

# Dental Implants in Patients With Type 2 Diabetes Mellitus: A Clinical Study

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Replacing missing teeth with osseointegrated dental implants is a predictable technique as evidenced by the overall 5-year implant survival rates ranging from 93% to 97%.<sup>1,2</sup> The first clinical application of dental implants was to retain and support a full-mouth prosthetic appliance in edentulous patients who had problems with retention or with adaptation to removable full dentures.<sup>3</sup>

In the last 15 years the use of dental implants has been extended to provide mechanical attachment for support and retention of removable overdentures. Some authors described a protocol for placement of four implants in the anterior mandible to support an overdenture.<sup>4,5</sup> The implant-supported overdenture should reduce stress on the tissues and stabilize the prosthesis,<sup>6</sup> making it more bearable to patients. Therefore, an implant-retained overdenture can be considered a good alternative.<sup>6,7</sup> A 5-year survival rate of more than 95% in studies of implant-supporting mandibular overdentures was reported, and research has demonstrated improved masticatory function and overall satisfaction in implants patients.<sup>4,5</sup>

Local and systemic factors can influence the success rate of dental implants. Adequate patient selection, treatment planning, implant design, suitable implant materials, good surgi-

**Purpose:** Systemic factors, such as diabetes mellitus, can influence the success rate of dental implants. The authors describe their experience using the MIS implant system (Medical Implant System, Shlomi, Israel) for retention of overdentures in patients with type 2 diabetes mellitus and provide data regarding the level of satisfaction of the patients, the improvement of function, mucosal and periimplant health, and bone level around implants in this group.

**Methods:** The study group consisted of 41 patients with type 2 diabetes mellitus who received 141 implants for retention of overdentures. **Results:** The success rate was 97.3% and 94.4% 1 and 5 years following implantation, respectively. The majority of patients reported improve-

ment of function following the new treatment. A high correlation was observed between mucosal health and improvement of function. No correlation was found between failed implants and glucose level.

**Conclusion:** The clinical outcome of dental implants in a selected group of patients with well-controlled type 2 diabetes mellitus is satisfying and encouraging. Further investigations and clinical trials over a longer period of time are needed to determine the long-term survival of implants in diverse groups of patients with diabetes mellitus. (*Implant Dent* 2003; 12:116–122)

**Key Words:** success rate, diabetes, dental implants, periimplantitis, glucose level

cal technique, and restorative treatment are crucial for the success of the procedure. Yet it can also be negatively affected by factors such as impaired wound healing, metabolic bone disease, and smoking.<sup>3,8,9</sup> As implant surgery and subsequent prosthodontic restoration are becoming more popular, the demand for implant-retaining overdentures will increase.

The populations that can benefit most from this treatment modality are older persons. Improvements in medical care have created a higher percentage of senior patients suffering from an increased incidence of chronic illnesses, such as diabetes mellitus and metabolic bone disease, which may influence success rates of dental implants. Umino and Nagao<sup>10</sup> investigated 1012 elderly patients and found

that one or more systemic diseases were present in approximately 65% of the subjects. In their study, cardiovascular diseases were the most frequent systemic diseases followed by diabetes mellitus, a disease related to an absolute or relative insulin insufficiency and the third leading cause of death in the United States. Diabetes presents in two distinct forms: the insulin-dependent and the non-insulin-dependent types. Diabetic patients are said to be more prone to develop infections and vascular complications. Tissue perfusion and microvascular diseases have an important role in wound healing. Since diabetes is associated with microvascular changes, patients with diabetes have poor wound-healing potential. The healing process of hard and soft

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tissues in the diabetic patient is also delayed as a result of decreased protein metabolism. It is also affected by impaired function of the neutrophilic leucocytes.<sup>11-13</sup> Because of such considerations, diabetes has sometimes been considered a contraindication for the use of dental implants.<sup>14,15</sup>

We describe our experience using the MIS implant system (Medical Implant System, Shlomi, Israel) for retention of overdentures in patients with type 2 diabetes mellitus, and provide data regarding the level of satisfaction of the patients and improvements in function, mucosal and periimplant health, and bone level around implants in this group.

