Does a higher glycemic level lead to a higher rate of dental implant failure?

A meta-analysis

Quan Shi, PhD(c); Juan Xu, PhD; Na Huo, PhD; Chuan Cai, PhD; Hongchen Liu, PhD

ABSTRACT

Background. Owing to limited evidence, it is unclear whether diabetes that is not well controlled would lead to a higher rate of dental implant failure. The authors of this meta-analysis evaluated whether the failure rate for patients with diabetes that was not well controlled was higher than the failure rate for patients with well-controlled diabetes.

Types of Studies Reviewed. The authors searched PubMed, the Cochrane Library, and ClinicalTrials.gov without limitations for studies whose investigators compared the dental implant failure rates between patients with well-controlled diabetes and diabetes that was not well controlled. The authors pooled the relative risk (RR) and 95% confidence interval (CI) values to estimate the relative effect of the glycemic level on dental implant failures. The authors used a subgroup analysis to identify the association between the implant failure rate and the stage at which the failure occurred.

Results. The authors included 7 studies in this meta-analysis, including a total of 252 patients and 587 dental implants. The results of the pooled analysis did not indicate a direct association between the glycemic level in patients with diabetes and the dental implant failure rate (RR, 0.620; 95% CI, 0.225-1.705). The pooled RR in the subgroup of patients who experienced early implant failure was 0.817 (95% CI, 0.096-6.927), whereas in the subgroup of patients who experienced late implant failure, the pooled RR was 0.572 (95% CI, 0.206-1.586).

Conclusions and Practical Implications. On the basis of the evidence, the results of this meta-analysis failed to show a difference in the failure rates for dental implants between patients with well-controlled diabetes and patients with diabetes that was not well controlled. However, considering the limitations associated with this meta-analysis, the authors determined that future studies that are well designed and provide adequate controls for confounding factors are required.

Key Words. Uncontrolled diabetes; dental implant failure; glycemic control; meta-analysis.

JADA 2016:■(■):■-■

http://dx.doi.org/10.1016/j.adaj.2016.06.011

Diabetes mellitus, which is characterized by relative or complete insulin deficiency or resistance leading to hyperglycemia, has become 1 of the most challenging public health problems worldwide.[1] It has placed a heavy burden on society and markedly increased health care costs.[2,3] In addition to medication therapy, diet plays an important role in the treatment of diabetes and in glycemic control. According to the latest scientific statement from the American Heart Association and the American Diabetes Association,[4] maintaining a careful diet and performing physical activity can affect overall diabetes control and can safely lead to weight loss, which can reduce the need for medication to control cardiovascular disease risk factors without a concomitant increase in the risk of experiencing cardiovascular events. Unfortunately, patients with diabetes have an increased frequency of tooth loss,[5,6] which affects their masticatory function and their intake of nutrients, both of which can lead to challenges in glycemic control and complications for the prevention of diabetes.[7,8]

Clinicians generally consider dental implants to be effective and reliable restorations to replace lost teeth and restore masticatory function.[9] Osseointegration is a prerequisite for a successful dental implant; however, there is evidence that diabetes has a negative influence on bone formation and remodeling.[10] Complications, including microvascular disease, susceptibility to infection, and delayed wound healing caused by hyperglycemia may affect implant osseointegration. Therefore, clinicians have long considered diabetes to be a relative contraindication for dental implants, depending on the patient's glycemic level.[10,11] The results of animal studies also have shown decreased levels

of implant osseointegration and reduced bone-to-implant contact caused by hyperglycemia.[12,13]

Therefore, glycemic control is the primary consideration for implant treatment. With proper treatment planning, prophylactic remedies and adequate post-surgical maintenance, patients with well-controlled diabetes may be considered candidates for implant treatment,[14] whereas patients with diabetes that is not well controlled may be ineligible for implant therapy.[6] However, the results of some clinical studies have shown that patients with diabetes that was not well controlled had higher rates of implant success.[15,16] Moreover, the authors of a systematic review[6] concluded that there were no clinical data to support the idea that patients with diabetes that is not well controlled would have a significantly increased risk of experiencing implant failure, but other investigators[14] noted that the authors of that review compared only the failure rates of various studies without conducting a statistical analysis. Therefore, it is still controversial whether the implant failure rate is higher in patients with diabetes who do not have good glycemic control.

