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REVIEW

Dental implant survival rate in well-controlled diabetic patients. A systematic review.

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Abstract: Background: Dental implants have now become one of the most popular options for replacing a missing tooth. On the other hand, diabetes mellitus is a systemic disease that affects a large part of the population and is generally considered an absolute or relative contraindication to implant therapy. Aim: To determine the survival rate of dental implants in controlled diabetic patients through a systematic review. Material and methods: A systematic search in Pubmed, SciELO and RedALyC databases was performed. The selection criteria were: studies published in the last 10 years, with at least 20 controlled diabetic patients, reporting survival rate and number of implants placed, with follow-up periods equal to or longer than 1 year, including a control group of healthy patients. Methodological quality was analyzed with the follwing scales: Jadad and Downs & Black's CMQ. Results: Three articles with a follow-up period between 1 and 12 years were analyzed. The overall survival rate of dental implants in diabetic controlled patients was 97.43%. Conclusion: The reviewed literature suggests that survival rate of dental implants in well-controlled diabetic patients is similar to non-diabetic patients.

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INTRODUCTION.

In the last two decades, dental implants have become an increasingly popular procedure, being considered effective and predictable restorations for replacing missing teeth[1,2]. However, although the success and long-term survival of dental implants are well documented in a large number of studies[3], failures still continue to occur for several reasons.

Given the above, risks associated with the failure of dental implants have become a topic widely discussed in recent dental research[2]. A variety of conditions are considered influential in the outcome of the success or failure of dental implants, including: the implant design (length, shape or surface texture), medical risk factors related to the patient (systemic diseases or habits like smoking) and factors related to surgery (experience of the surgeon or surgical planning)[4,5].

As there have already been technological advances in materials and surgical techniques, today attention is focused on conditions related to the patient as the major risk factors[6]. According to research by Buser *et al.*, patients exposed to irradiation (radiation therapy), patients with diabetes or those who smoke heavily are most susceptible to failure when a dental implant therapy is performed[7].

According to the World Health Organization (WHO), diabetes is one of the most prevalent health problems in the world[8,9]. Studies in China[10] and India[11] have shown that the number of people with diabetes has exceeded the estimate given by the IDF-2009[12] and is expected that most of the affected population will be in China, India and the USA[9]. During the last three decades the global burden of people with diabetes has increased from 30 million in 1985 to 382 million in 2014, and the International Diabetes Federation estimates that by 2035 10% of

the population will have diabetes[13].

For a long time, diabetes has been considered a relative contraindication for implant therapy[1,14] as these patients have an increased susceptibility to infection, delayed healing and microvascular complications[14]. Our understanding of diabetes mellitus as a relative contraindication depending on the level of glycemic control has changed little since the 1988 NIH conference[13,15]. As a result, well-controlled diabetic patients can be treated with implants, while uncontrolled diabetic patients cannot benefit from this therapy[13,16].

As life expectancy is projected to increase with the arrival of better therapies, a growing number of patients with diabetes may require treatment with dental implants. Despite the large number of recent published studies evaluating the failure of dental implants in the diabetic population, results have been varied, not reaching a clear conclusion, mainly due to confounding factors and bias.

The aim of this paper is to determine the overall survival rate of dental implants placed in controlled diabetic patients.

MATERIALS AND METHODS.

This review was carried out according to a research protocol based on the PRISMA[17] guidelines.

Search:

Extensive search strategy in biomedical databases PubMed, SciELO and RedALyC was performed until June 2015. A combination of subject headings and free terms was used: "implante dental, implante dental diabetes, implante dental diabético, dental implant, dental implant diabetes and dental implant diabetic". AND/OR were used as Boolean operators.

Selection criteria:

Publications that met the following criteria were included:

- Clinical trials or cohort studies published in the last 10 years, because the more current the research the more relevant and rigorous the data extracted from them.

- Published in English or Spanish.

- Reporting survival rate, understood as functional permanence without mobility, without periodontal disease (mucositis or periimplantitis) or fracture of any components of dental implants in patients with diabetes mellitus.

- Follow-up period equal to or longer than one year and sample size equal to or larger than 20 diabetic patients. This because a longer follow-up period and a larger sample allow more representative results, error range is reduced and confidence level increases.