## MATERIALS AND METHODS

The group under investigation included patients with well-controlled type 2 diabetes mellitus who were referred to our clinic for insertion of dental implants in the anterior mandible, destined to serve for retention of overdentures. A prosthodontist determined the treatment planning, an oral and maxillofacial surgeon examined the patients, and these specialists then decided whether there was an indication for implant insertion and restoration as defined. Blood glucose levels were monitored and tabulated for all patients 1 week preoperatively, on the day of the operation, and 1 week following implantation. Each patient's condition was managed and controlled by their assigned family physician. Efforts were made to meet the plasma glucose levels recommended by the American Diabetes Association (fasting plasma glucose of 140 mg/dL and 2-hour postprandial glucose of 200 mg/dL). The implants used in this study were the MIS implant system (Medical Implant System) screw type, with a 3.75-mm diameter and ranging in length from 10 to 16 mm. The second stage, uncovering, was accomplished 3 months after osseointegration of implants. Fabrication of the infrastructures, ball attachment, or bar-supporting overdenture was then started.

Periimplant health was evaluated during the observation period 3 weeks and 6 and 12 months after implantation in relation to periimplantitis, peri-

implant mucositis, mucosal hyperplasia, and fistula formation.

Each patient completed a questionnaire related to his or her level of satisfaction and to the improvement of function with the new dentures. All patients underwent standardized panoramic radiography preoperatively and at 3, 6, 12, 24, and 36 months after implantation. All x-rays were digitized and stored electronically using a computer-based measurement software (X-View Inc, Jerusalem), the height of the alveolar bone was measured from the top of the implant to the most apical end, all implants were submerged.

Patients were advised to continue taking their regular medication as prescribed. Eighteen patients were instructed to receive 2 g amoxicillin daily 1 day before the operation and for 5 additional days, whereas those who were allergic to penicillin (16 patients) received 600 mg clindamycin daily.

Using local anesthesia, implants were inserted in the anterior aspect of the mandible using a standard surgical technique. Patients were scheduled for follow-up visits 1 and 3 weeks and 3, 6, 12, and 36 months after implantation.

The criteria for success of the implant were stable implants and superstructures with no symptoms of pain and without signs of inflammation and purulent discharge, loss of no more than 1 mm bone around the implant in the first year, and radiolucency around implants. For the purpose of analysis we divided the patients into subgroups according to age (over 65 years and 65 years and under) and to the number of implants.

Pearson correlation coefficient test was used for statistical analysis. The Pearson coefficient of correlation measures the strength of a relationship between two variables in a population; its values range between  $-1$  for a negative correlation to  $+1$  for a positive correlation.

## RESULTS

The study group consisted of 41 patients (26 males and 15 females) with type 2 diabetes mellitus who were treated with dental implants. A

total of 141 implants were placed; every patient received three or four implants at the anterior aspect of the mandible for retention of overdentures (Figs. 1 and 2). Four implants failed during the observation period; two during the second surgical stage and two during the 2-year period after implantation and restoration. The failed implants were mobile during the clinical examination. Success rates of 97.2% and 94.4% were observed during the first and fifth years, respectively.

Three months after implantation, implants were uncovered and restored; 24 patients received ball attachments for retention of overdentures while 17 patients received bars (Fig. 3).

A gradual elevation in glucose level occurred during the intraoperative and immediate postoperative period. One week after implantation, levels returned to near-preoperative values (Fig. 4). No correlation was found between failed implants and glucose levels in our study group.

The majority of patients reported improvement of function, chewing, and general satisfaction from the new treatment. Only four patients (2.8%) were completely dissatisfied with their treatment and five patients (3.4%) reported no change in function with the new implant-retained overdenture. Periimplant complications were observed in three patients; these complications were confined to the mucosa only, or a combination of the mucosa and the bone. The complications appeared to be due to poor adaptation of the denture. Periimplant mucositis or hyperplasia was observed in 1 of 26 patients (3.8%) in the ball attachment-retained overdenture group and in 2 of 15 patients (13.3%) in the bar-retained group. A high correlation was observed between mucosal health and satisfaction from the treatment ( $R = 0.933$ ) (Fig. 4). In addition a good correlation was observed between mucosal health and improvement in function ( $R = 0.737$ ) and chewing ( $R = 0.842$ ). In the bar-retained overdenture group a good correlation was founded between mucosal health and satisfaction from the treatment ( $R = 0.865$ ) and between mucosal health and improvement of function ( $R = 0.859$ ) and chewing ( $R$

