	Screw-retained	14	2
2	Ayna et al, 2018	16	Mandible	64	4	7 Years	100	Immediate provisional	Screw-retained	2	3
3	Francetti et al, 2012	47	Maxilla, Mandible	196	4	5 Years	100	Immediate provisional	Screw-retained	8	2
4	Malo et al, 2011	245	Mandible	980	4	10 Years	93.8	Immediate provisional	Screw-retained	4	6
5	Mertens et al, 2011	17	Maxilla	99	6-8	8 Years	99	Conventional	Screw-retained	8	3
6	Cannizzaro et al, 2016	80	Mandible	160	2	5 Years	98.75	Immediate provisional	Screw-retained	9	3
7	Shigera et al, 2015	27	Maxilla, Mandible	189	6 or 5	5 Years	100	Immediate provisional	Screw-retained	11	NR
8	Tallarico et al, 2016	40	Maxilla	200	4 or 6	5 Years	G1 : 98.75 G2 : 95	Immediate provisional	Screw-retained	6	2
9	Tealdo et al, 2014	49	Maxilla	260	T :4-6 C :6-9	6 Years	T :93.9 C :95.9	T:immediat provisional C: delayed	Screw-retained	12	NR
10	Jokstad et al, 2014	35	Mandible	140	4	5 Years	100	Delayed	Screw-retained	NR	NR

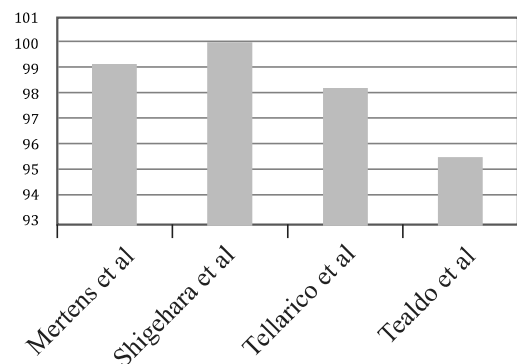
RESULTS

A total of 2980 implants were placed and a total of 728 patients (mean age of 60 years) were evaluated. The number of implants per jaw ranged between 2 and 9 in the maxilla, mandible, or both jaws. The antagonist arch had natural teeth, a removable partial denture, a tooth-supported fixed prosthesis, an implant-supported prosthesis or a complete denture.

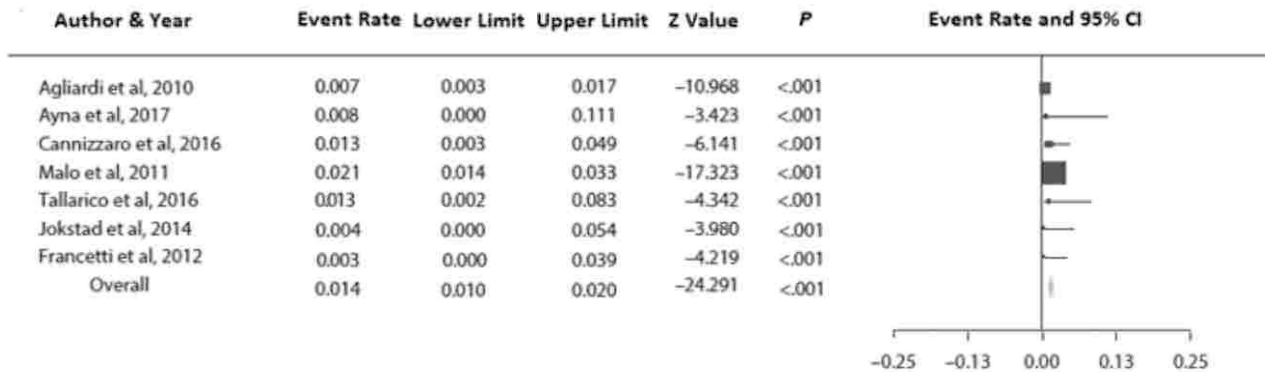
Implant survival rate in complete-archprosthesis with fewer than 5 implants per jaw