- Reporting glycemic control, as some studies state this could be a parameter which would determine whether these patients are eligible or not to receive a dental implant treatment[18-20].

-Including a healthy control group of patients in order to make a more representative comparison with controlled diabetic patients.

Publications with poor methodological quality were excluded because such studies would lead to bias results or serious confounding factors.

Selection process and data extraction:

Titles and abstracts of each of the studies obtained with the inclusion criteria described above were reviewed. Full texts were obtained in order to assess their methodological quality and eventual inclusion in the analysis.

To evaluate the studies a checklist in duplicate was made in order to extract relevant information and compare data. Two reviewers evaluated the papers independently considering name, author(s), date of publication, type of study, type of diabetes, disease control, number of patients, number of implants placed, survival rate, clinical follow-up and methodological quality. For the resolution of any disagreement between reviewers, both reviewers met and discussed their differences with a third reviewer in order to come to an agreement.

Assessment of methodological quality:

Clinical controlled randomized trials were analyzed according to the Jadad[21] scale (Table 1); uncontrolled clinical trials and observational studies with the Checklist for Measuring Quality (CMQ) developed by Downs and Black[21].

27 items were modified in CMQ, eliminating questions

Table 1. Methodological quality according to Jadad scale.

Criteria	Score	
	Tawil *et al.*[22]	Oates *et al.*[24]
Is the study described as randomized?	1	1
Is the method used to generate the sequence of randomization described, and is this method suitable?	1	1
Is the study described as double blind?	0	0
Are losses and withdrawals described in the study?	1	1
Is the masking method appropriate?	1	1
TOTAL	4	4

Table 2. Methodological quality according to Downs and Black's Checklist for Measuring Quality.

Criteria	Score Levin *et al.*[23]
Is the hypothesis / objective of the study clearly described?	1
Are primary endpoints clearly described in the Introduction or Methods?	1
Are the characteristics of patients included in the study clearly described?	1
Are distributions of major confounders in each group of subjects being compared clearly described?	2
Are the main results of the study clearly described?	1
Does the study provide estimates of the random variability in the data in relation to primary endpoints?	1
Have the characteristics of patients lost to follow-up been described?	0
Have the actual probability values for the primary endpoints been reported (for example, 0.035 instead of <0.05) unless the probability values were less than 0.001?	1
Were the subjects asked to participate in the study representative of the entire population from which they were selected?	1
If any of the results of the study were based on a "data dredging", it is clearly indicated?	1
In trials and cohort studies, were the analyses adjusted for the different durations of follow-up periods of the patients? Or in case-control studies, was the time between the intervention and the endpoint the same for cases and controls?	1
Were statistical analyses used to assess the primary endpoints appropriate?	1
Were the primary endpoints used accurate (valid and reliable)?	0
Were the patients in the different intervention groups (trials and cohort studies) or cases and controls (case-control studies) selected from the same population?	1
Were the subjects in different intervention groups (trials and cohort studies) or cases and controls (case-control studies) selected during the same time period?	1
Was there adequate adjustment for confounding factors in the analysis from which the main results were extracted?	0
Was loss of patients to follow-up considered?	1
TOTAL	15

related to experimental studies (4, 8, 12, 13, 14, 15, 19, 23, 24 and 27), (Table 2).

Jadad scale was chosen because it is a validated and widely known scale for determining the methodological quality of all clinical trials. It is also simple, efficient and easy to apply.

Figure 1. Flowchart of the selection of publications.