= 0.712). A low correlation was observed between glucose level and improvement of function. The analyses of our results show a very good correlation between males and females regarding improvement in chewing ( $R = 0.996$ ), while the male:female correlation concerning satisfaction from the new treatment and mucosal health was much lower ( $R = 0.528$ )

Analysis of our results by patient age showed a better satisfaction from the new treatment in patients older than 65 years, while the improvement of chewing was equal between older and younger age groups. The analysis of the results by number of implants showed a very low correlation between number of implants and improvement of function ( $R = 0.217$ ).

The main bone loss around implants was approximately 0.5 mm in the first year, and no correlation was found between bone loss and glucose level.

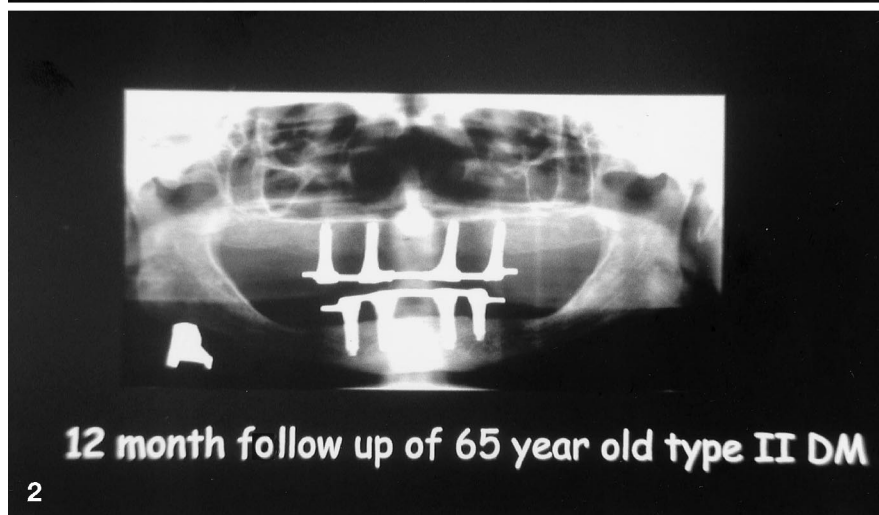
## DISCUSSION

Proper selection of patients for dental implants treatment is one of the most important factors that can influence the prognosis and integration of implants. A primary complication in the integration of dental implants includes traumatic surgery, in which the frictional heat generated during placement of implant causes necrosis to the surrounding tissues and consequently lack of healing and integration.<sup>3</sup> A second complication that interferes with bone integration is an implant recipient site of low healing potential. Some authors<sup>10,14-17</sup> claim that various systemic factors such as osteoporosis, diabetes, severe alcoholism, renal disease, and uncontrolled metabolic disorders increase the rate of implant failure. However, there is a lack of data regarding the influence of systemic diseases, especially diabetes mellitus, on dental implant integration and long-term success rate in humans.<sup>18,19</sup>

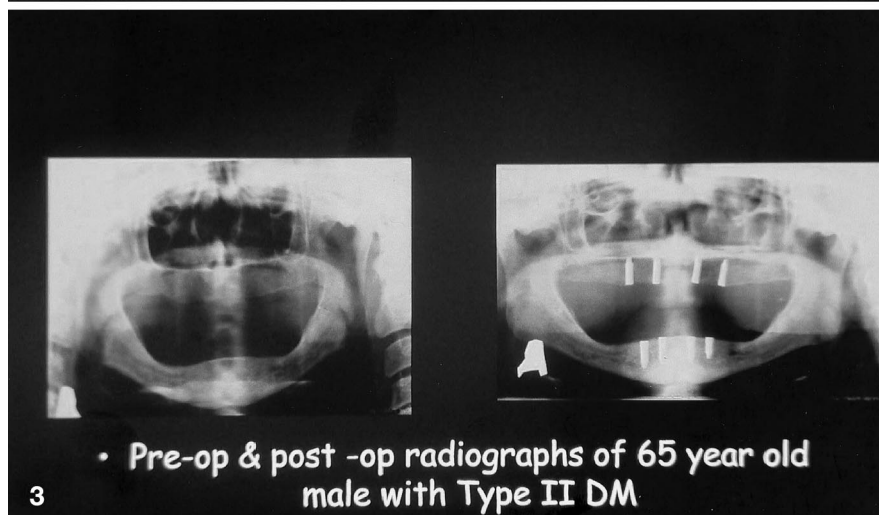
Takeshita et al<sup>18</sup> studied differences between diabetic and nondiabetic rats treated with hydroxyapatite-coated implants in the tibia. The diabetes group showed a 30% reduction in bone contact and 50% reduction in bone thickness around im-