Through this meta-analysis, we evaluated the evidence of the relationship between glycemic level and dental implant failure rate in patients with diabetes, and we analyzed whether the implant failure rate in patients with diabetes that was not well controlled was higher than the rate in patients with well-controlled diabetes. The results of this meta-analysis will give clinicians a better understanding of the risks of dental implant failure and help patients make rational decisions.

METHODS

Search strategy and study selection. In December 2015, we searched PubMed, the Cochrane Library, and ClinicalTrials.gov without language or time restrictions. We used the following key words: "dental implants," "oral implants," "diabetes," "hyperglycemia," and "diabetes mellitus." We identified additional studies by handsearching the reference lists of the included studies and related reviews. Two reviewers (Q.S., J.X.) independently assessed these results, and they resolved any disagreements by means of discussion with a third reviewer (H.L.).

To select the studies, we first excluded irrelevant records after reading the titles and abstracts. Then we scanned the full texts of articles of potential interest. After we excluded irrelevant and duplicate records, we included only the studies that met the inclusion criteria.

Inclusion and exclusion criteria. We included all clinical studies whose investigators described dental implant failure rates in patients with well-controlled diabetes and patients with diabetes that was not well controlled. Investigators had tested patients' glycemic levels preoperatively. We excluded animal studies and in vitro studies, reviews, letters, case reports, comments, and studies whose investigators did not compare patients with diabetes who did and who did not have good glycemic control as well as studies for which we found no available data to extract.

Data extraction and quality assessment. Two authors (Q.S., J.X.) independently extracted the following information from each included study: the name of the first author and the year of publication; the country in which the study was conducted; the study design; the characteristics of the study participants, including number of patients, type of diabetes, age range, and glycemic level; and the number of dental implants and data related to dental implant failures.

Two authors (N.H., C.C.) completed the quality assessment by using the Newcastle-Ottawa Scale (NOS).[17] In this assessment tool, study selection, comparability, and outcome are used to appraise the methodological quality of the included studies, with a maximum of 9 points for each study.[17]

Data synthesis and analysis. We used the Comprehensive Meta-Analysis (Version 2.0; Biostat) software to perform the meta-analysis of the extracted data. We pooled the relative risk (RR) and 95% confidence interval (CI) values to estimate the relative effect of glycemic level on dental implants. We tested heterogeneity between studies using I^2 tests. I^2 values of 25%, 50%, and 75% were considered low, moderate, and high, respectively.[18] We used a fixed-effects model if the heterogeneity was low; otherwise, we used a random-effects model.

We used the subgroup analysis to identify the association between implant failure rate and the stage at which the implant failed. On the basis of the results of previous studies,[19,20] we divided the failed implants into the following 2 groups: early failure (before or at abutment connection) and late failure (after implant loading). In some of the included studies, investigators divided patients with diabetes that was not well controlled into different groups, such as a group of patients with poorly controlled diabetes and a group of patients with moderately well-controlled diabetes. To perform a quantitative analysis, we combined these groups.

RESULTS

Study selection. Initially, we identified 360 records by means of our search. We reviewed 40 full-text articles and 2 clinical trials, of which 9 studies met our inclusion criteria.[15,16,21-27] However, the investigators of 1 of the 9 studies did not provide data related to dental implant failure rates.[27] Although we sent an e-mail to the

ABBREVIATION KEY. **FPG:** Fasting plasma glucose. **HbA_{1c}:** Glycosylated hemoglobin. **NA:** Not applicable. **NOS:** Newcastle-Ottawa Scale. **NWCD:** Not well-controlled diabetes. **T2D:** Type 2 diabetes. **WCD:** Well-controlled diabetes.