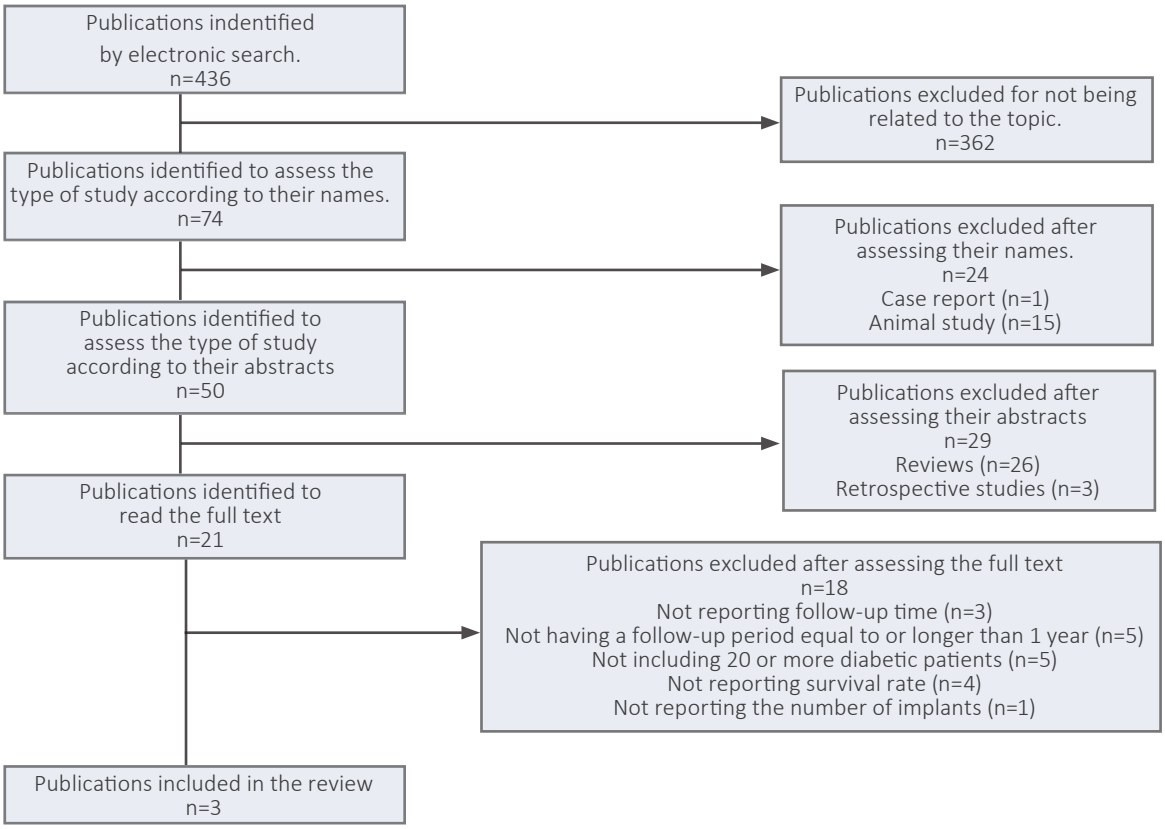

Table 3. Characteristic of included studies

Author	Year	Type of study	Type of diabetes	Control of diabetes	N° of patients	N° of implants	Survival rate	Clinical follow-up time	Methodological quality Jadad / CMQ*
Tawil *et al.*[22]	2008	Prospective /CCT	2	Controlled	45	255	97.20%	12 Years	4/--
				ND	45	244	98.80%		
Levin *et al.*[23]	2011	Prospective /Cohort	NR	Controlled	81	263	96.20%	12 Years	--/15
				ND	636	1996	95.84%		
Oates *et al.*[24]	2014	Prospective /RCT	1 and 2	Controlled	44	234	98.90%	12 Years	4/--
				ND	47		99%		

NR: Not registered; ND: Non-diabetic; RCT: randomized clinical trial; CCT: controlled clinical trial; *Check list for Measuring Quality.

RESULTS.

The general search strategy is summarized in Figure 1, three studies were finally included.

The first study is a controlled clinical trial conducted by Tawil *et al.*[22], published in 2008. Forty-five controlled patients with type 2 diabetes and 45 non-diabetic patients participated in the study, with 255 and 244 implants placed in each group respectively; follow-up was 12 years. Survival rate was 97.20% and 98.80% respectively for each group. The Jadad scale showed a value of 4 (good methodological quality).

The second is a cohort study conducted by Levin *et al.*[23], published in 2011. They did not register the type of diabetes that affected the patients. Eighty-one controlled dia-

betic patients and 636 non-diabetic patients participated in the study, with 263 and 1996 implants placed in each group respectively, follow-up was 12 years. Survival rate was 96.20% and 95.84% respectively for each group. CMQ scale showed a value of 15 (excellent methodological quality).

