



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

Micha Peled, DMD, MD,* Leon Ardekian, DDS,** Nirit Tagger-Green, DMD, MSc, MHA,*** Zvi Gutmacher, DMD,†
Eli E. Machtei, DMD‡

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

Micha Peled, DMD, MD,* Leon Ardekian, DDS,** Nirit Tagger-Green, DMD, MSc, MHA,*** Zvi Gutmacher, DMD,†
Eli E. Machtei, DMD‡

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%.^{1,2} 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.³

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.^{4,5} The implant-supported overdenture should reduce stress on the tissues and stabilize the prosthesis,⁶ making it more bearable to patients. Therefore, an implant-retained overdenture can be considered a good alternative.^{6,7} 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.^{4,5}

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.^{3,8,9} 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 Nagao¹⁰ 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

*Head, Department of Oral & Maxillofacial Surgery, Rambam Medical Center, Technion Faculty of Medicine, Haifa, Israel.
**Senior Staff, Department of Oral & Maxillofacial Surgery, Rambam Medical Center, Technion Faculty of Medicine (RMCTFM), Haifa, Israel.
***Resident, Unit of Periodontology, RMCTFM, Haifa, Israel.
†Senior Staff, Maxillofacial Prosthetics, RMCTFM, Haifa, Israel.
‡Head of Unit, Unit of Periodontology, RMCTFM, Haifa, Israel.

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.¹¹⁻¹³ Because of such considerations, diabetes has sometimes been considered a contraindication for the use of dental implants.^{14,15}

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.³ A second complication that interferes with bone integration is an implant recipient site of low healing potential. Some authors^{10,14-17} 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.^{18,19}

