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Review Article

A literature review of the 10-year survival rate of dental implants

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Abstract

Introduction: To identify and evaluate the most recent studies reporting dental implant survival using current implant systems for a period of 10 years. This updated knowledge will provide the clinician with a better estimation of the real-world risk of implant failures, thus helping the clinician communicate the potential risk to patients.
Aim: The research aims to address the variability around the clinical data available regarding the survival of dental implants in dental patients and if the survival rates mentioned in literature are replicable in actual clinical practice scenarios. This will help ensure quality control for the treatment and help clinicians provide more accurate patient implant survival information.
Method: MEDLINE, PUBMED and EMBASE were searched from 2010 to 2020 using modern dental implants.
Result: 22 studies met the inclusion criteria for the 10-year survival of the dental implant. These were essentially randomised controlled trials and prospective cohort studies.
Discussion: There is a lack of agreement around implant survival rates, mainly due to the previous studies on implant systems that are no longer in use, along with the absence of extended follow-up due to patient attrition. Previous studies showed exaggerated 10-year dental implant survival based on a limited number of studies. The studies with current implant systems show a more realistic 10-year implant survival rate. This is important for clinicians as they need reliable and updated information on implant survival rates when advising their patients on various treatment options. There is currently a gap in the knowledge leading to reliance on the data obtained on implant systems that are no longer in use or have been modified. Thus, the currently available implants need an update in the literature.
Keywords: Dental implants, survival, 10-Year, Literature review.

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1. Introduction

With the technological advances in treating patients with partial edentulism, implants have gained popularity as a mainstream treatment option for the replacement of missing teeth while preserving tooth structure and providing a more predictable functional and esthetic long-term treatment option. [1]

The outcome of implant therapy provided to patients is judged based on survival rates. These are subject to individual interpretation based on the various study designs, study periods and different definitions used in selecting a particular group of patients. [2-4] However, implant survival can be understood as the implant that stays in the mouth at the time of evaluation regardless of any sign or symptom or history of the problem. [5]

The previous systematic reviews by Pjetursson *et al*. 2004 [6] and 2012 [7] evaluated six prospective cohort studies and one randomised controlled trial and reported a 10-year survival rate for dental implants restored with fixed dental prosthesis superstructure as 92.8% and 94.8%, respectively. Another review in 2012, including six retrospective studies with 267 implants placed, reported a 10-year survival rate for dental implants with a single crown superstructure as 95.3% [8]. The group from Brazil reported on combined clinical trials of 10 studies reporting a 10-year survival rate of 96.5% [9].

Furthermore, the Swiss study in 2012 by the Srinivasan group, including three prospective clinical trials with 101 implants placed, reported 10-year survival of dental implants as 91.2 % for single crowns and 80.5% for over dentures, respectively. [10]

These reviews included studies initiated when the traditional version of implants was used at the time. Most of the studies included were retrospective. Hence, they were not reflective of the current dental implant practices and protocol. It is also equally important to understand the failure of an implant that may challenge the survival of a dental implant. Failure of an implant refers to a situation where an implant fails to meet the clinical and functional requirements of both the patient and the clinician. We defined the complete loss of an implant as a failure of the implant for this review.

The primary predictors of implant failure can be identified as poor bone quality, chronic periodontitis, systemic diseases such as diabetes, smoking, advanced age, implant location, parafunctional habits, loss of implant osseointegration and poor implant-supported prosthesis. [11, 12]

Failures can be grouped as early or late failures. Early is usually defined as those which occur before successful integration and restoration, whereas late is after restoration. Early failures can be due to integration failure because of infection, excessive mobility, anatomical complications such as nerve sensations or sinus complications and membrane exposures. Late failures can be caused by overheating bone during osteotomy or poor surgical techniques. The late failures occur after occlusal loading and are believed to be due to the established osseointegration failure, peri-implantitis, and implant fracture. [12, 13]

With the advent of modern implant systems, there is a paucity of literature identifying the survival rates with modern implants and their applicability to modern dental practice. Hence, this review aims to assess the scientific literature concerning the 10-year survival rates of dental implants using current implant systems.

Published studies from 2010 to 2020 were analysed to focus on contemporary implant systems, and the summary estimate for 10-year survival at the implant level was found to be 96% (95.99% CI 94.6% –97.4%).