The third study is a clinical trial conducted by Oates *et al.*[24] published in 2014, involving patients with diabetes mellitus type 1 and type 2. Forty-four controlled diabetic patients and 47 non-diabetic patients participated in the study, with 255 and 244 implants placed in each group respectively, follow-up was 1 year. The survival rate was 98.90% and 99% respectively for each group. The Jadad scale showed a value of 4 (good methodological quality).

In the 3 studies selected 2992 dental implants were placed, of which 2890 survived the follow-up periods ranging between 1 and 12 years. The overall survival rate of dental implants in controlled diabetic patients and non-diabetics was 97.43% and 97.88% respectively (Table 3).

DISCUSSION.

The relationship between systemic conditions and failure in the placement of dental implants has been widely studied in recent years, with mixed results. In the last decades the number of people suffering from diabetes has increased worldwide, an illness that has tooth loss and partial or total edentulism as one of its major complications

Today dental implants have become a widely accepted rehabilitation treatment among patients, showing high survival rates. Unfortunately, the results related to these studies are limited by the lack of specific information about the diabetic patient.

While most studies state that participants were in a "controlled or well-controlled condition", authors did not explain how glycemic control was assessed. Of the 3 studies included in this review, only two (Tawil *et al.*[22] and Oates *et al.*[24]) give accurate information about the glycemic control of patients with the glycosylated hemoglobin test (HbA1c), the other one does not provide information on glycemic control.

This condition and heterogeneity in the eligibility criteria of diabetic patients may be the explanation for the different results obtained so far. Moy *et al.*[6] indicate that diabetes can cause osseointegration problems and that these failures would be associated with the duration of diabetes and the length of the implants. However, the study did not indicate the number of implants placed and therefore failure rates were based on the number of patients. A similar situation occurs in the study of Busenlechner *et al.*[25], and that was the reason it was not included in this review, although it had an acceptable methodological quality (Jadad equal to 3).

Another problem with studies in diabetic patients published in the last 10 years is that the number of participants is not representative and they are not compared with a control group of clinically healthy individuals, as in the studies conducted by Erdogan *et al.*[26] and Turkayilman *et al.*[27], consequently they were also excluded from this review.

Our results are similar to those reported in other recent systematic reviews as the ones conducted by Chen *et al.*[28], Oates *et al.*[29] and Chrcanovic *et al.*[30]. However, these reviews did not take into account inclusion and exclusion criteria as rigorous as the ones used in this review, so that their analysis may have confounding factors and bias.

CONCLUSION.

Survival rate of dental implants in well-controlled diabetic patients is similar to non-diabetics, so this disease, if properly controlled, is not a contraindication.

Tasa de supervivencia de implantes dentales en pacientes diabéticos controlados. Una revisión sistemática.

Resumen: Antecedentes: Los implantes dentales se han convertido actualmente en una de las opciones más populares para sustituir un diente perdido. Por otro lado, la diabetes mellitus es una enfermedad sistémica que afecta a gran parte de la población y es considerada generalmente una contraindicación absoluta o relativa en la terapia con implantes. Objetivo: Determinar me-

diante una revisión sistemática la tasa de supervivencia de implantes dentales en pacientes diabéticos controlados. Materiales y métodos: Búsqueda sistemática en las bases de datos biomédicas Pubmed, SciELO y RedALyC. Los criterios de selección fueron: estudios publicados en los últimos 10 años, con al menos 20 pacientes diabéticos controlados, que reporten tasa de supervivencia y número de implantes colocados, con un seguimiento igual o superior a 1 año, con un grupo control de pacientes sanos. Se analizó la calidad metodológica de los estudios con las escalas Jadad y CMQ de Downs y Black. Resultados: Se analizaron tres artículos con un seguimiento de entre 1 y 12 años. La tasa de supervivencia global de los implantes dentales en los pacientes diabéticos controlados fue de un 97.43%. Conclusión: La literatura revisada sugiere que la supervivencia de los implantes dentales en pacientes diabéticos bien controlados es similar a pacientes no diabéticos.

Palabras clave: *Implante dental, Diabetes, Revisión, Tasa de supervivencia.*

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