Takeshita et al¹⁸ 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-

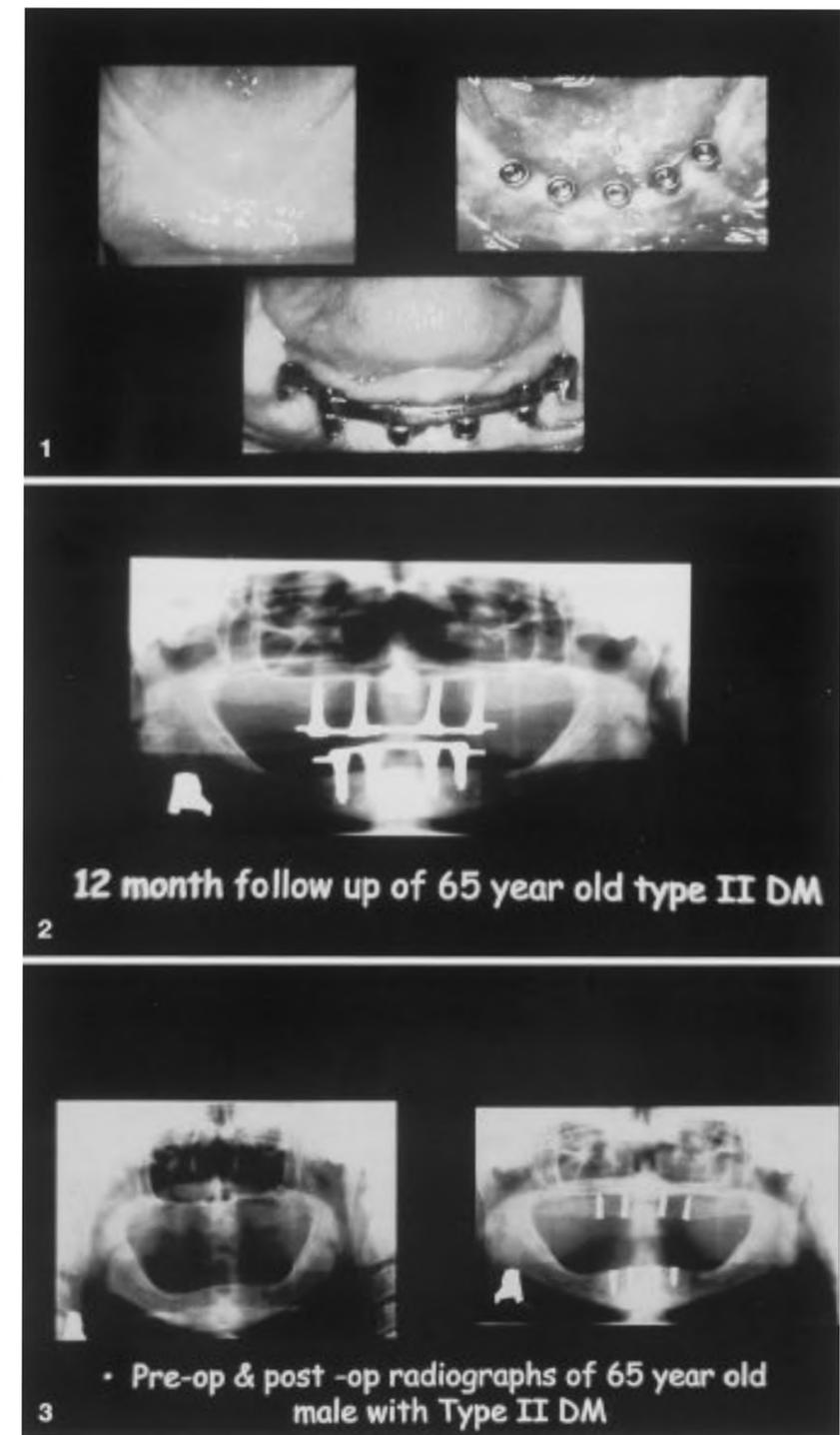


Fig. 1. Preoperative and postoperative radiographs of a 65-year-old man before and 6 months after implantation.

Fig. 2. Twelve months after implantation and restoration.

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

plants. El-deeb et al²⁰ 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-

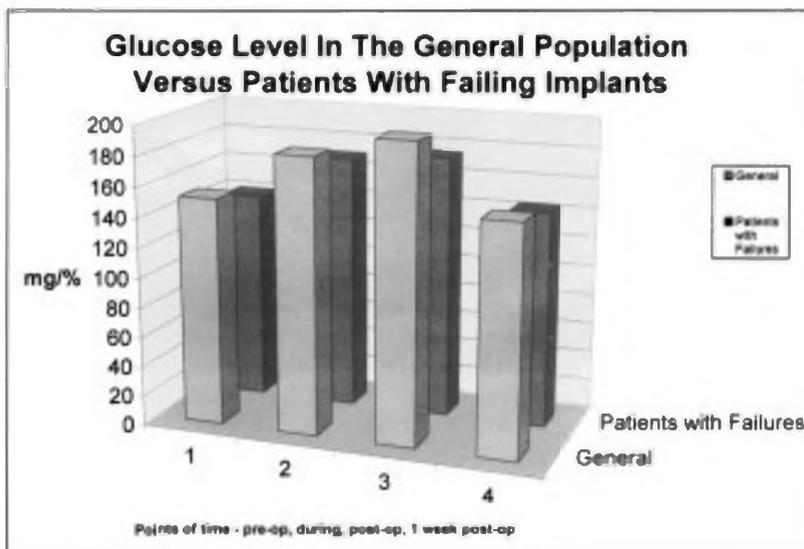


Fig. 4. Graph indicating the average glucose levels in the general population versus patients with failing implants.

nized healing response compared with the nondiabetic group. Nevines et al²¹ 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 al¹⁴ 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 al¹⁹ 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 al¹⁸ 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.

REFERENCES

1. Adell R, Eriksson B, Lekholm U, et al. A long-term follow-up study of osseointegrated implants in the treatment of totally edentulous jaws. *Int J Oral Maxillofac Implants.* 1990;5:347-359.
2. Henry PJ, Worthington P, et al. A retrospective multicenter evaluation of the survival rate of osseointegrated fixtures supporting bridges in the treatment of partial edentulism. *J Prosthet Dent.* 1989;61:217-223.
3. Branemark P-I, Zarb GA, Albrektsson T, eds. *Tissue-Integrated Prostheses: Osseointegration in Clinical Dentistry.* Chicago: Quintessence; 1985:11-76.
4. Donatsky O. Osseointegrated dental implants with ball attachments supporting overdentures in patients with mandibular alveolar ridge atrophy. *Int J Oral Maxillofac Implants.* 1993;8:162-166.
5. Mericske-Stern R, Zarb GA. Overdentures: An alternative implant methodology for edentulous patients. *Int J Prosthodont.* 1993;6:203-208.
6. Engquist B, Bergendal T, Kallus T, et al. A retrospective multicenter evaluation of osseointegrated implants supporting overdentures. *Int J Oral Maxillofac Implants.* 1988;3:129-134.
7. Jemt T, Chai J, Harnett J, et al. A 5-year prospective multicenter follow-up report on overdentures supported by osseointegrated implants. *Int J Oral Maxillofac Implants.* 1996;11:291-298.
8. Jones JK, Triplett RG. The relationship of cigarette smoking to impaired intraoral wound healing: a review of evidence and implications for patient care. *J Oral Maxillofac Surg.* 1992;50:237-239.
9. Casino A. Systemic factors contributing to implant failure. *Oral Maxillofac Clin North Am.* 1998;10:177-186.
10. Urmino M, Nagao M. Systemic diseases in elderly dental patients. *Int Dent J.* 1993;43:213-218.
11. Bell GW, Large DM, Barclay SC. Oral health care in diabetes mellitus. *Dent Update.* 1999;26:322-330.
12. Nishihira J. Novel pathophysiological aspects of macrophage migration inhibitory factor (review). *Int J Mol Med.* 1998;2:17-28.
13. Silhi N. Diabetes and wound healing. *J Wound Care.* 1998;7:47-51.
14. Smith A, Berger R, Dodson T. Risk factors associated with dental implants in healthy and medically compromised patients. *J Oral Maxillofac Implants.* 1992;7:367-372.
15. Fonseca R, Davis H. *Reconstructive Preprosthetic Oral & Maxillofacial Surgery.* Philadelphia: WB Saunders; 1986:165.