2. Material and Methods

To investigate the survival rate of implants, a comprehensive search was done to identify longitudinal studies in humans for at least ten years. This focused literature review was carried out following the steps of practice based on scientific evidence [14], and the methodology was adapted to the PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). [15, 16]

A general search was made from January 2010 to December 2020 in the MEDLINE, PubMed, Embase, and Scopus databases for relevant publications in indexed journals. The search strategy used the keywords: dental implants, implants, implant loss, implant survival, long-term, multilevel analyses, survival, prediction interval, ten-year, systematic review, retrospective, comparative, and longitudinal. These identified databases were searched for published studies from 2010 to 2020 to focus on modern implant systems. Randomised controlled, retrospective and prospective cohort studies with at least ten participants and thirty-five implants were included. The unit of study was the 'absolute survival rate of dental implants after ten years in the oral cavity.

The literature search had defined inclusion criteria: human study; publications in English, studies with a clear focus on modern implant systems; randomised controlled (RCT), retrospective, and prospective cohort studies; and studies with of determination of ‘Absolute survival’ rate for dental implants after ten years in the oral cavity. The exclusion criteria were outlined as animal studies, case reports and narrative reviews, and studies involving zygomatic implants; patients under the age of thirteen years; less than ten patients; less than thirty-five implants; and published research before 2010 and after 2020.

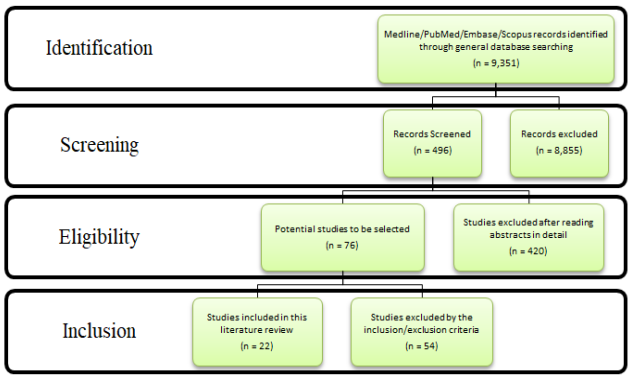

Figure 1: Flow diagram (PRISMA format) of the screening and selection process.

After the application of the inclusion and exclusion criteria and careful content analysis, a high number of the pre-selected articles were excluded. For this literature review, preference was given to randomised controlled, retrospective, and prospective cohort studies as these are the most common longitudinal studies in dentistry. Because of the low frequency of such studies, only five RCTs that met the criteria established for this review were identified; the other articles included were related to prospective and retrospective studies. After an exhaustive

search of the literature, we found few studies that analysed the survival of implants as per this duration of follow-up. Twenty-two of more than four hundred articles screened using abstracts and keywords met this research's inclusion/exclusion criterion. These were studied in detail in the literature review to evaluate the ten-year baseline survival rate of dental implants for comparison.

3. Results & Discussion:

The initial search resulted in 9,351 research articles. The titles with no abstract available and those that deviated from the subject of this review were excluded. After the first analysis, the abstracts of 496 articles were obtained.

Table 1: Characteristics and outcomes of the included studies

Author	Publication Year	Study Design	Number of patients	Age range	Implant System	Number of Implants	The estimated survival rate after ten years (%)
Vigolo	2012	RCT	18	27-42	Biomet3i	36	94.44
Degidi	2012	PCS	59	31-68	Nobel BioCare	210	97.62
Ostman	2012	PCS	46	50-52	Biomet3i	121	97.52
Shatkin	2012	RET	1260	13-95	N/A	5640	92.10
Rocci	2012	RET	46	24-77	Branemark, Nobel BioCare	97	91.10
Mertens	2012	PCS	14	37-71	Astra	52	100.00
Deporter	2012	PCS	24	20-72	Endopore	48	95.50
Roccuzzo	2013	PCS	149	30-64	Friadent	252	97.62
Schropp	2013	RCT	63	20-74	Biomet3i	63	95.24
De Carvalho	2013	RCT	30	≥65	Nobel BioCare, Lifecore, Biomet 3i, Globe Tech	60	95.00
Calvo-Guirado	(2014)	PCS	64	29-60	Straumann	86	96.51
Mangano	2014	PCS	194	24-74	Leone	215	98.50
Meyle	2014	PCS	20	39-57	Biomet3i	54	96.30
Cassetta	2015	PCS	16	48-69	Astra	188	97.87
Vigolo	2015	RCT	44	37-58	Straumann	132	97.73
Ma	2015	RCT	40	55-76	Straumann	117	86.32
Decide	2016	PCS	114	37-68	Southern	284	96.48
Walton	2016	PCS	35	15-79	Sweden & Martina	35	97.14
Zhang	2016	PCS	12	40-73	Astra	91	97.80
Correia	2017	RET	202	23-73	Straumann, Nobel Biocare, Biomet 3i, Neodent, Klockner Eurotaknika	689	93.10
Baumer	2020	RET	100	28-86	Xive	242	97.70
French	(2020)	RET	4247	38-70	Straumann	10871	92.50