1



2



3

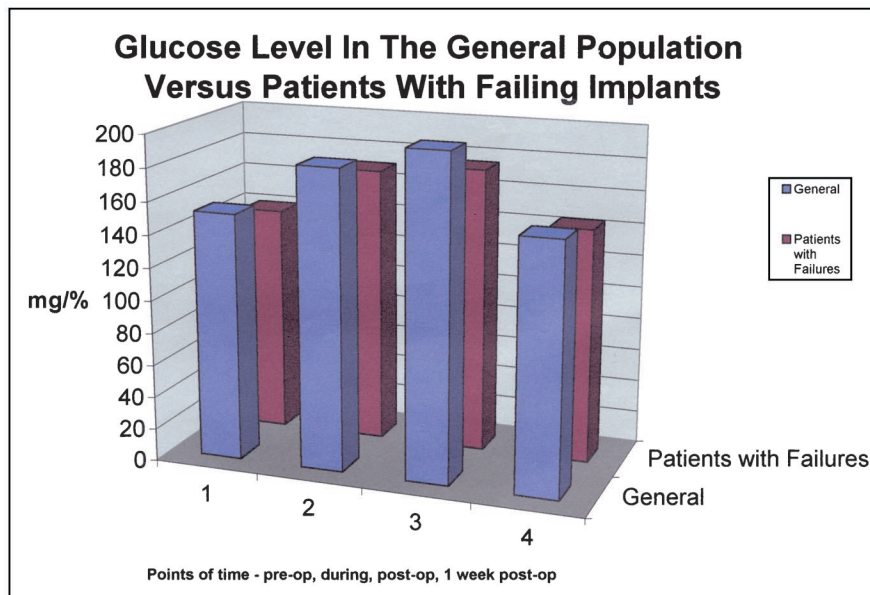
**Fig. 1.** Preoperative and postoperative radiographs of a 65-year-old man before and 6 months after implantation.

**Fig. 2.** Twelve months after implantation and restoration.

**Fig. 3.** Clinical view of the restoration. Note the mucosal health.

plants. El-deeb et al<sup>20</sup> studied the response of hydroxyapatite in diabetes-induced rats. The results of

the histologic analysis revealed that the reaction of the collagen fibers in the diabetic group showed a less orga-



**Fig. 4.** Graph indicating the average glucose levels in the general population versus patients with failing implants.

nized healing response compared with the nondiabetic group. Nevines et al<sup>21</sup> observed the osseointegration of dental implants in diabetic and nondiabetic animals, histometric results indicated that the quality of bone formation was similar for diabetic and control animals; however, less bone-implant contact was observed among diabetic animals.

There are limited series and sporadic reports on the use of dental implants in diabetic patients. Some authors claim that systemic diseases decrease vascular supply to the implant bed, thus decreasing wound-healing potential—a possible risk factor for placement of dental implants. In a retrospective analysis of 104 consecutive patients treated with 313 NobelBiocare implants in a different location in both jaws, Smith et al<sup>14</sup> studied the potential medical risk associated with dental implant failure and found no increase in implant failure in patients with a compromised medical status, including those with diabetes mellitus. Shernoff et al<sup>19</sup> studied 187 implants in 89 patients with type 2 diabetes mellitus and showed a short-term failure rate of 2.2%; however, the failure rate rose to 7.3% after 1 year. This study raised the question of whether failure is related to diabetes or improper implant loading. Balshi

et al<sup>18</sup> reported a 94.3% survival rate for implants placed in diabetic patients. The finding of our study is in agreement with others, and suggest that dental implants can be used safely in diabetic patients if a proper patient's selection is done and if diabetes is well controlled. The majority of patients in our study reported satisfaction and improvement with treatment, though treatment satisfaction was higher in patients older than 65 years. As our results show, mucosal health is the strongest predictive value related to treatment satisfaction in this patient group. Another parameter concerning this factor is that the diabetes did not affect mucosal health. Although it can cause discomfort and impair wound healing, diabetes should not alter mucosal health if the disease well controlled.