16. Bays RA. The influence of systemic bone disease on bone resorption following mandibular augmentation. *Oral Surg Oral Med Oral Pathol.* 1983;55:223-231.

17. Blomqvist JE, Alberius P, Isaksson S, et al. Factors in implant integration failure after bone grafting: an osteometric and endocrinologic matched analysis. *Int J Oral Maxillofac Surg.* 1996;25:63-68.

18. Balshi TJ, Wolfinger GJ. Dental implants in the diabetic patient: a retrospective study. *Implant Dent.* 1999;8:355-359.

19. Shernoff AF, Colwell JA, Bingham SF. Implants for type II diabetic patients: interim report. VA Implants in Diabetes Study Group. *Implant Dent.* 1994;3:183-185.

20. El Deeb M, Roszkowski M, el Hakim I. Tissue response to hydroxylapatite in induced diabetic and nondiabetic rats: histologic evaluation. *J Oral Maxillofac Surg.* 1990;48:476-481.

21. Nevins ML, Karimbux NY, Weber HP, et al. Wound healing around endosseous implants in experimental diabetes. *Int*

J Oral Maxillofac Implants. 1998;13:620-629.

Reprint requests and correspondence to:

Leon Ardekian, DDS
Department of Oral & Maxillofacial Surgery
Rambam Medical Center

Technion Faculty of Medicine

Haifa, Israel

Phone: 9724-8542345

Fax: 9724-8542557

E-mail: ardekian@netvision.net.il

Dental Implants in Diabetes Type II Patients



Abstract Translations [German, Spanish, Portuguese, Japanese]

AUTOR(EN): Micha Pelcd D.M.D., M.D.*, Leon Ardekian D.D.S.***, Nirit Tagger-Green D.M.D., M.Sc., M.H.A.***, Zvi Gutmacher D.M.D.****, Eli E. Machtei D.M.D.*****. *Leiter des Bereiches Gesichts- und Kieferchirurgie, medizinisches Zentrum Rambam, Technion medizinische Fakultät, Haifa, Israel. **Leitender Angestellter, Bereich Gesichts- und Kieferchirurgie, medizinisches Zentrum Rambam, Technion medizinische Fakultät, Haifa, Israel. ***Assistenzarzt, Abteilung für Orthodontie, medizinisches Zentrum Rambam, Technion medizinische Fakultät, Haifa, Israel. ****Leitender Angestellter, Kiefer- und Gesichtsprothetik, medizinisches Zentrum Rambam, Technion medizinische Fakultät, Haifa, Israel. *****Abteilungsleiter, Abteilung für Orthodontie, medizinisches Zentrum Rambam, Technion medizinische Fakultät, Haifa, Israel. Schriftvehrker: Leon Ardekian, DDS, Bereich Kiefer- und Gesichtschirurgie (Dept. Of Oral & Maxillofacial Surgery), medizinisches Zentrum Rambam (Rambam Medical Center), Technion medizinische Fakultät (Technion Faculty of Medicine), Haifa, Israel. Telefon: 9724 - 8542345, Fax: 9724 - 8542557. eMail: ardekian@netvision.net.il

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. Schwerpunktartig 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