Abbreviations: RCT – Randomised controlled trials, **PCS** – Prospective cohort study, **RET** – Retrospective study

Seventy-six complete articles were chosen for careful reading. After evaluating each article, 22 studies published between 2010 and 2020 were selected. The most frequent exclusion was the study duration being less than ten years. Of the potential studies for inclusion (n = 76), 54 were excluded after careful analysis. The study screening and selection process, including the frequency, is shown in figure 1.

The included studies used current implant systems with roughened titanium implant surfaces and solid screw design. The twenty-two studies that met the inclusion criterion were predominantly prospective cohort studies (n = 12) with only five randomised controlled trials (RCTs) and five retrospective studies. A total of 19,583 implants were evaluated, with fourteen different commercial brands used: Biomet 3i, Friadent, Lifecore, Globe Tech, Astra Tech, Sweden & Martina, Neodent, Klockner Eurotaknika, Xive, Straumann, Southern Implants, Nobel Biocare, Endospore and Leone Dental Implants. These studies included a total of 6797 patients ranged from 12 to 4247 patients with an age range from 13 to 95 years and respective estimated survival rates summarised in table 1. [17- 38]

The inclusion criteria of many of the included studies suffered from a selection bias that made the results representative of a controlled environment such as a specialist practice. Most of the studies excluded smokers or people with uncontrolled diabetes. However, a few studies, such as those by Schropp *et al*. 2014 [25] and Rocci 2012 [23], included the smokers in their studies but did not mention the number of cigarettes smoked or the duration of smoking. The inclusion of smokers in their inclusion criteria was reflected in their survival rates, which were slightly less than the studies that did not include smokers. Furthermore, the survival criteria used for most of the studies were very fluid. Notably, there were no standard

internationally accepted criteria to ascertain the survival of implants. Some authors followed the PISA 2008 consensus criteria for implant survival based on parameters such as pain, mobility, 2-4 mm or > 4mm radiographic bone loss with no or possible exudate history. [39]