## CONCLUSION

The clinical outcome of dental implant placement in a selected group of patients with well-controlled type 2 diabetes mellitus is encouraging. Further investigations and clinical trails over a longer period are needed to determinate the long-term survival of implants in diverse groups of patients with diabetes mellitus.

## Disclosure

The authors claim to have no financial interest in any company or product mentioned in this article.

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Dental Implants in Diabetes Type II Patients



## Abstract Translations [German, Spanish, Portuguese, Japanese]

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Klinische Studie zum Thema: Zahnimplantateinsatz bei Patienten mit Typ II Diabetes

**ZUSAMMENFASSUNG:** Der Erfolg einer Implantationsbehandlung kann durch systemische Faktoren, wie zum Beispiel durch das Vorliegen eines Diabetes Mellitus (DM), gefährdet sein. Schwerpunktmäßig befasst sich die vorliegende Studie daher mit unseren Erfahrungen bei der Zahnbehandlung von Typ II Diabetes Patienten, bei denen eine Deckprothese mittels Implantaten durch Verwendung des so genannten MIS-Implantierungssystems (Medical Implant System (System für medizinische Implantate), Shlomi, Israel) befestigt wurde. Im Einzelnen soll die Studie Informationen bezüglich der Zufriedenheit der Patienten mit dem Behandlungsergebnis, der Verbesserung der Funktionalität, des Zustandes der Schleimhäute und des um das Implantat gelegenen Gewebes und der Knochendichte im das Implantat umlagernden Knochen liefern. Methoden: Zur Untersuchung wurden 41 Patienten mit festgestelltem Typ II Diabetes herangezogen. Insgesamt wurden dieser Patientengruppe 141 Implantate zur Deckprothesenbefestigung eingepflanzt. Ergebnisse: Die bei den Nachuntersuchungen ein Jahr bzw. fünf Jahre nach erfolgter Implantation ermittelte Erfolgsrate lag bei 97,3% bzw. 94,4%. Nach Meinung der meisten Patienten erhöhte sich die Funktionalität in Folge der neuartigen Behandlungsmethode. Enorme Bedeutung wurde dem Zusammenwirken von gesunder Schleimhaut und Funktionsverbesserung beigemessen. Die Untersuchungsergebnisse lassen keinen Rückschluss auf einen Zusammenhang zwischen dem Fehlschlagen einer Implantationsbehandlung und dem Blutzuckerspiegel zu. Schlussfolgerung: Innerhalb der von uns zur Implantationsbehandlung ausgewählten Gruppe von Patienten mit einer guten Einstellung des Typ II Diabetes zeigten die klinischen Versuchsreihen bei Zahnimplantationsbehandlungen sehr zufrieden stellende Ergebnisse. Sind diese Ergebnisse auch ermutigend, so bedarf es doch noch weiterführender Forschungsreihen und Untersuchungen über einen längeren Zeitraum hinweg, um detaillierte Erkenntnisse über den langfristigen Behandlungserfolg nach Einsatz von Zahnimplantaten bei verschiedenen Gruppen von an Typ II Diabetes erkrankten Patienten zu gewinnen.