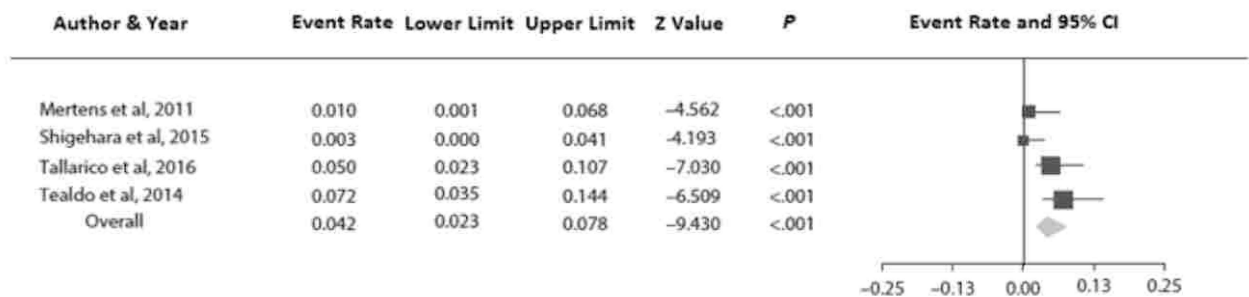
Implant survival rate in complete-archprosthesis with more than 4 implants per jaw



Forest plot for implant survival rate in complete-arch prostheses with fewer than 5 implants per jaw



Forest plot for implant survival rate in complete-arch prostheses with more than 4 implants per jaw



Effect On The Implant Survival Rate In Complete-Arch Prostheses

The implant survival rate in complete-arch prostheses with fewer than 5 implants was 98.7% for both jaws, 99% for the maxilla and 98.9% for the mandible. The pooled weighted event rate was 1.4%.

The implant survival rate in complete-arch prostheses with more than 4 implants was 96.6% for both jaws, 95.61% for the maxilla and 100% for the mandible. The pooled weighted event rate was 4.2%.

DISCUSSION

The number of implants utilized to support a complete-arch prosthesis is one of the popular topics discussed since the beginning of implant dentistry and still remains of interest, due to the several implications derived from the influence on the outcomes regarding the decision to place less or more implants^[16].

Some studies have reported that a reduction in the number of implants in complete-arch prostheses contributes to increased stress on the structures. However, distribution in addition to the number of implants may affect rehabilitation. The all-on-four technique was developed to overcome anatomic limitations and reduce the cantilever. The high survival rates for this technique may be attributable to appropriate patient selection because implant loss can be higher in patients with local or systemic disease. Moreover, implant survival rates also depend on the amount of residual ridge, independent of the arch. In complete-arch prostheses, the failure of only 1 implant represents a failure of the entire complete-arch prosthesis. Therefore, the use of at least 5 implants in the mandible and 6 in the maxilla could be indicated for immediate complete-arch prostheses. A study reported no impairment of rehabilitation in situations with at least 5 implants in the mandible and 6 implants in the maxilla.

Implant survival rates should not be evaluated without assessing correlation with prosthesis success rates^[9].

The mean complication rate for complete-arch prostheses was 15.75%. This indicates that number of implants is independent of the complication rate. The most common complications observed in the selected studies were screw loosening and acrylic resin fracture^[17]. These complications may occur because individuals with a complete denture recover their masticatory

efficiency and change their diet from soft to harder foods, causing fracture of the acrylic resin. Furthermore, when the masticatory forces are applied to the distal extension of the prostheses, screw loosening/fracture or acrylic resin fracture can occur, perhaps secondary to marginal bone loss.

The distribution of implants is as important as the number of implants. Biomechanical studies have reported that the increase in stress is related to the increase in cantilever length, which could also contribute to increased bone resorption around the implant^[18].

One limitation of the present systematic review was that most of the selected studies did not directly describe the groups used to evaluate and

compare different numbers of implants with the same design (fewer than 5 implants versus more than 4 implants); only 2 studies provided this direct comparison. According to the results of these studies, the number of implants did not influence the evaluated outcomes. Nevertheless, more RCTs are needed to evaluate the direct effect of the number of implants on treatment longevity^[13].

CONCLUSION

Based on the findings of this systematic review, there is no significant difference in longevity when fewer than 5 implants or more than 4 implants are used for complete-arch implant-supported prosthesis. Thus, the number of implants used in complete-arch prostheses does not influence implant survival rate, prosthesis complications or marginal bone loss in studies with a follow-up period of 5 to 15 years. However, additional key variables should ultimately be considered by clinicians when planning treatment for edentulous arches such as prosthesis material, one-piece or segmented prostheses, aesthetic factors (lip support, smile line), opposing dentition, available prosthetic space, anatomy of the edentulous ridge (maxilla, mandible, bone volume and quality, anatomic limitations), distribution of implants in the arch, cantilever length, hygiene space, patient preference and compliance.

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