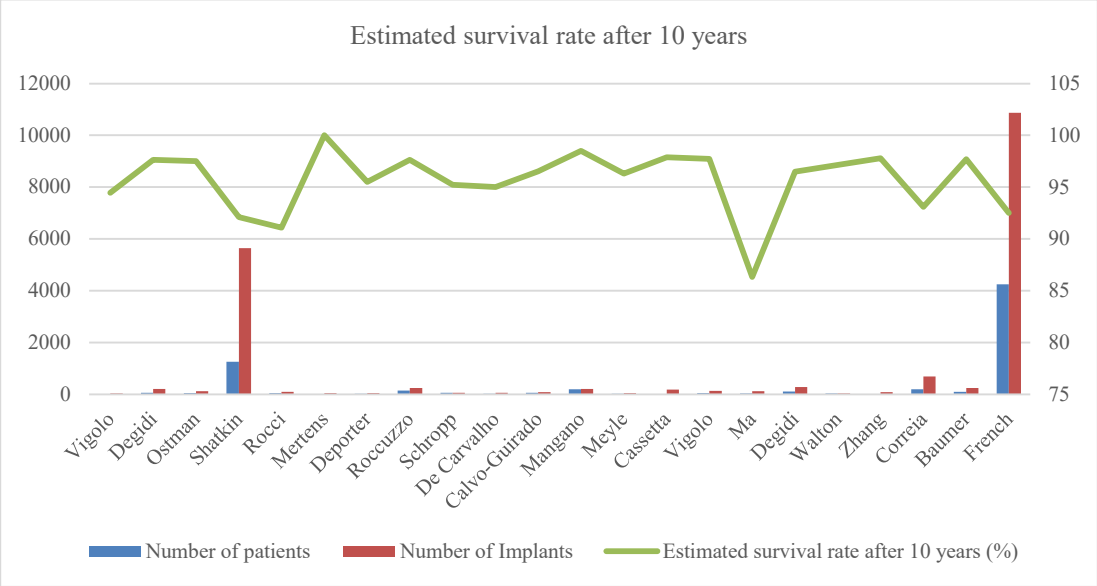

Figure 2: Literature – estimated survival rate after ten years

Nevertheless, other authors defined their survival criteria ranging from the implant that was not lost, by Deporter 2012 [21] to Rocci 2012 [23], who laid down its survival criteria based on no radiolucent zones, successful anchorage of the functional prosthesis, confirmed individual stability after at least six months loading with provisional prosthesis and no suppuration pain or ongoing pathologic processes. Despite a wide variation in how various studies defined the survival criteria, there was an increasing trend towards more significant usage of the PISA 2008 consensus criteria for survival. In addition, a common problem encountered in the studies with a 10-year follow-up was patient dropouts. This could be due to various reasons, such as the patient being deceased during the study, the patient moving elsewhere, or refusing a follow-up. Figure 2 summarises the ten-year implant survival analysis. A significant number of implants were placed and included in various studies, such as by French *et al*., and the variations in the survival rate for ten years across analysed studies are shown in the figure below.

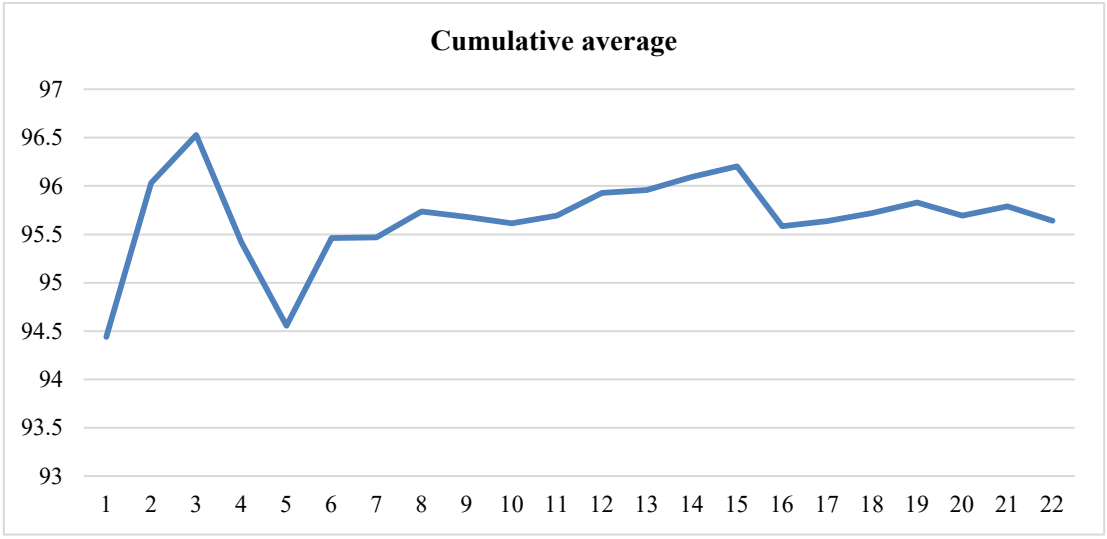

Figure 3: Cumulative survival rate average

A total of 22 studies evaluating the survival of implants were included in the final detailed review. Table 1 summarises the estimate for 10-year survival at the implant level with a value of 96% (Figure 3; 95.99% CI 94.6% – 97.4%), with variations from 86.3% to 100%. After carefully evaluating the final selected papers, considerable heterogeneity was observed in study designs and outcomes. It was, therefore, impossible to perform a statistically accurate quantitative analysis of the data. Instead, this research focused on a descriptive analysis of the data. [16]

In the past, the studies done to evaluate the 10-year implant survival were done on implant systems that have now been superseded or are no longer in use. These traditional studies overestimated the 10-year survival rate of dental implants. This did not reflect accurate information for clinical purposes. Furthermore, an update in literature is required with the currently available implants, especially in the Australian context. This will help ensure quality control for the treatment and help clinicians provide more accurate patient implant survival information.

Furthermore, with the ageing population and people's wishes to replace teeth even in the yesteryears of life, quality control and maintenance after implant placement is more critical than before. The knowledge about the long-term survival of implants helps build the workforce capacity and competency in the wider oral health sector to effectively address the needs of people to have a quality of life with the replacement of missing teeth via the form of Implant placements. It also reduces the economic burden on the health care budget to address the issue of failing implant and their replacement if the issues were addressed in the beginning. Thus, assuring quality control in the implant placement at a specialist oral health setting and helping in the strategic planning by the care provider.

In the future, it will also be meaningful to know the actual clinical impact on the survival of those implants concerning the modern developments in implant surfaces by various implant brands. The survival rates of implants concerning the gender of the patient or the implant site distribution in terms of placement in the maxilla or mandible, along with implant diameter or the implant length, is also an exciting area for further research.

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