**SCHLÜSSELWÖRTER:** Erfolgsrate, Diabetes, Zahnimplantate, Periimplantitis, Blutzuckerspiegel

Implantes dentales en pacientes con diabetes tipo II; un estudio clínico

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**ABSTRACTO: PROPÓSITO:** Factores sistémicos, tales como la diabetes mellitus (DM) pueden influenciar el éxito de los implantes dentales. El propósito de este estudio es describir nuestra experiencia usando el sistema de implante MIS (Medical Implant System Shlomi, Israel) para la retención de sobredentaduras en pacientes con diabetes tipo II. Debería proporcionar datos sobre el nivel de satisfacción de los pacientes, la mejora de la función, salud mucosal y periimplante y el nivel del hueso alrededor de los implantes en este grupo. **MÉTODOS:** El grupo de estudio consistió de 41 pacientes con diabetes mellitus tipo II quienes recibieron 141 implantes para la retención de sobredentaduras. **RESULTADOS:** El éxito fue del 97,3% y 94,4% luego de uno y cinco años posteriores a la colocación del implante. La mayoría de los pacientes indicaron una mejora en la función luego del nuevo tratamiento. Se observó una alta correlación entre la salud mucosal y la mejora de la función. No se encontró correlación entre los implantes fallados y el nivel de glucosa. **CONCLUSIÓN:** El resultado clínico de los implantes dentales en un grupo seleccionado de pacientes con diabetes mellitus II bien controlada es satisfactorio y positivo. Se necesitan investigaciones adicionales y pruebas clínicas durante un período largo de tiempo para poder determinar la supervivencia a largo plazo de los implantes en diversos grupos de pacientes que sufren de diabetes mellitus.

**PALABRAS CLAVES:** tasa de éxito, diabetes, implantes dentales, perimplantitis, nivel de glucosa

Implantes odontológicos em pacientes com diabetes do tipo II: estudo clínico

**SINOPSE:** Objetivo: fatores sistêmicos, como diabetes mellitus (DM) podem influenciar o índice de sucesso de implantes odontológicos. Este estudo tem como propósito descrever nosso experimento ao usarmos o sistema de implante médico (MIS, ou Medical Implant System, Shlomi, Israel) para a retenção de sobredentaduras em pacientes com diabetes do tipo II. Os dados provenientes deste estudo devem fornecer informações a respeito do grau de satisfação dos pacientes, de aprimoramento das funções, da saúde mucosal e periimplantária e do nível ósseo em redor dos implantes neste grupo. Metodologia: o grupo de estudo avaliou 41 pacientes com DM do tipo II, os quais receberam 141 implantes para retenção de sobredentaduras. Resultados: o índice de sucesso foi 97,3% e 94,4% para, respectivamente, um e cinco anos seguidos da implantação. A maioria dos pacientes registrou melhoria de funções consecutivas ao novo tratamento. Observou-se uma alta correlação entre a saúde das mucosas e o a melhoria das funções. Não registrou-se correlação entre implantes fracassados e nível de glicose. Conclusão: o resultado clínico de implantes odontológicos em um seletivo grupo de pacientes com diabetes mellitus do tipo II bem controlada é satisfatório e estimulador. Faz-se necessário um número maior de investigações e experimentos clínicos ao longo de um maior período de tempo, a fim de determinar a sobrevivência de implantes a longo prazo em diversos grupos de pacientes portadores de diabetes mellitus.

**PALAVRAS-CHAVES:** índice de sucesso, diabetes, implantes odontológicos, periimplantite, nível de glicose

## II型糖尿病患者におけるデンタルインプラント；臨床研究

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### 概要：

**目的：**糖尿病のような全身的要因は、デンタルインプラントの成功率に影響を与えることが考えられる。この研究の目的は、II型糖尿病患者におけるオーバーデンチャー保持のためにMIS (Medical Implant System, Shlomi, Israel)を使用した経験を解説することにある。この論文は、この種の症例における患者の満足度、機能の改善、粘膜とインプラント周辺部の健康、インプラント周辺部の骨高さについてデータを提供することができる。

**方法：**研究対象にはII型糖尿病患者41人が選ばれ、オーバーデンチャー保持のために141のインプラントが使われた。

**結果：**インプラント設置1年後の成功率は97.3%、5年後のそれは94.4%であった。患者の大多数が、処置後に機能の改善を報告した。粘膜の健康と機能改善の間には高い相関性が見られた。インプラント失敗とグルコース量との間には相関性が見られなかった。

**結論：**II型糖尿病がよく管理されたグループにおけるデンタルインプラントの臨床結果は、良好で希望が持てるものであった。しかし各種の糖尿病患者をすべて含む多様な患者群におけるインプラントの長期的な成功率を知るためには、さらに長期的な調査と臨床試験が必要である。

**キーワード：**成功率、糖尿病、デンタルインプラント、periimplantitis、グルコース量

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